Cambridge Waste Water Treatment Plant Relocation Project
Anglian Water Services Limited

Appendix 14.7: Ground Investigation Report for Cambridge Waste Water Treatment Plant – Part 1

Application Document Reference: 5.4.14.7
PINS Project Reference: WW010003
APFP Regulation No. 5(2)a

Revision No. 01
13 October 2023

SOIL ENGINEERING

REPORT ON A GROUND INVESTIGATION FOR CAMBRIDGE WASTE WATER TREATMENT PLANT RELOCATION


[redacted]

REPORT QUALITY ASSURANCE SHEET

TITLE: **REPORT ON A GROUND INVESTIGATION FOR CAMBRIDGE WASTE WATER TREATMENT PLANT RELOCATION**

PROJECT NUMBER: **TE8364**

STATUS: **Final**

TYPE: **Factual**

ISSUE NUMBER: **06**

ISSUE DATE: **25/01/2023**

ISSUED BY: **P. Staikos**

CHECKED BY: **M. Bellhouse**

APPROVED BY: **P. A. Rodgers** [redacted]

VERSION HISTORY:

Issue Number	Issue Date	Reason for Issue
01	12/11/2021	Draft for comment
02	23/02/2022	Revised Draft for comment. Additional laboratory test results and further commentary sections 4.6.5 and 4.6.12
03	23/08/2022	Final for comment
04	12/09/2022	Final following completion of laboratory testing
05	10/10/2022	Final following completed testing for comment
06	25/01/2023	Final following comments

Internal Form Information: Report No. SE-RRG-F-001 Issue.Revision Number 4.00 Issue Date 05/07/2021

REPORT CONTENTS

LIST OF TABLES

LIST OF FIGURES

REPORT CONTENTS

SUPPORTING FACTUAL DATA

SECTION A: FIELD RECORDS

- Exploratory Hole Log Legend and Notation Sheet
- Cable Percussion and Rotary Drilling Records
- Excavation Records
- In Situ Testing Records
- Groundwater / Gas Monitoring Results

SECTION B: LABORATORY TEST RESULTS

- Laboratory Test Data Key Sheet
- Laboratory Soil Test Summary Sheets
- Laboratory Soil Test Data Sheets
- Chemical Test Results

SECTION C: DRAWINGS

- Exploratory Hole Location Plan

SECTION D: PHOTOGRAPHS

- Core Photographs
- Excavation Photographs

APPENDICES

APPENDIX 1: NOTES ON FIELDWORK, LOGGING AND LABORATORY TESTING

- Notes on Fieldwork Procedures
- Terminology used in Soil Descriptions
- Terminology used in the Description of Made Ground
- Terminology used in the Description and Classification of Rock
- Assessment of Aggressive Ground and Groundwater Conditions

APPENDIX 2: CALIBRATION CERTIFICATES

1.0 INTRODUCTION

In July 2021 Soil Engineering Geoservices Ltd were instructed by Barhale Limited (The Employer) to carry out a ground investigation for the Cambridge Waste Water Treatment Plant Relocation project. The investigation was specified by Mott MacDonald Bentley Limited (The Engineer) and directly supervised on site by Sweco Limited (The Investigation Supervisor).

It is proposed to construct a new waste water treatment works in the eastern end of the site with two pipelines extended westwards, one terminating at the River Cam; the second extending beyond the river to the existing sewage treatment works in Milton, Cambridge.

The investigation comprised the formation of cable percussion boreholes, rotary cored boreholes and rotary open hole boreholes together with trial pitting and in situ testing.

An instruction was received from the Employer to stop all intrusive works on Friday 18th October 2021. At this stage of the fieldworks, fifty rotary boreholes of the fifty-six scheduled rotary boreholes had been completed, twelve of the fourteen scheduled cable percussion boreholes had been completed and one was in progress, and all twenty six of the scheduled trial pits excavations had been completed.

This factual report presents the results of the fieldwork and laboratory testing undertaken together with information on the ground and groundwater conditions encountered; the fieldwork was carried out between 13th July 2021 and 18h October 2021 in accordance with the project specification[1].

The works were resumed on 28th March 2022 to complete the the outstanding boreholes. These works are collectively known as Phase B and a separate report has been issued for Phase B.

---

[1] Specification for Ground Investigation: Cambridge Waste Water Treatment Plant Relocation: Mott MacDonald @One Alliance: April 2021: Doc Ref CWWTPR Specification for Ground Investigation Works Rev3 Issue for Tender

2.0 PURPOSE, SCOPE AND REPORT FORMAT

2.1 Purpose

The purpose of this investigation was to provide information to assist the design and construction of a new waste water treatment works together with a 2.5km length sewer tunnel, including access shafts and a 1.7km length final effluent pipeline with outfall structure, access roads and diversion of the Fen Ditton Rising Main. This information was obtained from a combination of intrusive and non-intrusive investigation techniques and laboratory testing.

2.2 Scope of Work

The scope of the investigation was as follows:

- To form fifty-six rotary boreholes
- To undertake a total of twenty-seven pressuremeter tests
- To undertake four in situ geophysical tests
- To form fourteen cable percussive boreholes
- To install gas and/or groundwater monitoring points in selected boreholes
- To form twenty-six machine excavated trial pits.
- To undertake in situ California Bearing Ratio tests in each of the trial pits
- To undertake seven plate load bearing tests
- To undertake a pumping test including the formation of pump and monitoring wells
- To monitor gas and/or groundwater monitoring points during and after the fieldwork
- To survey the as-built position of each of the exploratory hole locations
- To undertake geotechnical laboratory testing
- To undertake geochemical laboratory testing
- To undertake environmental laboratory testing
- Provision of factual report containing all findings from the investigation and including core and trial pit photographs
- Provision of electronic data.

Several changes to the proposed scope of works were made by the Engineer during the fieldwork period, these are summarised below.

- Cancellation of a number of proposed packer tests due to minimal water intake of the ground observed in packer tests undertaken to-date
- The Engineer instructed the installation of additional standpipes to the original specification to enable additional permeability testing
- Following formation and installation of the pump test well locations, the Engineer required that due to change in design, additional pumping test wells were drilled and pump test carried out at an alternative location. Therefore, all four pump test boreholes were re-drilled in a new location and labelled with the suffix ‘b’
- Addition of four rotary open holes to facilitate in situ testing
- Cancellation of one geophysical test location

2.3 Limitations

This report has been prepared in accordance with the project specification. Soil Engineering accepts no liability for any deficiencies in the report that arise from the specification's non-compliance with either European or British Standards. This particularly applies to exploratory hole spacings and depths and to the scope of laboratory testing.

It should be noted that the investigation data on which this report is based is only indicative of the actual ground, groundwater and ground gas conditions that exist at the locations of the exploratory holes and may not be representative of the conditions that exist on the site as a whole.

2.4 Report Format

This factual report is presented in the following format:

- Written description of fieldwork, laboratory testing and investigation results.
- Section A: Field Records - including exploratory hole logs, in situ test results and gas and/or groundwater monitoring results
- Section B: Laboratory Test Results - from geotechnical, geochemical and environmental testing laboratories
- Section C: Drawings - including exploratory hole location plans.
- Section D: Photographs - from core and trial pits
- Appendix 1: General Notes - on fieldwork, the logging of soil, made ground, rock and geochemical testing.
- Appendix 2: Calibration Certificates

The sources of information used in the compilation of this report are detailed in the footnotes at the base of the page upon which they are first referenced.

3.0 DESK STUDY INFORMATION

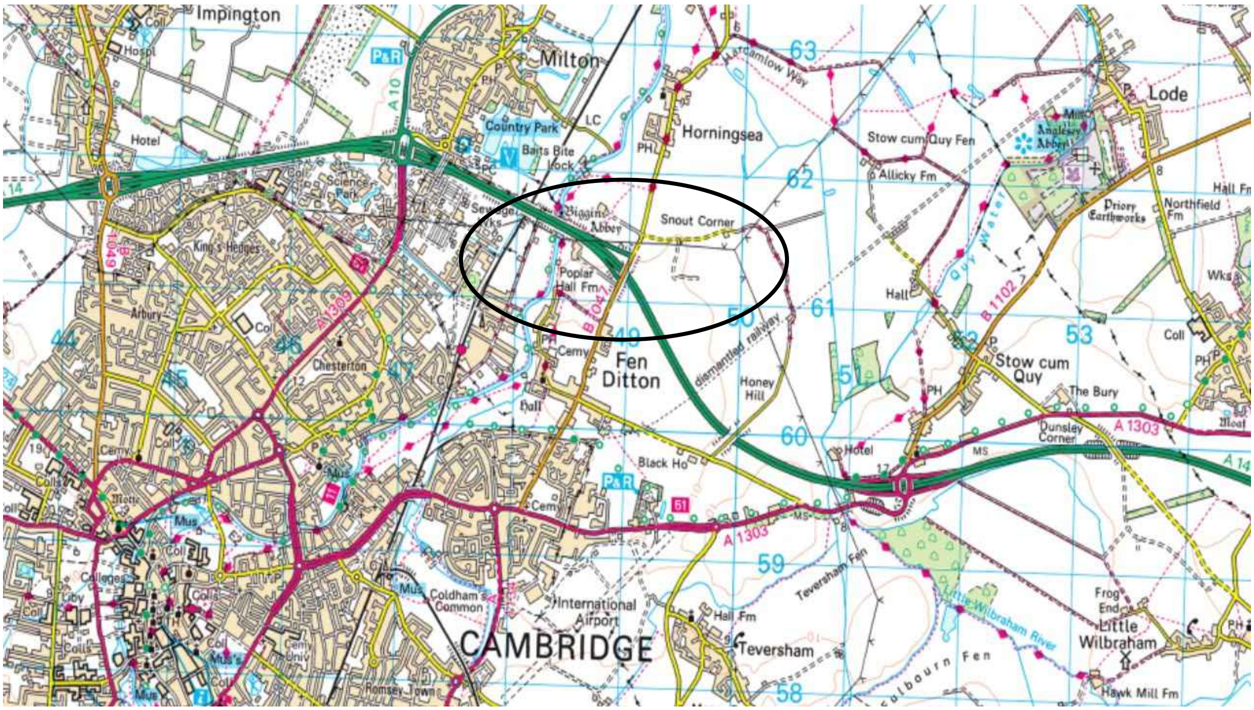
3.1 Scope of Study

A formal comprehensive (phase I) desk study was not requested by the Engineer for this investigation. The following sections however provide general details of site location and description as well as site geology as ascertained from published maps and memoirs, together with details of any previous investigation carried out on the site.

3.2 Site Location and Description

The site of the proposed new sewage treatment works will be located within existing arable land east of Horningsea Road. The outfall structure and final effluent pipeline extends from this new structure, north of the existing A14 and terminates at the River Cam. The proposed sewer tunnel extends westwards from the new treatment works south of the existing A14, across the River Cam and terminates within the existing sewage treatment works on Cowley Road.

FIGURE 1: SITE LOCATION PLAN



Reproduced from Ordnance Survey's 1:50,000 map number 154 © Crown copyright 2016 OS 100057933

TABLE 1: SITE LOCATION DETAILS

Postcode	CB5 8TB
Approximate National Grid Reference	TL 496 612
Northern Boundary	Open arable land
Eastern Boundary	Open arable land
Southern Boundary	Open arable land
Western Boundary	Residential / Industrial
Approximate Ground Level (m AOD)	3.85 – 11.75

3.3 Geology

From the available information on the 1:50,000 scale Geological Survey map of the area[2] the site east of the River Cam is shown to be underlain by the lower part of the Grey Chalk subgroup (formerly known as Lower Chalk) of Cretaceous age with deposits of Alluvium indicated within the vicinity of the River Cam. The area of the existing sewage treatment works is shown to be underlain by River Terrace Deposits underlain by the Gault Formation of Cretaceous age. The Lower Greensand Group underlies the Gault Formation.

3.4 Previous Investigations

The Engineer has supplied a report on a ground investigation for Cambridge Waste Water Treatment Plant Relocation undertaken by AF Howland Associates in November 2020. The investigation comprised the formation of five wireline rotary cored boreholes using a Pioneer multi-purpose rig, progressed initially by dynamic sampling until competent material was encountered that necessitated completion of the hole by wireline coring methods. Boreholes were formed to depths of between 30.00m and 40.50m and encountered various deposits of Chalk, fissured Clay, Sandstone and Mudstone with overlying superficial deposits of clay and granular materials.

---

[2] Sheet 188: 1981, Solid and Drift edition for Cambridge

4.0 FIELDWORK

4.1 Scope of Fieldwork

The scope of the fieldwork was specified by the Engineer and was undertaken in general accordance with Eurocodes[3] and, where there is no conflict, also with BS 5930[4]. Soil and rock logging has been undertaken in accordance with the relevant European Standards[5,6,7]. The exploratory hole locations were set out initially by the Engineer however in accordance with the project specification, Soil Engineering were required to survey the as-built exploratory hole locations.

Across the full site, rotary cored boreholes were formed from the base of the inspection pit with the exception of BH_TUN_006 which was formed from the base of a cable percussion borehole. Four rotary open hole boreholes were formed along the route of the sewer tunnel in the vicinity of rotary cored holes to facilitate in situ testing. Cable percussion boreholes were formed in the vicinity of selected rotary borehole locations in order to provide SPT profiles for design purposes. Various permeability tests were also scheduled during formation of both rotary and cable percussion boreholes. The pump test boreholes were formed both by rotary coring and rotary open hole drilling methods.

Trial pits were formed in the area of the proposed treatment works and route of the final effluent pipeline where in situ strength, permeability, bearing capacity and pavement design tests were also undertaken.

The exploratory hole locations are shown on the site plan presented in Section C of this report.

Details of the works undertaken are summarised in Table 2 below.

TABLE 2: SUMMARY OF ROTARY HOLE LOCATIONS

Borehole ID	Scheduled Depth / (Depth Achieved) [m]	Variable Head Tests	Packer Testing	Downhole Televiewer / Geophysics Testing	Pressuremeter Testing
BH_FE_001	15 (15.90)	✓			
BH_FE_002	10 (10)				
BH_FE_003	10 (10)				
BH_FE_004A	15 (15)				
BH_FE_005	15 (15)				
BH_FE_006	10 (10)				
BH_OUT_001	20 (20)				
BH_STW_001	15 (15.40)				

---

[3] Eurocode 7 Part 2 (BS EN 1997-2: 2007)

[4] BS 5930: 2015 + A1 2020: Code of Practice for Site Investigation. British Standards Institution

[5] BS EN ISO 14688-1: 2018: Geotechnical Investigation and testing – Identification and Classification of Soil – Part 1: Identification and Description.

[6] BS EN ISO 14688-2: 2018: Geotechnical Investigation and testing – Identification and Classification of Soil – Part 2: Principles for a Classification

[7] BS EN ISO 14689-1: 2018: Geotechnical Investigation and testing – Identification and Classification of Rock – Part 1: Identification and description.

Borehole ID	Scheduled Depth / (Depth Achieved) [m]	Variable Head Tests	Packer Testing	Downhole Televiewer / Geophysics Testing	Pressuremeter Testing
BH_STW_003A	10 (10)	1 (2no. in Schedule2)	✓		
BH_STW_004	15 (15.10)				
BH_STW_005A	30 (30)				
BH_STW_006	15 (15)				✓
BH_STW_007	15 (15.10)				
BH_STW_009	30 (30)				
BH_STW_010A	30 (30.20)				
BH_STW_011A	30 (30.20)				✓
BH_STW_012A	30 (30.35)				✓
BH_STW_013A	50 (48.45)	✓		Geophysics Only	
BH_STW_013C	12 (13.10)		✓		
BH_STW_014	30 (30)				
BH_STW_015	30 (30.20)				
BH_STW_016	30 (30.20)				
BH_STW_017	15 (15)				
BH_STW_018	30 (30)	1 (2no. in Schedule2)		✓	
BH_STW_019A	30 (30)				✓
BH_STW_020	30 (30.20)				✓
BH_STW_021	15 (15)				✓
BH_STW_022A	50 (50)	✓	✓		
BH_STW_023	15 (15.30)				
BH_STW_024	15 (15)				
BH_STW_025	15 (15.05)				
BH_STW_026	15 (15)				
BH_STW_031A	15 (15)				
BH_TUN_001A	35 (35)	1 (2no. in Schedule2)	✓		
BH_TUN_001PM	(18)				✓
BH_TUN_002	30 (30)				
BH_TUN_003	30 (30)				
BH_TUN_004c	30 (30)				
BH_TUN_005Ab	30 (30)				
BH_TUN_006	40 (40)	1 (2no. in Schedule2)			
BH_TUN_006PM	(18)		✓		✓
BH_TUN_007	30 (30.20)				
BH_TUN_011	40 (42.50)				
BH_TUN_011PM	(24.5)				
BH_TUN_015	30 (30.20)				

Borehole ID	Scheduled Depth / (Depth Achieved) [m]	Variable Head Tests	Packer Testing	Downhole Televiewer / Geophysics Testing	Pressuremeter Testing
BH_TUN_016	30 (30.20)				
BH_TUN_017	30 (30.20)				
BH_TUN_018	50 (49.50)	1 (2no. in Schedule2)		✓	
BH_TUN_018PM	(27.50)				✓
BH_TPS_001	15 (15.10)				
BH_TPS_001b	13 (13.70)				
BH_TPS_002	15 (15.20)				
BH_TPS_002b	13 (13.20)				
BH_TPS_003	15 (15.20)				
BH_TPS_003b	13 (13.30)				
BH_TPS_004	15 (15.20)				
BH_TPS_004b	13 (13.30)				

TABLE 3: SUMMARY OF CABLE PERCUSSION HOLE LOCATIONS

Borehole ID	Scheduled Depth / (Depth Achieved) [m]	Variable Head Tests (during borehole formation)	Standard Penetration Tests
BH_STW_003B	10 (10)		✓
BH_STW_005B	30 (30)	1 (2no. in Schedule2)	✓
BH_STW_010B	30 (30)		✓
BH_STW_011B	30 (30)		✓
BH_STW_012B	30 (30)		✓
BH_STW_013B	30 (30)	1 (2no. in Schedule2)	✓
BH_STW_019B	30 (11.20*)		✓
BH_STW_022B	30 (30)		✓
BH_STW_031B	15 (30)		✓
BH_TUN_001B	35 (35)		✓
BH_TUN_005B	30 (30)		✓
BH_FE_004B	15 (15)		✓
BH_TUN_006	Base of made ground		

TABLE 4: SUMMARY OF TRIAL PIT HOLE LOCATIONS

Borehole ID	Scheduled Depth / (Depth Achieved) [m]	Soakaway Testing	Hand Vane Testing	California Bearing Ratio Tests	Plate Load Tests
TP_FE_001	3 (2.5)	✓	✓	✓	
TP_FE_002	3 (2.2)	✓	✓	✓	
TP_FE_003	3 (2.8)		✓	✓	
TP_FE_004	3 (3)		✓	✓	
TP_FE_005	3 (3)		✓	✓	
TP_FE_006	3(3)		✓	✓	
TP_STW_003	3 (3)	✓	✓	✓	
TP_STW_004	3 (3)		✓	✓	
BH_STW_005	3 (3)		✓	✓	✓
BH_STW_006	3 (3)		✓	✓	
TP_STW_007	3 (3)		✓	✓	
TP_STW_010	3 (3)		✓	✓	
TP_STW_011	3 (3)		✓	✓	
TP_STW_012	3 (3)		✓	✓	✓
TP_STW_013	3 (3)	✓	✓	✓	
TP_STW_014	3 (3)		✓	✓	✓
TP_STW_015	3 (3)		✓	✓	✓
TP_STW_016	3 (3.10)	✓	✓	✓	✓
TP_STW_017	3 (3)		✓	✓	
TP_STW_018	3 (3)	✓	✓	✓	✓
TP_STW_019	3 (3)		✓	✓	✓
TP_STW_020	3 (3)		✓	✓	
TP_STW_021	3 (3)		✓	✓	
TP_STW_022	3 (3)	✓	✓	✓	
TP_STW_031	3 (3)	✓	✓	✓	
TP_STW_032	3 (3)		✓	✓	

In general, hole numbers commence with the hole type (BH, TP, IP) followed by an abbreviation of either STW (Sewage Treatment Works) , FE (Final Effluent) or TUN (sewage Tunnel) and then a final identification number. Where there is a suffix of 'A' for a rotary borehole, this indicates that a cable percussion borehole has been scheduled nearby with the suffix 'B'. All cable percussion boreholes have a suffix 'B'. Where there is a suffix 'PM' this indicates a rotary open hole formed to facilitate in situ testing close to a rotary cored borehole with the same number identification.

Where multiple attempts were made to form a borehole at each location, a standard approach was not adopted on site. BH_STW_013C is an additional borehole formed in the vicinity of BH_STW_013A solely to facilitate the scheduled packer testing at this location. BH_TUN_004c represents the successful attempt to form an inspection pit to facilitate drilling to depth at this location and there are seven additional inspection pit logs at this location. BH_TUN_005Ab represents the successful attempt to form an inspection pit to facilitate drilling to depth following a failed attempt at IP_TUN_005A.

It should be noted that BH_OUT_001 was originally labelled as BH_OUT_01A in the specification.

Backfill of the exploratory holes, including the installation of monitoring instrumentation, was undertaken in accordance with the specification and as instructed by the Engineer. Details of the backfill material used, and where relevant pipe construction, are provided on the individual exploratory hole logs presented in Section A of this report. Trial pits and trenches were backfilled with arisings placed in reverse order to excavation.

4.2 Inspection Pits

In order to reduce the risk of damaging buried services, the location of each exploratory hole was scanned using a cable avoidance tool (CAT) immediately prior to breaking ground. As a further precaution, an inspection pit was hand excavated to a depth of 1.20m at each location during which further scans were taken with the CAT at 300mm intervals to the base of each pit.

An additional inspection pit was instructed by the Engineer and designated IP_TUN_006 for the purposes of recovering large bulk disturbed samples for geotechnical laboratory testing. The inspection pit was located on the top of a man-made earth bund located within the existing sewage treatment works.

Additional inspection pits were formed at locations designated BH_TUN_004 and BH_TUN_005A due to buried obstructions and cable avoidance tools signals preventing work to continue safely. The details of all inspection pits are presented in Section A of this report.

Small disturbed samples for environmental testing were also obtained at locations specified by the engineer in a variety of glass and/or plastic containers as required by the project specification. These were kept refrigerated after collection and in order to meet sample holding times, were dispatched to the testing laboratory within twenty four hours of sampling.

4.3 Cable Percussion Boreholes

A total of twelve boreholes, see Table 3 for hole designations, were formed to depths between 10.00m and 35.00m. It should be noted that BH_STW_019B was abandoned at 11.20m due to the site instruction to halt all drilling works. In addition, a further cable percussion borehole designated BH_TUN_006 was formed to 7.50m in order to facilitate rotary coring to the scheduled depth.

Boreholes were formed using conventional light cable percussion techniques together with 200mm and 150mm diameter temporary steel casings. The boreholes were all formed in order to obtain an SPT profile of the underlying ground to aid geotechnical design and to obtain samples for laboratory testing. Five of the boreholes were also used for the installation of ground monitoring wells.

Standard Penetration Tests were carried out at 1m intervals throughout boring operations as specified by the Engineer. The results of these tests are given as a Standard Penetration “N” value or as a blow count for a given penetration at the appropriate position on the borehole logs.

Representative disturbed samples of all materials encountered were obtained and these were placed in sealed containers for transport to the laboratory.

The samples recovered from the boreholes were described by an Engineering Geologist in accordance with the terminology presented in Appendix 1 of this report. A detailed description of all strata encountered, groundwater conditions and the position and type of samples taken are included on the borehole logs presented in Section A of this report.

4.4 Rotary Drilling

A total of seven boreholes were formed using rotary open hole drilling methods. These included three pump test location boreholes BH_TPS_002b to BH_TPS_004b inclusive, formed to a depth of 13.30m using a tricone steel toothed rock roller drill bit with air mist flush to produce a hole diameter of 150mm. In addition, four open hole boreholes were formed close to existing locations to facilitate in situ testing. These four boreholes BH_TUN_001PM, BH_TUN_006PM, BH_TUN11PM and BH_TUN_018PM were formed to depths between 18.00m and 31.00m using either a PCD, tricone rock roller or drag bit together with air mist flush to produce a hole diameter between 146mm and 150mm.

In order to obtain information on the solid geology beneath the site, fifty boreholes were formed using rotary core drilling techniques to depths between 10.00m and 50.00m using either a Geobore S, HWF or SWF triple tube core barrel together with a protective semi rigid plastic liner and a Polycrystalline Diamond (PCD) core bit with air mist or water flush to produce cores of either 102mm, 73mm or 107mm nominal diameter.

Details of the strata encountered are given on the borehole logs along with the Engineering Geologist's assessment of Total Core Recovery (TCR), Solid Core Recovery (SCR), and Rock Quality Designation (RQD) each expressed as a percentage of the individual core runs. Where applicable a fracture spacing (I_f) has also been determined and this information is given on the logs.

The symbols and abbreviations used on the rotary borehole logs are explained on the exploratory hole log legend and notation sheet presented in Section A of this report.

The core samples recovered were photographed, sampled and described by an Engineering Geologist in accordance with the terminology presented in Appendix 1 of this report. The borehole logs are presented in Section A of this report and core photographic records are presented in Section D of this report.

Sub-samples of the core were obtained at depths specified by The Engineer and were taken by an Engineering Geologist once detailed logging of the core had been completed. Core sub-samples selected were wrapped in alternating layers of plastic film and wax then wrapped in protective plastic and placed into core boxes for secure onward transport to the laboratory. These undisturbed samples were given the sample type CS whilst disturbed samples taken from the core that were placed within a plastic tub or plastic bag were given the sample types: CD and CB respectively and any samples taken from the core for environmental purposes were given the sample type CES. Prior to transport to the laboratory, the samples were protected from the elements at all times in temporary site accommodation.

4.5 Trial Pits

Twenty-six trial pits were excavated using a JCB type backhoe excavator to depths between 2.20m and 3.10m. Six trial pits were formed along the route of the proposed final effluent sewer, these were designated TP_FE_001 to TP_FE_006 inclusive. The remaining twenty locations were formed within the footprint of the proposed sewage treatment works and designated

TP_STW_003 to TP_STW_022 inclusive and TP_STW_031 and TP_STW_032.
The trial pits were formed to assess the mass soil fabric of near surface natural deposits, to facilitate in situ strength and permeability testing and to obtain soil samples for geo environmental and geotechnical laboratory testing.

Small disturbed samples for environmental testing were also obtained at locations specified by the engineer in a variety of glass and/or plastic containers as required by the project specification. In order to meet sample holding times, samples were dispatched to the testing laboratory within twenty four hours of sampling.

The trial pits were not shored and were logged from the surface by an Engineering Geologist. The Engineering Geologist provided a detailed description of the ground conditions encountered in each pit and also obtained disturbed soil samples at regular intervals for geotechnical and chemical analysis. The strata encountered in the trial pits are described on the trial pit logs presented in Section A of this report and the location of each of the trial pits is indicated on the site plan presented in Section C of this report. Trial pit photographs are included in Section D of this report

4.6 In situ Testing

4.6.1 Standard Penetration Testing

Standard Penetration Tests[8] were carried out in all of the cable percussive boreholes using either a split spoon sampler or a solid 60° cone.

The test consists of driving a 50mm external diameter split barrel sampler into the soil using a 63.5kg hammer dropping 760mm. In coarse granular soils or in rock, the split barrel may be replaced by a solid cone. The penetration resistance is expressed as the number of blows required to obtain 300mm penetration, below an initial seating drive of 150mm through any disturbed ground at the bottom of the borehole. The number of blows for the 300mm test drive penetration is recorded on the borehole logs as the "N" value. A full record of the number of blows required to drive the sampler at 75mm intervals throughout the total 450mm drive is also tabulated along with the groundwater level and borehole casing depth at the time of test.

Where the test drive is terminated before full (300mm) penetration, the number of blows for the partial test drive (usually 50) and the penetration of the sampler within the test drive are recorded. If the total seating drive penetration is equal to or less than 150mm, then the number of blows (usually 25) and the depth of penetration within the initial seating penetration are recorded on the borehole logs.

The tests are carried out using automatic trip hammers that have been calibrated. The hammer ID and energy ratio are recorded on the 'header page' of each log and calibration certificates for the hammers used on the project are contained in Appendix 2 of this report. It should be noted that the "N" values reported on the logs are uncorrected for hammer energy efficiency.

The results of the tests are given as a Standard Penetration "N" value or as a blow count for a given penetration at the appropriate position on the relevant exploratory hole logs presented in Section A of this report.

---

[8] BS EN ISO 22476-3:2005 + A1: 2011: Geotechnical Investigation and Testing – Field Testing – Part 3: Standard Penetration Test.

4.6.2 Downhole Televiewer Survey

A total of three downhole optical and acoustic televiewer surveys were carried out by specialist subcontractor European Geophysical Services Limited. Testing was carried out in boreholes BH_STW_013A, BH_STW_018 and BH_TUN_018.

Prior to the survey a controlled flushing of the boreholes was carried out using clean water to purge the borehole of drilling debris, the water column was left to settle and the casing was retracted to a predetermined depth to allow the logging to be completed.

The results of these surveys are presented in the European Geophysical Services Limited report, presented in Section A of this report.

4.6.3 Downhole Geophysics Testing

Downhole geophysics tests were carried out in two boreholes, BH_STW_018 and BH_TUN_018. The tests undertaken comprised, in addition to the downhole televiewer survey described above, 3-arm calliper, which measures three diameters of the borehole and natural gamma, which measures naturally occurring gamma in rocks and sediments.

The tests were undertaken by specialist subcontractor European Geophysical Services Limited. Prior to logging a controlled flushing of the boreholes was carried out using clean water to purge the borehole of drilling debris, the water column was left to settle and the casing was retracted to a predetermined depth to allow the logging to be completed.

The results of these tests are presented in the European Geophysical Services Limited report, presented in Section A of this report.

4.6.4 Packer Testing

Packer testing was required in order to provide detailed information on the permeability of the ground at discrete depths. Packer tests were performed in accordance with BS22282-3[9] in five boreholes designated BH_STW_003A, BH_STW_013C, BH_STW_022, BH_TUN_001A and BH_TUN_006PM. Test depths were specified by the Engineer and at a frequency of one or two tests per borehole. Each test used double packers to isolate the test zone into which, once the packers were inflated to the required pressure, water was pumped and the flow rate measured. This was repeated for a number of pressure increments (typically five).

Test results are calculated in accordance with the method described in BS5930:1999[10] and are presented in Section A of this report.

4.6.5 Variable Head Permeability Testing

In accordance with the specification, falling head permeability tests were undertaken during formation of the following boreholes, BH_FE_001, BH_STW_003A, BH_STW_005B, BH_STW_013A, BH_STW_013B, BH_STW_018, BH_STW_022A, BH_TUN_001A, BH_TUN_006, BH_TUN_018.

---

[9] BS EN ISO 22282-2:2012. Geotechnical investigation and testing – Geohydraulic testing. Part 2: Water permeability tests in a borehole using open systems

[10] BS5930:1999 . Code of Practice for Site Investigations

In accordance with an Engineer's instruction, both rising and falling head tests were undertaken in the groundwater installations of the following boreholes, BH_STW_005A, BH_STW_010B, BH_STW_011B, BH_STW_022B, BH_STW_031B, BH_TUN_005B, BH_TUN_016 and BH_TUN_018.

The tests were undertaken in accordance with BS EN ISO 22282-2 with shape factor (F) derived from BS EN ISO 22282-1:2012 Annex B[11]

The results of the variable head testing are presented in Section A of this report.

4.6.6 Pressuremeter Testing

Pressuremeter tests were undertaken in boreholes; BH_STW_006, BH_STW_001A, BH_STW_012A, BH_STW_019, BH_STW_020, BH_STW_021, BH_TUN_001PM, BH_TUN_006PM, BH_TUN_011PM and BH_TUN_018PM by Cambridge Insitu Limited.

Pressuremeter tests were carried out using either a high-pressure dilatometer (HPD) or self-boring pressuremeter dependant on the in situ ground conditions encountered at each scheduled test depth. Test depths were scheduled by the Engineer immediately prior to formation of each exploratory hole. Pressuremeter testing was undertaken within the borehole during coring with the exception of boreholes with a 'PM' suffix, where a separate, open hole, was formed exclusively for the pressuremeter testing.

The results of the pressuremeter testing are presented in Cambridge Insitu's report, presented in Section A of this report.

4.6.7 Hand Vane Testing

In order to provide an approximate undrained shear strength of the cohesive soils encountered within the trial pits, hand vane testing was undertaken at 0.5m intervals where suitable cohesive material was encountered. Tests were undertaken in material recovered and contained within the excavation bucket.

The results of the hand vane testing are presented in Section A of this report.

4.6.8 Soakaway Testing

In accordance with the specification, nine soakaway tests designated TP_FE_001, TP_FE_002 test 1 and 2, TP_STW_003, TP_STW_013, TP_STW_016, TP_STW_018, TP_STW_022 and TP_STW_031 were undertaken in trial pits across the site. The tests were undertaken in accordance with BRE Digest 365[12].

The results of the soakaway testing are presented in Section A of this report.

4.6.9 California Bearing Ratio Tests

In accordance with the specification and in order to obtain an indication of the thickness of sub-base required to support a flexible road pavement, one in situ California Bearing Ratio (CBR) test

---

[11] BS EN ISO 22282-2:2012. Geotechnical investigation and testing – Geohydraulic testing. Part 1: General Rules

[12] BRE Digest 365 'Soakaway Design'. 2016.

was carried out within each trial pit except TP_STW_005 where two tests were undertaken due to the failure of the first test. A portable jack and load frame were utilised on site with a JCB type mechanical excavator providing the reaction force. The test was performed at a depth of 0.50m in accordance with BS 1377: 1990: Part 9[13].

The results of CBR testing are presented in Section A of this report.

4.6.10 Plate Load Tests

Seven plate load tests were undertaken in accordance with the specification and in order to provide information both on the settlement characteristics and to determine the bearing capacity of the ground in locations within the proposed footprint of the sewage treatment works.

These tests were carried out by a nominated sub-contractor, Construction Testing Solutions, close to existing trial pit locations. Tests were designated TP_STW_005, TP_STW_012, TP_STW_014, TP_STW_015, TP_STW_016, TP_STW_018 and TP_STW_019.

A 600mm diameter plate was used together with a minimum of three dial gauges and a reaction force was provided by a 25t tracked mechanical excavator. Incremental load tests were performed in accordance with the specification, and as instructed immediately prior to testing by the Client. The increases and decreases in load varied in the number of increments at each test location. Starting pressures varied between 20kN/m^2 and 21kN/m^2 and finished between 496kN/m^2 and 621kN/m^2.

The results of the plate load tests are presented in Section A of this report.

4.6.11 Photo Ionisation Detection

In order to determine the presence or otherwise of volatile organic compounds , all environmental samples were subject to head space testing using a photo ionisation detector (PID).

Test results are presented in Section A of this report.

4.6.12 Pumping Tests

Pump tests were undertaken in boreholes BH_TPS_001b to BH_TPS_004b which were formed to depths of 13.70m in BH_TPS_001b and 13.30m for boreholes BH_TPS_002b to BH_TPS_004b, inclusive. These holes were formed for the pump test in accordance with BS EN ISO 22282-4:2012 and BS ISO 14686:2003. The pump tests were completed under consent 'Consent to investigate a groundwater source' under consent number: 660/12/952 at the site of: Land to the south of Low Fen Drove Way, off Horningsea Road, Horningsea: dated 08/07/2021.

The pumping tests were undertaken by specialist subcontractor Stuart Wells Limited, which comprised equipment testing, a series of six step tests undertaken in each of the four abstraction wells, a constant rate test followed by recovery monitoring. The first two days of the constant rate test was undertaken at a flow rate of 0.36l/s, however, this flow rate was subsequently reduced to 0.25l/s, in agreement with the Engineer, in order to maintain the well for the full duration of the test.

---

[13] BS 1377: 1990: Part 9: Methods of Test for Soils For Civil Engineering Purposes. British Standards Institution

The results of the pumping tests are presented in Stuart Well's report, in Section A of this report.

4.7 Installations

A full summary of boreholes and their respective groundwater installations are summarised in Table 5 below.

TABLE 5: SUMMARY OF GROUNDWATER INSTALLATIONS

Borehole ID	Installation Number	Install Type	Distance (mBGL)	Slotted Section (mBGL)	Response Zone Top (mBGL)	Response Zone Base (mBGL)
BH_FE_001	S1	SP	3.90	1.50-3.50	1.50	3.90
BH_FE_002	S1	SP	5.00	1.50-4.00	1.50	5.00
BH_STW_001	S1	SP	9.50	2.00-9.00	1.50	9.50
BH_STW_005A	S1	SP	10.00	1.50-9.50	0.50	10.00
BH_STW_009	S1	SP	12.00	1.50-11.50	1.50	12.00
BH_STW_009	G1	SP	12.00	1.50-3.00	1.50	12.00
BH_STW_010B	S1	SP	12.00	11.50-12.00	11.50	12.00
BH_STW_011B	S1	SP	9.70	1.50-9.20	1.50	9.70
BH_STW_013C	G1	SP	1.50	0.50-1.50	0.50	1.50
BH_STW_015	S1	SP	12.00	1.50-12.00	1.50	12.00
BH_STW_015	G1	SP	1.50	1.50-3.00	1.50	12.00
BH_STW_018	S1	SP	12.20	1.50-11.70	1.50	12.20
BH_STW_022A	G1	SP	2.00	1.00-2.00	1.00	2.00
BH_STW_022B	S1	SP	11.70	11.30-11.70	0.70	11.70
BH_STW_023	S1	SP	14.50	2.00-14.00	2.00	14.50
BH_STW_024	S1	SP	11.50	1.50-11.00	1.50	11.50
BH_STW_025	S1	SP	9.00	2.00-8.50	2.00	9.00
BH_STW_026	S1	SP	10.00	1.50-9.50	1.50	10.00
BH_STW_031B	S1	SP	13.60	13.10-13.60	13.10	13.60
BH_TUN_001A	S1	SP	4.75	1.25-4.25	1.25	4.75
BH_TUN_001PM	G1	SP	1.50	0.50-1.50	0.50	1.50
BH_TUN_005B	S1	SP	10.00	7.00-10.00	7.00	10.00
BH_TUN_006	S1	SP	6.00	1.50-6.00	1.50	6.00
BH_TUN_006	G1	SP	3.50	1.50-3.50	1.50	6.00
BH_TUN_011	S1	SP	5.00	1.50-5.00	1.50	5.00
BH_TUN_011	G1	SP	5.00	1.50-2.50	1.50	5.00
BH_TUN_016	S1	SP	10.80	1.50-10.30	1.50	10.80
BH_TUN_018	S1	SP	10.20	1.50-9.70	1.50	10.20
BH_TPS_001b	S1	SP	13.70	4.00-12.00	0.00	13.70
BH_TPS_002b	S1	SP	13.30	4.00-12.00	0.00	13.30
BH_TPS_003b	S1	SP	13.30	4.00-12.00	0.00	13.30
BH_TPS_004b	S1	SP	13.30	3.85-11.85	0.00	13.30
Notes: SP = Standpipe , S1 = Groundwater installation, G1 = Gas installation						

Both slotted 19mm and 50mm diameter UPVC tubes were installed in each of the boreholes listed in Table 5 above. The tubing was slotted over various depths with the slotted section being surrounded by a pea gravel response zone with a bentonite seal placed above and below. A metal stopcock cover was concreted into place on each of the installations and a plastic cap.

Seven installations were installed with a gas valve to facilitate long-term gas and groundwater monitoring, these were BH_STW_009, BH_STW_013C, BH_STW_015, BH_STW_022A, BH_TUN_001PM, BH_TUN_006 and BH_TUN_011. In each case a gas bung was placed onto a 19mm standpipe.

The original pump test locations designated BH_TPS_001 to BH_TPS_004 inclusive, have been omitted from Table 5 above for clarity.

A schematic of each installation is shown on the relevant exploratory hole log presented in Section A of this report.

4.8 Groundwater and Gas Monitoring

In accordance with the specification, monitoring of groundwater in all of the boreholes scheduled for installation was carried out at weekly intervals during the fieldwork period. Groundwater monitoring was undertaken using a standard electronic dip tape.

Seven boreholes BH_STW_009, BH_STW_013C, BH_STW_015, BH_STW_022A, BH_TUN_001PM, BH_TUN_006 and BH_TUN_011 were installed with a gas and groundwater monitoring standpipe. Following installation, monitoring for methane, carbon dioxide, carbon monoxide, hydrogen sulphide and oxygen gases was carried out using a Geotechnical Instruments GA5000 gas analyser. The gas analyser calibration certificate is included in Appendix 2 of this report.

The results of the groundwater and gas monitoring are presented in Section A of this report.

4.9 Surveying

Following completion of the fieldworks an ‘as built’ survey of each exploratory hole was undertaken by SEGL. Co-ordinates and elevations were established using Leica GPS equipment and were related to the Ordnance Survey Active Rinex Network.

5.0 LABORATORY TESTING

5.1 Scope of Testing

All geotechnical (soil, rock and chemical) and environmental testing was specified and scheduled by the Engineer. The scope of the testing was required to assist the Engineer in geotechnical design and in establishing any potential site contamination levels.

At the time of writing, laboratory testing is still underway; all available results have been included within this report.

5.2 Geotechnical Soils Testing

In order to provide an indication of the properties of soils encountered within the site, geotechnical soil testing was undertaken on selected samples. The programme of laboratory testing was carried out generally in accordance with BS 1377[14] and BS EN ISO 17892[15]. The testing was carried out by Terra Tek Site Investigation and Laboratory Services Limited, a UKAS accredited testing laboratory No 0126. The testing undertaken and the standards used are summarised in Table 6 below.

TABLE 6: SUMMARY OF SOILS TESTING

Test Name	Standard and Part	Year
General Requirements and Sample Preparation	BS 1377 -1	2016
Determination of Water Content	BS EN ISO 17892 -1	2014
Determination of Bulk Density	BS EN ISO 17892 -2	2014
Determination of Particle Density	BS EN ISO 17892 -3	2015
Determination of Liquid and Plastic Limits	BS EN ISO 17892 -12	2018
Determination of Particle Size Distribution	BS EN ISO 17892 -4	2016
Determination of Carbonate Content in soil	BS EN ISO 10693	2014
Determination of Organic Matter by Titrimetry	BS 1377 -3	1990
Determination of Saturated Moisture Content of Chalk	BS 1377 -3.3	1990
Determination of Dry Density/Moisture Content Relationship	BS 1377 -3.4	1990
Determination of Moisture Condition Value	BS 1377 -4.5	1990
Determination of Chalk Crushing Value	BS 1377 -4.6	1990
Determination of California Bearing Ratio	BS 1377 -4.7	1990
Determination of One-dimensional Consolidation Properties	BS 1377 -5.3	1990
Determination of Dispersibility	BS 1377 -6.3	1990
Determination of Dispersion by Double Hydrometer Test	BS 1377 -6.4	1990
Determination of Linear Shrinkage	BS 1377 -6.5	1990
Determination of CBR (2.5Kgr)	BS 1377 -7.2.4	1990
Determination of Unconfined Compressive Strength	BS 1377 -7.2	1990
Determination of Shear Strength by Direct Shear (small shearbox apparatus)	BS1377 -7.4	1990
Determination of Shear Strength by Direct Shear (large shearbox apparatus)	BS1377 -7.5	1990

---

[14] BS 1377: 1990: Parts 1 to 9: Methods of Test for Soils For Civil Engineering Purposes. British Standards Institution

[15] BS EN ISO 17892 Geotechnical Investigation and Testing – Laboratory Testing of Soil

Determination of Undrained Shear Strength in Triaxial Compression without measurement of pore pressure (multistage method)	BS1377 -9	1990
Determination of Consolidated Shear Strength in Triaxial Compression with measurement of pore pressure	BS1377 -9	1990
Determination of Permeability by Constant Head Method	BS1377 -Clause 5	1990
Determination of swelling pressure	BS1377 -3.0	1990
Frost Heave of Soil	BS812-124	2009
X-Ray Diffraction	BS EN13925-3	2005

Results are given on the reports from Terra Tek presented in Section B of this report.

5.3 Geotechnical Rock Testing

In order to provide an indication of the properties of the solid geology encountered within the site, geotechnical rock testing was undertaken on selected core samples. The programme of laboratory testing was carried out generally in accordance with ISRM suggested Methods[16,17]. The testing was carried out by Terra Tek Site Investigation and Laboratory Services Limited, a UKAS accredited testing laboratory No 0126.

TABLE 7: SUMMARY OF ROCK TESTING

Test Name	Standard
Determining Water Content	ISRM Suggested Methods 1974-2006
Determining Porosity/Density	ISRM Suggested Methods 1974-2006
Determination of the Uniaxial Compressive Strength	ISRM Suggested Methods 1974-2006

Results are given on the reports from Terra Tek and SEGL presented in Section B of this report.

5.4 Geotechnical Chemical Testing

In order to assess concrete requirements from BRE Special Digest No 1[18], geotechnical chemical testing was undertaken on selected samples. The testing was carried out by Terra Tek Site Investigation and Laboratory Services Limited, a UKAS accredited testing laboratory No 0126.

The samples were prepared in general accordance with BS 1377 Part 3, although final analysis of total sulfate was performed using ICP and aqueous extract using Ion Chromatography.

5.5 Environmental Testing

In order to establish any potential contamination across the site, a programme of environmental testing was scheduled by the Engineer. Testing was carried out by Chemtest, a UKAS accredited testing laboratory No. 2183.

TABLE 8: SUMMARY OF ENVIRONMENTAL TEST SUITES

---

[16] ISRM 2007 The complete ISRM Suggested Methods for Rock Characterization, Testing and Monitoring: 1974-2006. Ulusay, R. and Hudson, J.A. (Eds).

[17] ISRM 2015 The ISRM Suggested Methods for Rock Characterization, Testing and Monitoring: 2007-2014. Ulusay, R. (Ed).

[18] BRE Special Digest 1: 2005: Concrete in Aggressive Ground. BRE Construction Division.

Test Suite ID	Test Suite Composition
Mott MacDonald Comprehensive Soil Suite	Antimony, Arsenic, Asbestos Screen, Barium, Beryllium, Boron, Benzene, Toluene, Ethylbenzene, m xylene, p xylene, o xylene, Cadmium, Chromium (III) & (VI), Copper, Cyanide (Free), Fraction of Organic Carbon, Iron, Lead, Manganese, Inorganic Mercury, Methylmercury, Elemental Mercury, Molybdenum, Nickel, pH, Phenols, BTEX, TPH, PAH (16 USEPA), Selenium, Sulphate Total (as SO_4), Sulphur, Vanadium, VOCs (Speciated) Zinc
Mott MacDonald Comprehensive Leachate Suite	Arsenic (dissolved), Ammoniacal Nitrogen, Antimony (Dissolved), Barium (Dissolved), Beryllium (Dissolved), Boron (Dissolved), Cadmium (Dissolved), Calcium (Dissolved), Calcium (Dissolved), Chloride, Chromium (III) & (IV) (Dissolved), Copper (Dissolved), Cyanide (Free), Cyanide (Complex), Fluoride, Iron (Dissolved), Lead (Dissolved), Magnesium (Dissolved), Manganese (Dissolved), Mercury (Dissolved), Molybdenum (Dissolved), Nickel (Dissolved), pH, Phenol, Cresols, Dimethylphenols, Trimethylphenols, Selenium (Dissolved), Sulphate (as SO_4), Vanadium (Dissolved), Zinc (Dissolved)
Notes:	

Testing was carried out in accordance with the methods identified in the test reports.

The results of the environmental testing are presented in Section B of this report.

6.0 RESULTS OF THE INVESTIGATION

6.1 Scope of Commentary

The results of this investigation appear to broadly concur with the published geology summarised in Section 3.3 of this report and also with the information presented in the previous investigation carried out on this site and referenced in Section 3.4 of this report. The following sections are only intended to provide a brief commentary on the ground conditions encountered during this investigation whilst the logs presented in Section A of this report give a detailed account of all the strata observed.

The ground conditions encountered in the deeper exploratory holes, namely, rotary cored boreholes and cable percussion boreholes are summarised in Table 9 below.

TABLE 9: SUMMARY OF GROUND CONDITIONS IN ROTARY HOLE LOCATIONS

Borehole ID	Depth Achieved (m)	Topsoil	Made Ground	Superficial Deposits	West Melbury Chalk Formation	Cambridge Greensand Formation	Gault Formation	Lower Greensand Formation
BH_FE_001	15.90	✓		✓			✓	
BH_FE_002	10	✓		✓	✓	✓	✓	
BH_FE_003	10	✓		✓	✓	✓	✓	
BH_FE_004A	15	✓		✓	✓	✓	✓	
BH_FE_005	15	✓		✓	✓	✓	✓	
BH_FE_006	10	✓		✓	✓			
BH_OUT_001	20	✓		✓			✓	
BH_STW 001	15.40	✓		✓	✓	✓	✓	
BH_STW 003A	10	✓		✓	✓			
BH_STW_004	15.10	✓		✓	✓	✓	✓	
BH_STW_005A	30	✓		✓	✓	✓	✓	
BH_STW 006	15	✓		✓	✓	✓	✓	
BH_STW 007	15.10	✓		✓	✓	✓	✓	
BH_STW 009	30	✓			✓	✓	✓	
BH_STW 010A	30.20	✓		✓	✓		✓	
BH_STW_011A	30.20	✓		✓	✓	✓	✓	
BH_STW_012A	30.35		✓		✓	✓	✓	
BH_STW 013A	48.45	✓		✓	✓	✓	✓	✓

Borehole ID	Depth Achieved (m)	Topsoil	Made Ground	Superficial Deposits	West Melbury Chalk Formation	Cambridge Greensand Formation	Gault Formation	Lower Greensand Formation
BH_STW_013C	13.10	✓		✓	✓		✓	
BH_STW_014	30	✓		✓	✓	✓	✓	
BH_STW_015	30.20	✓		✓	✓	✓	✓	
BH_STW_016	30.20	✓		✓	✓	✓	✓	
BH_STW_017	15	✓		✓	✓	✓	✓	
BH_STW_018	30	✓		✓	✓	✓	✓	
BH_STW_019A	30	✓		✓	✓		✓	
BH_STW_020	30.20	✓		✓	✓		✓	
BH_STW_021	15	✓		✓	✓		✓	
BH_STW_022A	50	✓		✓	✓	✓	✓	✓
BH_STW_023	15.30	✓		✓	✓	✓		
BH_STW_024	15	✓		✓	✓	✓	✓	
BH_STW_025	15.05	✓		✓	✓	✓	✓	
BH_STW_026	15	✓			✓	✓	✓	
BH_STW_031A	15	✓			✓	✓	✓	
BH_TUN_001A	35	✓	✓				✓	✓
BH_TUN_002	30		✓	✓			✓	
BH_TUN_003	30	✓	✓	✓			✓	
BH_TUN_004c	30	✓		✓			✓	
BH_TUN_005Ab	30		✓	✓			✓	
BH_TUN_006	40		✓	✓			✓	✓
BH_TUN_007	30.20	✓					✓	
BH_TUN_011	42.50	✓		✓	✓	✓	✓	✓
BH_TUN_015	30.20	✓		✓	✓	✓	✓	
BH_TUN_016	30.20	✓		✓	✓		✓	
BH_TUN_017	30.20	✓			✓	✓	✓	
BH_TUN_018	49.50	✓		✓	✓	✓	✓	✓
BH_TPS_001	15.10	✓		✓	✓	✓	✓	

Borehole ID	Depth Achieved (m)	Topsoil	Made Ground	Superficial Deposits	West Melbury Chalk Formation	Cambridge Greensand Formation	Gault Formation	Lower Greensand Formation
BH_TPS 001b	13.70	✓		✓	✓	✓	✓	
BH_TPS _002	15.20	✓		✓	✓	✓	✓	
BH_TPS _002b	13.20	✓					✓	
BH_TPS 003	15.20	✓		✓	✓	✓	✓	
BH_TPS 004	15.20	✓		✓	✓	✓	✓	

TABLE 10 – SUMMARY OF GROUND CONDITIONS IN CABLE PERCUSSION HOLE LOCATIONS

Borehole ID	Depth Achieved (m)	Topsoil	Made Ground	Superficial Deposits	West Melbury Chalk Formation	Cambridge Greensand Formation	Gault Formation	Lower Greensand Formation
BH_STW _003B	10	✓		✓	✓			
BH_STW _005B	30	✓		✓	✓		✓	
BH_STW 010B	30	✓		✓	✓	✓	✓	
BH_STW 011B	30	✓			✓		✓	
BH_STW 012B	30			✓	✓		✓	
BH_STW _013B	30	✓			✓		✓	
BH_STW _019B	11.20*	✓		✓	✓			
BH_STW 022B	30	✓		✓	✓	✓	✓	
BH_STW 031B	30	✓			✓	✓	✓	
BH_TUN 001B	35		✓	✓			✓	✓
BH_TUN _005B	30		✓	✓			✓	
BH_FE_ 004B	15	✓		✓	✓		✓	

TABLE 11 – SUMMARY OF GROUND CONDITIONS IN TRIAL PIT HOLE LOCATIONS

Borehole ID	Depth Achieved (m)	Topsoil	Made Ground	Superficial Deposits	West Melbury Chalk Formation	Gault Formation
TP_FE_001	2.5	✓		✓		
TP_FE_002	2.2			✓		✓
TP_FE_003	2.8	✓			✓	
TP_FE_004	3.0	✓			✓	
TP_FE_005	3.0		✓		✓	
TP_FE_006	3.0	✓		✓	✓	

Borehole ID	Scheduled Depth / (Depth Achieved) [m]	Topsoil	Made Ground	Superficial Deposits	West Melbury Chalk Formation	Gault Formation
TP_STW_003	3.0	✓			✓	
TP_STW_004	3.0		✓	✓	✓	
TP_STW_005	3.0		✓		✓	
TP_STW_006	3.0	✓		✓	✓	
TP_STW_007	3.0	✓		✓	✓	
TP_STW_010	3.0	✓		✓	✓	
TP_STW_011	3.0		✓		✓	
TP_STW_012	3.0	✓		✓	✓	
TP_STW_013	3.0	✓			✓	
TP_STW_014	3.0			✓	✓	
TP_STW_015	3.0	✓			✓	
TP_STW_016	3.1	✓		✓	✓	
TP_STW_017	3.0			✓	✓	
TP_STW_018	3.0	✓		✓	✓	
TP_STW_019	3.0	✓			✓	
TP_STW_020	3.0	✓		✓	✓	
TP_STW_021	3.0		✓	✓	✓	
TP_STW_022	3.0	✓		✓	✓	
TP_STW_031	3.0	✓			✓	
TP_STW_032	3.0	✓			✓	

6.2 Topsoil

Topsoil was encountered from ground level in the majority of the exploratory holes formed across the site to a maximum depth of 0.60m. Where found, this generally comprised dark brown slightly sandy slightly gravelly clay where the gravel portion consisted of flint.

6.3 Made Ground

Made ground was encountered in fifteen exploratory hole locations predominantly from ground level to a maximum of 1.80m depth. This is with the exception of BH_TUN_006 and BH_TUN_006PM where made ground was encountered to depths of 4.00m and 4.20m respectively.

Made Ground encountered varied in composition across the site. Where encountered in BH_TUN_001A to BH_TUN_005Ab, this was generally described as either sandy gravelly clay or sandy gravel where gravel sized fragments comprised brick, concrete, glass, mudstone, porcelain and flint.

Both BH_TUN_006 and IP_TUN_006 were formed through a raised man-made earth bund. This material was seen to comprise dark brown sandy slightly gravelly clay where gravel sized fragments comprised flint and sandstone.

Where Made Ground was encountered in TP locations and BH_STW_012A this generally comprised brown sandy gravelly clay, similar to that of topsoil, together with man-made brick fragments. Made Ground was recorded to a maximum of 1.80m depth in TP_FE_004.

6.4 Superficial Deposits

Superficial deposits were encountered beneath topsoil and made ground in the majority of the exploratory holes formed across the site and generally comprised a variable sequence of gravelly sands, sand and gravel and sandy gravelly clays.

The greatest thicknesses of these deposits were encountered in the western end of the site in boreholes designated BH_TUN_001A to BH_TUN_006, inclusive and in borehole BH_OUT_001.

The deposits encountered in boreholes designated BH_TUN_001A to BH_TUN_006, inclusive, could be considered as River Terrace Deposits, which comprised a variable sequence of sands and gravels.

The material encountered in BH_OUT_001 could be considered as Alluvium, where the material was described as dark grey mottled sandy gravelly clay.

The Superficial Deposits in the eastern end of the site in exploratory holes designated ‘FE’ and ‘STW’ could be considered as a reworked material of the underlying West Melbury Chalk Formation.

6.5 Cretaceous Deposits

6.5.1 West Melbury Chalk Formation

The West Melbury Chalk Formation was encountered in all boreholes formed in the eastern end of the site. It should be noted that the material encountered comprised either, calcareous clay, calcareous siltstone or calcareous mudstone. It was agreed with the Engineer that this material should be described as Chalk and classified using the CIRIA Guide C574.

The Chalk was described as both a structureless matrix and clast supported Chalk with a CIRIA Grade Dm or Dc and structured intact Chalk with various CIRIA grades from A to C and suffix of 1 to 5. Predominantly, the formation was described as structureless Grade Dm overlying structured, Grade B3 and B4 Chalk to depth.

The West Melbury Chalk Formation was recorded to deepest depth of 14.25m in borehole BH_STW_023. Where the base of the formation was proven, either Cambridge Greensand Member or Gault Formation deposits were encountered directly below.

6.5.2 Cambridge Greensand Member

The Cambridge Greensand Member was encountered at the base of the West Melbury Chalk Formation in twenty-four boreholes with a designation of either ‘FE’ or ‘STW’. Where described, this member of the West Melbury Chalk Formation generally comprised dark greenish grey slightly sandy slightly gravelly clay where the gravel portion consisted of coprolite nodules. The Cambridge Greensand Member was recorded to deepest depth of 15.30m in borehole BH_STW_023. Where the base of the Cambridge Greensand Member was proven, the Gault Formation was encountered directly below.

6.5.3 Gault Formation

The Gault Formation was encountered in the majority of boreholes across the site and within TP_FE_002, either directly underlying the West Melbury Chalk Formation in the eastern part of the site in the 'FE' and 'STW' boreholes or underlying Superficial Deposits in the western part of the site in the 'TUN' boreholes. Generally this formation comprised fissured thinly laminated dark grey clay with occasional phosphatic and siltstone nodules. Deposits were generally classified as partially weathered where mottling or staining of fissures was observed or unweathered.

The Gault Formation was recorded to deepest depth of 47.60m in borehole BH_STW_022A. Where the base of the Gault Formation was proven, the Lower Greensand Formation was encountered directly below.

6.5.4 Lower Greensand Formation

The Lower Greensand Formation was encountered in boreholes designated BH_STW_013A, BH_STW_022A, BH_TUN_001A, BH_TUN_001B, BH_TUN_006, BH_TUN_011 and BH_TUN_018. Where described, this formation generally comprised either dark greenish grey sandy gravelly glauconitic clay where gravel consisted of flint or dark greenish grey clayey gravelly fine sand. The base of the Lower Greensand Formation was not proven in any exploratory hole.

6.6 Groundwater

Groundwater was encountered during drilling in some of the boreholes at various depths. A summary of exploratory hole groundwater inflows is given in Table 1 in Section A, whilst the logs presented in Section A of this report provide full details of all groundwater information.

6.7 Results of CBR Testing

A total of twenty-seven California Bearing Ratio tests were undertaken which yielded CBR values in the range 2.7% to 27% for the chosen test depth of 0.50m. Further information regarding these tests is given on the individual test sheets presented in Section A of this report.

6.8 Groundwater Monitoring

Groundwater levels recorded during the fieldwork period in the eastern end of the site were generally between 2m and 5m below ground level whilst those recorded in the western end of the site were generally between 1m and 2m below ground level. The results of the groundwater monitoring undertaken weekly during the fieldwork period are presented in Section A of this report.

6.9 Gas Monitoring

Monitoring of gas levels commenced following cessation of the fieldwork period and produced no detectable levels of hydrogen sulfide and encountered detectable levels of methane, carbon dioxide, carbon monoxide and oxygen. During monitoring of BH_STW_009, levels of carbon dioxide were recorded between 1.8% and 1.9% with oxygen levels between 18.6% and 20.4%. Elevated lower explosive limits of methane were detected during monitoring rounds one and three in BH_TUN_006 between 4% and 6%. During monitoring of BH_TUN_001PM, elevated levels of carbon dioxide were recorded between 2.6% and 3.0% with oxygen levels of between 13.4% and 15.4%. The results of the gas monitoring are presented in Section A of this report.

SOIL ENGINEERING

SUPPORTING FACTUAL DATA

SECTION A
Exploratory Hole Records and Field Data

EXPLORATORY HOLE LOG LEGEND AND NOTATION SHEET

SECTION A EXPLORATORY HOLE LOG LEGENDS

CODE	DESCRIPTION	LEGEND	CODE	DESCRIPTION	LEGEND
101	Topsoil	▨	806	Coal	
102	Made Ground	▨	807	Breccia	△
104	Concrete	☐	808	Conglomerate	○
201	Clay	☐	809	Fine Grained Igneous	V
301	Silt	×	810	Medium Grained Igneous	+
401	Sand	☐	811	Coarse Grained Igneous	✚
501	Gravel	⁘	812	Fine Grained Metamorphic	⋀
601	Peat	▨	813	Coarse / Medium Grained Metamorphic	∿
701	Cobbles	○	EVT	Evaporite	◇
730	Boulders	○	MWS	Mine Workings	✕
801	Mudstone	☰	904	Grout	┄
802	Siltstone	×	905	Arisings	≈
803	Sandstone	⁘	BLK	Zone of No Recovery	☐
804	Limestone	▦	WTR	Water	∿
805	Chalk	▦			

Note: Most soils types comprise a mixture of particle sizes. These soil types are represented graphically on the exploratory hole logs by combining the legends shown on this sheet.

SECTION A: EXPLORATORY HOLE LOG LEGENDS

SAMPLING NOTATION

U	Undisturbed U100 or U38 sample (size given on log)
UT	Thin wall open drive tube sampler (size given on log)
P	Piston Sample
BLK	Block Sample
M	Mazier Sample
TW	Thin Walled Sample
L	Liner Sample obtained from windowless sampler
D	Small Disturbed Sample
B	Bulk Disturbed Sample
LB	Large Bulk Disturbed Sample
C	Core Sample
ES	Environmental Soil Sample
EW	Environmental Water Sample
W	Water Sample
UF	No Recovery in U Sample
UTF	No Recovery in UT Sample
PF	No Recovery in P Sample
TWF	No Recovery in TW Sample

IN SITU TEST NOTATION

SPT	Standard Penetration Test with a Split Spoon
SPT(C)	Standard Penetration Test with a Cone
C	Cone Penetration Test
NP	No Penetration for SPT or SPT(C)
V	Vane Test
HV	Hand Vane
HP	Hand Penetrometer
CBR	California Bearing Ratio Test
K	Permeability Test (test type not differentiated)
Pr	Pressuremeter Test

OTHER NOTATION

TCR	Total Core Recovery
SCR	Solid Core Recovery
RQD	Rock Quality Designation
FI	Fracture Index
If	Fracture Spacing
NI	Non Intact
NA	Data Not Applicable
NR	Data Not Recorded

GRAPHICS USED

▽	Standing water level
│	Joining bar indicates level risen
▼	Waterstrike level

soil engineering

SUPPORTING FACTUAL DATA

SECTION A
Exploratory Hole Records and Field Data

CABLE PERCUSSION AND ROTARY DRILLING RECORDS

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_FE_001
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+4.08mOD	Coordinates	548559.20E, 261623.30N	Grid	OSGB
Date Started	18/08/2021	Date Completed	19/08/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	18/08/2021 11:00	18/08/2021 12:00	BC	DT	NA	NA	Insulated hand tools	None	Stable	
1.20	15.90	RC	18/08/2021 12:00	19/08/2021 15:45	BC	CJ	Geobore S	PCD	Comacchio 205			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
18/08/2021 17:30	6.90	6.90	1.20	End of Shift
19/08/2021 07:30	6.90	6.90	Dry	Start of Shift
19/08/2021 15:45	0.00	0.00	Dry	Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	15.90	AIR/MIST	100	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
15.90	146	15.90	146						

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type
3.90	S1	SP	1.50	3.90	Pipe 1	Pipe 1	0.00	1.50	50	PLAIN
						Pipe 1	1.50	3.50	50	SLOTTED
						Pipe 1	3.50	3.90	50	PLAIN

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
-0.50	0.00	Upstanding cover	
0.00	0.50	Concrete	
0.50	1.00	Bentonite	
1.50	3.90	Gravel backfill	
3.90	15.90	Bentonite	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_FE_001
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 2

Ground Level	+4.08mOD	Coordinates	548559.20E, 261623.30N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Depth (Thickness)	Datum Level	Waterstrike
TOPSOIL: Brown slightly sandy slightly gravelly CLAY. Gravel is angular to subangular fine to medium of flint and quartz. Sand is fine to coarse. (TOP) [TOPSOIL]		(0.30) 0.30	3.78	
Firm brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of mixed lithologies and flint. (SUPD) [SUPERFICIAL DEPOSITS] from 0.40m to 0.50m dark brown from 0.50m to 1.00m occasional cobbles of flint		(0.70) 1.00	3.08	
Brownish grey slightly clayey sandy GRAVEL. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of mixed lithologies and flint. (SUPD) [SUPERFICIAL DEPOSITS]		1.20	2.88	
No recovery SAND and GRAVEL of flint (Driller's description) (SUPD) [SUPERFICIAL DEPOSITS]		(2.70) 3.90	0.18	
Stiff fissured dark grey CLAY. Fissures are horizontal to subhorizontal extremely closely to closely spaced, planar and undulating, smooth and polished, and subvertical to vertical, medium to widely spaced, undulating and planar, smooth and polished. Rare siltstone nodules (<7mm x 11mm) and rare coprolites (<10mm x 15mm). (GLT) [GAULT FORMATION] from 5.30m to 5.40m assumed zone of core loss from 6.35m to 6.55m recovered as soft, probably drilling induced from 6.70m to 6.90m assumed zone of core loss	Unweathered	(7.15)		

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details
D 1 0.05-0.10						K 0.00 - 1.20
ES 2 0.20-0.25						
B 3 0.10-0.40						
D 4 0.40-0.50						
ES 5 0.50-0.55						
B 6 0.40-0.80						
B 9 0.80-1.20						
D 7 1.00-1.10						
ES 8 1.10-1.20						
C 10 1.20-2.40	102	0			NR	
3.00 EW 1 3.00 EW 2 3.00 C 11 2.40-3.90	102	0				
C 12 3.90-5.40	102	93			NA	
C 13 5.40-6.90	102	87				
C 14 6.90-8.40	102	100				
C 15 8.40-9.90	102	100				

AGS

Notes. All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_FE_001 Sheet 2 of 2
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level +4.08mOD
Coordinates 548559.20E, 261623.30N
Grid OSGB
Hole Type IP+RC
Inclination 90° from horizontal

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Stiff fissured dark grey CLAY. Fissures are horizontal to subhorizontal extremely closely to closely spaced, planar and undulating, smooth and polished, and subvertical to vertical, medium to widely spaced, undulating and planar, smooth and polished. Rare siltstone nodules (<7mm x 11mm) and rare coprolites (<10mm x 15mm). (GLT) [GAULT FORMATION]			11.05	-6.97		C 16 9.90-11.40	102	77					
Assumed zone of core loss. Grey CLAY (Driller's description) (GLT) [GAULT FORMATION]			(0.35) 11.40	-7.32							NR		
Stiff fissured dark grey CLAY. Fissures are horizontal to subhorizontal extremely closely to closely spaced, planar, smooth and polished, and, subvertical to vertical, medium spaced, undulating and planar, smooth and polished. Rare siltstone nodules (<6mm x 10mm) and rare coprolites (<8mm x 10mm). (GLT) [GAULT FORMATION] from 13.80m to 13.90m very stiff			(4.20) 15.60	-11.52		C 17 11.40-12.90 C 18 12.90-14.40 C 19 14.40-15.90	102 102 102	100 100 80			NA		
Assumed zone of core loss. Grey CLAY (Driller's description) (GLT) [GAULT FORMATION]			(0.30) 15.90	-11.82							NR		
Complete at 15.90m. Termination Reason: Achieved Scheduled Depth													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_FE_002 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+6.54mOD	Coordinates	548721.40E, 261601.00N	Grid	OSGB
Date Started	12/08/2021	Date Completed	13/08/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	12/08/2021 10:15	12/08/2021 10:50	RL	DT			Insulated hand tools	None	Stable	
1.20	10.00	RC	12/08/2021 10:50	13/08/2021 10:00	RL	SAN	Geobore S (146)	PCD	Comacchio 205			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
12/08/2021 17:35	10.00	10.00	Dry	End of Shift
13/08/2021 07:30	10.00	10.00	Dry	Start of shift
13/08/2021 10:00	0.00	0.00	Dry	Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	2.30	AIR/MIST	0	Grey	
2.30	3.80	AIR/MIST	0	White	
3.80	10.00	AIR/MIST	0	Grey	

HOLE DIAMETER / CASING DIAMETER / DYNAMIC SAMPLING

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
10.00	146	10.00	146						

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref
5.00	S1	SP	1.50	5.00	Pipe 1

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type
Pipe 1	0.00	1.50	50	PLAIN
Pipe 1	1.50	4.00	50	SLOTTED
Pipe 1	4.00	5.00	50	PLAIN

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
-0.50	0.00	Upstanding cover	
0.00	0.50	Concrete	
0.50	0.70	Gravel backfill	
0.70	1.50	Bentonite	
1.50	5.00	Gravel backfill	
5.00	10.00	Bentonite	

LOCATION DETAILS

Remarks

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_FE_002
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 2

Ground Level	+6.54mOD	Coordinates	548721.40E, 261601.00N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Depth (Thickness)	Datum Level
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Gravel is angular to subrounded fine to medium of flint and quartz. Sand is fine to coarse. Frequent roots and rootlets. (TOP) [TOPSOIL]		(0.30) 0.30	6.54
Firm brown slightly gravelly sandy CLAY. Gravel is angular to subrounded fine to medium. Sand is fine to coarse. (SUPD) [SUPERFICIAL DEPOSITS]		0.40	6.54
Soft brown sandy CLAY. Sand is fine to medium. (SUPD) [SUPERFICIAL DEPOSITS]		0.50	6.54
Firm light brown slightly gravelly sandy CLAY. Gravel is angular to subrounded fine to medium of mixed lithologies and flint. Sand is fine to coarse. (SUPD) [SUPERFICIAL DEPOSITS]		(0.40) 0.90	6.54
CHALK recovered as Soft light brown to greyish slightly gravelly sandy calcareous CLAY. Gravel is angular to subrounded fine to medium of mixed lithologies and flint. (possible Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]		(0.30) 1.20	6.54
Structureless CHALK composed of GRAVEL. Gravel is weak low density buff subangular to subrounded coarse of calcareous siltstone and frequent fine gravel sized fragments of flint. (CIRIA Grade Dc) (WMCK) [WEST MELBURY CHALK FORMATION] from 1.50m to 1.70m assumed zone of core loss	Grade Dc Grade Dm Grade Dc	(0.70) 1.90	6.54
Structureless CHALK composed of firm fissured buff gravelly calcareous CLAY. Gravel is subangular fine of chalk. Fissures are closely spaced horizontal to subhorizontal planar and smooth infilled with clay and fragments of chalk and flint. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 2.10m to 2.30m assumed zone of core loss	Grade Dm	(0.80) 2.70	6.54
Assumed zone of core loss. Light grey Chalk/Chalk with gravel (Driller's description) (WMCK) [WEST MELBURY CHALK FORMATION]		(1.10) 3.80	6.54
Structureless CHALK composed of very stiff buff gravelly calcareous CLAY. Gravel is subangular to rounded medium to coarse of chalk and coprolite. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	4.00	6.54
Firm fissured dark grey CLAY. Fissures are horizontal very closely spaced planar smooth, infill localised yellowish orange staining. Occasional coarse gravel sized coprolite. (WMCK) [CAMBRIDGE GREENSAND MEMBER]		4.10	6.54
Assumed zone of core loss. CHALK with Clay bands. (Driller's description) (WMCK) [WEST MELBURY CHALK FORMATION]		(1.20) 5.30	6.54
Firm thinly laminated dark grey CLAY. Occasional coarse gravel sized subrounded coprolite. (GLT) [GAULT FORMATION] from 5.73m to 5.75m fissure, 0 to 30 degrees undulating rough	Partially Weathered	(1.33) 6.63	6.54
Very stiff thinly laminated dark grey CLAY with occasional coarse gravel of coprolite. (GLT) [GAULT FORMATION] at 7.55m fissure 0 to 10 degrees undulating smooth closed	Unweathered	(3.17) 9.80	6.54
Very stiff fissured dark grey CLAY. Fissures are extremely to very	Unweathered	10.00	6.54

Sampling Details	Dia	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details
D 1 0.05-0.10						
ES 2 0.20-0.25						
B 3 0.10-0.40						
D 4 0.40-0.50						
ES 5 0.50-0.55						
B 6 0.40-0.80						
B 9 0.80-1.20						
D 7 1.00-1.10						
ES 8 1.10-1.20						
C 10 1.20-1.70	102	60			NA	
C 11 1.70-2.30	102	67				
C 12 2.30-3.80	102	33			NR	
EW 1 4.00					NA	
C 13 3.80-5.30	102	33			NR	
EW 2 5.00						
C 14 5.30-6.80	102	100				
C 15 6.80-8.30	102	100			NA	
C 16 8.30-9.80	102	100				
C 17 9.80-10.00	102	100				

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_FE_002 Sheet 2 of 2
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+6.54mOD	Coordinates	548721.40E, 261601.00N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling		TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
						Details	Dia.						
Very stiff fissured dark grey CLAY. Fissures are extremely to very closely spaced horizontal to subhorizontal planar rough and subvertical planar and rough. (GLT) [GAULT FORMATION]													

Complete at 10.00m. Termination Reason: Achieved Scheduled Depth

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_FE_003
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+6.04mOD	Coordinates	548881.30E, 261572.10N	Grid	OSGB
Date Started	13/08/2021	Date Completed	16/08/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	13/08/2021 10:10	13/08/2021 10:50	RL	DT			Insulated Hand Tools	None	Stable	
1.20	10.00	RC	13/08/2021 10:50	16/08/2021 15:40	RL	SAN	Geobore S (146)	PCD	Comacchio 205			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
13/08/2021 17:30	2.00	2.00	Dry	End of Shift
16/08/2021 07:30	2.00	2.00	Dry	Start of shift
16/08/2021 15:40	0.00	0.00	Dry	Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	3.50	AIR/MIST	0	White	
3.50	10.00	AIR/MIST	0	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
10.00	146	10.00	146						

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	10.00	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

SOIL ENGINEERING
Part of the Bachy Soletanche Group

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Form No. SIEXPHOLEHDR Issue.Revision No. 2.02 Issue Date 22/06/2016

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_FE_003
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+6.04mOD	Coordinates	548881.30E, 261572.10N	Grid	OSGB		
Hole Type	IP+RC	Inclination					

Description of Strata	Weathering	Depth (Thickness)	Datum Level
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Gravel is angular to subrounded fine to medium of flint. Sand is fine to coarse. Frequent rootlets and roots (<6mm diameter). (TOP) [TOPSOIL]		0.16	6.04
Firm grey slightly gravelly sandy CLAY. Gravel is angular to subrounded medium to coarse of flint. Sand is fine to coarse. (SUPD) [SUPERFICIAL DEPOSITS]		(0.54) 0.70	6.04
CHALK recovered as firm light grey slightly gravelly sandy calcareous CLAY. Gravel is angular to subrounded medium to coarse of flint. Sand is fine to coarse. (WMCK) [WEST MELBURY CHALK FORMATION]		(0.50) 1.20	6.04
Structureless CHALK composed of stiff grey locally stained yellow calcareous CLAY. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(0.30) 1.50	6.04
Assumed zone of core loss. Chalky CLAY (Driller's Description) (WMCK) [WEST MELBURY CHALK FORMATION]		(0.50) 2.00	6.04
Structureless CHALK composed of stiff thinly bedded grey slightly gravelly calcareous CLAY. Gravel is angular to subangular fine to medium of extremely weak low density calcareous siltstone and flint. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]		(0.45) 2.45	6.04
Assumed zone of core loss. Chalky CLAY. (Driller's Description) (WMCK) [WEST MELBURY CHALK FORMATION]		(1.05) 3.50	6.04
Structureless CHALK composed of stiff thinly bedded grey slightly gravelly calcareous CLAY. Gravel is angular to subangular fine to medium of extremely weak low density calcareous siltstone and flint. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]		3.68	6.04
Stiff dark grey mottled greenish-grey CLAY with occasional subrounded to rounded fine to medium gravel of coprolite. (WMCK) [CAMBRIDGE GREENSAND MEMBER]	Unweathered	3.84	6.04
Stiff to very stiff dark grey mottled dark green glauconitic CLAY. Gravel is subrounded fine of coprolite. (GLT) [GAULT FORMATION]		(1.61) 5.45	6.04
Very stiff fissured dark grey CLAY with occasional subrounded to rounded fine gravel of coprolite. Fissures are very closely spaced to closely spaced inclined planar and rough. (GLT) [GAULT FORMATION]		(4.05) 9.50	6.04
Assumed zone of core loss. Grey CLAY. (Driller's Description) (GLT) [GAULT FORMATION]		(0.50) 10.00	6.04

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD
D 1 0.05-0.10				
ES 2 0.20-0.25				
B 3 0.10-0.40				
D 4 0.40-0.50				
ES 5 0.50-0.55				
B 6 0.40-0.80				
B 9 0.80-1.20				
D 7 1.00-1.10				
ES 8 1.10-1.20				
C 10 1.20-2.00	102	38		
C 11 2.00-3.50	102	30		
C 12 3.50-4.50	102	100		
C 13 4.50-6.00	102	97		
C 14 6.00-7.50	102	93		
C 15 7.50-9.00	102	93		
C 16 9.00-10.00	102	50		

Depth range	IF
1.20-1.50	NA
1.50-2.00	NR
2.00-2.45	NA
2.45-3.50	NR
3.50-9.50	NA
9.50-10.00	NR

In Situ Test Details

Install-ation

Complete at 10.00m. Termination Reason: Achieved Scheduled Depth

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_FE_004A
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+6.60mOD	Coordinates	549059.10E, 261525.10N	Grid	OSGB
Date Started	17/08/2021	Date Completed	18/08/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	17/08/2021 08:00	17/08/2021 09:00	BC	DT	NA	NA	Insulated Hand Tools	None	Stable	Inspection pit: Hand dug
1.20	15.00	RC	17/08/2021 09:00	18/08/2021 10:00	BC	SAN	Geobore S (146)		Comacchio 205			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
17/08/2021 17:30	15.00	15.00	Dry	End of Shift
18/08/2021 07:30	15.00	15.00	Dry	Start of shift
18/08/2021 10:00	0.00	0.00	Dry	Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	15.00	AIR/MIST	100	Grey	

HOLE DIAMETER

Depth Base	Diameter
15.00	146

CASING DIAMETER

Depth Base	Diameter
15.00	146

DYNAMIC SAMPLING

Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	15.00	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL   Print date and time 12/09/2022 13:55   Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation
Project No.	TE8364
Engineer	Mott MacDonald Bentley
Employer	Barhale Limited

Exploratory Hole Log

Hole ID

BH_FE_004A

Sheet 1 of 2

Ground Level	+6.60mOD	Coordinates	549059.10E, 261525.10N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Depth (Thickness)	Datum Level	Waterstrike	IF	In Situ Test Details
TOPSOIL: Dark brown slightly sandy slightly gravelly clay. Gravel is angular to subrounded fine to medium of flint. Sand is fine to coarse. Frequent rootlets and roots (<6mm diameter). (TOP) [TOPSOIL]		(0.32) 0.32	6.28			
Firm grey slightly gravelly sandy CLAY. Gravel is angular to subrounded medium to coarse of flint. Sand is fine to coarse. (SUPD) [SUPERFICIAL DEPOSITS]		(0.88) 1.20	5.40			
Structureless CHALK composed of stiff grey gravelly calcareous CLAY. Gravel is angular to subangular fine of extremely weak low density calcareous siltstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 1.85m to 2.00m assumed zone of core loss.	Grade Dm	(0.80) 2.00	4.60		NA	
Structureless CHALK composed of stiff grey gravelly calcareous CLAY. Gravel is angular to subangular fine of extremely weak low density calcareous siltstone and flint. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]		(0.30) 2.30	4.30			
Assumed zone of core loss. Grey CLAY. (Driller's Description) (WMCK) [WEST MELBURY CHALK FORMATION]		(1.20) 3.50	3.10		NR	
Structureless CHALK composed of stiff grey gravelly calcareous CLAY. Gravel is angular to subangular fine of extremely weak low density calcareous siltstone and flint. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]		3.72	2.88		NA	
Assumed zone of core loss. Grey CLAY. (Driller's Description) (WMCK) [WEST MELBURY CHALK FORMATION]		(0.78) 4.50	2.10		NR	
Firm dark grey mottled greenish-grey glauconitic CLAY with occasional subrounded to rounded fine gravel of coprolite. (WMCK) [CAMBRIDGE GREENSAND MEMBER]		(0.38) 4.88	1.72		NA	
Stiff fissured thinly laminated dark grey CLAY with occasional subrounded to rounded fine gravel of coprolite. Fissures are very closely to closely spaced horizontal to subhorizontal planar and smooth and subvertical to vertical planar and smooth. (GLT) [GAULT FORMATION] from 8.29m to 12.67m with inclined, closely to medium spaced, planar and smooth fissures. from 9.26m to 15.00m Very stiff.	Unweathered	(10.12)				

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD
D 1 0.05-0.10				
ES 3 0.20-0.25				
B 2 0.10-0.40				
D 4 0.40-0.50				
ES 6 0.50-0.55				
B 5 0.40-0.80				
B 7 0.80-1.20				
D 8 1.00-1.10				
ES 9 1.10-1.20				
C 10 1.20-2.00	102	81		
C 11 2.00-3.50	102	20		
C 12 3.50-4.50	102	23		
C 13 4.50-6.00	102	100		
C 14 6.00-7.50	102	100		
C 15 7.50-9.00	102	97		
C 16 9.00-10.50	102	100		

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL | Print date and time 12/09/2022 13:55 | Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_FE_004A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 2

Ground Level	+6.60mOD	Coordinates	549059.10E, 261525.10N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Stiff fissured thinly laminated dark grey CLAY with occasional subrounded to rounded fine gravel of coprolite. Fissures are very closely to closely spaced horizontal to subhorizontal planar and smooth and subvertical to vertical planar and smooth. (GLT) [GAULT FORMATION]													
						C 17 10.50-12.00	102	100					
						C 18 12.00-13.50	102	100					
						C 19 13.50-15.00	102	100					
Complete at 15.00m. Termination Reason: Achieved Scheduled Depth			15.00	-8.40									

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_FE_004B
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+6.61mOD	Coordinates	549059.30E, 261525.10N	Grid	OSGB
Date Started	31/08/2021	Date Completed	02/09/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	31/08/2021 15:00	31/08/2021 16:00	Danny Cundill	SAN	NA	NA	Insulated hand tools	None	Stable	
1.20	15.00	CP	01/09/2021 08:15	01/09/2021 17:30	Danny Cundill	SAN			Dando 2000			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
31/08/2021 17:30	1.20	1.20	Dry	End of Shift
01/09/2021 07:30	1.20	1.20	Dry	Start of shift
01/09/2021 17:30	15.00	5.20	Dry	Drilling Complete
02/09/2021 10:00	0.00	0.00	Dry	Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
01/09/2021 09:30	2.90	2.90	4.00	2.30	20	Slow

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water
1.20	S	N=9 (1,2:2,2,3,2)	AR3501	75	1.20	Dry
2.20	S	N=9 (1,1:2,2,2,3)	AR3501	75	2.20	Dry
3.20	S	N=9 (1,1:2,2,3,2)	AR3501	75	3.20	2.50
4.20	S	N=14 (1,2:3,3,4,4)	AR3501	75	4.20	3.50
5.20	S	N=16 (2,2:3,3,4,6)	AR3501	75	5.20	Dry
6.20	S	N=22 (2,3:4,5,6,7)	AR3501	75	5.20	Dry
7.20	S	N=26 (2,3:4,6,7,9)	AR3501	75	5.20	Dry
8.20	S	N=27 (3,3:4,6,8,9)	AR3501	75	5.20	Dry
9.20	S	N=29 (3,3:5,6,8,10)	AR3501	75	5.20	Dry
10.70	S	N=33 (4,5:6,8,9,10)	AR3501	75	5.20	Dry
12.20	S	N=33 (4,5:7,7,9,10)	AR3501	75	5.20	Dry
13.70	S	N=34 (4,6:7,8,9,10)	AR3501	75	5.20	Dry

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
15.00	200	5.20	200						

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	15.00	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

SOIL ENGINEERING

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Form No. SIEXPHOLEHDR Issue.Revision No. 2.02 Issue Date 22/06/2016

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_FE_004B
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 2

Ground Level	+6.61mOD	Coordinates	549059.30E, 261525.10N	Grid	OSGB
Hole Type	IP+CP	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
TOPSOIL: Greyish brown slightly sandy gravelly CLAY. Gravel is angular to subangular fine to medium of flint and quartz. Sand is fine to coarse. Frequent buried roots and rootlets. (TOP) [TOPSOIL]			(0.30) 0.30	6.31		D 1 0.10 B 2 0.20-0.30							
Firm light grey slightly gravelly sandy CLAY. Gravel is subangular to subrounded fine to coarse of flint. Sand is fine to coarse. (SUPD) [SUPERFICIAL DEPOSITS]			(0.90) 1.20	5.41		D 3 0.40 B 4 0.50-0.70 B 5 1.00-1.20							
CHALK recovered as: Soft yellowish grey locally stained yellowish orange and brown calcareous CLAY with occasional subrounded medium to coarse gravel of coprolite. (WMCK) [WEST MELBURY CHALK FORMATION]			(2.80) 4.00	2.61	▽ ▼	D 6 1.20-1.65 B 7 1.20-1.70 D 8 2.20-2.65 B 9 2.20-2.70 W 10 2.90 D 11 3.00 D 12 3.20-3.65 B 13 3.20-3.70						SPT(S) N=9 (1,2:2,2,3,2) 1.20 SPT(S) N=9 (1,1:2,2,2,3) 2.20 SPT(S) N=9 (1,1:2,2,3,2) 3.20	
Stiff fissured thinly laminated dark grey CLAY with occasional dark brown fossilised fragments (1mm x 3mm). Fissures are planar and smooth. (GLT) [GAULT FORMATION]			(11.00)			D 14 4.00 D 15 4.20-4.65 B 16 4.20-4.70 D 17 5.20-5.65 B 18 5.20-5.70 D 19 6.20-6.65 B 20 6.20-6.70 D 21 7.20-7.65 B 22 7.20-7.70 D 23 8.20-8.65 B 24 8.20-8.70 D 25 9.20-9.65 B 26 9.20-9.70						SPT(S) N=14 (1,2:3,3,4,4) 4.20 SPT(S) N=16 (2,2:3,3,4,6) 5.20 SPT(S) N=22 (2,3:4,5,6,7) 6.20 SPT(S) N=26 (2,3:4,6,7,9) 7.20 SPT(S) N=27 (3,3:4,6,8,9) 8.20 SPT(S) N=29 (3,3:5,6,8,10) 9.20	

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_FE_004B Sheet 2 of 2
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+6.61mOD	Coordinates	549059.30E, 261525.10N	Grid	OSGB
Hole Type	IP+CP	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Stiff fissured thinly laminated dark grey CLAY with occasional dark brown fossilised fragments (1mm x 3mm). Fissures are planar and smooth. (GLT) [GAULT FORMATION]													
						D 27 10.70-11.15 B 28 10.70-11.20						SPT(S) N=33 (4,5:6,8,9,10) 10.70	
						D 29 12.20-12.65 B 30 12.20-12.70						SPT(S) N=33 (4,5:7,7,9,10) 12.20	
						D 31 13.70-14.15 B 32 13.70-14.20						SPT(S) N=34 (4,6:7,8,9,10) 13.70	
			15.00	-8.39									
Complete at 15.00m. Termination Reason: Achieved Scheduled Dep h													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_FE_005 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+7.86mOD	Coordinates	549202.60E, 261513.60N	Grid	OSGB
Date Started	10/08/2021	Date Completed	12/08/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	10/08/2021 12:10	10/08/2021 13:10	RL	DT		PCD	Insulated Hand Tools	None	Stable	
1.20	15.00	RC	10/08/2021 14:10	12/08/2021 10:10	RL	MV	Geobore S (146)	PCD	Comacchio 205			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
10/08/2021 17:30	6.50	6.50	0.00	End of Shift
11/08/2021 07:30	6.50	6.50	5.00	Start of shift
11/08/2021 17:30	15.00	15.00	0.00	End of Shift
12/08/2021 10:10	0.00	0.00		Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	8.00	AIR/MIST	0	White	
8.00	15.00	AIR/MIST	0	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
15.00	146	15.00	146						

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	15.00	Grout	

LOCATION DETAILS

Remarks

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL　Print date and time 12/09/2022 13:55　Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_FE_005 Sheet 1 of 2
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+7.86mOD	Coordinates	549202.60E, 261513.60N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Gravel angular to subrounded fine to medium of flint. Sand is fine to coarse. Occasional rootlets. (TOP) [TOPSOIL]			(0.30) 0.30	7.86		D 1 0.05-0.10 ES 2 0.20-0.25 B 3 0.10-0.40 D 4 0.40-0.50							
Stiff brown slightly sandy slightly gravelly CLAY. Gravel is angular to subrounded fine to medium of flint and quartz. Sand is fine to coarse. (SUPD) [SUPERFICIAL DEPOSITS]			(0.40) 0.70	7.86		ES 5 0.50-0.55 B 6 0.40-0.80 B 7 0.40-0.80							
Structureless CHALK composed of very stiff light greyish brown slightly gravelly sandy calcareous CLAY. Gravel is angular to subangular fine to medium of extremely weak calcareous siltstone and flint. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(0.50) 1.20	7.86		B 9 0.80-1.20 D 8 1.00-1.10 ES 8 1.10-1.20							
Structureless CHALK composed of firm light grey slightly gravelly calcareous CLAY. Gravel is subangular to subrounded fine to medium of extremely weak low density calcareous siltstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]			(1.04) 2.24	7.86		C 10 1.20-2.00	103	100			NA		
Very weak medium density light grey CHALK composed of calcareous SILTSTONE. Discontinuities are very closely spaced randomly orientated planar and rough occasionally stained orange, (CIRIA Grade B4) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B4		(0.76) 3.00	7.86		C 11 2.00-3.50	103	97	51	0	20 40 60		
Structureless CHALK composed of stiff light grey gravelly calcareous CLAY. Gravel is subangular to subrounded fine to medium of extremely weak low density calcareous siltstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(0.83) 3.83	7.86							NA		
Very weak to weak medium density light grey CHALK composed of calcareous SILTSTONE. Discontinuities are 0-40 degrees very closely to closely locally medium spaced planar and rough occasionally slightly stained orange and occasional calcareous silt infill (<3mm) and 80-90degrees undulating and rough rare stained orange. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 4.80m to 5.00m assumed zone of core loss.	Grade B3		(2.67) 6.50	7.86		C 12 3.50-5.00 C 13 5.00-6.50	103 103	87 100	78 93	67 55	40 110 220		
Assumed zone of core loss. Greyish CHALK. (Driller's Description). (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(1.10) 7.60	7.86		C 14 6.50-8.00	103	27			NR		
Very stiff dark grey slightly sandy CLAY with frequent pockets(<3mm x <6mm) of grey fine sand. Sand is fine to medium. (WMCK) [CAMBRIDGE GREENSAND MEMBER]			7.80	7.86									
Very stiff fissured dark grey CLAY. Fissures are extremely closely to very closely spaced randomly orientated planar and smooth occasionally slightly polished. Rare nodules (<6mm x <12mm) of siltstone. (GLT) [GAULT FORMATION] from 8.85m to 9.00m assumed zone of core loss. from 9.20m to 9.60m 1no. 90degrees fissure planar and smooth			(1.90) 9.70	7.86		C 15 8.00-9.00 C 16 9.00-10.00	103 103	85 82					
Very stiff fissured thinly laminated dark grey CLAY. Fissures are 0-30degrees closely to medium spaced planar and smooth and													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:55   Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_FE_005 Sheet 2 of 2
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+7.86mOD	Coordinates	549202.60E, 261513.60N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff fissured thinly laminated dark grey CLAY. Fissures are 0-30degrees closely to medium spaced planar and smooth and 80-90degrees planar and smooth. Rare nodules (<8mm x <12mm) of siltstone. (GLT) [GAULT FORMATION] from 9.82m to 10.00m assumed zone of core loss.	Unweathered					C 17 10.00-11.50	103	100			NA		
from 11.55m to 11.66m 1 No. discontinuity 60 degrees planar smooth polished			(5.30)			C 18 11.50-13.00	103	93					
from 12.68m to 12.78m 1 No. discontinuity 60 degrees planar smooth polished from 12.90m to 13.00m assumed zone of core loss. from 13.45m to 13.50m thickly laminated						C 19 13.00-14.50	103	83					
from 14.25m to 14.50m assumed zone of core loss.											NR		
from 14.90m to 15.00m assumed zone of core loss.			15.00	7.86		C 20 14.50-15.00	103	80			NA		
Complete at 15.00m. Termination Reason: Achieved Scheduled Depth													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:55   Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_FE_006 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+9.67mOD	Coordinates	549318.20E, 261491.90N	Grid	OSGB
Date Started	09/08/2021	Date Completed	10/08/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	09/08/2021 11:30	09/08/2021 12:30	RL	DT			Insulated Hand Tools	None	Stable	
1.20	10.00	RC	09/08/2021 12:30	10/08/2021 11:50	RL	AL	Geobore S (146)	PCD	Comacchio 205			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
09/08/2021 17:30	6.50	6.50	Dry	End of Shift
10/08/2021 07:30	6.50	6.50	5.20	Start of shift
10/08/2021 11:50	0.00	0.00	Dry	Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	10.00	AIR/MIST	0	White	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
10.00	146	10.00	146						

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	10.00	Bentonite	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Form No. SIEXPHOLEHDR Issue.Revision No. 2.02 Issue Date 22/06/2016

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_FE_006 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level +9.67mOD   Coordinates 549318.20E, 261491.90N   Grid OSGB
Hole Type IP+RC   Inclination

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
TOPSOIL: Dark brown slightly sandy slightly gravelly clay. Gravel is angular to subrounded fine to coarse of flint. Sand is fine to coarse. (TOP) [TOPSOIL]			(0.35) 0.35	9.67		D 1 0.00-0.10 ES 2 0.20-0.25 B 3 0.10-0.40							
Very soft light brownish yellow sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine and medium of mudstone, chalk and flint. (SUPD) [SUPERFICIAL DEPOSITS]			(0.85) 1.20	9.67		D 4 0.40-0.50 ES 5 0.50-0.55 B 6 0.40-0.80 B 9 0.80-1.20 D 7 1.00-1.10 ES 8 1.10-1.20							
Weak low density greyish white and greyish brown CHALK composed of calcareous SILTSTONE. (unable to determine CIRIA Grade) (WMCK) [WEST MELBURY CHALK FORMATION] from 1.60m to 2.00m non intact core (recovered as angular to subangular fine to coarse gravel sized fragments)			(0.80) 2.00	9.67		C 10 1.20-2.00	102	100	44	44	NI		
Weak low density CHALK composed of greyish white and greyish brown locally stained orangish brown calcareous SILTSTONE. (unable to determine CIRIA Grade) (WMCK) [WEST MELBURY CHALK FORMATION] from 3.40m to 3.60m non intact core (recovered as angular to subangular fine to coarse gravel sized fragments)			(1.60) 3.60	9.67		C 11 2.00-3.50	102	100			NI 1200 1200		
Very weak to weak low density greyish brown locally stained orange CHALK composed of calcareous SILTSTONE. Discontinuities are horizontal to subhorizontal closely to medium spaced planar rough with orangish brown staining, inclined closely to medium spaced planar and rough with clay infill (<1mm) and reddish brown staining. (CIRIA Grade B2/3) (WMCK) [WEST MELBURY CHALK FORMATION] from 4.00m to 4.15m non intact core (recovered as angular to subangular fine to coarse gravel sized fragments)	Grade B2/3		(4.64) 8.24	9.67		C 12 3.50-5.00 C 13 5.00-6.50 C 14 6.50-8.00	102 102 102	93 100 97	67 68 59	29 62 45	NI 200 400		
Weak CHALK composed of grey locally dark grey calcareous SILTSTONE. Discontinuities are 25 degrees medium spaced planar smooth clay infill (<1mm). (unable to determine CIRIA Grade) (WMCK) [WEST MELBURY CHALK FORMATION]			(0.46) 8.70	9.67		C 15 8.00-9.50	102	93	73	61	630 630 630		
Weak CHALK composed of dark grey calcareous SILTSTONE. Discontinuities: 1) 0 to 10 degrees extremely closely to closely spaced planar smooth clean. 2) 65 to 75 degrees planar smooth with clay smearing and fine gravel infill (<1mm). (Probably CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B3		(0.80) 9.50	9.67							150 150 170		
No recovery. Greyish white CHALK (Driller's Description) (WMCK) [WEST MELBURY CHALK FORMATION]			(0.50) 10.00	9.67			102	0					

Complete at 10.00m. Termination Reason: Achieved Scheduled Dep h

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

SOIL ENGINEERING
Part of the Bachy Soletanche Group

FINAL   Print date and time 12/09/2022 13:55   Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_OUT_001
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+3.86mOD	Coordinates	548438.40E, 261621.80N	Grid	OSGB
Date Started	19/08/2021	Date Completed	24/08/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	19/08/2021 15:00	19/08/2021 16:00	BC	DT		NA	Insulated Hand Tools	None	Stable	
1.20	20.00	RC	19/08/2021 16:00	24/08/2021 10:10	BC/RL	SAN	Geobore S	PCD	Comacchio 205			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
19/08/2021 17:30	1.20	0.00	1.03	End of Shift
20/08/2021 07:30	1.20	0.00	1.20	Start of shift
20/08/2021 15:00	8.70	8.70	1.20	End of Shift
23/08/2021 07:30	8.70	8.70		Start of shift
23/08/2021 17:30	20.00	20.00	2.50	End of Shift
24/08/2021 07:30	20.00	20.00	4.80	Start of shift
24/08/2021 10:10	0.00			Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	8.70	AIR/MIST	100	Grey	
8.70	20.00	AIR/MIST	100	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
20.00	146	20.00	146						

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	20.00	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL | Print date and time 12/09/2022 13:55 | Log checked by David Howard

Form No. SIEXPHOLEHDR | Issue.Revision No. 2.02 | Issue Date 22/06/2016

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_OUT_001 Sheet 1 of 3
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+3.86mOD	Coordinates	548438.40E, 261621.80N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Depth (Thickness)	Datum Level	Waterstrike
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Gravel is angular to subrounded fine to medium of flint. Sand is fine to coarse. Occasional roots. (TOP) [TOPSOIL]		(0.30) 0.30	3.56	
Firm greyish brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium flint. (SUPD) [SUPERFICIAL DEPOSITS]		(0.30) 0.60	3.26	
Soft dark brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of mixed lithologies. (SUPD) [SUPERFICIAL DEPOSITS]		(0.60) 1.20	2.66	
Assumed zone of core loss. CLAY/broken sandstone (Driller's description) (SUPD) [SUPERFICIAL DEPOSITS]		(0.90) 2.10	1.76	
Firm dark grey mottled yellowish brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded medium to coarse flint. (SUPD) [ALLUV UM]		2.30	1.56	
Assumed zone of core loss. Grey CLAY (Driller's description) (SUPD) [ALLUV UM]		(0.68) 2.98	0.88	
Soft dark grey mottled orangish brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium flint. (SUPD) [ALLUV UM]		3.20	0.66	
Firm fissured thinly laminated dark yellowish grey CLAY. Fissures are randomly orientated extremely closely spaced planar smooth. (GLT) [GAULT FORMATION]	Partially Weathered	(0.50) 3.70	0.16	
Firm fissured thickly laminated dark grey CLAY. Fissures are randomly orientated extremely closely spaced planar smooth. (GLT) [GAULT FORMATION]		(1.35) 5.05	-1.19	
Stiff fissured thickly laminated dark grey CLAY. Fissures are randomly orientated extremely closely spaced planar smooth. (GLT) [GAULT FORMATION] from 5.60m to 5.70m assumed zone of core loss.		(1.35) 6.40	-2.54	
Assumed zone of core loss. Grey CLAY (Driller's Description) (GLT) [GAULT FORMATION]		(0.80) 7.20	-3.34	
Very stiff fissured thickly laminated dark grey CLAY with rare nodules of siltstone (10mm x 10mm). Fissures are randomly orientated extremely closely spaced planar smooth. (GLT) [GAULT FORMATION] from 7.20m to 7.40m stiff		(0.90) 8.10	-4.24	
Assumed zone of core loss. Grey CLAY (Driller's Description) (GLT) [GAULT FORMATION]		(0.60) 8.70	-4.84	
Very stiff fissured thickly laminated dark grey CLAY with rare nodules of siltstone (10mm x 10mm). Fissures are randomly orientated extremely closely spaced planar smooth. (GLT) [GAULT FORMATION]		(0.40) 9.10	-5.24	
Very stiff fissured thinly and thickly laminated dark grey CLAY with occasional nodules of siltstone (<15mm x 15mm). Fissures are randomly orientated closely to very closely spaced planar smooth. (Unweathered) (GLT) [GAULT FORMATION]		9.15	-5.29	
Assumed zone of core loss. Grey CLAY (Driller's description)		(1.05)		

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	In Situ Test Details
D 1 0.05-0.40					
ES 2 0.20-0.25					
B 3 0.10-0.40					
D 4 0.40-0.50					
ES 5 0.50-0.55					
B 6 0.40-0.80					
B 9 0.80-1.20					
D 7 1.00-1.20					
ES 8 1.10-1.20					
C 10 1.20-2.20	102	10			
C 11 2.20-3.20	102	22			
C 12 3.20-3.70	102	100			
C 13 3.70-4.20	102	100			
C 14 4.20-5.70	102	93			
C 15 5.70-7.20	102	47			
C 16 7.20-8.70	102	60			
C 17 8.70-10.20	102	30			

IF
NR
NA
NR
NA
NR
NA
NR
NA
NR

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_OUT_001 Sheet 2 of 3
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+3.86mOD	Coordinates	548438.40E, 261621.80N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Depth (Thickness)	Datum Level	Waterstrike
Assumed zone of core loss. Grey CLAY (Driller's description) (GLT) [GAULT CLAY FORMATION]	Unweathered	10.20	-6.34	
Very stiff fissured thinly and thickly laminated dark grey CLAY with occasional nodules of siltstone (<15mm x 15mm). Fissures are randomly orientated closely to very closely spaced planar smooth. (Unweathered) (GLT) [GAULT CLAY FORMATION] from 11.60m to 11.70m assumed zone of core loss.		(1.70) 11.90	-8.04	
Very stiff fissured thinly and thickly laminated dark grey CLAY with frequent nodules of siltstone. Fissures are generally horizontal to subhorizontal with occasional vertical to subvertical very closely spaced planar smooth, occasional dusting of silt. (GLT) [GAULT FORMATION] at 12.85m one coprolite (10mm x 20mm) from 12.95m to 13.20m assumed zone of core loss.		(1.30) 13.20	-9.34	
No recovery. Grey CLAY (Driller's Description) (GLT) [GAULT FORMATION]		(1.50) 14.70	-10.84	
Very stiff fissured thinly and thickly laminated dark grey CLAY with rare nodules of siltstone (10mm x 20mm). Fissures are horizontal to subhorizontal closely spaced planar smooth with occasional dusting of silt. (GLT) [GAULT FORMATION]		(0.90) 15.60	-11.74	
Very stiff fissured thickly laminated dark grey CLAY with occasional nodules of siltstone (10mm x 20mm). Fissures are horizontal to subhorizontal occasionally 45 degrees closely to very closely spaced undulating polished, with frequent silt infill. (GLT) [GAULT FORMATION]		(2.80) 18.40	-14.54	
Assumed zone of core loss. Grey CLAY (Driller's description) (GLT) [GAULT FORMATION]		(0.80) 19.20	-15.34	
Very stiff fissured dark grey CLAY with frequent nodules of siltstone (10mm x 20mm). Fissures are generally horizontal to subhorizontal and occasionally vertical to subvertical closely to very closely spaced planar smooth. (GLT) [GAULT FORMATION]		(0.50) 19.70	-15.84	
Assumed zone of core loss. Grey CLAY (Driller's description)		(0.30) 20.00	-16.14	

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD
C 18 10.20-11.70	102	93		
C 19 11.70-13.20	102	83		
C 20 13.20-14.70	102	0		
C 21 14.70-16.20	102	90		
C 22 16.20-17.70	102	97		
C 23 17.70-19.20	102	47		
C 24 19.20-20.00	102	63		

IF (depth range)	IF
10.20-13.20	NA
13.20-14.70	NR
14.70-18.40	NA
18.40-19.20	NR
19.20-19.70	NA
19.70-20.00	NR

In Situ Test Details

Install-ation

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_OUT_001
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 3 of 3

Ground Level	+3.86mOD	Coordinates	548438.40E, 261621.80N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling		TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
						Details	Dia.						
Assumed zone of core loss. Grey CLAY (Driller's description) (GLT) [GAULT FORMATION]													
Complete at 20.00m. Termination Reason: Achieved Scheduled Depth													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL | Print date and time 12/09/2022 13:55 | Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_001
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+9.51mOD	Coordinates	549223.10E, 261382.70N	Grid	OSGB
Date Started	16/07/2021	Date Completed	20/07/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	16/07/2021 12:30	16/07/2021 13:30	MM	AL	NA	NA	Insulated Hand Tools	None	Stable	
1.20	15.40	RC	20/07/2021 07:30	20/07/2021 17:30	MM	DH	Geobore S (146)	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
16/07/2021 17:30	1.20	0.00	Dry	End of Shift
20/07/2021 07:30	1.20	0.00	Dry	Start of Shift
20/07/2021 17:30	15.40	2.00	8.00	Drilling Complete
21/07/2021 14:00	0.00	0.00	Dry	Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	7.70	AIR/MIST	90	White	
7.70	15.40	AIR/MIST	90	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
2.00	150	2.00	150						
15.40	146	15.40	146						

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type
9.50	S1	SP	1.50	9.50	Pipe 1	Pipe 1	0.00	2.00	50	PLAIN
						Pipe 1	2.00	9.00	50	SLOTTED
						Pipe 1	9.00	9.50	50	PLAIN

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
-0.50	0.00	Upstanding cover	
0.00	0.50	Concrete	
0.50	1.50	Bentonite	
1.50	9.50	Gravel backfill	
9.50	15.40	Bentonite	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_001
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 2

Ground Level	+9.51mOD	Coordinates	549223.10E, 261382.70N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Depth (Thickness)	Datum Level	IF
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Gravel is angular to subrounded fine to medium of flint. Sand is fine to coarse. Occasional roots. (TOP) [TOPSOIL]		0.10	9.41	
Soft to firm dark brown slightly gravelly sandy CLAY. Sand is fine and medium. Gravel is subangular to subrounded fine and medium of flint. (SUPD) [SUPERFICIAL DEPOSITS]		(0.60) 0.70	8.81	
Brown slightly gravelly clayey fine to coarse SAND. Gravel is subangular to subrounded fine and medium of flint. (SUPD) [SUPERFICIAL DEPOSITS]		(0.50) 1.20	8.31	
Structureless CHALK composed of firm fissured buff calcareous CLAY. Fissures are 0 to 40 degrees extremely closely to very closely spaced planar smooth occasionally stained light yellow and dark brown. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 1.20m to 1.34m assumed zone of core loss	Grade Dm	(0.70) 1.90 (0.30) 2.20	7.61 7.31	NA
Structureless CHALK composed of subangular fine to coarse GRAVEL. Clasts are extremely weak low density off-white stained yellow and brown calcareous SILTSTONE. (CIRIA Grade Dc) (WMCK) [WEST MELBURY CHALK FORMATION] from 2.10m to 2.20m very weak, locally intact and with light brown staining	Grade Dc	(1.00)		
Structureless CHALK composed of buff slightly gravelly calcareous CLAY. Gravel is angular to subangular fine and medium of very weak low density buff chalk. Recovered as very soft. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]		3.20	6.31	
Structureless CHALK composed of stiff to very stiff fissured greyish white calcareous CLAY. Fissures are randomly oriented very closely spaced undulating smooth and occasionally striated. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] at 3.38m with orangish brown surface staining from 3.50m to 3.70m very weak low density greyish white locally stained orangish brown chalk with rare thin laminations of grey clay. Recovered as non intact core (angular to subangular fine to coarse gravel sized fragments)		(1.62) 4.82	4.69	
Very weak low density greyish white CHALK composed of calcareous SILTSTONE. Discontinuities 1) 0 to 30 degrees closely to medium spaced planar smooth stained dark orangish brown. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 5.09m to 5.45m 1 No. discontinuity 90 degrees undulating smooth occasionally stained light brown	Grade B3	(1.18) 6.00	3.51	60 170 250
Structureless CHALK composed of very stiff fissured greyish white calcareous CLAY. Fissures are randomly orientated closely locally extremely closely to very closely spaced planar smooth occasionally stained brown. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(0.95) 6.95	2.56	NA
Very weak low density light grey CHALK composed of calcareous SILTSTONE with medium spaced thin beds of structureless chalk composed of stiff fissured grey calcareous clay. Fissures are 0 to 40 degrees planar and curved smooth occasionally polished. Discontinuities are randomly oriented very closely to closely spaced planar smooth occasionally stained dark brown. (Probably CIRIA Grade B4) (WMCK) [WEST MELBURY CHALK FORMATION] from 7.27m to 7.34m with orangish brown staining and recovered as non intact core (subangular fine to coarse gravel sized fragments) from 7.61m to 7.70m recovered as non intact core (clayey angular to subangular fine to coarse gravel sized fragments) from 7.85m to 8.05m weak from 8.39m to 8.58m recovered as non intact core (angular to subangular fine to coarse gravel sized fragments)	Grade B4	(1.75) 8.70	0.81	NI 40 80
Assumed zone of core loss. Marl CHALK. (Driller's description) (WMCK) [WEST MELBURY CHALK FORMATION]		(0.30) 9.00	0.51	NR
Very weak low density grey CHALK composed of calcareous SILTSTONE. Recovered as non intact core (angular to subangular fine to coarse gravel sized fragments). (CIRIA Grade - unable to determine) (WMCK) [WEST MELBURY CHALK FORMATION]		9.20 9.40	0.31 0.11	NI NA
Very stiff dark grey CLAY with occasional subangular to subrounded fine to coarse gravel size fragments of coprolite. (WMCK) [CAMBRIDGE GREENSAND MEMBER]		(0.60) 10.00	-0.49	

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	In Situ Test Details
ES 1 0.30-0.35					
B 2 0.50-0.55					
D 3 0.50-0.55					
ES 4 0.70-0.75					
B 6 1.00-1.10					
D 7 1.00-1.10					
ES 5 1.00-1.10					
C 8 1.20-2.20	102	86			
C 9 2.20-3.70	102	100			
C 10 3.70-4.70	102	100			
C 11 4.70-5.70	102	100	88	82	
C 12 5.70-6.70	102	100	30	30	
C 13 6.70-7.70	102	100	0	0	
EW 1 8.00					
C 14 7.70-9.00	102	77	11	11	
C 15 9.00-10.50	102	67	0	0	

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_001 Sheet 2 of 2
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+9.51mOD	Coordinates	549223.10E, 261382.70N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very stiff fissured thinly and thickly laminated dark grey CLAY. Fissures are 0 to 20 degrees very closely to closely spaced planar smooth polished clean. Rare nodules (<10mm) of pyrite. (GLT) [GAULT FORMATION]			(0.50) 10.50	-0.99							NR		
No recovery. CLAY (Driller's description) (GLT) [GAULT FORMATION]													
Very stiff fissured thinly and thickly laminated dark grey CLAY. Fissures are 0 to 20 degrees, rarely 90 degrees, very closely to closely spaced planar smooth polished clean. Rare nodules (<10mm) of pyrite. (GLT) [GAULT FORMATION] from 11.26m to 11.50m assumed zone of core loss	Unweathered		(1.12) 11.62	-2.11		C 16 10.50-11.50	102	76			NA		
No recovery. Grey CLAY (Driller's description) (GLT) [GAULT FORMATION]			(0.38) 12.00	-2.49		C 17 11.50-12.00	102	24			NR		
Very stiff fissured thinly and thickly laminated dark grey CLAY. Fissures are 0 to 20 degrees, rarely 90 degrees, very closely to closely spaced planar smooth polished clean. Rare nodules (<10mm) of pyrite. (GLT) [GAULT FORMATION] at 12.55m 1 No. rounded siltstone nodule (<15mm) at 13.84m 1 No. light greyish brown siltstone nodule (<20mm) from 14.32m to 14.40m with closely spaced fissures 70 degrees undulating smooth polished from 15.26m to 15.40m assumed zone of core loss	Unweathered		(3.40) 15.40	-5.89		C 18 12.00-13.50 C 19 13.50-14.50 C 20 14.50-15.40	102 102 102	100 100 84			NA		
Complete at 15.40m. Termination Reason: Achieved Scheduled Depth													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:55   Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_003A Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.25mOD	Coordinates	549432.90E, 261353.70N	Grid	OSGB
Date Started	26/08/2021	Date Completed	01/09/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	26/08/2021 14:30	26/08/2021 15:15	CH	DT	NA	NA	Insulated hand tools	None	Stable	
1.20	10.00	RC	26/08/2021 15:05	01/09/2021 09:45	CH	CJ	Geobore S (146)	PCD	Soilmec SM6			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
26/08/2021 17:30	5.50	5.50	5.30	End of Shift
27/08/2021 07:30	5.50	5.50	5.20	Start of shift
27/08/2021 10:05	7.00	7.00	1.00	End of Shift
31/08/2021 07:30	7.00	7.00	5.60	Start of shift
31/08/2021 17:30	10.00	10.00	5.60	End of Shift
01/09/2021 07:30	10.00	10.00	5.60	Start of shift
01/09/2021 10:00	0.00	0.00	Dry	Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
27/08/2021 08:25	7.00	7.00		5.69	20	

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	2.40	AIR/MIST	100	White	
2.40	7.00	AIR/MIST	100	Grey	
7.00	10.00	AIR/MIST	100	White	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
10.00	146	1.40	150						
		10.00	146						

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	10.00	Grout	

LOCATION DETAILS

Remarks
1. Rising and falling head test undertaken during progress of borehole.

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

SOIL ENGINEERING
Part of the Bachy Soletanche Group

FINAL   Print date and time 12/09/2022 13:55   Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_003A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 2

Ground Level	+10.25mOD	Coordinates	549432.90E, 261353.70N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
TOPSOIL: Dark brown slightly gravelly sandy CLAY. Gravel is angular to subrounded fine to coarse of flint. Sand is fine to coarse. (TOP) [TOPSOIL]			(0.30) 0.30	10.25		D 1 0.05-0.10 ES 2 0.20-0.25 B 3 0.10-0.40							
Firm brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint. (SUPD) [SUPERFICIAL DEPOSITS]			(0.40) 0.70	10.25		D 4 0.40-0.50 ES 5 0.50-0.55 B 6 0.40-0.80							
CHALK recovered as firm greyish slightly gravelly sandy calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint. (WMCK) [WEST MELBURY CHALK FORMATION]			(0.50) 1.20	10.25		B 9 0.80-1.20 D 7 1.00-1.10 ES 8 1.10-1.20							
Structureless CHALK composed of stiff greyish brown slightly gravelly calcareous CLAY. Gravel is subangular to subrounded fine and medium of very weak calcareous mudstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(0.75) 1.95	10.25		C 10 1.20-1.90	102	100			NA	K 1.45 - 7.00	
Very weak medium density greyish brown CHALK composed of calcareous MUDSTONE. Discontinuities: 1) randomly orientated extremely closely to very closely spaced planar undulating smooth brown black staining. (CIRIA Grade B4) (WMCK) [WEST MELBURY CHALK FORMATION] from 2.25m to 2.51m non intact recovered as angular to subangular fine to coarse gravel sized fragments with brown staining on fracture surfaces. Fracture induced.	Grade B4		(0.98) 2.93	10.25		C 11 1.90-2.40	102	100	15	0	NI 30 40		
Structureless CHALK composed of stiff to very stiff greyish brown gravelly calcareous CLAY. Gravel is subangular fine to coarse of very weak calcareous mudstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 4.16m to 4.40m medium bed of very weak medium density brownish grey calcareous mudstone	Grade Dm		(2.47) 5.40	10.25		C 12 2.40-4.00 C 13 4.00-5.50	102 102	100 100	27 0	0 0	NA	K 3.70 - 5.30 K 3.70 - 5.30 K 3.70 - 5.30 K 3.70 - 5.30 K 3.70 - 5.30	
Very weak medium density greyish brown CHALK composed of calcareous MUDSTONE. Discontinuities: 1) 0 to 35 degrees very closely spaced planar undulating smooth brown staining. 2) 60 to 90 degrees very closely to closely spaced planar undulating smooth brown staining. (CIRIA Grade B3/4) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B3/4		(0.88) 6.28	10.25	▽	C 14 5.50-7.00	102	100	22	11	NI 60 70	K 6.20 - 7.80	
Structureless CHALK composed of very stiff greyish brown gravelly calcareous CLAY. Gravel is subangular fine to coarse of very weak calcareous mudstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(0.56) 6.84	10.25							NA		
Very weak medium density greyish brown CHALK composed of calcareous MUDSTONE. (unable to determine CIRIA Grade) (WMCK) [WEST MELBURY CHALK FORMATION]	Undetermined		(0.49) 7.33	10.25	▼						490 490 490		
Structureless CHALK composed of stiff to very stiff gravelly calcareous CLAY. Gravel is subangular medium and coarse of very weak calcareous mudstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 7.47m to 7.54m thin bed of very weak medium density brownish grey calcareous mudstone from 7.69m to 7.78m thin bed of very weak low density brownish grey chalk composed of calcareous mudstone	Grade Dm		(0.86) 8.19	10.25			102	100	53	22	NA		
Very weak medium density light grey CHALK composed of calcareous MUDSTONE. Discontinuities: 1) 55 to 90 degrees very closely to closely spaced planar undulating smooth brown staining clay infill. (CIRIA Grade B4) (WMCK) [WEST MELBURY CHALK FORMATION] from 8.50m to 8.68m thin bed of weak high density light grey calcareous mudstone	Grade B4		(0.69) 8.88	10.25							20 50 180		
Very weak medium density light grey CHALK composed of calcareous MUDSTONE with rare shell fragment (<5mm x 8mm). Discontinuities: 1) 60 to 90 degrees closely to medium spaced planar undulating smooth clean. (CIRIA Grade A2) (WMCK) [WEST MELBURY CHALK FORMATION] from 8.91m to 9.06m thin bed of structureless chalk composed of stiff	Grade A2		(1.12) 10.00	10.25			102	100	63	56	NI 220 280		

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:55   Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_003A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 2

Ground Level	+10.25mOD	Coordinates	549432.90E, 261353.70N	Grid	OSGB		
Hole Type	IP+RC	Inclination					

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling		TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
						Details	Dia.						
Very weak medium density light grey CHALK composed of calcareous MUDSTONE with rare shell fragment (<5mm x 8mm). Discontinuities: 1) 60 to 90 degrees closely to medium spaced planar undulating smooth clean. (CIRIA Grade A2) (WMCK) [WEST MELBURY CHALK FORMATION] from 8.91m to 9.06m thin bed of structureless chalk composed of stiff slightly gravelly calcareous clay. Gravel is subangular to subrounded fine of very weak calcareous mudstone at 9.48m fossilised shell fragment (<5mm x 8mm) from 9.53m to 9.66m thin bed of structureless chalk composed of stiff gravelly calcareous clay. Gravel is subangular to subrounded fine and medium of very weak mudstone from 9.76m to 9.82m non intact core recovered as subangular medium and coarse gravel sized fragments of calcareous mudstone from 9.82m to 9.90m thin bed of weak high density light grey chalk composed of calcareous mudstone													
Complete at 10.00m. Termination Reason: Achieved Scheduled Dep h													

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_003B
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+10.25mOD	Coordinates	549429.80E, 261353.00N	Grid	OSGB
Date Started	02/09/2021	Date Completed	03/09/2021	Inclination	90° f om horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	02/09/2021 11:00	02/09/2021 12:00	Danny Cundill	SAN			Insulated hand tools	None	Stable	
1.20	10.00	CP	02/09/2021 12:00	02/09/2021 17:30	Danny Cundill	SAN			Dando 2000			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
02/09/2021 07:30	0.00	0.00	Dry	Start of shift
02/09/2021 17:30	10.00	2.20	5.30	Drilling Complete
03/09/2021 12:30	0.00	0.00	Dry	Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
02/09/2021 15:00	7.10	2.20		5.30	20	Medium

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water
1.20	S	N=28 (5,6:8,9,6,5)	AR3501	75	1.20	Dry
2.20	S	N=19 (3,4:4,4,5,6)	AR3501	75	2.20	Dry
3.20	S	N=30 (4,5:6,7,8,9)	AR3501	75	2.20	Dry
4.20	S	N=26 (3,5:6,6,7,7)	AR3501	75	2.20	Dry
5.20	S	N=20 (3,3:4,5,5,6)	AR3501	75	2.20	Dry
6.20	S	N=28 (4,5:5,5,8,10)	AR3501	75	2.20	Dry
7.20	S	50/235mm (8,10:12,15,15,8/10mm)	AR3501	75	2.20	5.30
8.20	S	50/230mm (7,12:13,15,16,6/5mm)	AR3501	75	2.20	5.30
9.20	S	50/225mm (10,12:15,15,16,4/0mm)	AR3501	75	2.20	5.30

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks

HOLE DIAMETER

Depth Base	Diameter
10.00	200

CASING DIAMETER

Depth Base	Diameter
2.20	200

DYNAMIC SAMPLING

Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	10.00	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

SOIL ENGINEERING

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_003B Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.25mOD	Coordinates	549429.80E, 261353.00N	Grid	OSGB		
Hole Type	IP+CP	Inclination	90° from horizontal				

Description of Strata	Depth (Thickness)	Datum Level
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY with frequent root, rootlet and plant materials. Gravel is angular to subangular fine to coarse of flint. Sand is fine to coarse. (TOP) [TOPSOIL]	0.20	10.05
Stiff light orangish brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is angular to subangular fine to coarse of chalk and flint. Sand is fine to coarse. (SUPD) [SUPERFICIAL DEPOSITS]	(0.70) 0.90	9.35
CHALK recovered as stiff light greyish brown slightly sandy slightly gravelly calcareous CLAY with occasional very soft light grey clay laminations. Gravel is subangular to subrounded of chalk and flint. Sand is fine to medium. (WMCK) [WEST MELBURY CHALK FORMATION]	(0.30) 1.20	9.05
CHALK recovered as firm to stiff light grey calcareous CLAY. (WMCK) [WEST MELBURY CHALK FORMATION]	(3.00) 4.20	6.05
CHALK recovered as very stiff fissured light grey localised yellowish orange stained calcareous CLAY. Fissures are very closely to closely spaced planar and rough. (WMCK) [WEST MELBURY CHALK FORMATION]	(5.80) 10.00	0.25

Sampling Details	In Situ Test Details
D 1 0.10	
B 2 0.10-0.20	
D 3 0.30	
B 4 0.40-0.70	
D 5 0.90	
B 6 1.00-1.20	
D 7 1.20-1.65 B 8 1.20-1.70	SPT(S) N=28 (5,6:8,9,6,5) 1.20
D 9 2.00	
D 10 2.20-2.65 B 11 2.20-2.70	SPT(S) N=19 (3,4:4,4,5,6) 2.20
D 12 3.00	
D 13 3.20-3.65 B 14 3.20-3.70	SPT(S) N=30 (4,5:6,7,8,9) 3.20
D 15 4.00	
D 16 4.20-4.65 B 17 4.20-4.70	SPT(S) N=26 (3,5:6,6,7,7) 4.20
D 18 5.00	
D 19 5.20-5.65 B 20 5.20-5.70	SPT(S) N=20 (3,3:4,5,5,6) 5.20
D 21 6.00	
D 22 6.20-6.65 B 23 6.20-6.70	SPT(S) N=28 (4,5:5,5,8,10) 6.20
D 24 7.00	
W 25 7.10	
D 26 7.20-7.59 B 27 7.20-7.70	SPT(S) 50/235mm (8,10:12,15,15,8/10mm) 7.20
D 28 8.00	
D 29 8.20-8.58 B 30 8.20-8.70	SPT(S) 50/230mm (7,12:13,15,16,6/5mm) 8.20
D 31 9.00	
D 32 9.20-9.58 B 33 9.20-9.70	SPT(S) 50/225mm (10,12:15,15,16,4/0mm) 9.20
D 34 10.00	

Complete at 10.00m. Termination Reason: Achieved Scheduled Depth

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_004
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+10.46mOD	Coordinates	549403.20E, 261143.10N	Grid	OSGB
Date Started	05/08/2021	Date Completed	09/08/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	05/08/2021 14:45	05/08/2021 15:15	Colin Howard	PS	NA	NA	Insulated hand tools	None	Stable	
1.20	15.10	RC	05/08/2021 15:15	09/08/2021 17:00	Colin Howard	MV	Geobore S (146)	PCD	Soilmec SM6			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
05/08/2021 17:00	2.80	0.00	Dry	End of Shift
06/08/2021 07:30	2.80	2.70	Dry	Start of shift
06/08/2021 12:00	13.45	2.70	4.50	End of Shift
09/08/2021 12:00	13.45	2.70	4.50	Start of shift
09/08/2021 13:30	15.10	2.70	4.50	Drilling complete
09/08/2021 17:00	0.00	0.00		Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
06/08/2021 09:20	6.50	2.70		4.49	20	Medium

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	2.80	AIR/MIST	100	Brown	
2.80	10.25	AIR/MIST	100	White	
10.25	15.10	AIR/MIST	100	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
2.70	150	2.70	150						
15.10	146	15.10	146						

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	15.10	Grout	

LOCATION DETAILS

Remarks

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_004 Sheet 1 of 2
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.46mOD	Coordinates	549403.20E, 261143.10N	Grid	OSGB	
Hole Type	IP+RC	Inclination				

Description of Strata	Weathering	Depth (Thickness)	Datum Level	Waterstrike	IF
TOPSOIL: Dark brown slightly gravelly slightly sandy CLAY. Gravel is subangular to subrounded fine to medium of flint. Sand is fine to coarse. (TOP) [TOPSOIL]		(0.40) 0.40	10.46		
Firm light greyish brown slightly gravelly CLAY with low cobble content. Gravel is subangular to subrounded fine and medium of mudstone and flint. Cobbles are subangular of flint. (SUPD) [SUPERFICIAL DEPOSITS]		(0.30) 0.70	10.46		
Structureless CHALK composed of stiff light brown and off white slightly gravelly silty calcareous CLAY. Gravel is subangular to subrounded fine and medium of flint. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(0.50) 1.20	10.46		
Extremely weak low density light greyish brown locally stained orangish brown CHALK composed of calcareous SILTSTONE. Possibly CIRIA Grade C2 (WMCK) [WEST MELBURY CHALK FORMATION] from 1.20m to 1.30m assumed zone of core loss from 1.30m to 1.40m recovered as non intact core (subangular to subrounded fine and medium gravel sized fragments) (Drilling induced) at 1.43m 1 No. discontinuity 5 degrees planar smooth stained orange and infilled with clay (>3mm) from 1.73m to 1.92m recovered as non intact core (very silty angular to subangular fine to coarse gravel sized fragments) with light yellowish brown and orangish brown staining		(1.57) 2.77	10.46		NI 300 850
Extremely weak to very weak low density light greyish brown mottled orangish brown CHALK composed of calcareous SILTSTONE. Discontinuities 1) 5 to 20 degrees very closely to closely spaced undulating smooth and rough stained orangish brown and locally with gravelly clay infill (<3mm) (CIRIA Grade B3/4) (WMCK) [WEST MELBURY CHALK FORMATION] from 2.77m to 2.86m recovered as non intact core (clayey subangular fine to coarse gravel sized fragments) from 3.01m to 3.20m recovered as non intact core (clayey subangular fine to coarse gravel sized fragments) from 3.20m to 3.35m extremely weak from 3.35m to 3.45m with abundant orangish brown staining and generally recovered as non intact core (subangular fine to coarse gravel sized fragments) from 3.60m to 3.80m recovered as non intact core (subangular fine to coarse gravel sized fragments) from 3.80m to 4.00m extremely weak from 4.16m to 4.35m extremely weak	Grade B3/4	(1.58) 4.35	10.46		NI 60 100
Very weak low density light greyish brown occasionally stained orangish brown CHALK composed of calcareous SILTSTONE. Discontinuities 1) 5 to 20 degrees closely to medium spaced undulating smooth locally clay smeared. (CIRIA Grade B2/3). (WMCK) [WEST MELBURY CHALK FORMATION] from 5.85m to 5.96m recovered as non intact core (angular fine and medium gravel sized fragments)	Grade B2/3	(1.61) 5.96	10.46	▽	NI 200 510
Very weak low density off white to light greyish brown rarely stained orangish brown CHALK composed of calcareous SILSTONE. Possibly CIRIA Grade B1. (WMCK) [WEST MELBURY CHALK FORMATION] at 7.07m 1 No. discontinuity 15 degrees undulating smooth with localised orange surface staining (possibly drilling induced) from 7.70m to 7.75m recovered as non intact core (subangular fine to coarse gravel sized fragments) and with abundant orangish brown staining from 7.75m to 7.80m 1 No. discontinuity 80 degrees planar smooth with abundant orangish brown and black surface staining from 8.05m to 8.12m recovered as non intact core (clayey subangular fine to coarse gravel sized fragments) from 8.60m to 8.70m with abundant reddish brown staining and very closely spaced discontinuities 65 degrees planar smooth		(2.74) 8.70	10.46	▼	NI 680 1110
Very weak medium density off white to light brownish grey rarely stained orangish brown CHALK composed of calcareous SILTSTONE. Possibly CIRIA Grade B2. (WMCK) [WEST MELBURY CHALK FORMATION] from 9.20m to 9.25m recovered as non intact core (very clayey angular to subangular fine and medium gravel sized fragments) from 9.70m to 9.80m 1 No. discontinuity 70 degrees planar rough with abundant orangish brown staining and infilled (<3mm) with fine gravel		(1.13) 9.83	10.46		

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD
D 1 0.05-0.10				
ES 2 0.20-0.25				
D 3 0.10-0.40				
D 4 0.40-0.50				
ES 5 0.50-0.55				
B 6 0.40-0.80				
B 9 0.80-1.20				
D 7 1.00-1.10				
ES 8 1.10-1.20				
C 10 1.20-1.90	102	86	59	54
C 11 1.90-2.80	102	100	94	94
C 12 2.80-4.35	102	100	37	6
C 13 4.35-5.85	102	100	100	100
C 14 5.85-7.35	102	95	88	88
C 15 7.35-8.85	102	100	89	89
C 16 8.85-10.25	102	100	94	94

Legend	In Situ Test Details	Install-ation

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_004
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 2

Ground Level +10.46mOD Coordinates 549403.20E, 261143.10N Grid OSGB

Hole Type IP+RC Inclination

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike
Very weak medium density off white to light brownish grey rarely stained orangish brown CHALK composed of calcareous SILTSTONE. Possibly CIRIA Grade B2. (WMCK) [WEST MELBURY CHALK FORMATION] from 9.70m to 9.80m 1 No. discontinuity 70 degrees planar rough with abundant orangish brown staining and infilled (<3mm) with fine gravel sized fragments of chalk					
Weak high density light grey CHALK composed of calcareous SILTSTONE. No discontinuities identified. CIRIA Grade - unable to determine. (WMCK) [WEST MELBURY CHALK FORMATION] from 10.10m to 10.25m recovered as non intact core (angular to subangular fine to coarse gravel and cobble sized fragments)			(0.42) 10.25	10.46	
Very weak to weak medium to high density light grey CHALK composed of calcareous SILTSTONE. No discontinuities identified. CIRIA Grade - unable to determine. (WMCK) [WEST MELBURY CHALK FORMATION] from 10.50m to 10.58m recovered as non intact core (subangular medium to coarse gravel sized fragments) from 10.80m to 11.07m extremely weak low density, locally grading to structureless chalk composed of gravelly calcareous clay			(0.82) 11.07	10.46	
Very weak medium density grey CHALK composed of calcareous SILTSTONE with occasional fragments (<5-10mm) of coprolite. CIRIA Grade - unable to determine. (WMCK) [WEST MELBURY CHALK FORMATION] at 11.07m 1 No. discontinuity 20 degrees planar smooth and with clay infill (<3mm)			(0.43) 11.50	10.46	
Very stiff dark greenish grey glauconitic sandy CLAY. Sand is fine. With frequent angular to subangular fragments of coprolites (<30mm). (WMCK) [CAMBRIDGE GREENSAND MEMBER] from 11.62m to 11.75m assumed zone of core loss			11.75	10.46	
Very stiff dark greenish grey slightly glauconitic CLAY. (GLT) [GAULT FORMATION]			(0.50) 12.25	10.46	
Very stiff fissured dark grey CLAY with occasional rounded nodules of light greyish brown siltstone (<5mm). Fissures are randomly orientated closely spaced planar smooth. (GLT) [GAULT FORMATION]			(2.85) 15.10	10.46	

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
C 17 10.25-11.75	102	91	72	69	NI 430 500		
C 18 11.75-12.25	102	100			NA		
C 19 12.25-13.45	102	100					
C 20 13.45-15.10	102	97					

Complete at 15.10m. Termination Reason: Achieved Scheduled Dep h

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_005A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+9.30mOD	Coordinates	549531.39E, 261127.88N	Grid	OSGB
Date Started	20/09/2021	Date Completed	23/09/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	20/09/2021 14:00	20/09/2021 15:00	PS	DT			Insulated Hand Tools	None	Stable	
1.20	30.00	RC	21/09/2021 07:30	23/09/2021 09:15	TW	AY	Geobore S (146)	PCD	T46 Beretta			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
20/09/2021 17:30	1.20	0.00	Dry	End of Shift
21/09/2021 07:30	1.20	0.00	Dry	Start of Shift
21/09/2021 17:30	23.20	3.00	5.21	End of Shift
22/09/2021 07:30	23.20	3.00	3.28	Start of Shift
22/09/2021 17:30	10.00	3.00	2.84	End of Shift
23/09/2021 07:30	10.00	3.00	3.48	Start of Shift
23/09/2021 09:15	0.00	0.00		Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
21/09/2021 10:30	6.40	2.20		4.62	20	

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
0.00	30.00	AIR/MIST	100	Grey	

HOLE DIAMETER

Depth Base	Diameter
3.00	150
30.00	146

CASING DIAMETER

Depth Base	Diameter
3.00	150
30.00	146

DYNAMIC SAMPLING

Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref
10.00	S1	SP	1.00	10.00	Pipe 1

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type
Pipe 1	0.00	1.50	50	PLAIN
Pipe 1	1.50	9.50	50	SLOTTED

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
-0.50	0.00	Upstanding cover	
0.00	0.50	Concrete	
0.50	1.00	Bentonite	
1.00	10.00	Gravel backfill	
10.00	30.00	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_005A
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 3

Ground Level +9.30mOD Coordinates 549531.39E, 261127.88N Grid OSGB

Hole Type IP+RC Inclination 90° from horizontal

Description of Strata
TOPSOIL: Dark brown slightly gravelly sandy CLAY. Gravel is angular to subrounded fine to medium. (TOP) [TOPSOIL]
Firm brown slightly gravelly sandy CLAY. Gravel is angular to subrounded fine to coarse of mixed lithologies including flint. (SUPD) [SUPERFICIAL DEPOSITS]
Firm light brown greyish slightly gravelly calcareous clayey CHALK. Gravel is angular to subrounded fine to coarse of mixed lithologies including flint. (WMCK) [WEST MELBURY CHALK FORMATION]
Structureless CHALK composed of soft yellowish brown gravelly calcareous CLAY. Gravel is subangular fine to medium of calcareous siltstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 1.20m to 1.34m angular to subangular coarse flint
Extremely weak low density yellowish brown CHALK composed of calcareous SILTSTONE. Discontinuities: 1) randomly orientated extremely closely to very closely spaced planar undulating smooth rough with orange staining and silt infill (<3mm) (incipient fractures). (CIRIA Grade B4) (WMCK) [WEST MELBURY CHALK FORMATION]
Recovered as non intact core (angular to subangular medium to coarse GRAVEL of extremely weak low density yellowish brown siltstone with orange staining). (unable to determine CIRIA Grade) (WMCK) [WEST MELBURY CHALK FORMATION]
Extremely weak low density yellowish brown CHALK composed of calcareous SILTSTONE. Discontinuities: 1) randomly orientated extremely closely to very closely spaced planar undulating smooth rough with orange staining and silt infill (<3mm) (incipient fractures). (CIRIA Grade B4) (WMCK) [WEST MELBURY CHALK FORMATION]
Very weak low to medium density yellowish brown CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 0-15 degrees closely to medium spaced undulating rough with orange staining. 2) randomly orientated extremely closely to very closely spaced planar undulating smooth with orange staining incipient fractures. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 3.70m to 3.76m structureless chalk composed of soft yellowish brown gravelly calcareous siltstone. Gravel is subangular fine to medium (probably drilling induced) from 4.80m to 4.86m recovered as non intact core (angular to subangular fine to medium gravel sized fragments of very weak low to medium density yellowish brown calcareous siltstone) from 5.43m to 5.56m recovered as partially non intact core (angular medium to coarse gravel sized fragments of very weak low to medium density yellowish brown calcareous siltstone) from 6.04m to 6.29m recovered as partially non intact core (angular medium to coarse gravel sized fragments of very weak low to medium density yellowish brown calcareous siltstone)
Very weak to weak medium density light grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 0-20 degrees closely locally medium spaced undulating rough with orange staining. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION]
Extremely weak to very weak low to medium density light grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 0-20 degrees very closely to closely spaced planar undulating smooth rough with silt infill (<3mm). 2) randomly orientated extremely closely to very closely spaced planar undulating smooth rough with silt infill. (CIRIA Grade B4) (WMCK) [WEST MELBURY CHALK FORMATION] from 7.57m to 7.77m recovered as partially non intact core (angular to subangular fine to medium gravel)
Weak medium density light grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 0-30 degrees closely spaced undulating smooth. (CIRIA Grade A3) (WMCK) [WEST MELBURY CHALK FORMATION] from 8.24m to 8.48m 1 No. discontinuity 80-90 degrees undulating rough from 8.48m to 8.50m extremely weak low density
Extremely weak to very weak low density light grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) randomly orientated extremely closely to very closely spaced planar undulating smooth rough clean. (CIRIA Grade B4) (WMCK) [WEST MELBURY CHALK FORMATION] from 8.96m to 9.12m recovered as partially non intact core (angular to

Weathering	Depth (Thick-ness)	Datum Level	Waterstrike
	(0.30)		
	0.30	9.00	
	(0.35)		
	0.65	8.65	
	(0.55)		
	1.20	8.10	
Grade Dm	(0.42)		
	1.62	7.68	
Grade B4	(0.36)		
	1.98	7.32	
	(0.33)		
	2.31	6.99	
Grade B4	(0.63)		
	2.94	6.36	
Grade B3	(3.38)		▽
	6.32	2.98	▼
Grade B3	(1.01)		
	7.33	1.97	
Grade B4	(0.55)		
	7.88	1.42	
Grade A3	(0.74)		
	8.62	0.68	
Grade B4	(0.50)		
	9.12	0.18	

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	In Situ Test Details
D 1 0.05-0.10					
B 2 0.10-0.40					
D 3 0.40-0.50					
B 4 0.40-0.80					
B 6 0.80-1.20					K 1.00 - 10.00
D 5 1.00-1.10					K 1.00 - 10.00
C 7 1.20-2.20	102	100	23	0	
C 8 2.20-3.70	102	100	55	51	
C 9 3.70-5.20	102	100	87	87	
C 10 5.20-6.70	102	100	73	67	
C 11 6.70-8.20	102	100	66	47	
C 12 8.20-9.70	102	100	70	58	

IF
NA
10
NI
10 25 30
NI 140 590
110 170 390
NI 40 50
30 110 180
NI 35 50

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_005A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 3

Ground Level	+9.30mOD	Coordinates	549531.39E, 261127.88N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike
Extremely weak to very weak low density light grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) randomly orientated extremely closely to very closely spaced planar undulating smooth rough clean. (CIRIA Grade B4) (WMCK) [WEST MELBURY CHALK FORMATION] from 8.96m to 9.12m recovered as partially non intact core (angular to subrounded fine to coarse gravel)	Grade A2		(1.80)		
Weak medium to high density light grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 0-35 degrees closely to widely spaced planar undulating smooth rough clean. (CIRIA Grade A2) (WMCK) [WEST MELBURY CHALK FORMATION] from 9.38m to 9.45m recovered as non intact core (angular fine to coarse gravel) from 10.16m to 10.30m recovered as non intact core (angular fine to coarse gravel) (probably drilling induced)			10.92	-1.62	
Firm grey sandy CLAY with frequent phosphatic nodules (<30mm x 10mm). (WMCK) [CAMBRIDGE GREENSAND MEMBER] from 10.92m to 11.03m frequent phosphatic nodules (<30mm x 10mm) from 11.03m to 11.10m light grey slightly clayey sandy fine to medium gravel of calcareous siltstone with phosphatic nodules (<30mm x 10mm)			11.10	-1.80	
Very stiff fissured thinly laminated dark grey CLAY. Fissures: 1) 5-10 degrees very closely to closely spaced planar undulating smooth occasionally polished. 2) 30-40 degrees closely spaced planar undulating smooth frequently polished. 3) 70-80 degrees closely to medium spaced planar undulating smooth polished. 4) 90 degrees planar undulating polished. (GLT) [GAULT FORMATION] from 11.20m to 11.30m slightly sandy. Sand is fine to coarse at 16.00m 2 No. light grey coprolites (<10mm) at 17.70m 1 No. black lignite nodule and lignite thin band (<2mm)			(10.60)		

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
C 13 9.70-11.20	102	100	79	73	NI 230 740		
C 14 11.20-12.70	102	100					
C 15 12.70-14.20	102	100					
C 16 14.20-15.70	102	100					
C 17 15.70-17.20	102	100					
C 18 17.20-18.70	102	100					
C 19 18.70-20.20	102	100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_005A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 3 of 3

Ground Level	+9.30mOD	Coordinates	549531.39E, 261127.88N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very stiff fissured thinly laminated dark grey CLAY. Fissures: 1) 5-10 degrees very closely to closely spaced planar undulating smooth occasionally polished. 2) 30-40 degrees closely spaced planar undulating smooth frequently polished. 3) 70-80 degrees closely to medium spaced planar undulating smooth polished. 4) 90 degrees planar undulating polished. (GLT) [GAULT FORMATION]	Unweathered					C 20 20.20-21.70	102	100			NA		
Very stiff fissured dark grey CLAY with occasional dark brown and brown phosphatic nodules (<10mm x 15mm) and rare shell fragments (<2mm x 25mm). Fissures are inclined 0-10 degrees, 25-70 degrees and 90 degrees very closely and closely spaced planar smooth very tight and polished. (GLT) [GAULT FORMATION] from 21.74m to 21.77m with occasional shell fragments (<2mm x 25mm)			21.70	-12.40		C 21 21.70-23.20	102	100					
						C 22 23.20-24.70	102	100					
			(6.60)			C 23 24.70-26.20	102	100					
from 25.80m to 26.03m 1 No. fissure inclined (70 degrees) planar smooth and polished						C 24 26.20-27.70	102	100					
from 27.65m to 27.95m with occasional very weak light brown siltstone nodules (<5mm x 20mm)													
Very stiff fissured light greenish grey CLAY with rare shell fragments (<2mm x 40mm). Fissures are horizontal and vertical (0-10 degrees and 85-90 degrees) very closely to medium spaced planar smooth very tight and locally polished. (GLT) [GAULT FORMATION]			28.30	-19.00		C 25 27.70-29.20	102	100					
from 29.00m to 29.10m with frequent possibly inoceramid shell fragments (<2mm x 25mm) of extremely weak light brown mudstone			(1.70)			C 26 29.20-30.00	102	100					
Complete at 30.00m. Termination Reason: Achieved Scheduled Depth			30.00	-20.70									

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Form No. SIEXPHOLELOG Issue.Revision No. 2.05 Issue Date 02/03/2018

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_005B
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+9.31mOD	Coordinates	549531.40E, 261125.40N	Grid	OSGB
Date Started	03/09/2021	Date Completed	08/09/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	06/09/2021 08:00	06/09/2021 09:00	DC	SAN			Insulated hand tools	None	Stable	Inspection pit: Hand dug
1.20	30.00	CP	06/09/2021 09:00	07/09/2021 17:30	DC	SAN			Dando 2000			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
06/09/2021 17:30	13.00	11.60	Dry	End of Shift
07/09/2021 07:30	13.00	11.60	9.00	Start of shift
07/09/2021 17:30	0.00	0.00	Dry	Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
06/09/2021 11:40	6.20	6.20	11.30	4.80	20	Medium

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water
1.20	S	N=18 (2,3:4,4,5,5)	AR3501	75	1.20	Dry
2.20	S	N=21 (2,3:4,5,6,6)	AR3501	75	2.20	Dry
3.20	S	N=33 (2,5:9,8,8,8)	AR3501	75	3.20	Dry
4.20	S	N=25 (3,4:4,6,8,7)	AR3501	75	4.20	Dry
5.20	S	N=17 (2,2:4,5,4,4)	AR3501	75	5.20	Dry
6.20	S	N=28 (3,5:6,7,7,8)	AR3501	75	6.20	4.80
7.20	S	N=29 (4,5:5,7,8,9)	AR3501	75	7.20	4.80
8.20	S	N=17 (2,2:3,4,5,5)	AR3501	75	8.20	4.80
9.20	S	N=17 (1,3:4,4,4,5)	AR3501	75	9.20	4.80
10.70	S	N=28 (3,5:6,7,7,8)	AR3501	75	10.70	4.80
12.20	S	N=25 (4,5:5,6,7,7)	AR3501	75	11.60	Dry
13.70	S	N=30 (3,4:6,7,8,9)	AR3501	75	11.60	10.50
15.20	S	N=33 (4,6:7,8,9,9)	AR3501	75	11.60	14.00
16.70	S	N=40 (4,7:9,9,10,12)	AR3501	75	11.60	15.20
18.20	S	N=47 (5,6:9,11,12,15)	AR3501	75	11.60	17.40
19.70	S	N=50 (5,8:10,13,13,14)	AR3501	75	11.60	18.50
21.20	S	53/275mm (5,7:10,13,14,16/50mm)	AR3501	75	11.60	20.20
22.70	S	50/250mm (6,9:11,14,16,9/25mm)	AR3501	75	11.60	21.00
24.20	S	50/240mm (6,8:12,14,17,7/15mm)	AR3501	75	11.60	23.40
25.70	S	50/225mm (6,8:12,17,21,0/0mm)	AR3501	75	11.60	23.90
27.20	S	50/225mm (7,9:12,16,22,0/0mm)	AR3501	75	11.60	26.10
28.70	S	50/220mm (7,10:13,17,20/70mm)	AR3501	75	11.60	27.50

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks

HOLE DIAMETER

Depth Base	Diameter
30.00	200

CASING DIAMETER

Depth Base	Diameter
11.60	200

DYNAMIC SAMPLING

Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	30.00	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Form No. SIEXPHOLEHDR Issue.Revision No. 2.02 Issue Date 22/06/2016

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_005B Sheet 1 of 3
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+9.31mOD	Coordinates	549531.40E, 261125.40N	Grid	OSGB		
Hole Type	IP+CP	Inclination					

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
TOPSOIL: Dark brown slightly sandy gravelly CLAY with occasional root and rootlet. Gravel is angular to subangular fine to coarse of flint. Sand is fine to coarse (TOP) [TOPSOIL]			(0.30) 0.30	9.31		D 1 0.10 B 2 0.10-0.30 ES 3 0.30							
Stiff brown slightly sandy gravelly CLAY with occasional rootlet. Gravel is angular to subangular fine to coarse of flint sand is fine to coarse. (SUPD) [SUPERFICIAL DEPOSITS]			(0.60) 0.90	9.31		D 4 0.35 ES 5 0.50 B 6 0.50-0.80							
CHALK recovered as stiff light brownish grey locally stained yellowish orange slightly gravelly calcareous CLAY. Gravel is angular to subangular medium to coarse of flint. (WMCK) [WEST MELBURY CHALK FORMATION]			(1.30) 2.20	9.31		D 7 0.90 ES 8 1.00 B 9 1.00-1.20 D 10 1.20-1.65 B 11 1.20-1.70 D 12 2.00						SPT(S) N=18 (2,3:4,4,5,5) 1.20	
CHALK recovered as stiff to very stiff light brownish grey locally stained yellowish orange slightly gravelly calcareous CLAY. Gravel is angular to subangular medium to coarse of flint. (WMCK) [WEST MELBURY CHALK FORMATION]			(4.00) 6.20	9.31	▽ ▼	D 13 2.20-2.65 B 14 2.20-2.70 D 15 3.00 D 16 3.20-3.65 B 17 3.20-3.70 D 18 4.00 D 19 4.20-4.65 B 20 4.20-4.70 D 21 5.00 D 22 5.20-5.65 B 23 5.20-5.70 D 24 6.00						SPT(S) N=21 (2,3:4,5,6,6) 2.20 SPT(S) N=33 (2,5:9,8,8,8) 3.20 SPT(S) N=25 (3,4:4,6,8,7) 4.20 SPT(S) N=17 (2,2:4,5,4,4) 5.20	
CHALK recovered as very stiff grey gravelly calcareous CLAY. Gravel is fine to coarse of calcareous siltstone. (WMCK) [WEST MELBURY CHALK FORMATION]			(2.00) 8.20	9.31		W 25 6.20 D 26 6.20-6.65 B 27 6.20-6.70 D 28 7.00 D 29 7.20-7.65 B 30 7.20-7.70 D 31 8.00						SPT(S) N=28 (3,5:6,7,7,8) 6.20 K 6.20 SPT(S) N=29 (4,5:5,7,8,9) 7.20	
CHALK recovered as very stiff grey very gravelly calcareous CLAY with medium cobble content. Gravel is subangular to subrounded fine to coarse of chalk and very weak siltstone. Cobbles are very weak to weak subrounded to rounded and tabular of calcareous siltstone. (WMCK) [WEST MELBURY CHALK FORMATION]			(2.50)			D 32 8.20-8.65 B 33 8.20-8.70 D 34 9.00 D 35 9.20-9.65 B 36 9.20-9.70 D 37 10.00						SPT(S) N=17 (2,2:3,4,5,5) 8.20 SPT(S) N=17 (1,3:4,4,4,5) 9.20	

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_005B
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 3

Ground Level	+9.31mOD	Coordinates	549531.40E, 261125.40N	Grid	OSGB
Hole Type	IP+CP	Inclination			

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
CHALK recovered as very stiff grey very gravelly calcareous CLAY with medium cobble content. Gravel is subangular to subrounded fine to coarse of chalk and very weak siltstone. Cobbles are very weak to weak subrounded to rounded and tabular of calcareous siltstone. (WMCK) [WEST MELBURY CHALK FORMATION]													
CHALK recovered as very stiff grey very gravelly calcareous CLAY. Gravel is subangular to subrounded fine to coarse of very weak calcareous siltstone and coprolite. (WMCK) [WEST MELBURY CHALK FORMATION]			10.70 (0.60)	9.31		D 38 10.70-11.15 B 39 10.70-11.20						SPT(S) N=28 (3,5:6,7,7,8) 10.70	
Stiff thinly laminated dark grey CLAY with rare fossil (5x10) and occasional coarse gravel size fragments of very weak brown siltstone. (GLT) [GAULT FORMATION]			11.30	9.31		D 40 11.30							
						D 41 12.20-12.65 B 42 12.20-12.70						SPT(S) N=25 (4,5:5,6,7,7) 12.20	
			(3.90)										
						D 43 13.70-14.15 B 44 13.70-14.20						SPT(S) N=30 (3,4:6,7,8,9) 13.70	
Very stiff thinly laminated dark grey CLAY with rare fossil (5x10) and occasional gravel size fragments of very weak brown siltstone. (GLT) [GAULT FORMATION]			15.20	9.31		D 45 15.20-15.65 B 46 15.20-15.70						SPT(S) N=33 (4,6:7,8,9,9) 15.20	
						D 47 16.70-17.15 B 48 16.70-17.20						SPT(S) N=40 (4,7:9,9,10,12) 16.70	
						D 49 18.20-18.65 B 50 18.20-18.70						SPT(S) N=47 (5,6:9,11,12,15) 18.20	
						D 51 19.70-20.15 B 52 19.70-20.20						SPT(S) N=50 (5,8:10,13,13,14) 19.70	

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:55   Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_005B
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 3 of 3

Ground Level	+9.31mOD	Coordinates	549531.40E, 261125.40N	Grid	OSGB
Hole Type	IP+CP	Inclination			

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff thinly laminated dark grey CLAY with rare fossil (5x10) and occasional gravel size fragments of very weak brown siltstone. (GLT) [GAULT FORMATION]													
						D 53 21.20-21.63 B 54 21.20-21.70						SPT(S) 53/275mm (5,7:10,13,14,16/50mm) 21.20	
						D 55 22.70-23.10 B 56 22.70-23.20						SPT(S) 50/250mm (6,9:11,14,16,9/25 mm) 22.70	
						D 57 24.20-24.59 B 58 24.20-24.70						SPT(S) 50/240mm (6,8:12,14,17,7/15 mm) 24.20	
			(14.80)										
						D 59 25.70-26.08 B 60 25.70-26.20						SPT(S) 50/225mm (6,8:12,17,21,0/0 mm) 25.70	
						D 61 27.20-27.58 B 62 27.20-27.70						SPT(S) 50/225mm (7,9:12,16,22,0/0 mm) 27.20	
						D 63 28.70-29.07 B 64 28.70-29.20						SPT(S) 50/220mm (7,10:13,17,20/70 mm) 28.70	
			30.00	9.31									
Complete at 30.00m. Termination Reason: Achieved Scheduled Dep h													

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_006
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+9.39mOD	Coordinates	549502.50E, 261260.10N	Grid	OSGB
Date Started	04/08/2021	Date Completed	06/08/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	04/08/2021 13:00	04/08/2021 17:30	Paul McCoy	MM	NA	NA	Insulated hand tools	None	Stable	
1.20	15.00	RC	05/08/2021 07:30	06/08/2021 12:00	Paul McCoy	MM	Geobore S	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
04/08/2021 17:30	1.20	0.00	Dry	End of Shift
05/08/2021 07:30	1.20	0.00	Dry	Start of Shift
05/08/2021 17:30	11.50	11.50	0.00	End of Shift
06/08/2021 07:30	11.50	11.50	0.00	Start of Shift
06/08/2021 12:00	15.00	11.50	0.00	Drilling Complete
06/08/2021 13:00	0.00	0.00	Dry	Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	15.00	WATER	100	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
15.00	146	15.00	146						

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
2.20	3.20	Self Boring Pressuremeter Test
7.10	7.50	Self boring pressuremeter test failed
7.50	9.00	HPD pocket drilled

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	15.00	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Form No. SIEXPHOLEHDR Issue.Revision No. 2.02 Issue Date 22/06/2016

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_006 Sheet 1 of 2
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+9.39mOD	Coordinates	549502.50E, 261260.10N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Depth (Thickness)	Datum Level	In Situ Test Details
TOPSOIL: Dark brown slightly gravelly sandy CLAY. Gravel is subangular to subrounded fine to coarse of flint. Sand is fine to coarse. (TOP) [TOPSOIL]		(0.34) 0.34	9.05	
Stiff greyish light brown slightly gravelly CLAY with low cobble content. Gravel is angular to subrounded fine to medium of flint and calcareous mudstone. Cobbles are subangular of flint. (SUPD) [SUPERFICIAL DEPOSITS]		(0.46) 0.80	8.59	
CHALK recovered as stiff light brown and greyish white slightly gravelly silty calcareous CLAY with low cobble content. Gravel is subangular to subrounded fine to medium of flint and calcareous mudstone. Cobbles are subangular of flint. (WMCK) [WEST MELBURY CHALK FORMATION]		(0.40) 1.20	8.19	
Structureless CHALK comprised of soft yellowish and greyish brown calcareous CLAY. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 1.20m to 1.43m assumed zone of core loss	Grade Dm	(1.00) 2.20	7.19	
No recovery. CHALK (Driller's description) (WMCK) [WEST MELBURY CHALK FORMATION]		(1.00) 3.20	6.19	WRSBP 2.70
Structureless CHALK composed of firm to stiff yellowish and greyish brown calcareous CLAY (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(0.63) 3.83	5.56	
Extremely weak low density light greyish brown CHALK composed of calcareous SILTSTONE (Unable to determine CIRIA Grade) (WMCK) [WEST MELBURY CHALK FORMATION] from 4.00m to 4.10m assumed zone of core loss from 4.50m to 4.60m weak from 5.20m to 5.25m 1 No. discontinuity 30 degrees planar rough with gravel infill (<2mm) from 5.35m to 5.60m assumed zone of core loss		(1.77) 5.60	3.79	
Very weak medium density light grey CHALK composed of calcareous SILTSTONE. (Unable to determine CIRIA Grade) (WMCK) [WEST MELBURY CHALK FORMATION] from 5.85m to 5.88m 1 No. discontinuity 40 degrees stepped rough with gravel infill (<2mm)		(0.60) 6.20	3.19	
Assumed zone of core loss. CHALK (Driller's description) (WMCK) [WEST MELBURY CHALK FORMATION]		(0.90) 7.10	2.29	
No recovery. CHALK (Driller's description) (WMCK) [WEST MELBURY CHALK FORMATION]		(0.40) 7.50	1.89	
Very weak to weak medium to high density light grey CHALK composed of very thinly bedded calcareous SILTSTONE. Discontinuities are 10 to 30 degrees closely to medium spaced planar rough locally gravel infilled (<2mm). (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 7.55m to 7.90m non intact core (recovered as subangular to subrounded fine to coarse gravel sized fragments)	Grade B3	(1.00) 8.50	0.89	HPD 8.00
Very weak medium density grey CHALK composed of calcareous SILTSTONE. Discontinuities are 10 to 20 degrees closely spaced planar smooth clean. (CIRIA Grade A3) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade A3	(0.50) 9.00	0.39	
Weak high density grey CHALK composed of thinly bedded calcareous SILTSTONE. (Unable to determine CIRIA Grade) (WMCK) [WEST MELBURY CHALK FORMATION] from 9.20m to 9.25m recovered as non intact core (subangular coarse gravel sized fragments of chalk) at 9.44m 1 No. discontinuity 5 degrees		(1.70)		

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF
D 1 0.05-0.10					
ES 2 0.20-0.25					
B 3 0.10-0.40					
D 4 0.40-0.50					
ES 5 0.50-0.55					
B 6 0.40-0.80					
B 9 0.80-1.20					
D 7 1.00-1.10					
ES 8 1.10-1.20					
C 10 1.20-2.20	103	77			NA
	103	0			NR
C 11 3.20-4.10	103	89	19	19	NA
C 12 4.10-5.60	103	84	84	84	110 1020 1020
C 13 5.60-7.10	103	40	40	40	260 260 340 NR
	103	0			
C 14 7.50-9.00	76	97	63	30	NI 120 120
C 15 9.00-10.00	103	100	90	75	NI 190 1260

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_006
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 2

Ground Level	+9.39mOD	Coordinates	549502.50E, 261260.10N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Depth (Thickness)	Datum Level
Weak high density grey CHALK composed of thinly bedded calcareous SILTSTONE. (Unable to determine CIRIA Grade) (WMCK) [WEST MELBURY CHALK FORMATION]		10.70	-1.31
Very stiff dark greenish grey slightly sandy glauconitic CLAY. (WMCK) [CAMBRIDGE GREENSAND MEMBER] from 10.89m to 10.90m occasional subrounded to rounded fine to medium gravel of coprolite		10.90	-1.51
Stiff to very stiff dark grey CLAY. (GLT) [GAULT FORMATION] from 11.41m to 11.50m 1 No. fissure 70 degrees planar smooth clean at 12.30m 1 No. pyrite nodule (<2mm) and disarticulated bivalve shells from 12.30m to 12.45m very closely spaced fissures 0 to 10 degrees planar smooth clean from 12.70m to 13.00m assumed zone of core loss from 14.10m to 14.23m 1 No. fissure 70 degrees planar smooth clean from 14.80m to 15.00m assumed zone of core loss	Unweathered	(4.10) 15.00	-5.61

Complete at 15.00m. Termination Reason: Achieved Scheduled Depth

Waterstrike	Sampling Details		Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
	C 16	10.00-11.50	103	100	47	47			
	C 17	11.50-13.00	103	87			NA		
	C 18	13.00-14.10	103	100					
	C 19	14.10-15.00	103	89					

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL — Print date and time 12/09/2022 13:55 — Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_007
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+9.18mOD	Coordinates	549643.80E, 261323.90N	Grid	OSGB
Date Started	01/09/2021	Date Completed	02/09/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	01/09/2021 13:00	01/09/2021 14:00	TW	DT	NA	NA	Insulated hand tools	None	Stable	
1.20	15.10	RC	01/09/2021 14:00	02/09/2021 17:30	TW	AY	Geobore S	PCD	T46 Beretta			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
01/09/2021 17:30	1.60	1.50	Dry	End of Shift
02/09/2021 07:30	1.60	1.50	Dry	Start of shift
02/09/2021 14:30	15.10	2.00	4.50	Drilling Complete
02/09/2021 17:30	0.00	0.00		Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
02/09/2021 00:00	7.30	2.00		4.00	20	Not sealed.

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	9.60	AIR/MIST	100	Cream	
9.60	15.10	AIR/MIST	100	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
2.00	150	2.00	150						
15.10	146								

INSTALLATION DETAILS						PIPE CONSTRUCTION					
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	15.10	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

SOIL ENGINEERING
Part of the Bachy Soletanche Group

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Form No. SIEXPHOLEHDR Issue.Revision No. 2.02 Issue Date 22/06/2016

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_007
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 2

Ground Level	+9.18mOD	Coordinates	549643.80E, 261323.90N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Depth (Thickness)	Datum Level
TOPSOIL: Dark brown slightly gravelly sandy CLAY. (TOP) [TOPSOIL]		(0.30) 0.30	8.88
Firm brown slightly gravelly sandy CLAY. Sand is fine and medium. Gravel is subangular to subrounded fine to coarse of flint. (SUPD) [SUPERFICIAL DEPOSITS]		(0.80) 1.10	8.08
Firm light greyish brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint. (SUPD) [SUPERFICIAL DEPOSITS]		1.20	7.98
Recovered as: Multicoloured slightly clayey angular to subrounded medium to coarse GRAVEL of flint. (SUPD) [SUPERFICIAL DEPOSITS] from 1.40m to 1.60m assumed zone of core loss		(0.60) 1.80	7.38
Structureless CHALK composed of soft to firm light grey with yellowish brown and orangish brown staining slightly sandy slightly gravelly calcareous CLAY. Sand is fine to medium. Gravel is subangular to subrounded fine to medium of extremely weak low density grey calcareous siltstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 2.00m to 2.10m assumed zone of core loss	Grade Dm	(1.19) 2.99	6.19
Structureless CHALK composed of firm yellowish brown gravelly calcareous CLAY with medium spaced thin beds of very weak low density yellowish brown chalk composed of calcareous siltstone. Gravel is angular to subangular medium of extremely weak chalk. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 3.45m to 3.60m assumed zone of core loss		(2.49) 5.48	3.70
Very weak medium density yellowish brown CHALK composed of calcareous SILTSTONE. Discontinuities 1) 0 to 20 degrees closely spaced planar smooth with silt infill (>3mm). 2) 70 degrees medium spaced planar smooth with silt infill (>3mm) and with orange staining. (CIRIA Grade C3) (WMCK) [WEST MELBURY CHALK FORMATION] from 6.40m to 6.60m assumed zone of core loss	Grade C3	(1.20) 6.68	2.50
Structureless CHALK composed of firm light grey gravelly CLAY. Gravel is angular to subrounded fine to coarse of very weak low to medium density chalk. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(1.42) 8.10	1.08
Weak medium density light grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 0 to 20 degrees closely spaced, locally medium spaced, undulating smooth. (CIRIA Grade A3) (WMCK) [WEST MELBURY CHALK FORMATION] from 8.59m to 8.75m structureless chalk composed of slightly clayey angular to subangular medium to coarse gravel. Gravel is very weak low density grey chalk composed of calcareous siltstone. Matrix is light grey.		(0.65) 8.75	0.43
Structureless CHALK composed of firm light grey gravelly calcareous CLAY. Gravel is angular to subangular medium of very weak low to medium density chalk. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 9.04m to 9.20m weak medium density light grey chalk composed of calcareous siltstone from 9.30m to 9.40m structureless chalk composed of slightly clayey angular to subangular medium and coarse gravel . Gravel is very weak low		(0.65) 9.40	-0.22
		9.60	-0.42

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
D 1 0.05-0.10							
ES 2 0.20-0.25							
B 3 0.10-0.40							
D 4 0.40-0.50							
ES 5 0.50-0.55							
B 6 0.40-0.80							
B 9 0.80-1.20							
D 7 1.00-1.10							
ES 8 1.10-1.20							
C 10 1.20-1.60	102	50			NA		
C 11 1.60-2.10	102	90					
C 12 2.10-3.60	102	90					
C 13 3.60-5.10	102	100					
C 14 5.10-6.60	102	87	23	17	NI 80 140		
C 15 6.60-8.10	102	100	0	0	NA		
C 16 8.10-9.60	102	93	19	19	NI 70 240		

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_007
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 2

Ground Level	+9.18mOD	Coordinates	549643.80E, 261323.90N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Structureless CHALK composed of firm light grey gravelly calcareous CLAY. Gravel is angular to subangular medium of very weak low to medium density chalk. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 9.30m to 9.40m structureless chalk composed of slightly clayey angular to subangular medium and coarse gravel . Gravel is very weak low density light grey chalk composed of calcareous siltstone. Matrix is light grey.													
Stiff grey CLAY with frequent coprolites (<30mm x 10mm). (WMCK) [CAMBRIDGE GREENSAND MEMBER] from 9.50m to 9.60m assumed zone of core loss													
Stiff fissured dark grey CLAY with rare fossilised coprolites (<20mm x 10mm). Fissures are randomly orientated extremely closely to very closely spaced undulating and planar, smooth, polished. (GLT) [GAULT FORMATION]						C 17 9.60-11.10	102	100					
						C 18 11.10-12.60	102	100					
			(5.50)								NA		
						C 19 12.60-14.10	102	100					
						C 20 14.10-15.10	102	100					
			15.10	-5.92									
Complete at 15.10m. Termination Reason: Achieved Scheduled Depth													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_009 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+11.04mOD	Coordinates	549374.10E, 260933.60N	Grid	OSGB
Date Started	28/07/2021	Date Completed	30/07/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	28/07/2021 16:00	28/07/2021 17:30	CB	MM	NA	NA	Insulated hand tools	None	Stable	
1.20	30.00	RC	29/07/2021 07:30	30/07/2021 17:30	CB	MM	Geobore S (146)	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
28/07/2021 17:30	1.20	0.00	Dry	End of Shift
29/07/2021 07:30	1.20	0.00	Dry	Start of Shift
29/07/2021 17:30	21.20	2.85	21.10	End of Shift
30/07/2021 07:30	21.20	2.85	21.00	Start of Shift
30/07/2021 15:30	30.00	2.85	4.82	Drilling Complete
02/08/2021 10:00	0.00	0.00		Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	6.20	AIR/MIST	90	White	
6.20	7.70	AIR/MIST	90	Grey	
7.70	9.20	AIR/MIST	90	White	
9.20	30.00	AIR/MIST	90	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
2.85	150	2.85	150						
30.00	146	30.00	146						

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref
12.00	S1	SP	1.50	12.00	Pipe 1
12.00	G1	SP	1.50	12.00	Pipe 2

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type
Pipe 1	0.00	1.50	50	PLAIN
Pipe 2	0.00	1.50	19	PLAIN
Pipe 2	1.50	3.00	19	SLOTTED
Pipe 1	1.50	11.50	50	SLOTTED
Pipe 1	11.50	12.00	50	PLAIN

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
-0.50	0.00	Upstanding cover	
0.00	0.50	Concrete	
0.50	0.75	Gravel backfill	
0.75	1.50	Bentonite	
1.50	12.00	Gravel backfill	
12.00	30.00	Grout	Cement / Bentonite Grout

LOCATION DETAILS

Remarks

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Form No. SIEXPHOLEHDR Issue.Revision No. 2.02 Issue Date 22/06/2016

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_009
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 3

Ground Level	+11.04mOD	Coordinates	549374.10E, 260933.60N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
TOPSOIL: Brown slightly gravelly fine to medium SAND. (TOP) [TOPSOIL]			(0.50) 0.50	11.04		D 1 0.05-0.10 ES 2 0.20-0.25 B 3 0.10-0.50							
Structureless CHALK composed of soft to firm greyish white gravelly CLAY. Gravel is subangular to subrounded fine to medium of flint and mudstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(0.70) 1.20	11.04		D 4 0.50-0.55 ES 5 0.60-0.65 B 6 0.50-1.00 D 7 1.00-1.10 ES 8 1.10-1.20							
Very weak medium density light greyish brown locally stained orangish brown CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 10 degrees medium to widely spaced stepped and undulating rough clean. (Possibly CIRIA Grade A2) (WMCK) [WEST MELBURY CHALK FORMATION] from 2.20m to 2.35m recovered as non intact core (subangular to subrounded fine to coarse gravel sized fragments) from 3.65m to 3.70m recovered as non intact core (subangular medium to coarse gravel sized fragments) (Drilling induced)			(2.50) 3.70	11.04		C 9 1.20-2.20 C 10 2.20-3.70	102 102	100 97	97 87	97 87	NI 450 950		
Very weak to weak medium to high density light greyish brown locally stained orangish brown CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 10 to 20 degrees medium spaced planar rough clean. (Possibly CIRIA Grade A1) (WMCK) [WEST MELBURY CHALK FORMATION] from 5.00m to 5.20m recovered as non intact core (subangular to subrounded fine to coarse gravel sized fragments) from 6.12m to 6.20m assumed zone of core loss			(3.00) 6.70	11.04		C 11 3.70-5.20 C 12 5.20-6.20	102 102	100 92	87 83	87 83			
Very weak to weak medium to high density light grey CHALK composed of calcareous SILTSTONE with closely spaced dark grey lenses of mudstone (<5-25mm x <5mm-50mm). Discontinuities: 1) 40 to 60 degrees medium spaced planar smooth stained orangish brown and with gravel infill (<2mm). (CIRIA Grade B2) (WMCK) [WEST MELBURY CHALK FORMATION] from 8.25m to 8.32m recovered as non intact core (angular fine to coarse gravel sized fragments)	Grade B2		(2.28) 8.98	11.04		C 13 6.20-7.70 C 14 7.70-9.20	102 102	99 98	76 70	75 57	NI 240 330		
Very weak medium density light grey and grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 25 to 30 degrees closely spaced planar smooth stained orangish brown. 2) 50 to 70 degrees medium to widely spaced stained orangish brown and with gravel infill (<3mm). (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 9.15m to 9.25m recovered as non intact core (subangular to subrounded fine to coarse gravel sized fragments)	Grade B3		(1.72)			C 15 9.20-10.70	102	100	89	66	NI 160 260		
						EW 1 10.00							

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_009
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 3

Ground Level	+11.04mOD	Coordinates	549374.10E, 260933.60N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very weak medium density light grey and grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 25 to 30 degrees closely spaced planar smooth stained orangish brown. 2) 50 to 70 degrees medium to widely spaced stained orangish brown and with gravel infill (<3mm). (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION]			10.70	11.04									
Very weak medium density light grey and grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 10 to 30 degrees medium spaced planar smooth clean. (CIRIA Grade A2) (WMCK) [WEST MELBURY CHALK FORMATION] at 10.93m 1 No. nodule (<10mm) of siltstone from 11.60m to 11.70m 1 No. discontinuity 75 degrees planar smooth clean from 12.05m to 12.20m recovered as non intact core (subangular to subrounded fine to coarse gravel sized fragments) from 12.20m to 12.45m becoming slightly sandy, locally glauconitic and with extremely closely spaced thick laminations to very thin beds of dark grey mudstone	Grade A2		(1.75) 12.45	11.04		C 16 10.70-12.20	102	100	69	67	NI 210 350		
Stiff to very stiff grey slightly sandy glauconitic CLAY. Sand is fine. (WMCK) [CAMBRIDGE GREENSAND MEMBER] from 12.54m to 12.56m with occasional medium to coarse gravel sized fragments of coprolite			12.70	11.04		C 17 12.20-13 70	102	100	17	14			
Stiff fissured thinly laminated dark greenish grey CLAY. Fissures are predominantly 30 degrees closely spaced planar smooth. (GLT) [GAULT FORMATION]			(2.50) 15.20	11.04		C 18 13.70-15.20	102	100					
Stiff fissured dark grey glauconitic CLAY. Fissures are 25 to 40 degrees medium to widely spaced planar smooth and polished. (GLT) [GAULT FORMATION]						C 19 15.20-16.70	102	100					
at 17.02m 1 No. nodule (<15mm) of siltstone						C 20 16.70-18.20	102	97					
						C 21 18.20-19.70	102	97					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log		Hole ID
Project No.	TE8364			BH_STW_009
Engineer	Mott MacDonald Bentley			
Employer	Barhale Limited			Sheet 3 of 3

Ground Level	+11.04mOD	Coordinates	549374.10E, 260933.60N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Stiff fissured dark grey glauconitic CLAY. Fissures are 25 to 40 degrees medium to widely spaced planar smooth and polished. (GLT) [GAULT FORMATION]	Unweathered		(14.80)			C 22 19.70-21.20	102	100			NA		
at 22.15m 1 No. nodule (<30mm) of siltstone						C 23 21.20-22.70	102	100					
from 23.50m to 23.80m slightly sandy. Sand is fine						C 24 22.70-24.20	102	100					
						C 25 24.20-25.70	102	100					
						C 26 25.70-27.20	102	98					
from 28.40m to 28.50m 1 No. fissure 70 degrees planar smooth						C 27 27.20-28.70	102	97					
			30.00	11.04		C 28 28.70-30.00	102	96					
Complete at 30.00m. Termination Reason: Achieved Scheduled Depth													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:55   Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_010A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+10.17mOD	Coordinates	549493.80E, 261023.60N	Grid	OSGB
Date Started	08/09/2021	Date Completed	10/09/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	08/09/2021 16:30	08/09/2021 17:30	CB	DT	NA	NA	Insulated hand tools	None	Stable	
1.20	30.20	RC	09/09/2021 07:30	10/09/2021 15:30	CB	CJ	Geobore S (146)	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
08/09/2021 17:30	1.20	0.00	Dry	End of Shift
09/09/2021 07:30	1.20	0.00	Dry	Start of Shift
09/09/2021 17:30	27.20	2.75	4.15	End of Shift
10/09/2021 07:30	27.20	2.75	3.60	Start of Shift
10/09/2021 15:30	30.20			Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	9.20	AIR/MIST	90	White	
9.20	30.20	AIR/MIST	90	Grey	

HOLE DIAMETER / CASING DIAMETER / DYNAMIC SAMPLING

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
30.20	146	2.75	150						

INSTALLATION DETAILS / PIPE CONSTRUCTION

Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	30.20	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

SOIL ENGINEERING
Part of the Bachy Soletanche Group

FINAL   Print date and time 12/09/2022 13:55   Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_010A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 4

Ground Level	+10.17mOD	Coordinates	549493.80E, 261023.60N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Gravel is angular to subrounded fine to medium of flint. Sand is fine to coarse. Occasional roots. (TOP) [TOPSOIL]			(0.30) 0.30	9.87		D 1 0.05-0.10 B 2 0.10-0.40							
Firm light brown slightly gravelly sandy CLAY. Gravel is angular to subrounded fine to medium of flint. (SUPD) [SUPERFICIAL DEPOSITS]			(0.90) 1.20	8.97		D 3 0.40-0.50 B 4 0.40-0.80 B 6 0.80-1.20 D 5 1.00-1.10							
Stiff to very stiff greyish brown slightly sandy slightly gravelly calcareous CLAY. Sand is fine. Gravel is angular to subrounded fine to coarse of flint. (SUPD) [SUPERFICIAL DEPOSITS]			(0.65) 1.85	8.32		C 7 1.20-2.20	102	95			NA		
Structureless CHALK composed of stiff greyish brown gravelly calcareous CLAY. Gravel is angular to subangular fine to coarse of very weak calcareous mudstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 2.15m to 2.20m assumed zone of core loss from 3.15m to 3.20m assumed zone of core loss at 3.41m thin lamination of orangish brown silt (<2mm) from 5.44m to 5.51m very stiff from 5.85m to 5.95m firm from 6.20m to 6.39m thin bed of very weak medium density chalk composed of calcareous mudstone	Grade Dm		(4.84) 6.69	3.48		C 8 2.20-3.20 C 9 3.20-4.70 C 10 4.70-6.20	102 102 102	95 100 100					
Very weak medium density greyish brown CHALK composed of calcareous MUDSTONE. (unable to determine CIRIA Grade) (WMCK) [WEST MELBURY CHALK FORMATION]			(0.58) 7.27	2.90		C 11 6.20-7.70	102	100	51	51			
Structureless CHALK composed of very stiff greyish brown gravelly calcareous CLAY. Gravel is angular to subangular fine to coarse of very weak calcareous mudstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(0.43) 7.70	2.47									
Weak high density greyish brown CHALK composed of calcareous MUDSTONE Discontinuities: 1) very closely to closely spaced undulating planar smooth with brown staining. 2) 60-85 degrees closely spaced undulating smooth with brown staining. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 8.20m to 8.42m medium bed of structureless chalk composed of very stiff gravelly calcareous clay. Gravel is angular to subangular fine to coarse of very weak calcareous mudstone	Grade B3		(0.72) 8.42	1.75		C 12 7.70-9.20	102	100	42	42	50 90 150		
Structureless CHALK composed of very stiff gravelly calcareous CLAY. Gravel is angular to subangular fine to coarse of very weak calcareous mudstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(0.65) 9.07	1.10							NA		
Weak high density light grey CHALK composed of calcareous MUDSTONE (unable to determine CIRIA Grade) (WMCK) [WEST MELBURY CHALK FORMATION]			(0.34) 9.41	0.76									
Structureless CHALK composed of stiff gravelly calcareous CLAY.	Grade Dm		(0.64)			C 13 9.20-10.70	102	100	57	57			

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_010A
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 4

Ground Level	+10.17mOD	Coordinates	549493.80E, 261023.60N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Structureless CHALK composed of stiff gravelly calcareous CLAY. Gravel is angular to subangular fine to coarse of very weak calcareous mudstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade A1		10.05	0.12									
Very weak medium density light grey CHALK composed of calcareous MUDSTONE. Discontinuities: 1) 5-10 degrees widely spaced planar smooth clean. 2) 60-90 degrees medium spaced undulating planar smooth clean. (WMCK) [WEST MELBURY CHALK FORMATION]			(1.69)								250 670 750		
						C 14 10.70-12.20	102	100	69	69			
from 11.45m to 11.53m thin bed of structureless chalk composed of stiff gravelly calcareous clay. Gravel is angular medium and coarse of very weak calcareous mudstone													
Very stiff dark grey glauconitic CLAY with abundant fossilised coprolites (<18mm x 30mm) and rare fossilised shell fragments (4mm x 6mm). CAMBRIDGE GREENSAND MEMBER (GLT) [GAULT FORMATION]			11.74 (0.31)	-1.57									
Stiff fissured dark grey CLAY with rare nodules of siltstone (11mm x 18mm). Fissures are extremely closely to closely spaced planar undulating smooth polished. (GLT) [GAULT FORMATION]			12.05	-1.88									
						C 15 12.20-13.70	102	100					
			(3.83)										
						C 16 13.70-15.20	102	100					
						C 17 15.20-16.70	102	100					
Very stiff fissured dark grey CLAY with rare nodules of siltstone (<11mm x 17mm). Subhorizontal to horizontal fissures are very closely to closely spaced planar undulating smooth clean. (GLT) [GAULT FORMATION]			15.88 (1.57)	-5.71									
from 17.18m to 17.45m 1 No. 90 degrees fissure planar polished													
Very stiff fissured dark grey CLAY with rare nodules of siltstone (9mm x 11mm). Fissures are randomly orientated planar undulating smooth polished. (GLT) [GAULT FORMATION]			17.45 (0.79)	-7.28		C 18 16.70-18.20	102	100					
Very stiff fissured dark grey CLAY with rare nodules of siltstone (6mm x 11mm). Fissures are randomly orientated planar undulating smooth. (GLT) [GAULT FORMATION]			18.24 (0.72)	-8.07									
Very stiff fissured dark grey CLAY with rare nodules of siltstone (10mm x 16mm). Fissures are subhorizontal to horizontal extremely closely to closely spaced planar undulating smooth polished and subvertical to vertical medium spaced planar undulating smooth polished. (GLT) [GAULT FORMATION]			18.96	-8.79		C 19 18.20-19.70	102	100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_010A Sheet 3 of 4
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.17mOD	Coordinates	549493.80E, 261023.60N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff fissured dark grey CLAY with rare nodules of siltstone (10mm x 16mm). Fissures are subhorizontal to horizontal extremely closely to closely spaced planar undulating smooth polished and subvertical to vertical medium spaced planar undulating smooth polished. (GLT) [GAULT FORMATION]						C 20 19.70-21.20	102	100					
from 21.45m to 21.47m occasional coprolites (<8mm x 13mm)						C 21 21.20-22.70	102	100					
			(6.91)			C 22 22.70-24.20	102	100					
						C 23 24.20-25.70	102	100			NA		
Very stiff fissured dark grey CLAY with rare nodules of siltstone (<11mm x 16mm). Fissures are randomly orientated extremely closely to very closely spaced planar undulating smooth polished. (GLT) [GAULT FORMATION]			25.87	-15.70									
			(1.45)			C 24 25.70-27.20	102	100					
from 27.05m to 27.32m 1 No. 85 degrees fissure planar polished													
Very stiff fissured dark grey CLAY with rare nodule of siltstone (<11mm x 16mm) and rare fossilised shell fragments (4mm x 8mm). Fissures are randomly orientated undulating planar smooth polished. (GLT) [GAULT FORMATION]			27.32	-17.15									
						C 25 27.20-28.70	102	100					
			(2.88)										
at 29.31m fossilised shell fragment (4mm x 5mm) at 29.42m fossilised shell fragment (4mm x 8mm)						C 26 28.70-30.20	102	100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL　　Print date and time 12/09/2022 13:55　　Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_010A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 4 of 4

Ground Level	+10.17mOD	Coordinates	549493.80E, 261023.60N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff fissured dark grey CLAY with rare nodule of siltstone (<11mm x 16mm) and rare fossilised shell fragments (4mm x 8mm). Fissures are randomly orientated undulating planar smooth polished. (GLT) [GAULT FORMATION] at 29.99m fossilised shell fragment (3mm x 6mm)			30.20	-20.03									
Complete at 30.20m. Termination Reason: Achieved Scheduled Depth													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL | Print date and time 12/09/2022 13:55 | Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Form No. SIEXPHOLELOG | Issue.Revision No. 2.05 | Issue Date 02/03/2018

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_010B
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+10.26mOD	Coordinates	549493.73E, 261023.34N	Grid	OSGB
Date Started	01/10/2021	Date Completed	07/10/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	01/10/2021 09:00	01/10/2021 10:00	DS	AM	NA	NA	Insulated Hand Tools	None	Stable	
1.20	30.00	CP	01/10/2021 10:00	07/10/2021 11:30	DC	AM	NA	NA	Dando 2000			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
01/10/2021 15:30	7.00	7.00	Dry	End of Shift
04/10/2021 07:30	7.00	7.00	4.20	Start of Shift
04/10/2021 17:30	16.50	13.00	4.50	End of Shift
05/10/2021 07:30	16.50	13.00	4.50	Start of Shift
05/10/2021 17:30	30.00	13.00	4.50	End of Shift
06/10/2021 07:30	30.00	13.00	4.50	Start of Shift
06/10/2021 17:30	12.00	12.00	0.50	End of Shift
07/10/2021 07:30	12.00	12.00	0.50	Start of Shift
07/10/2021 11:30				Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water
1.50	S	N=32 (4,6:7,7,8,10)	AR3501	75	1.50	Dry
2.50	S	N=34 (5,6:7,8,8,11)	AR3501	75	2.50	Dry
3.50	S	N=41 (3,4:6,10,10,15)	AR3501	75	3.50	Dry
4.50	S	N=36 (4,5:6,8,9,13)	AR3501	75	4.50	Dry
5.50	S	N=35 (4,4:8,7,9,11)	AR3501	75	5.50	Dry
6.50	S	N=29 (4,5:6,6,8,9)	AR3501	75	6.50	Dry
7.50	S	N=27 (3,4:5,6,7,9)	AR3501	75	7.50	4.50
8.50	S	N=32 (4,5:7,8,8,9)	AR3501	75	8.50	4.50
9.50	S	N=34 (4,6:7,8,9,10)	AR3501	75	9.50	4.50
10.50	S	N=28 (3,5:6,7,7,8)	AR3501	75	10.50	5.00
12.00	S	N=25 (2,3:4,6,7,8)	AR3501	75	12.00	4.50
13.50	S	N=32 (3,4:6,8,9,9)	AR3501	75	13.00	4.50
15.00	S	N=39 (3,5:8,9,10,12)	AR3501	75	13.00	4.50
16.50	S	N=46 (5,7:10,10,11,15)	AR3501	75	13.00	4.50
18.00	S	N=47 (3,6:8,10,12,17)	AR3501	75	13.00	4.50
19.50	S	50/285mm (4,8:10,12,15,13/60mm)	AR3501	75	13.00	4.50
21.00	S	50/280mm (7,9:11,13,15,11/55mm)	AR3501	75	13.00	4.50
22.50	S	50/270mm (6,8:11,14,16,9/45mm)	AR3501	75	13.00	4.50
24.00	S	50/270mm (7,8:10,13,17,10/45mm)	AR3501	75	13.00	4.50
25.50	S	50/235mm (7,9:12,14,18,6/10mm)	AR3501	75	13.00	4.50
27.00	S	50/235mm (8,10:12,15,17,6/10mm)	AR3501	75	13.00	4.50
28.50	S	50/230mm (8,9:13,15,18,4/5mm)	AR3501	75	13.00	4.50

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks

HOLE DIAMETER

Depth Base	Diameter
30.00	200

CASING DIAMETER

Depth Base	Diameter
13.00	200

DYNAMIC SAMPLING

Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref
12.00	S1	SP	11.50	12.00	Pipe 1

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type
Pipe 1	0.00	11.50	50	PLAIN
Pipe 1	11.50	12.00	50	SLOTTED

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
-0.50	0.00	Upstanding cover	
0.00	0.50	Concrete	
0.50	0.70	Gravel backfill	
0.70	11.50	Bentonite	
11.50	12.00	Gravel backfill	
12.00	30.00	Bentonite	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL   Print date and time 12/09/2022 13:55   Log checked by

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_010B
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 3

Ground Level	+10.26mOD	Coordinates	549493.73E, 261023.34N	Grid	OSGB
Hole Type	IP+CP	Inclination	90° from horizontal		

Description of Strata	Depth (Thickness)	Datum Level	Sampling Details	In Situ Test Details
TOPSOIL: Dark brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint and quartzite. (TOP) [TOPSOIL]	(0.40)		D 1 0.05 B 2 0.05-0.30 D 3 0.30	
	0.40	9.86	B 4 0.30-0.60	
Firm brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint and quartzite. (SUPD) [SUPERFICIAL DEPOSITS]	0.60	9.66	D 5 0.60	
	(0.50)		B 6 0.60-1.00	
Stiff brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and quartzite. (SUPD) [SUPERFICIAL DEPOSITS]	1.10	9.16	D 7 1.10	
	(0.40)		B 8 1.10-1.50	
CHALK recovered as very stiff light greyish brown slightly gravelly sandy calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint and calcareous siltstone.. (WMCK) [WEST MELBURY CHALK FORMATION]	1.50	8.76		SPT(S) N=32 (4,6:7,7,8,10) 1.50
CHALK recovered as stiff light grey mottled brown slightly gravelly sandy calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse very weak medium density calcareous siltstone. (WMCK) [WEST MELBURY CHALK FORMATION]			D 9 1.50-1.95 B 10 1.50-2.00	
			D 11 2.50-2.95 B 12 2.50-3.00	SPT(S) N=34 (5,6:7,8,8,11) 2.50
			D 13 3.50-3.95 B 14 3.50-4.00	SPT(S) N=41 (3,4:6,10,10,15) 3.50
	(6.50)		D 15 4.50-4.95 B 16 4.50-5.00	SPT(S) N=36 (4,5:6,8,9,13) 4.50
			D 17 5.50-5.95 B 18 5.50-6.00	SPT(S) N=35 (4,4:8,7,9,11) 5.50
from 6.50m to 8.50m gravelly			D 19 6.50-6.95 B 20 6.50-7.00	SPT(S) N=29 (4,5:6,6,8,9) 6.50
			D 21 7.50-7.95 B 22 7.50-8.00	SPT(S) N=27 (3,4:5,6,7,9) 7.50
CHALK recovered as very stiff grey slightly sandy gravelly calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse very weak medium density calcareous siltstone. (WMCK) [WEST MELBURY CHALK FORMATION]	8.00	2.26		
			D 23 8.50-8.95 B 24 8.50-9.00	SPT(S) N=32 (4,5:7,8,8,9) 8.50
	(3.40)			
			D 25 9.50-9.95 B 26 9.50-10.00	SPT(S) N=34 (4,6:7,8,9,10) 9.50

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_010B
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 3

Ground Level	+10.26mOD	Coordinates	549493.73E, 261023.34N	Grid	OSGB
Hole Type	IP+CP	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
CHALK recovered as very stiff grey slightly sandy gravelly calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse very weak medium density calcareous siltstone. (WMCK) [WEST MELBURY CHALK FORMATION]						D 27 10.50-10.95 B 28 10.50-11.00						SPT(S) N=28 (3,5:6,7,7,8) 10.50	
			11.40	-1.14		D 29 11.40							
Firm to stiff dark grey sandy CLAY. Sand is fine to medium. Frequent black speckling and black phosphate nodules (<20mm). (WMCK) [CAMBRIDGE GREENSAND MEMBER]			(0.50)									K 11.50 - 12.00 K 11.50 - 12.00	
			11.90	-1.64		D 30 11.90							
Very stiff fissured thinly laminated dark grey CLAY. Fissures are randomly orientated extremely closely to closely spaced undulating planar smooth occasionally polished. (GLT) [GAULT FORMATION]						D 31 12.00-12.45 B 32 12.00-12.50						SPT(S) N=25 (2,3:4,6,7,8) 12.00	
from 13.50m to 14.00m slightly sandy. Sand is fine						D 33 13.50-13.95 B 34 13.50-14.00						SPT(S) N=32 (3,4:6,8,9,9) 13.50	
						D 35 15.00-15.45 B 36 15.00-15.50						SPT(S) N=39 (3,5:8,9,10,12) 15.00	
						D 37 16.50-16.95 B 38 16.50-17.00						SPT(S) N=46 (5,7:10,10,11,15) 16.50	
						D 39 18.00-18.45 B 40 18.00-18.50						SPT(S) N=47 (3,6:8,10,12,17) 18.00	
						D 41 19.50-19.94 B 42 19.50-20.00						SPT(S) 50/285mm (4,8:10,12,15,13/60mm) 19.50	

AGS

Notes. All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by

Form No. SIEXPHOLELOG Issue.Revision No. 2.05 Issue Date 02/03/2018

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_010B
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 3 of 3

Ground Level	+10.26mOD	Coordinates	549493.73E, 261023.34N	Grid	OSGB
Hole Type	IP+CP	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very stiff fissured thinly laminated dark grey CLAY. Fissures are randomly orientated extremely closely to closely spaced undulating planar smooth occasionally polished. (GLT) [GAULT FORMATION]													
						D 43 21.00-21.43 B 44 21.00-21.50						SPT(S) 50/280mm (7,9:11,13,15,11/55mm) 21.00	
from 22.50m to 23.00m slightly sandy. Sand is fine						D 45 22.50-22.92 B 46 22.50-23.00						SPT(S) 50/270mm (6,8:11,14,16,9/45mm) 22.50	
						D 47 24.00-24.42 B 48 24.00-24.50						SPT(S) 50/270mm (7,8:10,13,17,10/45mm) 24.00	
			(18.10)										
						D 49 25.50-25.89 B 50 25.50-26.00						SPT(S) 50/235mm (7,9:12,14,18,6/10mm) 25.50	
from 27.00m to 30.00m very stiff						D 51 27.00-27.39 B 52 27.00-27.50						SPT(S) 50/235mm (8,10:12,15,17,6/10mm) 27.00	
from 28.50m to 29.00m slightly sandy. Sand is fine						D 53 28.50-28.88 B 54 28.50-29.00						SPT(S) 50/230mm (8,9:13,15,18,4/5mm) 28.50	
			30.00	19.74		D 55 30.00							
Complete at 30.00m. Termination Reason: Achieved Scheduled Depth													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

SOIL ENGINEERING
Part of the Bachy Soletanche Group

FINAL Print date and time 12/09/2022 13:55 Log checked by

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_011A Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+8.93mOD	Coordinates	549643.40E, 261116.60N	Grid	OSGB
Date Started	31/08/2021	Date Completed	03/09/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	31/08/2021 09:00	31/08/2021 10:00	Craig Blackett	DT	NA	NA	Insulated hand tools	None	Stable	
1.20	12.20	RC	31/08/2021 10:00	31/08/2021 17:30	Craig Blackett	AL	Geobore S (146)	PCD	Soilmec SM8			
12.20	14.50	RC	01/09/2021 09:45	01/09/2021 11:00	Craig Blackett	AL	HWF	PCD	Soilmec SM8			
14.50	21.20	RC	01/09/2021 11:00	01/09/2021 17:30	Craig Blackett	AL	Geobore S (146)	PCD	Soilmec SM8			
21.20	22.20	RO	02/09/2021 08:30	02/09/2021 09:45	Craig Blackett	CB	NA	Drag Bit	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
31/08/2021 17:30	12.20	1.45	3.10	End of Shift
01/09/2021 07:30	12.20	1.40	2.80	Start of shift
01/09/2021 17:30	21.20	2.50	3.30	End of Shift
02/09/2021 07:30	21.20	2.50	3.20	Start of shift
02/09/2021 17:30	30.20	2.50	3.70	Drilling Complete
03/09/2021 07:30	30.20	2.50	3.40	Start of shift
03/09/2021 11:00	0.00	0.00		Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
31/08/2021 11:30	4.00			0.00	0	Seepage noted, increased with depth. Rise not recorded.

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	7.70	AIR/MIST	90	White	
7.70	30.20	AIR/MIST	90	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
2.50	150	2.50	150						
30.20	146								

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
3.80	3.80	High Pressure Dilatometer Test
12.20	13.20	Self Boring Pressuremeter Test attempted. Aborted at 12.80m due to no penetration
13.80	13.80	High Pressure Dilatometer Test
21.70	21.70	Self Boring Pressuremeter Test

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	30.20	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

SOIL ENGINEERING
Part of the Bachy Soletanche Group

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Form No. SIEXPHOLEHDR Issue.Revision No. 2.02 Issue Date 22/06/2016

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_011A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 4

Ground Level	+8.93mOD	Coordinates	549643.40E, 261116.60N	Grid	OSGB
Hole Type	IP+RC+RO	Inclination	90° from horizontal		

Description of Strata	Weathering	Depth (Thickness)	Datum Level	Waterstrike
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Gravel is angular to subrounded fine to medium of flint. Sand is fine to coarse. Occasional roots. (TOP) [TOPSOIL]		(0.35) 0.35	8.58	
Firm brown slightly gravelly sandy CLAY. Sand is fine and medium. Gravel is angular to subrounded fine to coarse of flint. (SUPD) [SUPERFICIAL DEPOSITS]	Grade Dm	0.58	8.35	
Structureless CHALK composed of firm light greyish brown slightly gravelly sandy CLAY. Sand is fine and medium. Gravel is angular to subrounded fine to coarse of flint. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]		(0.62) 1.20	7.73	
Structureless CHALK composed of firm yellowish grey slightly sandy slightly gravelly CLAY. Sand is fine and medium. Gravel is subangular to subrounded fine to coarse of flint and extremely weak chalk. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]		(0.40) 1.60	7.33	
Structureless CHALK composed of firm yellowish grey slightly gravelly calcareous CLAY. Gravel is subangular to subrounded fine to coarse of extremely weak chalk. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]		(1.80) 3.40	5.53	
Structureless CHALK composed of stiff yellowish grey mottled and stained orange calcareous CLAY with closely spaced thin beds of extremely weak low density yellowish grey chalk composed of calcareous siltstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]		(1.20) 4.60	4.33	▽
Very weak low density yellowish grey CHALK composed of calcareous SILTSTONE with medium spaced medium beds of stiff yellowish grey calcareous clay. Discontinuities 1) 5 to 35 degrees medium spaced undulating rough with slight orangish brown staining. (CIRIA Grade B2) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B2	(2.85) 7.45	1.48	
Weak high density grey CHALK composed of grey calcareous SILTSTONE with medium spaced thin beds of stiff grey calcareous clay. Discontinuities 1) 10 to 45 degrees medium spaced undulating smooth with clay infill. (CIRIA Grade B2) (WMCK) [WEST MELBURY CHALK FORMATION]		(3.15)		

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD
D 1 0.05-0.10				
ES 2 0.20-0.25				
B 3 0.10-0.40				
D 4 0.40-0.50				
ES 5 0.50-0.55				
B 6 0.40-0.80				
B 9 0.80-1.20				
D 7 1.00-1.10				
ES 8 1.10-1.20				
C 10 1.20-2.20	102	100		
C 11 2.20-4.60	102	79		
C 12 4.60-4.70	102	100	100	100
C 13 4.70-6.20	102	100	100	85
C 14 6.20-7.70	102	100	100	100
C 15 7.70-9.20	102	100	80	60
	102	100	83	67
C 16 9.20-10.70				

IF	In Situ Test Details
NA	HPD 3.80
100 300 700	
50 286 530	

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_011A Sheet 2 of 4
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+8.93mOD	Coordinates	549643.40E, 261116.60N	Grid	OSGB
Hole Type	IP+RC+RO	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Weak high density grey CHALK composed of grey calcareous SILTSTONE with medium spaced thin beds of stiff grey calcareous clay. Discontinuities 1) 10 to 45 degrees medium spaced undulating smooth with clay infill. (CIRIA Grade B2) (WMCK) [WEST MELBURY CHALK FORMATION]			10.60	-1.67									
Stiff dark greenish grey slightly sandy slightly gravelly CLAY. Sand is fine. Gravel is subangular to subrounded fine to coarse of black coprolite. (WMCK) [CAMBRIDGE GREENSAND MEMBER]			(0.30) 10.90	-1.97									
Stiff fissured dark grey CLAY with occasional nodules of siltstone (<15mm x <30mm). Fissures are 0 to 10 degrees extremely closely spaced planar smooth polished. (GLT) [GAULT FORMATION]						C 17 10.70-12.20	102	93					
			(4.80)			C 18 12.20-14.50	73	96				HPD 13.50	
						C 19 14.50-15.20	102	100			NA		
from 15.20m to 15.60m with rare nodules of pyrite (40mm x 55mm). Fissures are 5 to 20 degrees closely spaced.													
Very stiff fissured dark grey CLAY with occasional nodules of siltstone (<15mm x <20mm). Fissures are 0 to 25 degrees closely spaced planar smooth polished. (GLT) [GAULT FORMATION]			15.70	-6.77		C 20 15.20-16.70	102	100					
			(5.50)			C 21 16.70-18.20	102	100					
						C 22 18.20-19.70	102	100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_011A Sheet 3 of 4
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+8.93mOD	Coordinates	549643.40E, 261116.60N	Grid	OSGB
Hole Type	IP+RC+RO	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very stiff fissured dark grey CLAY with occasional nodules of siltstone (<15mm x <20mm). Fissures are 0 to 25 degrees closely spaced planar smooth polished. (GLT) [GAULT FORMATION]						C 23 19.70-21.20	102	100					
Rotary open-hole drilling. Grey CLAY. (Driller's description) (GLT) [GAULT FORMATION]			21.20 (1.00)	-12.27							NR	WRSBP 21.70	
Very stiff fissured dark grey CLAY with occasional nodules of siltstone (<15mm x <20mm). Fissures are 0 to 25 degrees closely spaced planar smooth polished. (GLT) [GAULT FORMATION]			22.20	-13.27		C 24 22.20-22.70	102	100					
						C 25 22.70-24.20	102	100					
			(3.90)										
						C 26 24.20-25.70	102	100					
from 25.50m to 25.60m with rare fossilised shell fragments (<5mm x 5mm)													
Very stiff dark grey CLAY with rare nodules of siltstone (<15mm x 20mm). (GLT) [GAULT FORMATION]			26.10	-17.17		C 27 25.70-27.20	102	100			NA		
from 27.50m to 27.60m with rare fossilised shell fragments (5mm x 5mm)			(2.80)										
						C 28 27.20-28.70	102	100					
Very stiff fissured dark brownish grey slightly sandy CLAY with occasional fossilised shell fragments (10mm x 15mm). Sand is fine. (GLT) [GAULT FORMATION]			28.90 (1.30)	-19.97		C 29 28.70-30.20	102	100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_011A Sheet 4 of 4
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+8.93mOD	Coordinates	549643.40E, 261116.60N	Grid	OSGB
Hole Type	IP+RC+RO	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff fissured dark brownish grey slightly sandy CLAY with occasional fossilised shell fragments (10mm x 15mm). Sand is fine. (GLT) [GAULT FORMATION]			30.20	-21.27									
Complete at 30.20m. Termination Reason: Achieved Scheduled Dep h													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_011B
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+8.93mOD	Coordinates	549650.20E, 261112.30N	Grid	OSGB
Date Started	15/09/2021	Date Completed	21/09/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	15/09/2021 16:00	15/09/2021 17:00	DC		NA	NA	Insulated hand tools	None	Stable	
1.20	30.00	CP	15/09/2021 17:00	21/09/2021 10:30	DC	AM	NA	NA	Dando 2000			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
15/09/2021 17:30	2.00	2.00	Dry	End of Shift
16/09/2021 07:30	2.00	2.00	Dry	Start of Shift
16/09/2021 17:30	20.20	11.60	Dry	End of Shift
17/09/2021 07:30	20.20	11.60	3.50	Start of Shift
17/09/2021 17:30	30.00	11.60	3.50	End of Shift
20/09/2021 07:30	30.00	11.60	3.50	Start of Shift
20/09/2021 17:30	9.70	9.70	1.00	End of Shift
21/09/2021 07:30	9.70	9.70	1.00	Start of Shift
21/09/2021 10:30	0.00			Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
16/09/2021 09:00	4.20	4.20	10.70	3.00	20	Medium

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water
1.20	S	N=10 (2,2:2,2,3,3)	AR3501	75	1.20	Dry
2.20	S	N=25 (3,4:5,6,7,7)	AR3501	75	2.20	Dry
3.20	S	N=24 (2,4:5,6,6,7)	AR3501	75	3.20	Dry
4.20	S	N=29 (4,5:7,7,7,8)	AR3501	75	4.20	3.00
5.20	S	N=26 (3,4:5,6,7,8)	AR3501	75	5.20	3.00
6.20	S	N=26 (4,5:6,7,6,7)	AR3501	75	6.20	3.00
7.20	S	N=28 (4,5:6,7,8,7)	AR3501	75	7.20	3.00
8.20	S	N=34 (4,6:7,8,10,9)	AR3501	75	8.20	3.00
9.20	S	N=36 (5,6:7,9,10,10)	AR3501	75	9.20	3.00
10.70	S	N=23 (3,4:6,5,6,6)	AR3501	75	10.70	5.00
12.20	S	N=29 (4,6:8,7,7,7)	AR3501	75	11.60	Dry
13.70	S	N=31 (5,6:7,8,8,8)	AR3501	75	11.60	Dry
15.20	S	N=32 (5,6:7,8,9,8)	AR3501	75	11.60	Dry
16.70	S	N=35 (4,5:8,9,8,10)	AR3501	75	11.60	Dry
18.20	S	N=35 (5,7:7,8,9,11)	AR3501	75	11.60	Dry
19.70	S	N=43 (6,8:9,10,12,12)	AR3501	75	11.60	Dry
21.20	S	N=44 (6,7:9,10,11,14)	AR3501	75	11.60	3.50
22.70	S	N=54 (7,9:10,12,15,17)	AR3501	75	11.60	3.50
24.20	S	50/290mm (7,10:11,13,15,11/65mm)	AR3501	75	11.60	3.50
25.70	S	50/250mm (6,9:12,14,16,8/25mm)	AR3501	75	11.60	3.50
27.20	S	50/230mm (8,10:13,14,17,6/5mm)	AR3501	75	11.60	3.50
28.70	S	50/225mm (9,11:14,15,17,4/0mm)	AR3501	75	11.60	3.50

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
30.00	200	11.60	200						

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref
9.70	S1	SP	1.50	9.70	Pipe 1

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type
Pipe 1	0.00	1.50	50	PLAIN
Pipe 1	1.50	9.20	50	SLOTTED

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
-0.50	0.00	Upstanding cover	
0.00	0.50	Concrete	
0.50	0.80	Gravel backfill	
0.80	1.50	Bentonite	
1.50	9.70	Gravel backfill	
9.70	30.00	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL — Print date and time 12/09/2022 13:55 — Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_011B
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 3

Ground Level	+8.93mOD	Coordinates	549650.20E, 261112.30N	Grid	OSGB		
Hole Type	IP+CP	Inclination	90° from horizontal				

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. (TOP) [TOPSOIL]			(0.30) 0.30	8.63		D 1 0.10 B 2 0.10-0.20 D 3 0.30							
Firm orangish brown slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse. (SUPD) [SUPERFICIAL DEPOSITS]			(0.30) 0.60	8.33		B 4 0.30-0.50 D 5 0.60							
CHALK recovered as very stiff light brownish grey locally stained orangish yellow slightly gravelly calcareous clay. Gravel is subangular to subrounded fine to coarse of flint. (WMCK) [WEST MELBURY CHALK FORMATION]			(1.40) 2.00	6.93		B 6 0.60-1.00 D 7 1.20-1.65 B 8 1.20-1.70						SPT(S) N=10 (2,2:2,2,3,3) 1.20 K 1.50 - 9.70 K 1.50 - 9.70 K 1.50 - 9.70	
CHALK recovered as stiff fissured light grey mottled brown slightly gravelly sandy calcareous clay. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and extremely weak low density calcareous siltstone. Fissures are 10-30 degrees extremely closely to very closely spaced undulating rough randomly orientated. (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(1.20) 3.20	5.73		D 9 2.00 D 10 2.20-2.65 B 11 2.20-2.70 D 12 3.00						SPT(S) N=25 (3,4:5,6,7,7) 2.20	
CHALK recovered as stiff fissured light grey mottled brown slightly sandy slightly gravelly calcareous clay. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of very weak medium density calcareous siltstone. Fissures are extremely closely to very closely spaced planar undulating rough 80-90 degrees, 5-10 degrees randomly orientated. (WMCK) [WEST MELBURY CHALK FORMATION] from 4.20m to 7.00m gravelly subrounded calcareous medium density siltstone	Grade Dm		(3.80) 7.00	1.93		D 13 3.20-3.65 B 14 3.20-3.70 D 15 4.00 D 16 4.20-4.65 B 17 4.20-4.70 D 18 5.00 D 19 5.20-5.65 B 20 5.20-5.70 D 21 6.00 D 22 6.20-6.65 B 23 6.20-6.70						SPT(S) N=24 (2,4:5,6,6,7) 3.20 SPT(S) N=29 (4,5:7,7,7,8) 4.20 SPT(S) N=26 (3,4:5,6,7,8) 5.20 SPT(S) N=26 (4,5:6,7,6,7) 6.20	
CHALK recovered as very stiff fissured slightly sandy gravelly calcareous clay. Sand is fine to medium. Gravel is angular to subrounded fine to coarse of very weak medium density calcareous siltstone. Fissures are randomly orientated extremely closely to very closely spaced undulating planar rough. (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(3.70)			D 24 7.00 D 25 7.20-7.65 B 26 7.20-7.70 D 27 8.00 D 28 8.20-8.65 B 29 8.20-8.70 D 30 9.00 D 31 9.20-9.65 B 32 9.20-9.70 D 33 10.00						SPT(S) N=28 (4,5:6,7,8,7) 7.20 SPT(S) N=34 (4,6:7,8,10,9) 8.20 SPT(S) N=36 (5,6:7,9,10,10) 9.20	

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

SOIL ENGINEERING

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_011B
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 3

Ground Level	+8.93mOD	Coordinates	549650.20E, 261112.30N	Grid	OSGB
Hole Type	IP+CP	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
CHALK recovered as very stiff fissured slightly sandy gravelly calcareous clay. Sand is fine to medium. Gravel is angular to subrounded fine to coarse of very weak medium density calcareous siltstone. Fissures are randomly orientated extremely closely to very closely spaced undulating planar rough. (WMCK) [WEST MELBURY CHALK FORMATION]			10.70	-1.77									
Stiff fissured dark grey CLAY. Fissures are 5-20 degrees and 80-90 degrees extremely closely to very closely spaced planar undulating rough smooth occasionally polished. (GLT) [GAULT FORMATION]						D 34 10.70-11.15 B 35 10.70-11.20						SPT(S) N=23 (3,4:6,5,6,6) 10.70	
						D 36 12.00							
						D 37 12.20-12.65 B 38 12.20-12.70						SPT(S) N=29 (4,6:8,7,7,7) 12.20	
from 13.70m to 30.00m very stiff						D 39 13.70-14.15 B 40 13.70-14.20						SPT(S) N=31 (5,6:7,8,8,8) 13.70	
						D 41 15.20-15.65 B 42 15.20-15.70						SPT(S) N=32 (5,6:7,8,9,8) 15.20	
						D 43 16.70-17.15 B 44 16.70-17.20						SPT(S) N=35 (4,5:8,9,8,10) 16.70	
						D 45 18.20-18.65 B 46 18.20-18.70						SPT(S) N=35 (5,7:7,8,9,11) 18.20	
						D 47 19.70-20.15 B 48 19.70-20.20						SPT(S) N=43 (6,8:9,10,12,12) 19.70	

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_011B
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 3 of 3

Ground Level	+8.93mOD	Coordinates	549650.20E, 261112.30N	Grid	OSGB
Hole Type	IP+CP	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Stiff fissured dark grey CLAY. Fissures are 5-20 degrees and 80-90 degrees extremely closely to very closely spaced planar undulating rough smooth occasionally polished. (GLT) [GAULT FORMATION]													
from 21.20m to 30.00m fissures are very closely to closely spaced						D 49 21.20-21.65 B 50 21.20-21.70						SPT(S) N=44 (6,7:9,10,11,14) 21.20	
						D 51 22.70-23.15 B 52 22.70-23.20						SPT(S) N=54 (7,9:10,12,15,17) 22.70	
						D 53 24.20-24.64 B 54 24.20-24.70						SPT(S) 50/290mm (7,10:11,13,15,11/65mm) 24.20	
			(19.30)										
						D 55 25.70-26.10 B 56 25.70-26.20						SPT(S) 50/250mm (6,9:12,14,16,8/25mm) 25.70	
						D 57 27.20-27.58 B 58 27.20-27.70						SPT(S) 50/230mm (8,10:13,14,17,6/5mm) 27.20	
						D 59 28.70-29.08 B 60 28.70-29.20						SPT(S) 50/225mm (9,11:14,15,17,4/0mm) 28.70	
			30.00	21.07		D 61 30.00							
Complete at 30.00m. Termination Reason: Achieved Scheduled Depth													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL　Print date and time 12/09/2022 13:55　Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_012A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+8.12mOD	Coordinates	549712.90E, 261183.30N	Grid	OSGB
Date Started	09/08/2021	Date Completed	12/08/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	09/08/2021 14:30	09/08/2021 16:00	Craig Blackett	DT	NA	NA	Insulated hand tools	None	Stable	
1.20	30.35	RC	09/08/2021 16:00	12/08/2021 16:30	Craig Blackett	AL/MV	Geobore S (146)	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
09/08/2021 17:30	1.20	0.00	Dry	End of Shift
10/08/2021 07:30	1.20	0.00	Dry	Start of shift
10/08/2021 17:30	8.70	8.70	1.20	End of Shift
11/08/2021 07:30	8.70	8.70	1.20	Start of shift
11/08/2021 17:30	21.35	21.35	2.80	End of Shift
12/08/2021 07:30	21.35	21.35	2.25	Start of shift
12/08/2021 16:30	0.00	0.00		Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	6.70	WATER	90	White	
6.70	8.70	WATER	50	White	
8.70	11.20	AIR/MIST	90	White	
11.20	30.35	AIR/MIST	90	Grey	

HOLE DIAMETER

Depth Base	Diameter
4.40	150
30.35	146

CASING DIAMETER

Depth Base	Diameter
4.40	150
30.35	146

DYNAMIC SAMPLING

Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
4.20	4.20	Self Boring Pressuremeter Test
7.70	7.70	High pressure dilatometer test
13.20	13.20	Self Boring Pressuremeter Test

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	30.35	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

SOIL ENGINEERING

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Form No. SIEXPHOLEHDR Issue.Revision No. 2.02 Issue Date 22/06/2016

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_012A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 4

Ground Level	+8.12mOD	Coordinates	549712.90E, 261183.30N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
MADE GROUND: Dark brown slightly gravelly sandy clay with frequent rootlets. Sand is fine to coarse. Gravel sized fragments are angular to subrounded fine to medium of flint, quartz and brick. (MGR) [MADE GROUND]			(0.50) 0.50	8.12		D 1 0.05 ES 2 0.20 B 3 0.20-0.40							
Structureless CHALK composed of stiff light grey slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and extremely weak chalk composed of siltstone. (WMCK) [WEST MELBURY CHALK FORMATION]			(0.70) 1.20	8.12		D 4 0.50 ES 5 0.60 B 6 0.50-0.80 D 7 0.90 ES 8 1.00 B 9 1.00-1.20							
Structureless CHALK composed of stiff light grey stained orangish-brown gravelly calcareous CLAY. Gravel is subangular to subrounded fine to medium of very weak low density calcareous siltstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(0.50) 1.70	8.12		C 10 1.20-2.20	102	100	0	0	NA		
Very weak medium density light grey CHALK composed of calcareous SILTSTONE. Discontinuities are 1) 0-30 degrees extremely closely to very closely spaced planar rough occasionally stained orange. 2) 70-90 degrees closely spaced planar rough occasionally stained orange. (CIRIA Grade B4/5) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B4/5		(1.13) 2.83	8.12		C 11 2.20-3.70	102	100	100	47	15 20 60		
Very weak medium density light grey CHALK composed of calcareous SILTSTONE. Discontinuities are 0-20 degrees very closely to closely spaced planar rough with rare orange staining. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B3		(0.87) 3.70	8.12							40 200 200		
Recovered as: Firm light grey gravelly calcareous CLAY. Gravel is subangular fine to medium of extremely weak slow and medium density calcareous siltstone. (possible Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]			(0.45) 4.15	8.12		C 12 3.70-5.20	102	30	16	16	NA		
Assumed zone of core loss. CHALK (Driller's Description) (WMCK) [WEST MELBURY CHALK FORMATION]			(1.05) 5.20	8.12							NR	WRSBP 4.20	
Very weak to weak medium density light grey CHALK composed of calcareous SILTSTONE. Discontinuities are 1) 0-20 degrees very closely to closely spaced planar and rough occasionally stained orange. 2) 40-60 degrees closely spaced planar and rough occasionally stained orange. 3) 70-90 degrees widely spaced planar and rough occasionally stained orange. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B3		(6.10)			C 13 5.20-6.70 C 14 6.70-8.70 C 15 8.70-9.70	102 73 102	99 100 100	99 100 100	76 77 87	20 160 200	HPD 7.70	

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_012A
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 4

Ground Level	+8.12mOD	Coordinates	549712.90E, 261183.30N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very weak to weak medium density light grey CHALK composed of calcareous SILTSTONE. Discontinuities are 1) 0-20 degrees very closely to closely spaced planar and rough occasionally stained orange. 2) 40-60 degrees closely spaced planar and rough occasionally stained orange. 3) 70-90 degrees widely spaced planar and rough occasionally stained orange. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION]			11.30	8.12		C 16 9.70-11.20	102	100	100	89			
Very stiff dark grey gravelly CLAY. Gravel is subrounded medium to coarse of coprolites. (WMCK) [CAMBRIDGE GREENSAND MEMBER]			11.43	8.12									
Very stiff fissured thinly laminated dark grey CLAY. Fissures are 0-40 degrees very closely to closely spaced planar undulating smooth and 70-90 degrees medium spaced planar and smooth. (GLT) [GAULT FORMATION]			(1.02) 12.45	8.12		C 17 11.20-12.70	102	83					
Assumed zone of core loss. Grey CLAY (Driller's Description). (GLT) [GAULT FORMATION]			(0.98) 13.43	8.12		C 18 12.70-13.85	102	28				WRSBP 13.20	
Very stiff fissured thinly laminated dark grey CLAY. Fissures are 0-40 degrees very closely to closely spaced planar undulating smooth and 70-90 degrees medium spaced planar and smooth. (GLT) [GAULT FORMATION] from 13.85m to 16.85m occasional nodules of siltstone (5mm x 5mm).						C 19 13.85-15.35	102	100					
						C 20 15.35-16.85	102	100					
			(8.12)			C 21 16.85-18.35	102	100					
from 18.85m to 21.55m rare nodules (<5mm x 5mm) of pyrite.						C 22 18.35-19.85	102	100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_012A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 3 of 4

Ground Level	+8.12mOD	Coordinates	549712.90E, 261183.30N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very stiff fissured thinly laminated dark grey CLAY. Fissures are 0-40 degrees very closely to closely spaced planar undulating smooth and 70-90 degrees medium spaced planar and smooth. (GLT) [GAULT FORMATION] from 20.85m to 21.45m 2 No. nodules (<5mm x 5mm) of siltstone.						C 23 19.85-21.35	102	100					
Very stiff fissured thinly laminated dark grey CLAY with rare nodules (5 x 7mm) of siltstone. Fissures are 0 to 30 degrees closely to medium spaced planar rough. (GLT) [GAULT FORMATION] from 21.55m to 24.35m rare nodules (5mm x 7mm) of siltstone.			21.55	8.12		C 24 21.35-22.85	102	100					
			(2.80)			C 25 22.85-24.35	102	100					
Very stiff fissured thinly laminated grey CLAY. Fissures are 0 to 30 degrees closely spaced planar smooth. (GLT) [GAULT FORMATION]	Unweathered		24.35	8.12		C 26 24.35-25.85	102	100			NA		
from 25.85m to 26.50m occasional nodules of siltstone (<5mm x 5mm)						C 27 25.85-27.35	102	100					
			(6.00)			C 28 27.35-28.85	102	100					
						C 29 28.85-30.35	102	100					

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_012A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 4 of 4

Ground Level	+8.12mOD	Coordinates	549712.90E, 261183.30N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff fissured thinly laminated grey CLAY. Fissures are 0 to 30 degrees closely spaced planar smooth. (GLT) [GAULT FORMATION]			30.35	8.12									

Complete at 30.35m. Termination Reason: Achieved Scheduled Depth

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

SOIL ENGINEERING

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_012B
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+8.15mOD	Coordinates	549712.20E, 261182.10N	Grid	OSGB
Date Started	13/09/2021	Date Completed	15/09/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	13/09/2021 10:00	13/09/2021 11:00	Danny Cundill	SAN			Insulated Hand tools	None	Stable	Inspection pit: Hand dug
1.20	30.00	CP	13/09/2021 11:00	15/09/2021 15:00	Danny Cundill	SAN			Dando 2000			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
13/09/2021 17:30	12.00	11.60	6.00	End of Shift
14/09/2021 07:30	12.00	11.60	3.00	Start of shift
14/09/2021 17:30	30.00	11.60	Dry	End of Shift
15/09/2021 07:30	30.00	11.60	10.00	Start of shift
15/09/2021 15:00	0.00	0.00		Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
13/09/2021 13:00	5.20	5.20		4.00	20	Medium

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water
1.20	S	N=24 (3,4:5,6,7,6)	AR3501	75	1.20	Dry
2.20	S	N=26 (3,5:7,6,6,7)	AR3501	75	2.20	Dry
3.20	S	N=26 (2,5:7,6,6,7)	AR3501	75	3.20	Dry
4.20	S	N=24 (3,5:6,6,7,5)	AR3501	75	4.20	Dry
5.20	S	N=30 (2,5:6,7,8,9)	AR3501	75	5.20	Dry
6.20	S	N=26 (2,4:6,7,6,7)	AR3501	75	6.20	5.00
7.20	S	N=24 (4,4:6,7,6,5)	AR3501	75	7.20	5.20
8.20	S	N=35 (3,5:7,9,9,10)	AR3501	75	8.20	5.20
9.20	S	N=42 (5,6:8,9,10,15)	AR3501	75	9.20	5.20
10.70	S	N=23 (3,5:6,5,6,6)	AR3501	75	10.70	5.20
12.20	S	N=26 (3,4:6,7,7,6)	AR3501	75	11.60	3.20
13.70	S	N=32 (3,5:7,8,8,9)	AR3501	75	11.60	Dry
15.20	S	N=33 (3,4:7,8,9,9)	AR3501	75	11.60	Dry
16.70	S	N=36 (4,6:8,9,9,10)	AR3501	75	11.60	Dry
18.20	S	N=36 (4,6:7,9,10,10)	AR3501	75	11.60	Dry
19.70	S	N=40 (5,6:8,9,11,12)	AR3501	75	11.60	Dry
21.20	S	N=48 (6,8:9,9,14,16)	AR3501	75	11.60	Dry
22.70	S	N=48 (6,7:9,11,13,15)	AR3501	75	11.60	Dry
24.20	S	50/280mm (8,10:12,14,16,8/55mm)	AR3501	75	11.60	Dry
25.70	S	50/275mm (8,9:12,15,16,7/50mm)	AR3501	75	11.60	Dry
27.20	S	50/225mm (5,10:12,17,21,0/0mm)	AR3501	75	11.60	Dry
28.70	S	50/200mm (7,12:15,17,18/50mm)	AR3501	75	11.60	Dry

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
30.00	200	11.60	200						

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	30.00	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL | Print date and time 12/09/2022 13:55 | Log checked by David Howard

Form No. SIEXPHOLEHDR | Issue.Revision No. 2.02 | Issue Date 22/06/2016

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_012B
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 3

Ground Level	+8.15mOD	Coordinates	549712.20E, 261182.10N	Grid	OSGB
Hole Type	IP+CP	Inclination			

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
TOPSOIL: Dark brown slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint. Frequent rootlets. (TOP) [TOPSOIL]						D 1 0.10							
			(0.50)			B 2 0.10-0.40							
Firm orangish brown slightly sandy gravelly CLAY. Gravel is angular to subrounded medium to coarse of flint and calcareous siltstone. (SUPD) [SUPERFICIAL DEPOSITS]			0.50	8.15		D 3 0.50							
			(0.60)			B 4 0.50-1.00							
CHALK recovered as firm light yellowish grey with localised yellow staining slightly gravelly calcareous CLAY. Gravel is medium to coarse angular to subangular of flint. (WMCK) [WEST MELBURY CHALK FORMATION]			1.10	8.15		D 5 1.10							
						D 6 1.20-1.65 B 7 1.20-1.70						SPT(S) N=24 (3,4:5,6,7,6) 1.20	
						D 8 2.00							
						D 9 2.20-2.65 B 10 2.20-2.70						SPT(S) N=26 (3,5:7,6,6,7) 2.20	
						D 11 3.00							
						D 12 3.20-3.65 B 13 3.20-3.70						SPT(S) N=26 (2,5:7,6,6,7) 3.20	
					▽	D 14 4.00							
						D 15 4.20-4.65 B 16 4.20-4.70						SPT(S) N=24 (3,5:6,6,7,5) 4.20	
					▼	D 17 5.00							
			(9.60)			D 18 5.20-5.65 B 19 5.20-5.70						SPT(S) N=30 (2,5:6,7,8,9) 5.20	
						D 20 6.00							
						D 21 6.20-6.65 B 22 6.20-6.70						SPT(S) N=26 (2,4:6,7,6,7) 6.20	
						D 23 7.00							
						D 24 7.20-7.65 B 25 7.20-7.70						SPT(S) N=24 (4,4:6,7,6,5) 7.20	
						D 26 8.00							
						D 27 8.20-8.65 B 28 8.20-8.70						SPT(S) N=35 (3,5:7,9,9,10) 8.20	
						D 29 9.00							
						D 30 9.20-9.65 B 31 9.20-9.70						SPT(S) N=42 (5,6:8,9,10,15) 9.20	
						~~D 32 10.00~~							

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_012B Sheet 2 of 3
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+8.15mOD	Coordinates	549712.20E, 261182.10N	Grid	OSGB		
Hole Type	IP+CP	Inclination					

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
CHALK recovered as firm light yellowish grey with localised yellow staining slightly gravelly calcareous CLAY. Gravel is medium to coarse angular to subangular of flint. (WMCK) [WEST MELBURY CHALK FORMATION]													
CHALK recovered as stiff grey with localised yellow staining slightly sandy gravelly calcareous CLAY. Sand is fine to coarse fragments of coprolite. Gravel is subangular to subrounded fine to coarse of coprolite. (WMCK) [WEST MELBURY CHALK FORMATION]			10.70 (1.30)	8.15		D 33 10.70-11.15 B 34 10.70-11.20						SPT(S) N=23 (3,5:6,5,6,6) 10.70	
Stiff to very stiff fissured thinly laminated dark grey CLAY with rare subrounded brown gravel of siltstone (10x10). Fissures are 0-5 degrees very closely spaced planar and smooth. (GLT) [GAULT FORMATION] from 12.00m to 15.20m occasional fine to medium gravel of coprolite			12.00	8.15		D 35 12.00							
						D 36 12.20-12.65 B 37 12.20-12.70						SPT(S) N=26 (3,4:6,7,7,6) 12.20	
from 13.70m to 15.20m very stiff						D 38 13.70-14.15 B 39 13.70-14.20						SPT(S) N=32 (3,5:7,8,8,9) 13.70	
						D 40 15.20-15.65 B 41 15.20-15.70						SPT(S) N=33 (3,4:7,8,9,9) 15.20	
						D 42 16.70-17.15 B 43 16.70-17.20						SPT(S) N=36 (4,6:8,9,9,10) 16.70	
						D 44 18.20-18.65 B 45 18.20-18.70						SPT(S) N=36 (4,6:7,9,10,10) 18.20	
						D 46 19.70-20.15 B 47 19.70-20.20						SPT(S) N=40 (5,6:8,9,11,12) 19.70	

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:55   Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_012B Sheet 3 of 3
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+8.15mOD	Coordinates	549712.20E, 261182.10N	Grid	OSGB
Hole Type	IP+CP	Inclination			

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Stiff to very stiff fissured thinly laminated dark grey CLAY with rare subrounded brown gravel of siltstone (10x10). Fissures are 0-5 degrees very closely spaced planar and smooth. (GLT) [GAULT FORMATION]													
						D 48 21.20-21.65 B 49 21.20-21.70						SPT(S) N=48 (6,8:9,9,14,16) 21.20	
						D 50 22.70-23.15 B 51 22.70-23.20						SPT(S) N=48 (6,7:9,11,13,15) 22.70	
						D 52 24.20-24.63 B 53 24.20-24.70						SPT(S) 50/280mm (8,10:12,14,16,8/5mm) 24.20	
			(18.00)										
						D 54 25.70-26.13 B 55 25.70-26.20						SPT(S) 50/275mm (8,9:12,15,16,7/50mm) 25.70	
						D 56 27.20-27.58 B 57 27.20-27.70						SPT(S) 50/225mm (5,10:12,17,21,0/0mm) 27.20	
						D 58 28.70-29.05 B 59 28.70-29.20						SPT(S) 50/200mm (7,12:15,17,18/50mm) 28.70	
			30.00	8.15		D 60 30.00							
Complete at 30.00m. Termination Reason: Achieved Scheduled Dep h													

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:55   Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_013A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+6.89mOD	Coordinates	549809.10E, 261288.10N	Grid	OSGB
Date Started	12/08/2021	Date Completed	24/08/2021	Inclination	90° f om horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	12/08/2021 13:45	12/08/2021 14:45	Colin Howard	AM	NA	NA	Insulated hand tools	None	Stable	
1.20	6.60	RC	12/08/2021 14:45	16/08/2021 16:30	Colin Howard	AL	SWF	TCB	Soilmec SM6			
6.60	15.50	RC	17/08/2021 07:30	18/08/2021 17:15	Colin Howard	AL	SWF	PCD	Soilmec SM6			
15.50	48.45	RC	19/08/2021 07:30	20/08/2021 11:30	Colin Howard	AL	Geobore S (146)	PCD	Soilmec SM6			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
12/08/2021 17:00	2.20	1.20	Dry	End of Shift
13/08/2021 07:30	2.20	1.20	Dry	Start of shift
13/08/2021 12:00	3.70	1.40	0.65	End of Shift
16/08/2021 12:00	3.70	1.40	1.60	Start of shift
16/08/2021 16:30	6.60	1.40	1.60	End of Shift
17/08/2021 07:30	6.60	1.40	1.60	Start of shift
17/08/2021 17:00	13.00	10.40	1.60	End of Shift
18/08/2021 07:30	13.00	10.40	1.60	Start of shift
18/08/2021 17:15	15.50	13.10	14.70	End of Shift
19/08/2021 07:30	15.50	13.10	14.70	Start of shift
19/08/2021 17:15	38.05	13.10	37.80	End of Shift
20/08/2021 07:30	38.05	13.10	36.50	Start of shift
20/08/2021 11:30	48.45	13.10	17.60	Drilling Complete
20/08/2021 15:30	13.00	13.00	3.50	End of Shift
23/08/2021 07:30	13.00	13.00	4.00	Start of shift
23/08/2021 16:30	13.00	0.00	4.00	End of Shift

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
13/08/2021 09:10	3.70	1.40		2.75	20	Slow

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	48.45	AIR/MIST	100	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
13.00	200	13.00	200						
13.10	150	13.10	150						
48.45	146								

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	48.45	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL | Print date and time 12/09/2022 13:55 | Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_013A
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 5

Ground Level	+6.89mOD	Coordinates	549809.10E, 261288.10N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
TOPSOIL: Dark brown slightly gravelly sandy CLAY with occasional rootlets. Sand is fine to coarse. (TOP) [TOPSOIL]			(0.40) 0.40	6.49		ES 1 0.20 B 2 0.20-0.40 D 3 0.30							
Stiff brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and quartz. (SUPD) [SUPERFICIAL DEPOSITS]			(0.40) 0.80	6.09		B 5 0.40-0.60 ES 4 0.50							
Structureless CHALK composed of very stiff light grey mottled brown slightly sandy CLAY. Sand is fine to coarse. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(0.40) 1.20	5.69		B 6 0.60-1.00 ES 7 1.00						K 1.20 - 3.50	
Structureless CHALK composed of yellowish grey slightly gravelly calcareous CLAY. Gravel is subangular to subrounded fine to coarse of flint and very weak low density chalk. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 1.20m to 1.40m recovered as non intact core (angular to subrounded coarse gravel sized fragments)			(1.40) 2.60	4.29		C 8 1.20-2.20	107	100					
Structureless CHALK composed of very stiff yellowish grey calcareous CLAY. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 3.70m to 3.95m yellowish grey mottled brown			(1.35) 3.95	2.94		C 9 2.20-3.70	107	100					
Structureless CHALK composed of very stiff fissured light grey calcareous CLAY. Fissures are randomly orientated closely spaced undulating rough. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]			(1.00) 4.95	1.94		C 10 3.70-5.10	107	100			NA		
Structureless CHALK composed of very stiff fissured light grey calcareous CLAY with clasts of subangular to subrounded fine to coarse gravel sized fragments of very weak chalk. Fissures are randomly orientated closely spaced undulating rough. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]			(1.35) 6.30	0.59		C 11 5.10-6.60	107	100					
Structureless CHALK composed of very stiff fissured grey calcareous CLAY with closely spaced thin beds of very weak low density grey chalk composed of calcareous siltstone. Fissures are randomly orientated closely spaced undulating smooth. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]			(2.30) 8.60	-1.71		C 12 6.60-8.10 C 13 8.10-8.60	107 107	100 100					
Weak high density grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 10 to 25 degrees closely to medium spaced undulating rough with silt infill. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 8.60m to 8.70m recovered as non intact core (subangular to subrounded fine to coarse gravel sized fragments)	Grade B3		(1.80)			C 14 8.60-10.20	107	100	100	31	NI 170 410		

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_013A
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 5

Ground Level	+6.89mOD	Coordinates	549809.10E, 261288.10N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike
Weak high density grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 10 to 25 degrees closely to medium spaced undulating rough with silt infill. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 9.95m to 10.20m recovered as non intact core (subangular to subrounded fine to coarse gravel sized fragments)			10.40	-3.51	
Dark greenish grey very gravelly glauconitic fine SAND. Gravel is subangular to subrounded fine to coarse of coprolites. (WMCK) [CAMBRIDGE GREENSAND MEMBER]			(0.35) 10.75	-3.86	
Firm thinly laminated dark grey CLAY with occasional subangular to subrounded fine to coarse gravel sized fragments of coprolites. (WMCK) [CAMBRIDGE GREENSAND MEMBER]			11.00	-4.11	
Stiff thinly laminated dark grey CLAY. (GLT) [GAULT FORMATION]			(1.38) 12.38	-5.49	
Stiff fissured thinly laminated dark grey CLAY. Fissures are 0 to 20 degrees closely spaced planar rough. (GLT) [GAULT FORMATION]			12.65	-5.76	
Stiff fissured thinly laminated dark grey CLAY. Fissures are 20 degrees closely spaced planar rough. (GLT) [GAULT FORMATION]			(1.60) 14.25	-7.36	
Stiff fissured thinly laminated dark grey CLAY. Fissures are 0 to 10 degrees closely spaced undulating rough. (GLT) [GAULT FORMATION] from 14.25m to 14.75m with rare subrounded fragments of coprolite (<15mm x 20mm)			(1.25) 15.50	-8.61	
Stiff fissured thinly laminated dark grey CLAY with occasional nodules of siltstone (<10mm x 5mm). Fissures are 65 degrees closely spaced planar smooth polished. (GLT) [GAULT FORMATION]			(0.72) 16.22	-9.33	
Stiff fissured thinly laminated dark grey CLAY with rare nodules of siltstone (<20mm x 10mm). Fissures are 20 to 60 degrees closely spaced planar smooth polished. (GLT) [GAULT FORMATION]			(0.78) 17.00	-10.11	
Very stiff fissured thinly laminated dark grey CLAY with rare nodules of pyrite (<5mm x <5mm) and occasional nodules of siltstone (<10mm x 5mm). Fissures are 25 to 40 degrees closely spaced planar smooth. (GLT) [GAULT FORMATION]			(1.55) 18.55	-11.66	
Very stiff fissured thinly laminated dark grey CLAY with rare nodules of pyrite (<5mm x 5mm). Fissures are 20 to 55 degrees closely spaced planar smooth with clay infill. (GLT) [GAULT FORMATION]					

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
C 15 10.20-11.70	107	100					
C 16 11.70-13.00	107	98					
C 17 13.00-14.00	107	100					
C 18 14.00-15.50	107	100					
C 19 15.50-17.00	102	100					
C 20 17.00-18.55	102	97					
C 21 18.55-20.05	102	100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:55   Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_013A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 3 of 5

Ground Level	+6.89mOD	Coordinates	549809.10E, 261288.10N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very stiff fissured thinly laminated dark grey CLAY with rare nodules of pyrite (<5mm x 5mm). Fissures are 20 to 55 degrees closely spaced planar smooth with clay infill. (GLT) [GAULT FORMATION]	Unweathered		(3.05)			C 22 20.05-21.60	102	100			NA		
			21.60	-14.71									
Very stiff fissured thinly laminated dark grey CLAY with rare nodules of siltstone (<10mm x 5mm). Fissures are 20 to 40 degrees closely spaced planar smooth. (GLT) [GAULT FORMATION]			(1.60)			C 23 21.60-23.20	102	100					
			23.20	-16.31									
Very stiff fissured thinly laminated dark grey CLAY with occasional nodules of siltstone (<8mm x 5mm). Fissures are 20 to 40 degrees closely spaced planar smooth. (GLT) [GAULT FORMATION]						C 24 23.20-24.70	102	100					
			(2.85)										
from 25.10m to 26.05m nodules of siltstone become rare from 25.45m to 25.60m fissures are 20 degrees closely spaced planar smooth						C 25 24.70-26.05	102	100					
			26.05	-19.16									
Very stiff fissured thinly laminated grey CLAY with occasional nodules of siltstone (<10mm x 5mm). Fissures are 20 to 60 degrees closely spaced planar smooth (GLT) [GAULT FORMATION]						C 26 26.05-27.05	102	100					
from 27.53m to 27.54m 1 No. thick lamination of silt from 27.75m to 30.25m with occasional fossilised shell fragments (<5mm x 5mm) and some belemnite fragments (<5mm x 5mm)						C 27 27.05-28.65	102	99					
			(7.12)										
						C 28 28.65-30.25	102	100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_013A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 4 of 5

Ground Level	+6.89mOD	Coordinates	549809.10E, 261288.10N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff fissured thinly laminated grey CLAY with occasional nodules of siltstone (<10mm x 5mm). Fissures are 20 to 60 degrees closely spaced planar smooth (GLT) [GAULT FORMATION]						C 29 30.25-31.90	102	100					
						C 30 31.90-33.40	102	99					
			33.17	-26.28									
Very stiff fissured thinly laminated grey CLAY with occasional nodules of siltstone (<10mm x 5mm) and occasional fossilised shell fragments (<5mm x 5mm). Fissures are 20 to 60 degrees closely spaced undulating rough. (GLT) [GAULT FORMATION]						C 31 33.40-35.05	102	100					
			(4.43)			C 32 35.05-36.65	102	100					
						C 33 36.65-38.05	102	100					
			37.60	-30.71									
Very stiff fissured thinly laminated grey CLAY with occasional nodules of siltstone (<8mm x 5mm) and occasional belemnite fragments (<5mm x 5mm). Fissures are 20 to 55 degrees closely spaced planar smooth. (GLT) [GAULT FORMATION]			(1.30)			C 34 38.05-38.55	102	100					
			38.90	-32.01									
Very stiff fissured thinly laminated grey CLAY with occasional nodules of siltstone (<8mm x 5mm). Fissures are 15 to 50 degrees closely spaced planar smooth. (GLT) [GAULT FORMATION]			(2.00)			C 35 38.55-40.00	102	100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_013A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 5 of 5

Ground Level	+6.89mOD	Coordinates	549809.10E, 261288.10N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff fissured thinly laminated grey CLAY with occasional nodules of siltstone (<8mm x 5mm). Fissures are 15 to 50 degrees closely spaced planar smooth. (GLT) [GAULT FORMATION]						C 36 40.00-40.90	102	100					
			40.90	-34.01									
Very stiff fissured thinly laminated grey CLAY with occasional nodules of siltstone (<10mm x 5mm). Fissures are 30 to 75 degrees closely spaced planar smooth. (GLT) [GAULT FORMATION]						C 37 40.90-42.45	102	100					
			(3.10)										
						C 38 42.45-43.95	102	93					
			44.00	-37.11									
Very stiff fissured slightly sandy CLAY with rare belemnite fragments (<5mm x 5mm). Sand is fine. Fissures are 0 to 20 degrees closely spaced planar rough. (GLT) [GAULT FORMATION]			(0.95)			C 39 43.95-44.95	102	100					
			44.95	-38.06									
Greenish grey slightly gravelly fine SAND. Gravel is subrounded to rounded fine to medium of flint. (LGF) [LOWER GREENSAND FORMATION] at 45.19m very clayey			(1.45)			C 40 44.95-46.95	102	70					
			46.40	-39.51									
Dark greenish grey fine SAND. (LGF) [LOWER GREENSAND FORMATION] at 46.95m very clayey from 47.70m to 47.95m dark greenish grey with occasional dark brown silt lenses (<5mm x 10mm)			(1.80)			C 41 46.95-48.45	102	90					
			48.20	-41.31									
Dark greenish grey gravelly fine SAND. Gravel is rounded fine to medium of flint. (LGF) [LOWER GREENSAND FORMATION]			48.45	-41.56									

Complete at 48.45m. Termination Reason: Achieved Scheduled Depth

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_013B
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+6.96mOD	Coordinates	549810.10E, 261283.10N	Grid	OSGB
Date Started	08/09/2021	Date Completed	13/09/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	08/09/2021 10:00	08/09/2021 11:00	Danny Cundill	SAN			Insulated hand tools	None	Stable	Inspection pit: Hand dug
1.20	30.00	CP	08/09/2021 11:00	10/09/2021 13:30	Danny Cundill	SAN			Dando 2000			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
08/09/2021 09:00				Start of shift
08/09/2021 17:30	9.20	9.20	3.90	End of Shift
09/09/2021 07:30	9.20	9.20	2.30	Start of shift
09/09/2021 17:30	25.00	11.60	8.00	End of Shift
10/09/2021 07:30	25.00	11.60	2.30	Start of shift
10/09/2021 13:00	0.00	0.00	Dry	Installation Complete, Borehole Complete
10/09/2021 17:30	0.00			End of Shift
13/09/2021 07:30	0.00			Start of shift
13/09/2021 09:00	0.00			End of Shift

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
08/09/2021 13:40	4.20	4.20		2.00	20	Medium

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water
1.20	S	N=21 (5,7:5,5,6,5)	AR3501	75	1.20	Dry
2.20	S	N=18 (3,4:4,4,5,5)	AR3501	75	2.20	Dry
3.20	S	N=17 (2,2:4,4,4,5)	AR3501	75	3.20	Dry
4.20	S	N=19 (2,2:4,4,5,6)	AR3501	75	4.20	2.00
5.20	S	N=19 (2,3:4,5,5,5)	AR3501	75	5.20	3.90
6.20	S	N=24 (3,5:5,6,7,6)	AR3501	75	6.20	3.90
7.20	S	N=25 (2,4:6,7,6,6)	AR3501	75	7.20	3.90
8.20	S	N=35 (4,6:7,8,10,10)	AR3501	75	8.20	3.90
9.20	S	N=33 (3,4:6,8,9,10)	AR3501	75	9.20	2.30
10.70	S	N=38 (3,5:8,10,10,10)	AR3501	75	10.70	3.90
12.20	S	N=25 (4,5:5,6,7,7)	AR3501	75	11.60	8.00
13.70	S	N=29 (4,6:7,7,8,7)	AR3501	75	11.60	8.00
15.20	S	N=35 (4,7:8,8,9,10)	AR3501	75	11.60	8.00
16.70	S	N=39 (6,7:8,9,11,11)	AR3501	75	11.60	8.00
18.20	S	N=46 (6,8:10,11,12,13)	AR3501	75	11.60	8.00
19.70	S	N=48 (6,7:10,11,13,14)	AR3501	75	11.60	8.00
21.20	S	50/275mm (7,9:12,13,15,10/50mm)	AR3501	75	11.60	8.00
22.70	S	50/270mm (7,9:12,14,15,9/45mm)	AR3501	75	11.60	8.00
24.20	S	N=50 (6,10:10,12,14,14)	AR3501	75	11.60	8.00
25.70	S	50/225mm (7,10:13,15,22,0/0mm)	AR3501	75	11.60	3.00
27.20	S	50/225mm (8,11:12,19,19,0/0mm)	AR3501	75	11.60	3.50
28.70	S	50/220mm (7,9:13,18,19/70mm)	AR3501	75	11.60	3.80

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks

HOLE DIAMETER

Depth Base	Diameter
30.00	200

CASING DIAMETER

Depth Base	Diameter
11.60	200

DYNAMIC SAMPLING

Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	30.00	Grout	

LOCATION DETAILS

Remarks

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_013B
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 3

Ground Level	+6.96mOD	Coordinates	549810.10E, 261283.10N	Grid	OSGB
Hole Type	IP+CP	Inclination			

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike
TOPSOIL: Dark brown slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subrounded to subangular of flint. (TOP) [TOPSOIL]			(0.60) 0.60	6.96	
CHALK recovered as stiff light yellowish grey locally stained yellowish orange calcareous CLAY. (WMCK) [WEST MELBURY CHALK FORMATION]			(2.60) 3.20	6.96	
CHALK recovered as stiff brownish grey slightly gravelly calcareous CLAY. Gravel is subangular to subrounded medium to coarse of extremely weak low density calcareous siltstone. (WMCK) [WEST MELBURY CHALK FORMATION]			(2.00) 5.20	6.96	
CHALK recovered as stiff grey slightly gravelly calcareous CLAY. Gravel is subangular to subrounded medium to coarse of extremely weak low density siltstone. (WMCK) [WEST MELBURY CHALK FORMATION] from 5.20m to 9.20m Clay is grey			(5.60)		

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
D 1 0.10							
D 2 0.20							
B 3 0.30-0.50							
D 4 0.60							
B 5 0.70-1.00							
D 6 1.20						SPT(S) N=21 (5,7:5,5,6,5) 1.20	
D 7 1.20-1.65							
B 8 1.20-1.70							
D 9 2.00							
D 10 2.20-2.65						SPT(S) N=18 (3,4:4,4,5,5) 2.20	
B 11 2.20-2.70							
D 12 3.00							
D 13 3.20-3.65						SPT(S) N=17 (2,2:4,4,4,5) 3.20	
B 14 3.20-3.70							
D 15 4.00							
W 16 4.20						SPT(S) N=19 (2,2:4,4,5,6) 4.20 K 4.20	
D 17 4.20-4.65							
B 18 4.20-4.70							
D 19 5.00							
D 20 5.20-5.65						SPT(S) N=19 (2,3:4,5,5,5) 5.20	
B 21 5.20-5.70							
D 22 6.00							
D 23 6.20-6.65						SPT(S) N=24 (3,5:5,6,7,6) 6.20	
B 24 6.20-6.70							
D 25 7.00							
D 26 7.20-7.65						SPT(S) N=25 (2,4:6,7,6,6) 7.20	
B 27 7.20-7.70							
D 28 8.00							
D 29 8.20-8.65						SPT(S) N=35 (4,6:7,8,10,10) 8.20	
B 30 8.20-8.70							
D 31 9.00							
D 32 9.20-9.65						SPT(S) N=33 (3,4:6,8,9,10) 9.20	
B 33 9.20-9.70							
~~D 34 10.00~~							

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_013B
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 3

Ground Level	+6.96mOD	Coordinates	549810.10E, 261283.10N	Grid	OSGB
Hole Type	IP+CP	Inclination			

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
CHALK recovered as stiff grey slightly gravelly calcareous CLAY. Gravel is subangular to subrounded medium to coarse of extremely weak low density siltstone. (WMCK) [WEST MELBURY CHALK FORMATION]													
Stiff thinly laminated dark grey slightly sandy CLAY with occasional fine to coarse gravel size nodules of coprolite. Sand is fine black of coprolite. (GLT) [GAULT FORMATION]			10.80	6.96		D 35 10.70-11.15 B 36 10.70-11.20						SPT(S) N=38 (3,5:8,10,10,10) 10.70	
			(1.40)										
Stiff fissured thinly laminated dark grey CLAY with rare subrounded gravel of brown siltstone (10mmx10mm). Fissures are horizontal, planar, smooth and slightly polished. (GLT) [GAULT FORMATION]			12.20	6.96		D 37 12.20-12.65 B 38 12.20-12.70						SPT(S) N=25 (4,5:5,6,7,7) 12.20	
						D 39 13.70-14.15 B 40 13.70-14.20						SPT(S) N=29 (4,6:7,7,8,7) 13.70	
			(4.50)										
						D 41 15.20-15.65 B 42 15.20-15.70						SPT(S) N=35 (4,7:8,8,9,10) 15.20	
Very stiff fissured thinly laminated dark grey CLAY with rare subrounded gravel of brown siltstone (10mmx10mm) and fossil (1mmx10mm). Fissures are horizontal, planar and smooth, slightly polished and subvertical planar and smooth. (GLT) [GAULT FORMATION]			16.70	6.96		D 43 16.70-17.15 B 44 16.70-17.20						SPT(S) N=39 (6,7:8,9,11,11) 16.70	
						D 45 18.20-18.65 B 46 18.20-18.70						SPT(S) N=46 (6,8:10,11,12,13) 18.20	
						D 47 19.70-20.15 B 48 19.70-20.20						SPT(S) N=48 (6,7:10,11,13,14) 19.70	

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:55   Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_013B
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 3 of 3

Ground Level	+6.96mOD	Coordinates	549810.10E, 261283.10N	Grid	OSGB
Hole Type	IP+CP	Inclination			

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff fissured thinly laminated dark grey CLAY with rare subrounded gravel of brown siltstone (10mmx10mm) and fossil (1mmx10mm). Fissures are horizontal, planar and smooth, slightly polished and subvertical planar and smooth. (GLT) [GAULT FORMATION]													
						D 49 21.20-21.63 B 50 21.20-21.70						SPT(S) 50/275mm (7,9:12,13,15,10/50mm) 21.20	
						D 51 22.70-23.12 B 52 22.70-23.20						SPT(S) 50/270mm (7,9:12,14,15,9/45mm) 22.70	
						D 53 24.20-24.65 B 54 24.20-24.70						SPT(S) N=50 (6,10:10,12,14,14) 24.20	
			(13.30)										
						D 55 25.70-26.08 B 56 25.70-26.20						SPT(S) 50/225mm (7,10:13,15,22,0/0mm) 25.70	
						D 57 27.20-27.58 B 58 27.20-27.70						SPT(S) 50/225mm (8,11:12,19,19,0/0mm) 27.20	
						D 59 28.70-29.07 B 60 28.70-29.20						SPT(S) 50/220mm (7,9:13,18,19/70mm) 28.70	
			30.00	6.96		D 61 30.00							

Complete at 30.00m. Termination Reason: Achieved Scheduled Dep h

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL
Print date and time 12/09/2022 13:55
Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_013C Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+7.01mOD	Coordinates	549799.40E, 261288.80N	Grid	OSGB
Date Started	24/08/2021	Date Completed	26/08/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	24/08/2021 11:30	24/08/2021 12:10	CH	SAN	NA	NA	Insulated hand tools	None	Stable	
1.20	13.10	RC	24/08/2021 12:10	26/08/2021 11:15	CH	CJ			Soilmec SM6			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
24/08/2021 17:00	11.60	11.60	3.50	End of Shift
25/08/2021 07:30	11.60	11.60	1.70	Start of shift
25/08/2021 17:15	13.10	13.10	1.70	End of Shift
26/08/2021 07:30	13.10	13.10	1.70	Start of shift
26/08/2021 11:15	0.00	0.00	Dry	Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
24/08/2021 13:15	3.90	1.20		3.50	20	Medium

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	13.10	AIR/MIST	100	Grey	

HOLE DIAMETER

Depth Base	Diameter
13.10	146

CASING DIAMETER

Depth Base	Diameter
13.10	146

DYNAMIC SAMPLING

Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref
1.50	G1	SP	0.50	1.50	Pipe 1

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type
Pipe 1	0.00	0.50	19	PLAIN
Pipe 1	0.50	1.50	19	SLOTTED

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
7.60	7.60	Packer test attempted
9.45	9.45	Packer test attempted

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
-0.50	0.00	Upstanding cover	
0.00	0.25	Concrete	
0.25	0.50	Bentonite	
0.50	1.50	Gravel backfill	
1.50	1.70	Bentonite	
1.70	13.10	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

SOIL ENGINEERING

Part of the Bachy Soletanche Group

FINAL   Print date and time 12/09/2022 13:55   Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_013C
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 2

Ground Level	+7.01mOD	Coordinates	549799.40E, 261288.80N	Grid	OSGB	
Hole Type	IP+RC	Inclination				

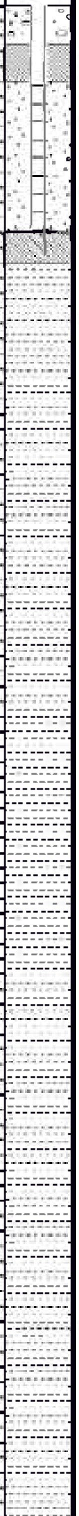
Description of Strata	Weathering	Depth (Thickness)	Datum Level	Waterstrike
TOPSOIL: Dark brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and quartz. Occasional buried rootlets. (TOP) [TOPSOIL]		(0.40) 0.40	7.01	
Stiff brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and quartz. (SUPD) [SUPERFICIAL DEPOSITS]		(0.40) 0.80	7.01	
CHALK recovered as: Very stiff light grey mottled brown slightly sandy calcareous CLAY. Sand is fine to coarse. (WMCK) [WEST MELBURY CHALK FORMATION]		(0.40) 1.20	7.01	
Structureless CHALK composed of firm greyish brown slightly gravelly calcareous CLAY. Gravel is angular to subangular fine and medium of very weak calcareous mudstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(0.71) 1.91	7.01	
Extremely weak to very weak medium density greyish brown CHALK composed of calcareous MUDSTONE. (Unable to determine CIRIA Grade) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade A2	(0.39) 2.30	7.01	
Structureless CHALK composed of firm to stiff greyish brown slightly gravelly calcareous CLAY. Gravel is angular to subangular fine to coarse of very weak calcareous mudstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(1.15) 3.45	7.01	
Very weak medium density greyish brown CHALK composed of calcareous MUDSTONE. Discontinuities: 1) 60 to 85 degrees very closely to closely spaced undulating planar smooth brown staining. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 3.85m to 3.90m non intact core (recovered as subangular medium and coarse gravel sized fragments)	Grade A3	(0.45) 3.90	7.01	▽ ▼
Structureless CHALK composed of stiff to very stiff light grey slightly gravelly calcareous CLAY. Gravel is angular to subangular fine and medium of very weak calcareous mudstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 4.14m to 4.23m thin bed of very weak medium density light grey chalk composed of calcareous mudstone	Grade Dm	(1.46) 5.36	7.01	
Very weak to weak high density light grey CHALK composed of calcareous MUDSTONE. Discontinuities: 1) 60 to 80 degrees very closely to closely spaced planar undulating smooth. (CIRIA Grade A4) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade A4	(0.44) 5.80	7.01	
Structureless CHALK composed of soft to firm light grey gravelly calcareous CLAY. Gravel is angular to subangular fine to coarse of very weak calcareous siltstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(0.95) 6.75	7.01	
Very weak medium density light grey CHALK composed of calcareous MUDSTONE. Discontinuities. 1) 5 to 10 degrees medium spaced undulating smooth with black staining. 2) 60 to 85 degrees closely spaced planar undulating smooth with black staining. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade A3	(0.52) 7.27	7.01	
Structureless CHALK composed of stiff light grey slightly gravelly calcareous CLAY. Gravel is angular to subangular fine of very weak calcareous mudstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] at 7.70m occasional fossilised shell fragments (<6mm x 8mm) from 7.72m to 7.78m non intact core (recovered as angular to subangular fine to coarse gravel sized fragments of weak chalk composed of calcareous mudstone) from 7.93m to 8.00m thin bed of very weak chalk composed of calcareous mudstone from 8.07m to 8.13m very thin bed of very weak chalk composed of calcareous mudstone	Grade Dm	(1.01) 8.28	7.01	
Very weak low density light grey CHALK composed of calcareous MUDSTONE. (Unable to determine CIRIA Grade) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade A2	(0.53) 8.81	7.01	
Structureless CHALK composed of very stiff light grey gravelly calcareous CLAY. Gravel is angular to subangular fine to coarse of very weak calcareous mudstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(0.65) 9.46	7.01	
at 8.85m occasional fossilised shell fragments (<11mm x 16mm)	Grade A3	(0.53) 9.99	7.01	

Sampling Details	Dia	TCR/Sample Recovery %	SCR/Blows	RQD
ES 1 0.20 B 2 0.20-0.40 D 3 0.30 B 5 0.40-0.60 ES 4 0.50 B 6 0.80-1.00 ES 7 1.00 D 8 1.20				
C 9 1.20-2.30	102	100	35	35
C 10 2.30-3.90	102	100	17	8
C 11 3.90-5.50	102	100	16	9
C 12 5.50-7.00	102	100	20	20
C 13 7.00-8.50	102	100	41	33
C 14 8.50-10.10	102	100	53	38

IF
NA
NI 110 130
NA
20 50 80
NA
70 90 130
NA
40 130 160

In Situ Test Details
K 6.80 - 8.40 K 6.80 - 8.40
K 8.65 - 10.25 K 8.65 - 10.25

Install-ation



AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:55   Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_013C
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 2

Ground Level	+7.01mOD	Coordinates	549799.40E, 261288.80N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very weak medium density light grey CHALK composed of calcareous MUDSTONE with frequent coprolites at base (<35mm x 45mm). Discontinuities: 1) 5 to 30 degrees very closely to closely spaced undulating planar smooth. (CIRIA Grade A3) (WMCK) [WEST MELBURY CHALK FORMATION] from 9.90m to 9.99m frequent coprolites (<35mm x 45mm) at 9.94m fossilised shark tooth (<10mm x 15mm)	Unweathered		(1.11) 11.10	7.01			102	100			NA		
Stiff fissured dark grey CLAY with rare fossilised coprolites (<13mm x 18mm). Subhorizontal to horizontal fissures are extremely closely to closely spaced planar undulating smooth polished. Subvertical fissures are medium spaced planar smooth polished. (GLT) [GAULT FORMATION]			(0.50) 11.60	7.01									
Very stiff fissured dark grey CLAY with rare fossilised coprolites (8mmx 11mm). Fissures are subhorizontal to horizontal very closely to closely spaced planar undulating smooth. (GLT) [GAULT FORMATION]													
Very stiff fissured dark grey CLAY with rare fossilised coprolites (<7mm x 12mm). Subhorizontal to horizontal fissures are extremely closely to closely spaced planar undulating smooth polished. Subvertical to vertical fissures are medium spaced planar smooth polished. (GLT) [GAULT FORMATION] from 12.95m to 13.10m assumed zone of core loss			(1.50) 13.10	7.01		C 15 11.60-13.10	102	90					
Complete at 13.10m. Termination Reason: Achieved Scheduled Depth													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_014 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.60mOD	Coordinates	549537.50E, 260872.96N	Grid	OSGB
Date Started	23/09/2021	Date Completed	27/09/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	23/09/2021 09:15	23/09/2021 11:00	TW	DT			Insulated Hand Tools	None	Stable	
1.20	30.00	RC	23/09/2021 11:00	27/09/2021 14:15	TW	AY	Geobore S (146)	PCD	T46 Beretta			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
23/09/2021 17:30	15.70	2.20	4.16	End of Shift
24/09/2021 07:30	15.70	2.20	3.94	Start of Shift
24/09/2021 17:30	27.20	2.20	5.15	End of Shift
27/09/2021 00:00	22.70	2.20	3.95	Start of Shift
27/09/2021 14:15	0.00			Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
23/09/2021 14:00	6.40	2.20		4.52	20	

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
0.00	30.00	AIR/MIST	100	Grey	

HOLE DIAMETER

Depth Base	Diameter
2.20	150
30.00	146

CASING DIAMETER

Depth Base	Diameter
2.20	150
30.00	146

DYNAMIC SAMPLING

Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	30.00	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_014 Sheet 1 of 3
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.60mOD	Coordinates	549537.50E, 260872.96N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Depth (Thickness)	Datum Level
TOPSOIL: Dark brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to rounded fine to coarse of flint. (TOP) [TOPSOIL]		(0.30) 0.30	10.60
Firm light brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint. (SUPD) [SUPERFICIAL DEPOSITS]		(0.80) 1.10	10.60
CHALK recovered as: Firm light grey slightly gravelly sandy calcareous CLAY. Gravel is angular to subrounded fine to medium of flint. (WMCK) [WEST MELBURY CHALK FORMATION]		1.20	10.60
Structureless CHALK composed of soft yellowish brown gravelly calcareous CLAY with orange staining. Gravel is subangular to subrounded medium to coarse of extremely weak low density calcareous siltstone and flint. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(0.70) 1.90	10.60
Assumed zone of core loss. CHALK. (Driller's Description) (WMCK) [WEST MELBURY CHALK FORMATION]		(0.30) 2.20	10.60
Extremely weak low density yellowish brown CHALK composed of calcareous SILTSTONE with rare shell fragments (<10mm x 10mm). Discontinuities: 1) randomly orientated extremely closely to very closely spaced planar smooth with silt infill (<3mm). (CIRIA Grade B4) (WMCK) [WEST MELBURY CHALK FORMATION] from 2.20m to 2.32m structureless chalk composed of soft yellowish brown gravelly calcareous clay. Gravel is subangular to subangular fine to medium of calcareous siltstone from 2.93m to 3.20m recovered as non intact core (subangular medium to coarse gravel sized fragments of extremely weak low density calcareous siltstone) at 3.42m black specks staining	Grade B4	(1.40) 3.60	10.60
Extremely weak to very weak low density yellowish brown CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 0-10 degrees closely to widely spaced undulating rough with silt infill (<3mm). (CIRIA Grade B1) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B1	(2.60) 6.20	10.60
Very weak to weak medium density yellowish brown CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 0-10 degrees closely to medium spaced undulating rough with silt infill (<3mm). (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 6.55m to 6.70m discontinuities 2) randomly orientated very closely spaced planar smooth with orange staining.	Grade B3	(1.47) 7.67	10.60
Very weak to weak medium to high density light grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) randomly orientated extremely closely to very closely locally closely spaced planar smooth with orange staining. (CIRIA Grade B4) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B4	(0.53) 8.20	10.60
Weak high density light grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 0-20 degrees medium spaced undulating rough smooth with orange staining. (CIRIA Grade B2) (WMCK) [WEST MELBURY CHALK FORMATION] from 8.40m to 8.47m extremely weak low density from 8.90m to 8.95m extremely weak low density from 9.35m to 9.42m extremely to very weak low density		(3.60)	

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF
D 1 0.05-0.10					
ES 2 0.20-0.25					
B 3 0.10-0.40					
D 4 0.40-0.50					
ES 5 0.50-0.55					
B 6 0.40-0.80					
B 9 0.80-1.20					
D 7 1.00-1.10					
ES 8 1.10-1.20					
C 10 1.20-2.20		70			NA
C 11 2.20-3.70		100	7	0	NI 35 50
C 12 3.70-5.20		100	100	100	120 800 1000
C 13 5.20-6.70		100	100	97	
C 14 6.70-8.20		100	92	89	40 150 370
					15 45 130
C 15 8.20-9.70		100	83	75	

In Situ Test Details

Installation

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_014 Sheet 2 of 3
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.60mOD	Coordinates	549537.50E, 260872.96N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Weak high density light grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 0-20 degrees medium spaced undulating rough smooth with orange staining. (CIRIA Grade B2) (WMCK) [WEST MELBURY CHALK FORMATION] from 9.89m to 9.99m recovered as partially non intact core (angular medium to coarse fragments) from 10.33m to 10.54m extremely weak low density with randomly orientated extremely closely spaced planar smooth orange stained fractures from 10.99m to 11.10m 1 No. fractures 45 degrees planar rough	Grade B2		11.80	10.60		C 16 9.70-11.20		100	73	59	NI 240 460		
Stiff grey CLAY with frequent phosphatic nodules (<10mm x 40mm). (WMCK) [CAMBRIDGE GREENSAND MEMBER] from 11.80m to 12.04m frequent phosphatic nodules (<10mm x 40mm)			12.04	10.60		C 17 11.20-12.70		100	49	49			
Very stiff fissured dark grey CLAY. Fissures are 0-30 degrees closely spaced planar smooth polished and randomly orientated very closely spaced planar undulating smooth occasionally polished. (GLT) [GAULT FORMATION]			(4.88)			C 18 12.70-14.20		100					
						C 19 14.20-15.70		100					
						C 20 15.70-17.20		100					
Very stiff fissured dark grey CLAY with occasional siltstone nodules (<20mm x 20mm) and phosphate nodules (<20mm x 30mm). Fissures are 0-20 degrees medium spaced planar polished smooth with occasional dusting of silt, 70-90 degrees medium spaced planar polished and randomly orientated very closely to closely spaced planar smooth. (GLT) [GAULT FORMATION]			16.92	10.60		C 21 17.20-18.70		100					
						C 22 18.70-20.20		100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:55   Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_014
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 3 of 3

Ground Level	+10.60mOD	Coordinates	549537.50E, 260872.96N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very stiff fissured dark grey CLAY with occasional siltstone nodules (<20mm x 20mm) and phosphate nodules (<20mm x 30mm). Fissures are 0-20 degrees medium spaced planar polished smooth with occasional dusting of silt, 70-90 degrees medium spaced planar polished and randomly orientated very closely to closely spaced planar smooth. (GLT) [GAULT FORMATION]	Unweathered					C 23 20.20-21.70		100			NA		
						C 24 21.70-23.20		100					
			(8.91)										
						C 25 23.20-24.20		100					
						C 26 24.20-25.70		100					
Very stiff dark grey CLAY with occasional siltstone nodules (<20mm x 20mm) and phosphate nodules (<20mm x 20mm). (GLT) [GAULT FORMATION]			25.83	10.60									
						C 27 25.70-27.20		100					
			(2.37)										
from 28.13m to 28.20m 1 No. fissure 30 degrees undulating polished						C 28 27.20-28.70		67					
Assumed zone of core loss. CLAY. (Driller's Description) (GLT) [GAULT FORMATION]			28.20 (0.50)	10.60									
Very stiff fissured dark grey CLAY. Fissures are 0-15 degrees closely spaced planar polished, 75-90 degrees closely spaced planar undulating polished and randomly orientated very closely spaced planar undulating smooth polished. (GLT) [GAULT FORMATION]			28.70	10.60									
			(1.30)			C 29 28.70-30.00		100					
Complete at 30.00m. Termination Reason: Achieved Scheduled Depth			30.00	10.60									

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_015
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+9.92mOD	Coordinates	549671.50E, 260975.20N	Grid	OSGB
Date Started	22/07/2021	Date Completed	28/07/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	22/07/2021 12:30	22/07/2021 14:00	Craig Blackett	DT	NA	NA	Insulated hand tools	None	Stable	
1.20	30.20	RC	22/07/2021 14:00	28/07/2021 14:00	Craig Blackett	MV	Geobore S (146)	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
22/07/2021 17:30	7.80	2.85	2.20	End of Shift
23/07/2021 07:30	7.80	2.85	2.85	Start of shift
23/07/2021 17:00	24.10	4.35	2.80	End of Shift
26/07/2021 07:30	24.10	4.35	2.75	Start of shift
26/07/2021 17:30	30.20	4.35	3.35	End of Shift
27/07/2021 07:30	30.20	4.35	2.80	Drilling Complete
27/07/2021 17:30	12.00	4.35	2.80	End of Shift
28/07/2021 07:30	13.50	4.35	2.80	Start of shift
28/07/2021 15:00	0.00	0.00	2.80	Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
22/07/2021 00:00	4.50	2.85		4.50	0	Rise not recorded, masked by flush.
23/07/2021 12:00	12.30	2.85		12.30	0	Heavy influx noted. Rise not recorded.

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	3.60	AIR/MIST	90	White	
3.60	30.20	AIR/MIST	90	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
30.20	146	4.35	150						
		15.30	146						

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref
12.00	S1	SP	1.25	12.00	Pipe 1
12.00	G1	SP	1.25	12.00	Pipe 2

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type
Pipe 1	0.00	1.50	50	PLAIN
Pipe 2	0.00	1.50	19	PLAIN
Pipe 1	1.50	12.00	50	SLOTTED
Pipe 2	1.50	3.00	19	SLOTTED

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
-0.50	0.00	Upstanding cover	
0.00	0.50	Concrete	
0.50	0.75	Gravel backfill	
0.75	1.25	Bentonite	
1.25	12.00	Gravel backfill	
12.00	13.50	Bentonite	
13.50	30.20	Grout	Cement / Bentonite Grout

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

SOIL ENGINEERING

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_015
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 4

Ground Level	+9.92mOD	Coordinates	549671.50E, 260975.20N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Depth (Thickness)	Datum Level	Waterstrike
TOPSOIL: Dark brown slightly gravelly clayey fine to coarse SAND with occasional rootlets. (TOP) [TOPSOIL]		(0.30) 0.30	9.62	
Orangish brown gravelly slightly silty fine to coarse SAND. Gravel is subangular to subrounded fine to coarse of flint. (SUPD) [SUPERFICIAL DEPOSITS]		(0.50) 0.80	9.12	
Structureless CHALK composed of greyish white gravelly fine to coarse SAND. Gravel is subangular to subrounded fine to coarse of chalk and flint. (CIRIA Grade - unable to determine) (WMCK) [WEST MELBURY CHALK FORMATION]		(0.40) 1.20	8.72	
Assumed zone of core loss. CHALK with flint. (Driller's Description) (WMCK) [WEST MELBURY CHALK FORMATION]		(0.40) 1.60	8.32	
Structureless CHALK composed of greyish cream slightly sandy slightly gravelly SILT. Gravel is very weak low density greyish white. With occasional subangular and rounded fine to coarse gravel and cobbles of flint with thin white cortex. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 1.60m to 1.80m recovered as non intact core (subangular fine to coarse gravel sized fragments)	Grade Dm	(0.60) 2.20	7.72	
Very weak medium density off white to light brown locally stained yellowish brown CHALK composed of calcareous SILTSTONE. (CIRIA Grade - unable to determine) (WMCK) [WEST MELBURY CHALK FORMATION] from 2.20m to 2.31m recovered as non intact core (subangular fine to coarse gravel sized fragments)		(0.30) 2.50	7.42	
Very weak medium density light greyish brown locally stained yellowish brown CHALK composed of calcareous SILTSTONE. Recovered as non intact core (subangular to subrounded fine to coarse gravel sized fragments). (CIRIA Grade - unable to determine) (WMCK) [WEST MELBURY CHALK FORMATION] from 3.00m to 3.09m intact core from 3.54m to 3.80m assumed zone of core loss from 3.60m to 3.76m recovered as non intact core (gravelly clay) with occasional angular coarse black flints with thin grey cortex (<1-2mm)		(1.26) 3.76	6.16	
Very weak medium density light greyish brown CHALK composed of calcareous SILTSTONE. Discontinuities 1) 10 to 20 degrees medium to widely spaced, rarely closely spaced, planar rough. (Possibly CIRIA Grade A2) (WMCK) [WEST MELBURY CHALK FORMATION] from 4.92m to 4.96m 1 No. discontinuity 45 degrees undulating rough clean from 6.05m to 6.18m recovered as non intact core (subangular to subrounded medium and coarse gravel sized fragments and subangular cobble sized fragments) from 6.18m to 6.30m assumed zone of core loss		(2.54) 6.30	3.62	▽
Very weak medium density light grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 10 to 20 degrees closely to medium spaced planar rough locally infilled with silt (<3mm). 2) 60 to 85 degrees closely to medium spaced planar and undulating smooth gravel infill (<1mm). (CIRIA Grade B2/3) (WMCK) [WEST MELBURY CHALK FORMATION] from 6.70m to 6.84m recovered as non intact core (subangular to subrounded fine to coarse gravel sized fragments) from 6.84m to 7.00m very weak low density	Grade B2/3	(6.20)		

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD
D 1 0.05				
B 3 0.05-0.30				
ES 2 0.20				
D 4 0.45				
ES 5 0.50				
B 6 0.45-0.75				
D 7 0.80				
ES 8 0.90				
B 9 0.80-1.20				
C 10 1.20-2.20	102	60		
C 11 2.20-2.70	102	90	38	38
C 12 2.70-3.60	102	93	10	0
C 13 3.60-4.80	102	100	87	87
C 14 4.80-6.30	102	92	83	83
C 15 6.30-7.80	102	100	85	73
C 16 7.80-9.30	102	100	100	70
EW 1 10.00				

IF
NR
NI
NA
NI
NI 90
NI 310 900
NI 200 310

In Situ Test Details

Install-ation

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_015
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 4

Ground Level	+9.92mOD	Coordinates	549671.50E, 260975.20N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very weak medium density light grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 10 to 20 degrees closely to medium spaced planar rough locally infilled with silt (<3mm). 2) 60 to 85 degrees closely to medium spaced planar and undulating smooth gravel infill (<1mm). (CIRIA Grade B2/3) (WMCK) [WEST MELBURY CHALK FORMATION] from 10.30m to 10.45m recovered as non intact core (angular to subangular fine to coarse gravel sized fragments) from 10.70m to 10.80m assumed zone of core loss						C 17 9.30-10.80	102	93	83	76			
from 11.55m to 11.65m recovered as non intact core (angular coarse gravel sized fragments) from 11.90m to 11.98m recovered as non intact core (angular coarse gravel sized fragments)					▽	C 18 10.80-12.30	102	100	88	60			
Very weak greenish grey SILTSTONE with occasional subrounded to rounded medium and coarse gravel of coprolite. (WMCK) [CAMBRIDGE GREENSAND MEMBER]			12.50	-2.58									
Stiff to very stiff dark grey fissured CLAY. Fissures are 0 to 30 degrees closely to medium spaced planar smooth locally polished and striated. (GLT) [GAULT FORMATION]			12.65	-2.73		C 19 12.30-13.80	102	100	0	0			
from 13.80m to 14.10m 1 No. medium bed of weak light grey siltstone													
from 14.80m to 15.16m from 14.80m to 15.16m 1 No. fissure 55 to 75 degrees planar smooth polished and striated						C 20 13.80-15.30	102	100					
						C 21 15.30-16.80	102	100					
						C 22 16.80-18.30	102	100					
						C 23 18.30-19.80	102	100					

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_015 Sheet 3 of 4
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+9.92mOD	Coordinates	549671.50E, 260975.20N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Stiff to very stiff dark grey fissured CLAY. Fissures are 0 to 30 degrees closely to medium spaced planar smooth locally polished and striated. (GLT) [GAULT FORMATION] from 20.30m to 20.50m recovered as firm (Drilling induced)						C 24 19.80-21.30	102	100					
from 22.05m to 22.20m very closely fissured						C 25 21.30-22.80	102	100					
						C 26 22.80-24.10	102	100					
						C 27 24.10-24.30	102	100					
from 25.55m to 25.70m 1 No. fissure 70 degrees undulating smooth clean	Unweathered		(17.55)			C 28 24.30-25.80	102	100			NA		
						C 29 25.80-27.30	102	100					
						C 30 27.30-28.80	102	100					
at 29.04m with occasional light grey fragments of weak siltstone (<8mm)						C 31 28.80-30.20	102	100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_015 Sheet 4 of 4
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+9.92mOD	Coordinates	549671.50E, 260975.20N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Stiff to very stiff dark grey fissured CLAY. Fissures are 0 to 30 degrees closely to medium spaced planar smooth locally polished and striated. (GLT) [GAULT FORMATION]			30.20	-20.28									

Complete at 30.20m. Termination Reason: Achieved Scheduled Depth

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_016
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+8.32mOD	Coordinates	549807.10E, 261084.70N	Grid	OSGB
Date Started	10/08/2021	Date Completed	12/08/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	10/08/2021 09:30	10/08/2021 10:15	Colin Howard	DT			Insulated Hand tools	None	Stable	Inspection pit: Hand dug
1.20	30.20	RC	10/08/2021 10:15	12/08/2021 12:00	Colin Howard	DH	Geobore S (146)	PCD	Soilmec SM6			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
10/08/2021 17:30	15.75	0.00	4.50	End of Shift
11/08/2021 07:30	15.75	0.00	4.50	Start of shift
11/08/2021 17:00	30.20	0.00	5.10	End of Shift
12/08/2021 12:00	0.00			Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
10/08/2021 11:30	5.65	0.00		4.50	20	Fast

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	5.65	AIR/MIST	100	White	
5.65	30.20	AIR/MIST	100	Grey	

HOLE DIAMETER / CASING DIAMETER / DYNAMIC SAMPLING

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
30.20	146	30.20	146						

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	30.20	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL | Print date and time 12/09/2022 13:55 | Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_016 Sheet 1 of 4
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level +8.32mOD Coordinates 549807.10E, 261084.70N Grid OSGB

Hole Type IP+RC Inclination

Description of Strata	Weathering	Depth (Thickness)	Datum Level
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint. Occasional roots. (TOP) [TOPSOIL]		(0.50) 0.50	8.32
Firm light grey slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium of flint and mudstone. (SUPD) [SUPERFICIAL DEPOSITS]		(0.70) 1.20	8.32
Structureless CHALK composed of very stiff light greyish-brown occasionally stained orangish-brown gravelly calcareous CLAY. Gravel is subangular fine to coarse of very weak to weak medium density light grey calcareous siltstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 1.55m to 1.60m: Assumed zone of core loss.	Grade Dm	(2.36) 3.56	8.32
Very weak to weak medium density light greyish brown frequently stained orangish-brown CHALK comprised of calcareous SILTSTONE. Discontinuities are 0-40degrees very closely to closely spaced planar, rough with rare black smearing and frequently stained orangish-brown and 70-90degrees planar, rough with frequent orangish-brown staining. (CIRIA Grade B4) (WMCK) [WEST MELBURY CHALK FORMATION] from 4.57m to 4.70m: 0-40degree discontinuities are extremely closely spaced. from 5.09m to 5.17m: 0-40degree discontinuities are extremely closely spaced.	Grade B4	(2.02) 5.58	8.32
Very weak low to medium density light grey unstained CHALK composed of calcareous SILTSTONE. Discontinuities are randomly orientated extremely closely to very closely locally closely spaced planar, rough frequently stained orangish-brown and speckled black. (CIRIA Grade B4/5) (WMCK) [WEST MELBURY CHALK FORMATION] from 5.84m to 5.95m: Weak medium density light grey calcareous SITLSTONE.	Grade B4/5	(0.77) 6.35	8.32
Very weak low to medium density light grey unstained CHALK composed of calcareous SILTSTONE. Discontinuities are randomly orientated extremely closely to very closely spaced planar, rough and unstained. (CIRIA Grade A4/5) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade A4/5	(0.75) 7.10	8.32
Weak medium to high density light grey unstained CHALK composed of calcareous SILTSTONE. Discontinuities are 0-30 degrees closely locally medium spaced, planar, rough, unstained and 80-90 degrees planar, rough and unstained. (CIRIA Grade A3) (WMCK) [WEST MELBURY CHALK FORMATION] from 8.00m to 8.15m 2No. extremely closely spaced 30degree discontinuities, planar rough unstained.	Grade A3	(3.32)	

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD
D 1 0.20				
ES 2 0.20				
B 3 0.20-0.50				
D 4 0.50				
ES 5 0.60				
B 6 0.60-1.00				
D 7 1.00				
ES 8 1.20				
C 9 1.20-1.60	102	88		
C 10 1.60-2.80	102	100		
C 11 2.80-4.30	102	100	49	0
C 12 4.30-5.65	102	100	84	0
C 13 5.65-6.90	102	100	6	0
C 14 6.90-8.55	102	100	100	35
C 15 8.55-10.10	102	100	92	34

IF
NA
NA 10 50 90
10 20 90
20 90 220

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_016 Sheet 2 of 4
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+8.32mOD	Coordinates	549807.10E, 261084.70N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Depth (Thickness)	Datum Level
Weak medium to high density light grey unstained CHALK composed of calcareous SILTSTONE. Discontinuities are 0-30 degrees closely locally medium spaced, planar, rough, unstained and 80-90 degrees planar, rough and unstained. (CIRIA Grade A3) (WMCK) [WEST MELBURY CHALK FORMATION]		10.42	8.32
Extremely weak to very weak low to medium density grey unstained CHALK composed of calcareous MUDSTONE. Discontinuities are randomly orientated extremely closely to closely spaced planar and rough, unstained. (CIRIA Grade A4/5) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade A4/5	(0.86) 11.28	8.32
Very stiff dark grey slightly sandy CLAY with occasional fine to coarse gravel size nodules of black coprolite. Sand is fine to medium. (WMCK) [CAMBRIDGE GREENSAND MEMBER]		11.55	8.32
Very stiff fissured thinly and thickly laminated dark grey CLAY with rare nodules (<6 x <10mm) of brown siltstone. Fissures are 0-30degrees extremely closely to very closely spaced, planar, smooth and 80-90degrees planar and smooth occasionally polished. (GLT) [GAULT FORMATION] from 13.05m to 13.12m: 1no. 40degree fissure planar and polished. from 13.14m to 13.35m: 1no. 75degree fissure planar and polished. from 14.01m to 14.27m: 1no. 65degree fissure planar and polished.		(3.00) 14.55	8.32
Very stiff fissured thinly and thickly laminated dark grey CLAY with rare nodules (<6 x <10mm) of brown siltstone. Fissures are 0-20degrees closely to medium spaced, planar, smooth occasionally polished and 80-90degrees, planar, smooth and occasionally polished. (GLT) [GAULT FORMATION]		(1.90) 16.45	8.32
Very stiff fissured dark grey CLAY with rare nodules (<6 x <10mm). Fissures are 0-20degrees very closely to closely spaced planar smooth occasionally slightly polished. 30-60degrees closely spaced planar smooth occasionally slightly polished. 80-90degrees planar smooth occasionally slightly polished. (GLT) [GAULT FORMATION] from 17.53m to 17.90m: 1no. 70degree fissure planar and polished.		(5.30)	

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details
C 16 10.10-11.40	102	100	44	12	10 30 150	
C 17 11.40-12.60	102	100				
C 18 12.60-14.25	102	100				
C 19 14.25-15.75	102	100				
C 20 15.75-17.05	102	100				
C 21 17.05-18.65	102	99				
C 22 18.65-20.25	102	100				

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_016 Sheet 3 of 4
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+8.32mOD	Coordinates	549807.10E, 261084.70N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Depth (Thickness)	Datum Level	Waterstrike	IF
Very stiff fissured dark grey CLAY with rare nodules (<6 x <10mm). Fissures are 0-20degrees very closely to closely spaced planar smooth occasionally slightly polished. 30-60degrees closely spaced planar smooth occasionally slightly polished. 80-90degrees planar smooth occasionally slightly polished. (GLT) [GAULT FORMATION] from 20.25m to 20.47m: 1no. 65degree fissure undulating and smooth. from 20.85m to 21.10m: 1no. 65degree fissure undulating and smooth.	Unweathered	21.75	8.32		NA
Very stiff fissured thinly laminated dark grey CLAY with rare nodules (<8 x <10mm) of brown siltstone. Fissures are 0-40degrees extremely closely to very closely spaced planar smooth occasionally slightly polished. 80-90degrees planar smooth occasionally slightly polished. (GLT) [GAULT FORMATION] at 22.30m: 1no. belemnite (8x45mm). at 27.35m: 1no. belemnite (8x50mm). at 28.66m: 1no. band (10mm) of brown shell fragments (6x6mm).		(8.45)			

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD
C 23 20.25-21.85	102	100		
C 24 21.85-22.85	102	100		
C 25 22.85-24.40	102	99		
C 26 24.40-25.90	102	98		
C 27 25.90-27.50	102	96		
C 28 27.50-29.00	102	100		
C 29 29.00-30.20	102	100		

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:55   Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_016 Sheet 4 of 4
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+8.32mOD	Coordinates	549807.10E, 261084.70N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very stiff fissured thinly laminated dark grey CLAY with rare nodules (<8 x <10mm) of brown siltstone. Fissures are 0-40degrees extremely closely to very closely spaced planar smooth occasionally slightly polished. 80-90degrees planar smooth occasionally slightly polished. (GLT) [GAULT FORMATION]			30.20	8.32									
Complete at 30.20m. Termination Reason: Achieved Scheduled Depth													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_017
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+7.38mOD	Coordinates	549940.00E, 261108.70N	Grid	OSGB
Date Started	04/08/2021	Date Completed	05/08/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	04/08/2021 10:00	04/08/2021 10:20	Colin Howard	MM	NA	NA	Insulated hand tools	None	Stable	
1.20	15.00	RC	04/08/2021 10:21	05/08/2021 13:00	Colin Howard	MM	Geobore S	PCD	Soilmec SM6			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
04/08/2021 17:15	10.70	2.70	2.90	End of Shift
05/08/2021 07:30	10.70	2.70	2.30	Start of Shift
05/08/2021 14:00	15.00	2.70	2.30	End of Hole
05/08/2021 16:00	0.00	0.00		Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
04/08/2021 11:30	5.50	2.70		2.70	20	Medium

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	5.20	AIR/MIST	100	Brown	
5.20	15.00	AIR/MIST	100	Grey	

HOLE DIAMETER

Depth Base	Diameter
15.00	146

CASING DIAMETER

Depth Base	Diameter
2.70	150
15.00	146

DYNAMIC SAMPLING

Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	15.00	Grout	

LOCATION DETAILS

Remarks

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Form No. SIEXPHOLEHDR Issue.Revision No. 2.02 Issue Date 22/06/2016

SOIL ENGINEERING

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_017
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 2

Ground Level	+7.38mOD	Coordinates	549940.00E, 261108.70N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Depth (Thickness)	Datum Level	Waterstrike
TOPSOIL: Dark brown slightly sandy slight gravelly CLAY. Sand is fine to coarse. Gravel is angular to subangular fine to coarse of flint and quartz. (TOP) [TOPSOIL]		0.25	7.13	
Soft to firm brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine and medium of mudstone and flint. (SUPD) [SUPERFICIAL DEPOSITS]		(0.75) 1.00	6.38	
Firm light brownish grey slightly gravelly silty CLAY. Gravel is subangular to subrounded fine and medium of mudstone and flint. (SUPD) [SUPERFICIAL DEPOSITS]		1.20	6.18	
Stiff to very stiff orange brown slightly sandy CLAY. Sand is fine. (SUPD) [SUPERFICIAL DEPOSITS]		(0.85) 2.05	5.33	
Orange brown locally slightly gravelly calcareous fine SAND. Gravel is subangular fine of siltstone and flint. (SUPD) [SUPERFICIAL DEPOSITS] from 2.15m to 2.20m 1 No. very thin bed of soft light bluish grey silty clay		(0.35) 2.40	4.98	
Structureless CHALK composed of stiff to very stiff light greyish brown calcareous silty CLAY with occasional black and orange brown flints (<25mm) with thin light grey cortex (<1mm). (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(0.70) 3.10	4.28	▽
Structureless CHALK composed of stiff to very stiff fissured light greyish white to creamy white and brown calcareous silty CLAY. Fissures are extremely closely spaced 10 degrees planar striated and clay infilled (<1mm). (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 3.45m to 3.50m 1 No. fissure 65-70 degrees planar smooth and clay infilled (<1mm) from 3.95m to 4.00m assumed zone of core loss		(0.90) 4.00	3.38	
Structureless CHALK composed of firm to stiff light grey to grey silty CLAY. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] at 4.30m gravelly. Gravel is subangular fine and medium of very weak low density chalk and occasional flint. from 4.45m to 4.70m recovered as non intact core (firm to stiff grey and dark grey clay with high cobble content. Cobbles are subangular of siltstone)		(0.70) 4.70	2.68	
Assumed zone of core loss. Greyish brown CLAY. (Driller's description) (WMCK) [WEST MELBURY CHALK FORMATION]		(0.50) 5.20	2.18	
Extremely weak to very weak low density light grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 0 to 20 degrees medium to widely spaced planar smooth with clay infill (<2mm). (CIRIA Grade B2) (WMCK) [WEST MELBURY CHALK FORMATION] from 6.20m to 6.30m recovered as non intact core (subangular fine to coarse gravel sized fragments) (Drilling induced) from 7.25m to 7.35m recovered as non intact core (angular to subangular fine to coarse gravel sized fragments) (Drilling induced) from 7.35m to 7.44m extremely closely to very closely spaced discontinuities, 0 to 10 degrees and 80 to 90 degrees planar and undulating smooth and infilled with soft clay (<1mm) from 7.80m to 7.85m grey and recovered as non intact core (clayey angular to subangular fine to coarse gravel sized fragments)	Grade B2	(2.65) 7.85	-0.47	▼
Assumed zone of core loss. Strata presumed to be CHALK composed of SILTSTONE. (WMCK) [WEST MELBURY CHALK FORMATION]		(0.35) 8.20	-0.82	
Very weak low to medium density grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 10 to 40 degrees closely to medium spaced planar rough. (Probably CIRIA Grade B2/3) (WMCK) [WEST MELBURY CHALK FORMATION]		(0.34) 8.54	-1.16	
Very weak low to medium density grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 10 to 30 degrees closely to medium spaced undulating rough. (CIRIA Grade B2/3) (WMCK) [WEST MELBURY CHALK FORMATION] from 8.54m to 8.63m and 8.70m to 9.20m fractures of discontinuity set 1) are very closely to closely spaced from 8.63m to 8.70m assumed zone of core loss from 8.70m to 9.02m 1 No. discontinuity 85 degrees planar rough infilled	Grade B3 Grade B2/3	(1.76)		

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details
D 1 0.05-0.10						
ES 2 0.20-0.25						
B 3 0.10-0.40						
D 4 0.40-0.50						
ES 5 0.50-0.55						
B 6 0.40-0.80						
B 9 0.80-1.20						
D 7 1.00-1.10						
ES 8 1.10-1.20						
C 10 1.20-2.20	102	100			NA	
C 11 2.20-2.80	102	100				
C 12 2.80-3.10	102	100				
C 13 3.10-4.00	102	94				
C 14 4.00-5.20	102	58				
C 15 5.20-5.70	102	60	60	24	NI 210 620	
C 16 5.70-6.20	102	100	100	100		
C 17 6.20-6.70	102	100	100	68		
C 18 6.70-7.35	102	100	82	82		
C 19 7.35-8.20	102	59	41	24	NR	
C 20 8.20-8.70	102	86	72	56	130	
C 21 8.70-9.20	102	64	30	0	NI 60 90	
C 22 9.20-9.70	102	80	68	60	NI 140 230	
C 23 9.70-10.20	102	100	80	52		

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_017
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 2

Ground Level +7.38mOD
Coordinates 549940.00E, 261108.70N
Grid OSGB
Hole Type IP+RC
Inclination 90° from horizontal

Description of Strata	Weathering	Depth (Thickness)	Datum Level
Very weak low to medium density grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 10 to 30 degrees closely to medium spaced undulating rough. (CIRIA Grade B2/3) (WMCK) [WEST MELBURY CHALK FORMATION] from 8.70m to 9.02m 1 No. discontinuity 85 degrees planar rough infilled with fine gravel (<3mm) from 9.02m to 9.20m assumed zone of core loss from 9.20m to 9.97m with very closely to closely spaced very thin to thin beds of grey calcareous mudstone from 9.60m to 9.70m assumed zone of core loss from 9.76m to 9.87m 1 No. discontinuity 50 degrees undulating smooth from 9.97m to 10.03m recovered as non intact core (angular fine to coarse gravel sized fragments)	Unweathered	10.30	-2.92
Very stiff grey becoming dark grey slightly sandy glauconitic CLAY. Sand is fine. (WMCK) [CAMBRIDGE GREENSAND MEMBER] at 10.38m with frequent angular to subangular coarse gravel sized fragments of black coprolite at 10.51m with frequent angular to subangular coarse gravel sized fragments of black coprolite		10.54	-3.16
Stiff to very stiff fissured dark grey CLAY with occasional rounded fine and medium gravel sized nodules of siltstone. Fissures are 0 to 20 degrees rarely 90 degrees closely spaced planar smooth. (GLT) [GAULT FORMATION] from 10.58m to 10.70m assumed zone of core loss		(1.16) 11.70	-4.32
Stiff to very stiff fissured thinly laminated dark grey CLAY. Fissures are 10 to 40 degrees closely to medium spaced planar smooth. (GLT) [GAULT FORMATION] at 12.30m light grey brown gravel (<5mm) of siltstone at 12.58m 1 No. elongate fragment of coprolite (<20mm x <5mm) at 12.66m 1 No. elongate fragment of coprolite (<35mm x <5mm) at 13.00m 1 No. rounded fragment of coprolite (15mm) with outer light brown surface coatings from 13.23m to 13.29m 1 No. fissure 35 degrees planar smooth polished from 13.29m to 13.37m 1 No. fissure 35 degrees planar smooth polished at 14.45m 1 No. nodule of siltstone (<10mm) at 14.97m 1 No. nodule of siltstone (<10mm)		(3.30) 15.00	-7.62

Complete at 15.00m. Termination Reason: Achieved Scheduled Dep h

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
C 24 10.20-10.70	102	76			NA		
C 25 10.70-11.20	102	100					
C 26 11.20-11.70	102	100					
C 27 11.70-13.00	102	100					
C 28 13.00-14.50	102	100					
C 29 14.50-15.00	102	100					

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Form No. SIEXPHOLELOG Issue.Revision No. 2.05 Issue Date 02/03/2018

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_018
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+10.37mOD	Coordinates	549676.15E, 260782.25N	Grid	OSGB
Date Started	15/09/2021	Date Completed	20/09/2021	Inclination	90° f om horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	15/09/2021 12:00	15/09/2021 13:00	TW	DT			Insulated Hand Tools	None	Stable	
1.20	30.00	RC	15/09/2021 13:00	20/09/2021 10:30	TW	AY	Geobore S (146)	PCD	T46 Beretta			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
15/09/2021 17:30	12.70	3.70	5.94	End of Shift
16/09/2021 07:30	12.70	3.70	3.34	Start of Shift
16/09/2021 17:30	30.00	2.50	14.23	End of Shift
17/09/2021 07:30	30.00	2.50	3.25	Start of Shift
17/09/2021 17:30	12.50	2.50	3.25	End of Shift
20/09/2021 07:30	12.50	2.50	3.25	Start of Shift
20/09/2021 10:30	0.00			Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
15/09/2021 14:40	7.40	2.20		3.27	20	

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
0.00	30.00	AIR/MIST	100	Grey	

HOLE DIAMETER / CASING DIAMETER / DYNAMIC SAMPLING

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
3.70	150	3.70	150						
30.00	146	30.00	146						

INSTALLATION DETAILS / PIPE CONSTRUCTION

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type
12.20	S1	SP	1.50	12.20	Pipe 1	Pipe 1	0.00	1.50	50	PLAIN
						Pipe 1	1.50	11.70	50	SLOTTED

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
2.50	12.50	Geophysics testing
7.50	7.50	Falling Head Test

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
-0.50	0.00	Upstanding cover	
0.00	0.40	Concrete	
0.40	1.50	Bentonite	
1.50	12.20	Gravel backfill	
12.20	12.50	Bentonite	
12.50	30.00	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

SOIL ENGINEERING
Part of the Bachy Soletanche Group

FINAL   Print date and time 12/09/2022 13:55   Log checked by David Howard

Form No. SIEXPHOLEHDR   Issue.Revision No. 2.02   Issue Date 22/06/2016

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_018
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 3

Ground Level	+10.37mOD	Coordinates	549676.15E, 260782.25N	Grid	OSGB		
Hole Type	IP+RC	Inclination	90° from horizontal				

Description of Strata	Weathering	Depth (Thickness)	Datum Level
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint. (TOP) [TOPSOIL]		(0.32) 0.32	10.05
Firm reddish brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint. (SUPD) [SUPERFICIAL DEPOSITS]		(0.48) 0.80	9.57
Firm light greyish brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint. (SUPD) [SUPERFICIAL DEPOSITS]		(0.40) 1.20	9.17
No recovery. CHALK (Driller's description) (WMCK) [WEST MELBURY CHALK FORMATION]		(1.00) 2.20	8.17
Structureless CHALK composed of firm yellowish brown slightly gravelly calcareous CLAY with orange staining. Gravel is angular to subangular fine of extremely low density calcareous siltstone. (Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(0.90) 3.10	7.27
Structureless CHALK composed of firm yellowish brown gravelly calcareous CLAY with orange staining. Gravel is angular to subangular fine to coarse of extremely weak low density calcareous siltstone. (Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 3.79m to 3.89m recovered as non intact core (subangular coarse gravel sized fragments)	Grade Dm	(1.29) 4.39	5.98
Structureless CHALK composed of firm yellowish brown gravelly calcareous CLAY with closely spaced thin beds of extremely weak to very weak low density yellowish brown chalk composed of calcareous siltstone. Gravel is angular to subangular fine to coarse of extremely weak to very weak low density calcareous siltstone. (Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(2.23) 6.62	3.75
Extremely weak to very weak low density yellowish brown CHALK composed of calcareous SILTSTONE with closely spaced thin beds of structureless chalk composed of firm yellowish brown gravelly calcareous clay. Gravel is angular fine to coarse of extremely weak low density orange stained calcareous siltstone. Discontinuities: 1) randomly orientated closely spaced planar and undulating smooth with orange staining. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 7.78m to 7.84m recovered as non intact core (angular medium to coarse gravel sized orange stained fragments)	Grade B3	(1.93) 8.55	1.82
Extremely weak to very weak low density light grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) randomly orientated very closely spaced planar smooth with orange staining. (CIRIA Grade B4) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B4	(1.15) 9.70	0.67
Very weak to weak high density light grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 0-20 degrees closely			

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details
		0			NR	K 2.10 - 7.40
		100				
		100				
		100				
		100	64	40	NI 170 200	
		100	53	39	10 30 290	

Waterstrike | Installation

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_018
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 3

Ground Level +10.37mOD Coordinates 549676.15E, 260782.25N Grid OSGB

Hole Type IP+RC Inclination 90° from horizontal

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very weak to weak high density light grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 0-20 degrees closely spaced planar occasionally undulating smooth clean. 2) 45 degrees medium spaced planar and undulating smooth clean. 3) randomly orientated extremely closely to very closely spaced planar smooth clean. (CIRIA Grade A3) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade A3		(1.07) 10.77	-0.40				100	65	58	30 90 190		
Very weak to weak high density light grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 0-20 degrees closely to medium spaced planar occasionally undulating smooth clean. 2) 70-90 degrees medium spaced planar smooth clean. (CIRIA Grade A3) (WMCK) [WEST MELBURY CHALK FORMATION] from 13.00m to 13.20m frequent phosphatic nodules (<30mm x 10mm)	Grade A3		(2.43) 13.20	-2.83				100	69	60	50 190 470		
Stiff greenish grey slightly sandy glauconitic CLAY with occasional black coprolite (<10mm x 10mm) and occasional light grey burrows (<1mm x 10mm). Sand is fine to medium. (WMCK) [CAMBRIDGE GREENSAND MEMBER]			13.28	-2.91				100	33	33			
Stiff fissured dark grey CLAY with rare dark brown phosphatic nodules (<10mm x 10mm). Fissures are 0-10 degrees and 20-25 degrees extremely closely and very closely spaced planar smooth very tight polished and locally striated. (GLT) [GAULT FORMATION] from 13.83m to 13.95m 1 No. fissure inclined (65 degrees) planar smooth tight and polished from 13.84m to 14.02m 1 No. fissure inclined (70 degrees) planar smooth tight and polished			(1.07) 14.35	-3.98									
Very stiff fissured dark grey CLAY with rare dark brown and brown phosphatic nodules (<10mm x 15mm). Fissures are horizontal and vertical 0-10 degrees and 90 degrees extremely closely to closely spaced planar smooth tight and polished. (GLT) [GAULT FORMATION] from 15.23m to 16.60m silty			(4.35) 18.70	-8.33				100 100 100 100					
Very stiff fissured dark grey CLAY with rare dark brown and brown phosphatic nodules (<10mm x 15mm). Fissures are inclined 0-10 degrees, 25-75 degrees and 90 degrees closely to medium spaced planar smooth tight and polished. (GLT) [GAULT FORMATION]								100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_018 Sheet 3 of 3
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.37mOD	Coordinates	549676.15E, 260782.25N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very stiff fissured dark grey CLAY with rare dark brown and brown phosphatic nodules (<10mm x 15mm). Fissures are inclined 0-10 degrees, 25-75 degrees and 90 degrees closely to medium spaced planar smooth tight and polished. (GLT) [GAULT FORMATION] from 19.95m to 20.20m 1 No. fissure inclined (75 degrees) planar smooth tight and polished from 23.53m to 23.87m 1 No. fissure inclined (75 degrees) planar smooth and polished from 28.65m to 28.95m slightly sandy with occasional dark brown and brown phosphatic nodules (<10mm x 20mm) and occasional dark brown decomposed plant material (<5mm x 10mm) and with rare shell fragments (<5mm x 5mm). Sand is fine	Unweathered		(10.60) 29.30	-18.93				100 100 100 100 100 100			NA		
Very stiff thickly laminated light greenish grey CLAY with rare dark brown and brown phosphatic nodules (<5mm x 15mm). (GLT) [GAULT FORMATION]			(0.35) 29.65	-19.28				81					
Assumed zone of core loss. CLAY (Driller's description)			(0.35) 30.00	-19.63									

Complete at 30.00m. Termination Reason: Achieved Scheduled Depth

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_019A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+9.42mOD	Coordinates	549790.40E, 260872.90N	Grid	OSGB
Date Started	17/08/2021	Date Completed	20/08/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	17/08/2021 16:00	17/08/2021 17:30	Craig Blackett	DT	NA	NA	Insulated Hand Tools	None	Stable	
1.20	30.00	RC	18/08/2021 07:30	20/08/2021 11:00	Craig Blackett	AL	Geobore S (146)	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
17/08/2021 17:30	1.20	0.00	Dry	End of Shift
18/08/2021 07:30	1.20	0.00	Dry	Start of shift
18/08/2021 17:30	10.50	10.50	3.40	End of Shift
19/08/2021 07:30	10.50	10.50	2.50	Start of shift
19/08/2021 17:30	30.00	30.00	4.20	End of Shift
20/08/2021 07:30	30.00	30.00	2.80	Start of shift
20/08/2021 11:00	0.00	0.00		Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	8.20	AIR/MIST	90	White	
8.20	30.00	AIR/MIST	90	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
2.50	150	2.50	150						
30.00	146	30.00	146						

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
2.90	2.90	High pressure dilatometer test
6.50	6.50	High pressure dilatometer test
9.40	9.40	High pressure dilatometer test

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	30.00	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_019A
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 3

Ground Level	+9.42mOD	Coordinates	549790.40E, 260872.90N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint. Occasional roots. (TOP) [TOPSOIL]			(0.30) 0.30	9.42		D 1 0.05-0.10 ES 2 0.20-0.25 B 3 0.10-0.40							
Firm light brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint. (SUPD) [SUPERFICIAL DEPOSITS]			(0.50) 0.80	9.42		D 4 0.40-0.50 ES 5 0.50-0.55 B 6 0.40-0.80							
Firm light brown to greyish slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint. (SUPD) [SUPERFICIAL DEPOSITS]			(0.40) 1.20	9.42		B 9 0.80-1.20 D 7 1.00-1.10 ES 8 1.10-1.20							
Brown clayey subangular to subrounded fine to coarse GRAVEL of flint. (SUPD) [SUPERFICIAL DEPOSITS] from 1.20m to 1.55m assumed zone of core loss.			(0.45) 1.65	9.42		C 10 1.20-2.20	102	65			NA		
Structureless CHALK composed of firm yellowish grey slightly gravelly calcareous CLAY. Gravel is subangular to subrounded fine to coarse of very weak low density calcareous siltstone with orange staining. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 3.30m to 3.50m slightly sandy. Sand is fine to coarse	Grade Dm		(2.05) 3.70	9.42		C 11 2.20-3.70	102	100				HPD 2.90	
Structureless CHALK composed of yellowish grey slightly gravelly calcareous CLAY. Gravel is subrounded to rounded fine to medium of white and brown flint and very weak low density calcareous siltstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(0.40) 4.10	9.42		C 12 3.70-4.10	102	100					
Very weak low density CHALK composed of grey calcareous SILTSTONE. Discontinuities are 0 to 10 degrees closely spaced rough planar unstained. (CIRIA Grade A3) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade A3		(1.50) 5.60	9.42		C 13 4.10-5.60	102	100	100	50	NI 100 200		
Weak medium density CHALK composed to grey calcareous SILTSTONE. Discontinuities are 0 to 20 degrees medium spaced rough planar infilled with clay films (CIRIA Grade B2) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B2		(1.50) 7.10	9.42		C 14 5.60-7.60	102	93	83	68	NI 230 400	HPD 6.50	
Weak low density CHALK composed of grey calcareous SILTSTONE. Discontinuities are 0 to 20 degrees closely spaced rough planar. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B3		(1.10) 8.20	9.42		C 15 7.60-8.20	102	100	100	88	130 190 240		
Structureless CHALK composed of grey gravelly calcareous CLAY. Gravel is subangular to subrounded fine to coarse of weak low density calcareous siltstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 8.60m to 8.75m chalk recovered as subangular to subrounded fine to coarse fragments	Grade Dm		(0.55) 8.75	9.42		C 16 8.20-10.20	102	90	77	73	NA		
Weak medium density CHALK composed of grey calcareous SILTSTONE. Discontinuities are 0 to 30 degrees closely spaced rough undulating unstained. (probably CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 8.92m to 9.00m recovered as weak medium density grey subangular to subrounded fine to coarse fragments of chalk			9.00	9.42							NI 120 320	HPD 9.40	
Very weak medium density grey CHALK composed of calcareous MUDSTONE. Discontinuities: 1) 5 to 40 degrees closely to medium	Grade B3		(1.20)										

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_019A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 3

Ground Level	+9.42mOD	Coordinates	549790.40E, 260872.90N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Depth (Thickness)	Datum Level	Waterstrike
Very weak medium density grey CHALK composed of calcareous MUDSTONE. Discontinuities: 1) 5 to 40 degrees closely to medium spaced planar smooth stained light brown. 2) 60 to 85 degrees medium spaced undulating planar smooth clean. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 9.00m to 9.20m extremely weak low density from 9.62m to 9.70m non intact core (recovered as subangular medium and coarse gravel sized fragments) from 9.89m to 10.00m structureless chalk composed of soft clay (Dm) from 10.00m to 10.20m assumed zone of core loss		10.20	9.42	
Weak high density grey CHALK composed of calcareous MUDSTONE. Discontinuities: 1) 40 to 60 degrees medium spaced undulating planar smooth stained light brown. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 10.50m to 10.57m disturbed by drilling, recovered as clayey subangular to subrounded fine to coarse gravel sized fragments	Grade A2	(0.66) 10.86	9.42	
Extremely weak low density grey CHALK composed of calcareous MUDSTONE. (Unable to determine CIRIA Grade) (WMCK) [WEST MELBURY CHALK FORMATION] from 10.86m to 10.99m structureless chalk composed of soft slightly gravelly clay (Dm) from 11.20m to 11.34m very weak medium density from 11.90m to 12.00m assumed zone of core loss from 12.00m to 12.18m very weak medium density from 12.18m to 12.19m frequent coprolites (<15mm x 15mm)		(1.45) 12.31	9.42	
Stiff fissured dark grey CLAY with rare siltstone nodules (6mm x 8mm) and rare fossilised phosphatic nodules (<6mm x 10mm). Fissures are horizontal to subhorizontal very closely to closely spaced planar smooth polished and vertical to subvertical medium spaced planar smooth polished. (GLT) [GAULT FORMATION]		(6.48) 18.79	9.42	
Very stiff fissured dark grey CLAY with rare phosphatic nodules (<11mm x 15mm) and rare siltstone nodules (<8mm x 15mm). Fissures are subhorizontal very closely spaced undulating smooth polished. (GLT) [GAULT FORMATION]		(0.42) 19.21	9.42	
Very stiff fissured dark grey CLAY with rare siltstone nodules (<6mm x 10mm) and rare phosphatic nodules (8mm x 28mm). Subhorizontal to horizontal fissures are very closely to closely spaced undulating planar smooth polished, subvertical to vertical fissures are closely to				

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
C 17 10.20-10.50	102	100	100	100			
C 18 10.50-12.00	102	93	85	85	1320 1320 1320		
C 19 12.00-13.50	102	100	21	21			
C 20 13.50-15.00	102	100					
C 21 15.00-16.50	102	100					
C 22 16.50-18.00	102	100					
C 23 18.00-19.50	102	100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_019A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 3 of 3

Ground Level	+9.42mOD	Coordinates	549790.40E, 260872.90N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very stiff fissured dark grey CLAY with rare siltstone nodules (<6mm x 10mm) and rare phosphatic nodules (8mm x 28mm). Subhorizontal to horizontal fissures are very closely to closely spaced undulating planar smooth polished, subvertical to vertical fissures are closely to medium spaced planar smooth polished. (GLT) [GAULT FORMATION]						C 24 19.50-21.00	102	100					
						C 25 21.00-22.50	102	100					
			(6.52)			C 26 22.50-24.00	102	100					
						C 27 24.00-25.50	102	100			NA		
Very stiff fissured dark grey CLAY with rare phosphatic nodules (12mm x 24mm). Fissures are subvertical to vertical medium spaced undulating planar smooth, fissures are subhorizontal to horizontal closely spaced undulating planar smooth polished. (GLT) [GAULT FORMATION]			25.73 (0.70)	9.42		C 28 25.50-27.00	102	100					
Very stiff fissured dark grey CLAY with rare phosphatic nodules (<15mm x 20mm). Fissures are subhorizontal to subvertical very closely to closely spaced planar undulating smooth polished. Fissures are subvertical to vertical are closely spaced planar polished. (GLT) [GAULT FORMATION]			26.43 (1.16)	9.42									
Very stiff fissured dark grey CLAY with rare phosphatic nodules (<12mm x 18mm). Fissures are subhorizontal to horizontal very closely spaced planar undulating smooth polished. (GLT) [GAULT FORMATION]			27.59 (1.44)	9.42		C 29 27.00-28.50	102	100					
Very stiff fissured dark grey CLAY with rare phosphatic nodules (<15mm x 20mm) and rare siltstone nodules (<7mm x 11mm). Fissures are subhorizontal to horizontal very closely to closely spaced planar undulating smooth polished, and subvertical to vertical medium spaced planar polished smooth. (GLT) [GAULT FORMATION] at 29.17m thin lamination (5mm) of very weak siltstone			29.03 (0.97)	9.42		C 30 28.50-30.00	102	100					
			30.00	9.42									
Complete at 30.00m. Termination Reason: Achieved Scheduled Depth													

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Form No. SIEXPHOLELOG Issue.Revision No. 2.05 Issue Date 02/03/2018

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_019B Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+9.32mOD	Coordinates	549788.16E, 260872.77N	Grid	OSGB
Date Started	14/10/2021	Date Completed	18/10/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	14/10/2021 15:00	14/10/2021 16:00	DC	DT	NA	NA	Insulated Hand Tools	None	Stable	
1.20	11.20	CP	14/10/2021 16:00	18/10/2021 12:30	DC	GL	NA	NA	Dando 2000			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
14/10/2021 17:30	4.00	4.00	Dry	End of Shift
15/10/2021 07:30	4.00	4.00	Dry	Start of Shift
15/10/2021 17:30	11.20	11.20	5.20	End of Shift
18/10/2021 07:30	11.20	11.20	4.00	Start of Shift
18/10/2021 12:30	0.00			Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
15/10/2021 12:00	8.70	8.70		4.50	20	Medium

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water
1.20	S	N=8 (2,2:1,2,2,3)	AR3501	75	1.20	Dry
2.20	S	N=11 (2,2:3,2,3,3)	AR3501	75	2.20	Dry
3.20	S	N=9 (1,2:2,2,3,2)	AR3501	75	3.20	Dry
4.20	S	N=15 (2,3:3,4,4,4)	AR3501	75	4.20	Dry
5.20	S	N=19 (3,4:5,4,5,5)	AR3501	75	5.20	Dry
6.20	S	N=23 (3,4:6,5,6,6)	AR3501	75	6.20	Dry
7.20	S	N=23 (3,5:6,5,6,6)	AR3501	75	7.20	Dry
8.20	S	N=23 (4,4:5,5,6,7)	AR3501	75	8.20	Dry
9.20	S	N=30 (4,5:6,7,8,9)	AR3501	75	9.20	4.50
10.70	S	N=31 (4,6:7,8,7,9)	AR3501	75	10.70	5.20

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
11.20	200	11.20	200						

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	11.20	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL   Print date and time 12/09/2022 13:55   Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_019B Sheet 1 of 2
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+9.32mOD	Coordinates	549788.16E, 260872.77N	Grid	OSGB
Hole Type	IP+CP	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse flint. Frequent rootlets. (TOP) [TOPSOIL]			(0.30) 0.30	9.02		D 1 0.10 B 2 0.10-0.30							
Firm light brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint. (SUPD) [SUPERFICIAL DEPOSITS]			0.45	8.87		D 3 0.35 B 4 0.40-0.60							
Firm grey slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of flint and chert. (SUPD) [SUPERFICIAL DEPOSITS]			(0.45) 0.90	8.42									
CHALK. Recovered as firm grey slightly sandy slightly gravelly calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint, chert and extremely weak low density calcareous siltstone. (WMCK) [WEST MELBURY CHALK FORMATION]			(0.30) 1.20	8.12		B 5 0.90-1.10							
CHALK. Recovered as firm grey slightly gravelly calcareous CLAY. Gravel is subangular to subrounded fine to coarse of extremely low density calcareous siltstone. (WMCK) [WEST MELBURY CHALK FORMATION]			(4.00) 5.20	4.12	▽	D 6 1.20 D 7 1.20-1.65 B 8 1.20-1.70 D 9 2.00 D 10 2.20-2.65 B 11 2.20-2.70 D 12 3.00 D 13 3.20-3.65 B 14 3.20-3.70 D 15 4.00 D 16 4.20-4.65 B 17 4.20-4.70 D 18 5.00						SPT(S) N=8 (2,2:1,2,2,3) 1.20 SPT(S) N=11 (2,2:3,2,3,3) 2.20 SPT(S) N=9 (1,2:2,2,3,2) 3.20 SPT(S) N=15 (2,3:3,4,4,4) 4.20	
CHALK. Recovered as stiff grey slightly gravelly calcareous CLAY. Gravel is subangular to subrounded fine to coarse of very weak medium density calcareous siltstone. (WMCK) [WEST MELBURY CHALK FORMATION] from 9.20m to 11.20m very stiff			(6.00)		▼	D 19 5.20-5.65 B 20 5.20-5.70 D 21 6.00 D 22 6.20-6.65 B 23 6.20-6.70 D 24 7.00 D 25 7.20-7.65 B 26 7.20-7.70 D 27 8.00 D 28 8.20-8.65 B 29 8.20-8.70 D 30 9.00 D 31 9.20-9.65 B 32 9.20-9.70 D 33 10.00						SPT(S) N=19 (3,4:5,4,5,5) 5.20 SPT(S) N=23 (3,4:6,5,6,6) 6.20 SPT(S) N=23 (3,5:6,5,6,6) 7.20 SPT(S) N=23 (4,4:5,5,6,7) 8.20 SPT(S) N=30 (4,5:6,7,8,9) 9.20	

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:55   Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Form No. SIEXPHOLELOG   Issue.Revision No. 2.05   Issue Date 02/03/2018

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_019B
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 2

Ground Level	+9.32mOD	Coordinates	549788.16E, 260872.77N	Grid	OSGB
Hole Type	IP+CP	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
CHALK. Recovered as stiff grey slightly gravelly calcareous CLAY. Gravel is subangular to subrounded fine to coarse of very weak medium density calcareous siltstone. (WMCK) [WEST MELBURY CHALK FORMATION]			11.20	-1.88		D 34 10.70-11.15 B 35 10.70-11.20						SPT(S) N=31 (4,6:7,8,7,9) 10.70	
Complete at 11.20m. Termination Reason: Borehole abandoned due to site instruction to stop intrusive works													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_020
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+8.13mOD	Coordinates	549898.80E, 260975.80N	Grid	OSGB
Date Started	03/09/2021	Date Completed	08/09/2021	Inclination	90° f om horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	03/09/2021 14:00	03/09/2021 15:00	Craig Blackett	DT	NA	NA	Insulated hand tools	None	Stable	
1.20	15.20	RC	06/09/2021 07:30	06/09/2021 17:30	Craig Blackett	CJ	Geobore S (146)	PCD	Soilmec SM8			
15.20	16.20	RO	07/09/2021 08:00	07/09/2021 09:15	Craig Blackett	CB	NA	Drag Bit	Soilmec SM8			
16.20	30.20	RC	07/09/2021 09:15	08/09/2021 14:30	Craig Blackett	CJ	Geobore S (146)	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
03/09/2021 15:30	1.20	0.00	Dry	End of Shift
06/09/2021 07:30	1.20	0.00	Dry	Start of shift
06/09/2021 17:30	15.20	1.45	1.70	End of Shift
07/09/2021 07:30	15.20	1.45	2.20	Start of shift
07/09/2021 17:30	24.20	7.35	4.90	End of Shift
08/09/2021 07:30	24.20	7.35	2.10	Start of shift
08/09/2021 11:00	30.20	7.35	4.45	Drilling Complete
08/09/2021 14:30	0.00	0.00		Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
06/09/2021 11:30	5.40			0.00	0	Seepage. Rise not recorded.

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	9.50	AIR/MIST	90	White	
9.50	19.70	AIR/MIST	90	Grey	
19.70	27.20	AIR/MIST	50	Grey	
27.20	28.70	AIR/MIST	90	Grey	
28.70	30.20	AIR/MIST	50	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
7.35	150	7.35	150						
30.20	146								

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	30.20	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

SOIL ENGINEERING
Part of the Bachy Soletanche Group

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Hole ID
Project No.	TE8364	BH_STW_020
Engineer	Mott MacDonald Bentley	
Employer	Barhale Limited	Sheet 1 of 4

Exploratory Hole Log

Ground Level	+8.13mOD	Coordinates	549898.80E, 260975.80N	Grid	OSGB
Hole Type	IP+RC+RO	Inclination	90° from horizontal		

Description of Strata	Weathering	Depth (Thickness)	Datum Level	Waterstrike
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint. Occasional roots. (TOP) [TOPSOIL]		(0.30) 0.30	7.83	
Firm light brown slightly gravelly sandy CLAY. Sand is fine to medium. Gravel is angular to subrounded medium and coarse of flint. (SUPD) [SUPERFICIAL DEPOSITS]		(0.30) 0.60	7.53	
Firm light greyish brown slightly gravelly sandy CLAY. Sand is fine to medium. Gravel is angular to subrounded medium and coarse of flint. (SUPD) [SUPERFICIAL DEPOSITS]		(0.60) 1.20	6.93	
Very stiff greyish brown slightly sandy slightly gravelly CLAY. Sand is fine. Gravel is angular to subrounded fine and medium of flint. (SUPD) [SUPERFICIAL DEPOSITS]		(0.67) 1.87	6.26	
Structureless CHALK composed of stiff greyish brown slightly gravelly calcareous CLAY. Gravel is angular to subangular fine to coarse of very weak calcareous mudstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(1.33) 3.20	4.93	
Structureless CHALK composed of firm to stiff greyish brown gravelly calcareous CLAY with closely to medium spaced thin and medium beds of very weak to weak medium and high density chalk composed of calcareous mudstone. Gravel is angular to subangular fine to coarse of very weak calcareous mudstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 5.15m to 5.40m assumed zone of core loss		(3.05) 6.25	1.88	▽
Structureless CHALK composed of stiff light grey gravelly calcareous CLAY. Gravel is angular to subangular fine to coarse of very weak calcareous mudstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 6.38m to 6.43m very thin bed of very weak medium density chalk composed of calcareous mudstone		(0.39) 6.64	1.49	
Very weak medium density light grey CHALK composed of calcareous MUDSTONE. No discontinuities identified. CIRIA Grade - unable to determine. (WMCK) [WEST MELBURY CHALK FORMATION]		(0.56) 7.20	0.93	
Weak high density light grey CHALK composed of calcareous MUDSTONE. Discontinuities 1) 50 to 85 degrees very closely to closely spaced undulating planar smooth with black staining. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 7.70m to 7.83m recovered as non intact core (subangular fine to coarse gravel sized fragments)	Grade B3	(0.63) 7.83	0.30	
Structureless CHALK composed of soft to firm light grey gravelly calcareous CLAY. Gravel is angular to subangular fine to coarse of very weak calcareous mudstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 8.04m to 8.10m very thin bed of very weak medium density chalk composed of calcareous mudstone	Grade Dm	(0.40) 8.23	-0.10	
Weak high density light grey CHALK composed of calcareous MUDSTONE. No discontinuities identified. CIRIA Grade - unable to determine. (WMCK) [WEST MELBURY CHALK FORMATION]		(0.32) 8.55	-0.42	
Weak high density light grey CHALK composed of calcareous MUDSTONE. Discontinuities 1) 5 to 15 degrees very closely spaced	Grade B4	(0.31) 8.86	-0.73	

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD
D 1 0.05-0.10 ES 2 0.20-0.25 B 3 0.10-0.40 D 4 0.40-0.50 ES 5 0.50-0.55 B 6 0.40-0.80 B 9 0.80-1.20 D 7 1.00-1.10 ES 8 1.10-1.20				
C 10 1.20-2.20	102	100		
C 11 2.20-3.20	102	100		
C 12 3.20-5.40	102	89		
C 13 5.40-6.20	102	100		
C 14 6.20-7.70	102	100	66	66
C 15 7.70-9.50	102	94	34	18

IF
NR
NA
560 560 560
NI 100 140
NA
320
40

In Situ Test Details
HPD 4.50
HPD 8.50

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL　Print date and time 12/09/2022 13:55　Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_020
Project No.	TE8364		Sheet 2 of 4
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+8.13mOD	Coordinates	549898.80E, 260975.80N	Grid	OSGB
Hole Type	IP+RC+RO	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Weak high density light grey CHALK composed of calcareous MUDSTONE. Discontinuities 1) 5 to 15 degrees very closely spaced planar and undulating smooth with black staining. 2) 80 to 85 degrees closely spaced planar smooth. (CIRIA Grade B4) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade A2		(2.54)			C 16 9.50-10.70	102	100	93	93	NI 530 700		
Very weak medium density light grey CHALK composed of calcareous MUDSTONE. Discontinuities 1) 40 to 70 degrees medium to widely spaced undulating smooth clean. (CIRIA Grade A2) (WMCK) [WEST MELBURY CHALK FORMATION] from 8.96m to 9.06m thin bed of structureless chalk composed of very stiff calcareous clay from 9.24m to 9.37m recovered as non intact core (subangular fine to coarse gravel sized fragments) from 9.40m to 9.50m assumed zone of core loss from 9.50m to 9.58m thin bed of soft gravelly clay (possibly drilling induced) from 11.31m to 11.40m with occasional coprolites (<6mm x 7mm) and sand sized glauconite (CAMBRIDGE GREENSAND FORMATION)			11.40	-3.27		C 17 10.70-12.20	102	53	47	47			
Assumed zone of core loss. Grey CLAY (Driller's description) (GLT) [GAULT FORMATION]			(0.70) 12.10	-3.97							NR		
Stiff to very stiff fissured dark grey CLAY with rare coprolites (<7mm x 10mm). Fissures are randomly orientated extremely closely to closely spaced planar and undulating smooth polished. (GLT) [GAULT FORMATION]			(2.14) 14.24	-6.11		C 18 12.20-12.95 C 19 12.95-13.70	102 102	100 100			NA		
Very stiff fissured dark grey CLAY with rare coprolites (<8mm x 12mm). Fissures are randomly orientated very closely to closely spaced planar and undulating smooth polished. (GLT) [GAULT FORMATION]			(0.96) 15.20	-7.07		C 20 13.70-15.20	102	93					
Rotary open-hole drilling. Grey CLAY. (Driller's description) (GLT) [GAULT FORMATION]			(1.00) 16.20	-8.07							NR	WRSBP 15.70	
Stiff locally very stiff fissured dark grey CLAY with rare coprolites (<10mm x 14mm). Fissures are 0 to 20 degrees very closely to closely spaced planar and undulating smooth polished and 80 to 90 degrees medium spaced planar polished. (GLT) [GAULT FORMATION] from 16.24m to 17.10m 1 No. fissure 85 degrees planar smooth polished from 17.20m to 17.71m 1 No. fissure 90 degrees planar smooth polished from 17.60m to 17.70m very stiff from 17.95m to 18.16m very stiff at 18.86m 1 No. coprolite (5mm x 10mm) at 19.25m 1 No. coprolite (8mm x 14mm)			(4.49)			C 21 16.20-16.70 C 22 16.70-18.20 C 23 18.20-19.70	102 102 102	100 100 100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_020
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 3 of 4

Ground Level	+8.13mOD	Coordinates	549898.80E, 260975.80N	Grid	OSGB
Hole Type	IP+RC+RO	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Stiff locally very stiff fissured dark grey CLAY with rare coprolites (<10mm x 14mm). Fissures are 0 to 20 degrees very closely to closely spaced planar and undulating smooth polished and 80 to 90 degrees medium spaced planar polished. (GLT) [GAULT FORMATION]			20.69	-12.56		C 24 19.70-21.20	102	100			NA		
Very stiff fissured dark grey CLAY with rare coprolite (<8mm x 11mm). Fissures are 0 to 20 degrees closely to medium to spaced planar and undulating smooth polished. (GLT) [GAULT FORMATION] at 21.22m 1 No. burrow infilled with silt (3mm x 12mm) from 21.44m to 21.50m recovered as soft (possibly drilling induced) at 21.73m 1 No. coprolite (5mm x 8mm) at 22.62m 1 No. coprolite (6mm x 11mm)			(3.22) 23.91	-15.78		C 25 21.20-22.70 C 26 22.70-24.20	102 102	100 100					
Stiff fissured dark grey CLAY. Fissures are randomly orientated very closely spaced planar and undulating smooth polished. (GLT) [GAULT FORMATION] from 23.91m to 23.93m with frequent coprolites (<8mm x 14mm)			(0.41) 24.32	-16.19									
Very stiff fissured dark grey CLAY with rare coprolites (<5mm x 8mm). (GLT) [GAULT FORMATION] from 24.45m to 24.62m 1 No. fissure 90 degrees planar smooth polished at 24.67m 1 No. coprolite (6mm x 11mm)			(0.47) 24.79	-16.66		C 27 24.20-25.70	102	100					
Stiff fissured dark grey CLAY with rare coprolites (6mm x 10mm). Fissures are randomly orientated extremely closely to closely spaced planar undulating smooth polished. (GLT) [GAULT FORMATION] from 25.36m to 25.58m 1 No. fissure 90 degrees planar smooth polished from 25.37m to 25.60m 1 No. fissure 80 degrees planar smooth polished from 26.03m to 26.19m 1 No. fissure 75 degrees undulating smooth polished at 26.17m with occasional coprolites (<18mm x 25mm) from 26.23m to 26.61m 1 No. fissure 85 degrees planar smooth polished			(2.61) 27.40	-19.27		C 28 25.70-27.20	102	100					
Very stiff fissured dark grey CLAY with rare coprolites (<9mm x 14mm). Fissures are randomly orientated extremely closely to closely spaced planar and undulating smooth. (GLT) [GAULT FORMATION] at 28.24m 1 No. coprolite (<9mm x 14mm)			(2.80)			C 29 27.20-28.70 C 30 28.70-30.20	102 102	100 100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_020
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 4 of 4

Ground Level	+8.13mOD	Coordinates	549898.80E, 260975.80N	Grid	OSGB
Hole Type	IP+RC+RO	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff fissured dark grey CLAY with rare coprolites (<9mm x 14mm). Fissures are randomly orientated extremely closely to closely spaced planar and undulating smooth. (GLT) [GAULT FORMATION] from 29.92m to 30.02m thin bed of siltstone, recovered as non intact core (subangular medium and coarse gravel sized fragments) with occasional fossilised shell fragments (5mm x 8mm)			30.20	-22.07									

Complete at 30.20m. Termination Reason: Achieved Scheduled Depth

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_021 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.98mOD	Coordinates	549642.70E, 260664.30N	Grid	OSGB
Date Started	13/08/2021	Date Completed	17/08/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	13/08/2021 12:00	13/08/2021 13:00	Craig Blackett	DT			Insulated Hand tools	None	Stable	
1.20	15.00	RC	13/08/2021 13:00	17/08/2021 12:30	Craig Blackett	AY	Geobore S (146)	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
13/08/2021 17:30	5.00	5.00	1.80	End of Shift
16/08/2021 07:30	5.00	5.00	1.85	Start of shift
16/08/2021 17:30	13.00	13.00	2.40	End of Shift
17/08/2021 07:30	13.00	13.00	3.00	Start of shift
17/08/2021 12:30	0.00			Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	8.00	AIR/MIST	90	White	
8.00	10.00	WATER	90	Grey	
10.00	11.00	AIR/MIST	90	Grey	
11.00	13.00	WATER	90	Grey	
13.00	15.00	AIR/MIST	90	Grey	

HOLE DIAMETER / CASING DIAMETER / DYNAMIC SAMPLING

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
15.00	146	15.00	146						

INSTALLATION DETAILS / PIPE CONSTRUCTION

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
5.45	5.45	Self Boring Pressuremeter Test
9.20	9.20	High Pressure Dilatometer Test
12.00	12.00	High Pressure Dilatometer Test

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	15.00	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

SOIL ENGINEERING
Part of the Bachy Soletanche Group

FINAL   Print date and time 12/09/2022 13:55   Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_021 Sheet 1 of 2
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.98mOD	Coordinates	549642.70E, 260664.30N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Depth (Thickness)	Datum Level	Waterstrike	IF
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint. Occasional rootlets. (TOP) [TOPSOIL]		(0.30) 0.30	10.98		
Firm brown slightly gravelly sandy CLAY. Gravel is angular to subrounded fine to coarse of flint. Sand is fine to coarse. (SUPD) [SUPERFICIAL DEPOSITS]		(0.40) 0.70	10.98		
Structureless CHALK composed of firm yellowish brown calcareous CLAY. Gravel is angular to subangular medium to coarse of flint and extremely weak low density calcareous siltstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(0.36) 1.56	10.98		NA
No recovery. CHALK. (Driller's description) (WMCK) [WEST MELBURY CHALK FORMATION]		(0.64) 2.20	10.98		
Extremely weak to very weak low density yellowish brown CHALK composed of calcareous SILTSTONE. Fractures are 0-10 degrees closely to medium spaced planar rough with silt infill (<3mm). (CIRIA Grade B2) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B2	(1.51) 3.71	10.98		120 210 350
Structureless CHALK composed of firm yellowish brown gravelly calcareous CLAY. Gravel is angular medium to coarse of extremely weak low density calcareous siltstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(0.53) 4.24	10.98		NA
Very weak low to medium density yellowish brown CHALK composed of calcareous SILTSTONE with orange stained incipient fractures. Fractures are 0-5 degrees closely to medium spaced planar rough clean. (CIRIA Grade A2) (WMCK) [WEST MELBURY CHALK FORMATION] from 4.24m to 4.50m extremely weak low density	Grade A2	(1.07) 5.31	10.98		110 380 410
Very weak medium density light grey CHALK composed of calcareous SILTSTONE. Fractures are randomly orientated extremely closely to very closely spaced planar undulating smooth rough with orange staining. (CIRIA Grade B4) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B4	5.60	10.98		10 30 40
Assumed zone of core loss. CHALK. (Driller's description) (WMCK) [WEST MELBURY CHALK FORMATION]		(1.00) 6.60	10.98		
Very weak medium density light grey CHALK composed of calcareous SILTSTONE. Fractures are randomly orientated extremely to very closely spaced planar undulating smooth rough with orange staining. (CIRIA Grade B4) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B4	(0.51) 7.11	10.98		
Very weak low to medium density light grey CHALK composed of calcareous SILTSTONE. Fractures are 0-10 degrees widely spaced planar rough clean. (Unable to determine CIRIA Grade) (WMCK) [WEST MELBURY CHALK FORMATION] from 7.11m to 7.34m extremely weak low density	Undetermined	(0.61) 7.72	10.98		610 610 610
Very weak to weak medium to high density light grey CHALK composed of calcareous SILTSTONE. Fractures are 0-30 degrees closely spaced planar undulating rough clean. (CIRIA Grade A3) (WMCK) [WEST MELBURY CHALK FORMATION] from 8.23m to 8.50m recovered as non intact core (angular to subangular fine to coarse gravel sized fragments of very weak medium density calcareous siltstone) from 8.53m to 8.65m 1 No. fracture 65 degrees planar smooth from 9.87m to 10.00m assumed zone of core loss	Grade A3	(3.87)			NI 95 190

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD
D 1 0.05-0.10				
ES 2 0.20-0.25				
B 3 0.10-0.40				
D 4 0.40-0.50				
ES 5 0.50-0.55				
B 6 0.40-0.80				
B 9 0.80-1.20				
D 7 1.00-1.10				
ES 8 1.10-1.20				
C 10 1.20-2.20	102	38		
C 11 2.20-2.70	102	100	40	22
C 12 2.70-3.50	102	100	98	84
C 13 3.50-5.00	102	100	58	58
C 14 5.00-6.60	102	38	13	13
C 15 6.60-8.00	102	100	44	44
C 16 8.00-10.00	102	94	44	36

In Situ Test Details:
WRSBP 5.45
HPD 9.20

Install-ation

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_021
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 2

Ground Level	+10.98mOD	Coordinates	549642.70E, 260664.30N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very weak to weak medium to high density light grey CHALK composed of calcareous SILTSTONE. Fractures are 0-30 degrees closely spaced planar undulating rough clean. (CIRIA Grade A3) (WMCK) [WEST MELBURY CHALK FORMATION] from 10.00m to 10.14m extremely weak low density (possibly drilling induced) from 11.13m to 11.20m recovered as non intact core (angular to subangular fine to coarse gravel sized fragments of very weak medium density calcareous siltstone) from 11.22m to 11.36m 1 No. fracture 70 degrees undulating smooth from 11.50m to 11.59m 1 No. fracture 80 degrees undulating smooth			11.59	10.98		C 17 10.00-11.00	102	100	71	62			
Extremely weak to very weak low density light grey CHALK composed of calcareous SILTSTONE. Fractures are 0-5 degrees closely spaced planar undulating rough clean. (CIRIA Grade A3) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade A3		(0.46) 12.05	10.98		C 18 11.00-13.00	102	100	94	94	80 95 155	HPD 12.00	
Very weak to weak medium to high density light grey CHALK composed of calcareous SILTSTONE. Fractures are 0-5 degrees closely spaced undulating rough planar clean. (CIRIA Grade A3) (WMCK) [WEST MELBURY CHALK FORMATION] from 14.03m to 14.11m frequent phosphate nodules (<15mm x 30mm)	Grade A3		(2.06) 14.11	10.98		C 19 13.00-14.00	102	100	90	75	80 110 190		
Very stiff fissured dark grey CLAY with occasional phosphate nodules (<15mm x 25mm). Fissures are 0-15 degrees closely spaced undulating smooth. (GLT) [GAULT FORMATION]	Unweathered		(0.89) 15.00	10.98		C 20 14.00-15.00	102	100	11	11	NA		

Complete at 15.00m. Termination Reason: Achieved Scheduled Dep h

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Form No. SIEXPHOLELOG Issue.Revision No. 2.05 Issue Date 02/03/2018

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_022A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+8.46mOD	Coordinates	549910.00E, 260770.60N	Grid	OSGB
Date Started	03/09/2021	Date Completed	14/09/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	03/09/2021 11:15	03/09/2021 11:45	TW	DT			Insulated Hand Tools	None	Stable	
1.20	50.00	RC	06/09/2021 07:30	14/09/2021 12:00	TW	AL	Geobore S (146)	PCD	T46 Beretta			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
03/09/2021 15:30	1.20	0.00	Dry	End of Shift
06/09/2021 07:30	1.20	0.00	Dry	Start of Shift
06/09/2021 17:30	14.10	3.00	2.98	End of Shift
07/09/2021 07:30	14.10	3.00	1.94	Start of Shift
07/09/2021 17:30	14.10	1.00	1.94	End of Shift
08/09/2021 07:30	14.10	0.00	1.94	Start of Shift
08/09/2021 17:30	17.10	14.10	Dry	End of Shift
09/09/2021 07:30	17.10	14.10	Dry	Start of Shift
09/09/2021 17:30	30.60	21.00	Dry	End of Shift
10/09/2021 07:30	30.60	21.00	Dry	Start of Shift
10/09/2021 17:30	39.60	21.00	Dry	End of Shift
13/09/2021 07:30	39.60	21.00	Dry	Start of Shift
13/09/2021 17:30	50.00	21.00	2.58	End of Shift
14/09/2021 07:30	50.00	21.00	1.95	Start of Shift
14/09/2021 12:00	0.00	0.00		Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	14.10	AIR/MIST	100	Cream	
14.10	50.00	AIR/MIST	100	Grey	

HOLE DIAMETER

Depth Base	Diameter
12.00	200
21.00	150
50.00	146

CASING DIAMETER

Depth Base	Diameter
12.00	200
21.00	150
50.00	146

DYNAMIC SAMPLING

Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref
2.00	G1	SP	1.00	2.00	Pipe 1

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type
Pipe 1	0.00	1.00	50	PLAIN
Pipe 1	1.00	2.00	50	SLOTTED

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
7.00	7.00	Falling Head Test
8.00	8.00	Packer Test
10.50	12.00	Aquifer Seal

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
-0.50	0.00	Upstanding cover	
0.00	0.40	Concrete	
0.40	1.00	Bentonite	
1.00	2.00	Gravel backfill	
2.00	50.00	Bentonite	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_022A
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 5

Ground Level	+8.46mOD	Coordinates	549910.00E, 260770.60N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Depth (Thick-ness)	Datum Level
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint. Occasional roots. (TOP) [TOPSOIL]		(0.35) 0.35	8.11
Firm light brown slightly gravelly sandy CLAY. Gravel is angular to subrounded fine to medium of flint. Nodules of chalk. (SUPD) [SUPERFICIAL DEPOSITS]		(0.75) 1.10	7.36
Firm light brown greyish slightly gravelly sandy CLAY. Gravel is angular to subrounded fine to medium of mixed lithologies including flint. (SUPD) [SUPERFICIAL DEPOSITS]	Grade Dm	1.20	7.26
Structureless CHALK composed of firm yellowish brown calcareous CLAY with orange staining. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 1.20m to 1.30m multicoloured slightly sandy subangular to subrounded medium to coarse gravel of flint		(0.37) 1.57 (0.53) 2.10	6.89 6.36
Assumed zone of core loss. CHALK. (Driller's description) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(0.45) 2.55	5.91
Structureless CHALK composed of firm yellowish brown calcareous CLAY with orange staining. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 2.10m to 2.22m multicoloured slightly sandy slightly clayey subangular to subrounded medium to coarse gravel of flint (possible cavings from hole)	Grade Dm	(1.05)	
Structureless CHALK composed of firm yellowish brown gravelly calcareous CLAY with orange staining. Gravel is angular to subangular fine to coarse of extremely weak low density calcareous siltstone. (WMCK) [WEST MELBURY CHALK FORMATION] from 2.75m to 2.80m assumed zone of core loss		3.60	4.86
Structureless CHALK composed of firm yellowish brown gravelly calcareous CLAY with medium spaced thin beds of extremely weak to very weak low density yellowish brown chalk composed of calcareous siltstone. Gravel is angular to subangular medium of extremely weak low density calcareous siltstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(1.00) 4.60	3.86
Structureless CHALK composed of light grey gravelly calcareous CLAY with closely to medium spaced thin beds of very weak medium density light grey chalk composed of calcareous siltstone. Gravel is angular to subangular medium to coarse of extremely weak to very weak low density calcareous siltstone. (WMCK) [WEST MELBURY CHALK FORMATION] from 5.10m to 5.20m assumed zone of core loss	Grade Dm	(3.00) 7.60	0.86
Very weak to weak medium to high density light grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 0-20 degrees very closely to closely spaced undulating smooth with dustings of silt. 2) 80-90 degrees very closely to closely spaced undulating smooth with dustings of silt. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 8.28m to 8.34m structureless chalk composed of stiff light grey gravelly calcareous clay. Gravel is angular to subangular fine to medium of very weak chalk	Grade B3	(1.43) 9.03	-0.57
Structureless CHALK composed of stiff light grey gravelly calcareous CLAY. Gravel is angular to subangular fine to coarse of very weak to weak calcareous siltstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 9.45m to 9.69m weak high density light grey chalk composed of calcareous siltstone	Grade Dm	(1.22)	

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD
D 1 0.05–0.10				
ES 2 0.20–0.25				
B 3 0.10–0.40				
D 4 0.40–0.50				
ES 5 0.50–0.55				
B 6 0.40–0.80				
B 9 0.80–1.20				
D 7 1.00–1.10				
ES 8 1.10–1.20				
C 10 1.20–2.10		41		
C 11 2.10–2.80		93		
C 12 2.80–3.60		100		
C 13 3.60–5.10		100		
C 14 5.10–6.60		93		
C 15 6.60–8.10		100	39	33
C 16 8.10–9.60		100	48	43

IF: NA; NR; NA; NI 140 200; NA

In Situ Test Details: K 2.80 - 6.80; K 7.20 - 8.80

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL | Print date and time 12/09/2022 13:55 | Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_022A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 5

Ground Level	+8.46mOD	Coordinates	549910.00E, 260770.60N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Structureless CHALK composed of stiff light grey gravelly calcareous CLAY. Gravel is angular to subangular fine to coarse of very weak to weak calcareous siltstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]			10.25	-1.79		C 17 9.60-11.10		100	53	43			
Very weak to weak medium density light CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 0-20 degrees closely spaced planar undulating smooth. (CIRIA Grade A3) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade A3		(1.19) 11.44	-2.98							90 160 200		
Firm greenish grey slightly sandy slightly gravelly CLAY. Sand is fine. Gravel is subangular to subrounded fine to coarse of coprolite. (WMCK) [CAMBRIDGE GREENSAND MEMBER]			11.53	-3.07									
Stiff fissured dark grey CLAY with rare fossilised shell fragments (<10mm x 10mm) and rare fossilised coprolites (<30mm x 10mm). Fissures are 0-10 degrees closely spaced smooth occasionally polished with occasional dustings of silt and randomly orientated extremely closely to very closely spaced planar smooth occasionally polished. (GLT) [GAULT FORMATION]						C 18 11.10-12.60		100	24	24			
						C 19 12.60-14.10		100					
			(4.32)										
						C 20 14.10-15.60		100					
			15.85	-7.39									
Very stiff fissured dark grey CLAY with occasional phosphatic nodules (<30mm x 10mm). Fissures are 0-20 degrees closely spaced planar polished smooth and randomly orientated extremely closely to closely spaced planar undulating smooth polished. (GLT) [GAULT FORMATION]						C 21 15.60-17.10		100					
			(4.08)			C 22 17.10-18.60		100					
from 19.42m to 19.60m vertical undulating polished fissure						C 23 18.60-20.10		100					
			19.93	-11.47									

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

SOIL ENGINEERING

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Form No. SIEXPHOLELOG Issue.Revision No. 2.05 Issue Date 02/03/2018 Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_022A
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 3 of 5

Ground Level	+8.46mOD	Coordinates	549910.00E, 260770.60N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very stiff fissured dark grey CLAY with occasional phosphatic nodules (<30mm x 10mm). Fissures are 0-15 degrees closely to medium spaced planar smooth polished. (GLT) [GAULT FORMATION]													
						C 24 20.10-21.60		100					
from 22.34m to 22.60m subvertical planar polished fissure						C 25 21.60-23.10		100					
						C 26 23.10-24.60		100					
			(18.87)										
						C 27 24.60-26.10		100					
						C 28 26.10-27.60		100					
from 27.34m to 27.53m 1 No. 45 degrees planar polished fissure													
						C 29 27.60-29.10		100					
								100					
						C 30 29.10-30.60							

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_022A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 4 of 5

Ground Level	+8.46mOD	Coordinates	549910.00E, 260770.60N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff fissured dark grey CLAY with occasional phosphatic nodules (<30mm x 10mm). Fissures are 0-15 degrees closely to medium spaced planar smooth polished. (GLT) [GAULT FORMATION]													
from 30.60m to 30.76m 1 No. 45 degrees undulating polished fissure						C 31 30.60-32.10		100					
from 32.90m to 32.97m 1 No. 45 degrees planar polished fissure						C 32 32.10-33.60		100					
						C 33 33.60-35.10		100			NA		
						C 34 35.10-36.60		100					
						C 35 36.60-38.10		100					
Very stiff fissured thinly laminated dark grey CLAY with occasional phosphatic nodules (<30mm x 10mm) fossilised shell fragments (<10mm x 10mm) and fossilised belemnite (<30mm x 5mm). Fissures are 0 degrees very closely to closely spaced planar polished and 70-90 degrees medium spaced planar undulating polished smooth rarely rough. (GLT) [GAULT FORMATION]			38.80	-30.34		C 36 38.10-39.60		100					

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_022A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 5 of 5

Ground Level	+8.46mOD	Coordinates	549910.00E, 260770.60N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike
Very stiff fissured thinly laminated dark grey CLAY with occasional phosphatic nodules (<30mm x 10mm) fossilised shell fragments (<10mm x 10mm) and fossilised belemnite (<30mm x 5mm). Fissures are 0 degrees very closely to closely spaced planar polished and 70-90 degrees medium spaced planar undulating polished smooth rarely rough. (GLT) [GAULT FORMATION]			(5.43) 44.23	-35.77	
Very stiff thinly laminated dark grey CLAY with frequent fossilised belemnite (<30mm x 5mm), phosphatic nodules (<30mm x 10mm) and shell fragments (<10mm x 10mm). Fissures are 0-10 degrees very closely to closely spaced planar rough occasionally undulating rough smooth and 70-80 degrees medium to widely spaced planar polished. (GLT) [GAULT FORMATION] from 45.36m to 45.60m assumed zone of core loss			(3.37) 47.60	-39.14	
Very stiff dark grey slightly sandy gravelly CLAY. Sand is fine to medium. Gravel is subrounded to rounded fine of flint. (LGF) [LOWER GREENSAND FORMATION] from 48.40m to 48.60m assumed zone of core loss			(1.40) 49.00	-40.54	
Dark greenish grey slightly gravelly slightly clayey fine SAND. Gravel is subrounded fine to medium of flint. (LGF) [LOWER GREENSAND FORMATION] from 49.00m to 49.08m medium strong light grey gravelly medium grained sandstone. Gravel is subrounded to rounded fine of flint			(0.50) 49.50	-41.04	
Assumed zone of core loss. Very sandy CLAY. (Driller's Description)			(0.50) 50.00	-41.54	

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
C 37 39.60-41.10		100					
C 38 41.10-42.60		100					
C 39 42.60-44.10		100					
C 40 44.10-45.60		84					
C 41 45.60-47.10		100					
C 42 47.10-48.60		87					
C 43 48.60-50.00		64					

Complete at 50.00m. Termination Reason: Achieved Scheduled Depth

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:55 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_022B
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+8.51mOD	Coordinates	549907.72E, 260768.09N	Grid	OSGB
Date Started	07/10/2021	Date Completed	12/10/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	07/10/2021 13:00	07/10/2021 14:00	DC	DT			Insulated Hand Tools	None	Stable	
1.20	30.00	CP	07/10/2021 14:00	12/10/2021 11:30	DC	GL			Dando 2000			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
07/10/2021 17:30	5.20	5.20	Dry	End of Shift
08/10/2021 07:30	5.20	5.20	2.90	Start of shift
08/10/2021 17:30	15.20	12.20	5.20	End of Shift
11/10/2021 07:30	15.20	12.20	2.90	Start of shift
11/10/2021 17:30	11.70	11.70	2.90	End of Shift
12/10/2021 07:30	11.70	11.70	2.50	Start of shift
12/10/2021 11:00	0.00	0.00		Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water
1.20	S	N=7 (1,1:2,1,2,2)	AR3501	75	1.20	Dry
2.20	S	N=8 (1,2:2,2,2,2)	AR3501	75	2.20	Dry
3.20	S	N=9 (1,2:2,2,3,2)	AR3501	75	3.20	Dry
4.20	S	N=14 (2,3:3,3,4,4)	AR3501	75	4.20	Dry
5.20	S	N=20 (3,4:4,5,5,6)	AR3501	75	5.20	2.90
6.20	S	N=25 (3,5:6,6,7,6)	AR3501	75	6.20	4.00
7.20	S	N=27 (4,5:6,7,7,7)	AR3501	75	7.20	4.20
8.20	S	N=28 (5,5:7,6,7,8)	AR3501	75	8.20	4.20
9.20	S	N=28 (4,5:5,7,8,8)	AR3501	75	9.20	4.20
10.70	S	N=31 (4,5:6,8,9,8)	AR3501	75	10.70	4.20
12.20	S	N=32 (5,6:7,8,8,9)	AR3501	75	12.20	5.20
13.70	S	N=33 (6,7:7,8,9,9)	AR3501	75	12.20	5.20
15.20	S	N=31 (5,6:7,7,8,9)	AR3501	75	15.20	2.90
16.70	S	N=34 (5,7:7,8,9,10)	AR3501	75	15.20	Dry
18.20	S	N=39 (6,7:8,9,10,12)	AR3501	75	15.20	Dry
19.70	S	N=50 (6,8:10,11,13,16)	AR3501	75	15.20	Dry
21.20	S	50/295mm (7,8:10,12,14,14/70mm)	AR3501	75	15.20	Dry
22.70	S	50/290mm (6,7:10,11,14,15/65mm)	AR3501	75	15.20	Dry
24.20	S	50/280mm (8,9:11,14,16,9/55mm)	AR3501	75	15.20	Dry
25.70	S	50/280mm (8,10:12,15,16,7/55mm)	AR3501	75	15.20	Dry
27.20	S	52/275mm (10,12:13,15,18,6/50mm)	AR3501	75	15.20	Dry
28.70	S	50/265mm (10,13:16,18,16,0/40mm)	AR3501	75	15.20	Dry

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
30.00	150	15.20	150						

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type
11.70	S1	SP	11.30	11.70	Pipe 1	Pipe 1	0.00	11.30	50	PLAIN
						Pipe 1	11.30	11.70	50	SLOTTED

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
-0.50	0.00	Upstanding cover	
0.00	0.50	Concrete	
0.50	11.30	Bentonite	
11.30	11.70	Gravel backfill	
11.70	30.00	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL　Print date and time 12/09/2022 13:56　Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log		Hole ID	
Project No.	TE8364			BH_STW_022B	
Engineer	Mott MacDonald Bentley				
Employer	Barhale Limited			Sheet 1 of 3	
Ground Level	+8.51mOD	Coordinates	549907.72E, 260768.09N	Grid	OSGB
Hole Type	IP+CP	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to medium of flint. Occasional roots (2mm diameter). (TOP) [TOPSOIL]			(0.30) 0.30	8.21		D 1 0.10 B 2 0.10-0.30							
Soft light brown mottled dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of flint and chert. (SUPD) [SUPERFICIAL DEPOSITS]			(0.70) 1.00	7.51		D 3 0.40 B 4 0.50-0.70							
Firm light grey slightly sandy slightly gravelly CLAY with orangish brown staining. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of flint and chert. (SUPD) [SUPERFICIAL DEPOSITS] from 1.20m to 1.65m gravel of flint and calcareous siltstone			(0.70) 1.70	6.81		D 5 1.00 B 6 1.00-1.20 D 7 1.20-1.65 B 8 1.20-1.70						SPT(S) N=7 (1,1:2,1,2,2) 1.20	
Orangish brown slightly clayey slightly gravelly fine to coarse SAND. Gravel is subangular to subrounded fine to coarse of flint. Occasional pockets (>30mm x <20mm) of soft grey clay. (SUPD) [SUPERFICIAL DEPOSITS]			(0.30) 2.00	6.51		D 9 1.70							
CHALK recovered as: Firm light grey slightly sandy slightly gravelly calcareous CLAY. Sand is fine. Gravel is subangular to subrounded fine to coarse of extremely weak low density light grey with orangish brown staining calcareous siltstone and flint. (WMCK) [WEST MELBURY CHALK FORMATION]			(3.20) 5.20	3.31		D 10 2.00 D 11 2.20-2.65 B 12 2.20-2.70 D 13 3.20-3.65 B 14 3.20-3.70 D 15 4.20-4.65 B 16 4.20-4.70						SPT(S) N=8 (1,2:2,2,2,2) 2.20 SPT(S) N=9 (1,2:2,2,3,2) 3.20 SPT(S) N=14 (2,3:3,3,4,4) 4.20	
CHALK recovered as: Very stiff grey slightly gravelly CLAY with low cobble content. Gravel is subangular to subrounded fine to coarse of very weak medium density grey calcareous siltstone. Cobbles are subangular of very weak medium density calcareous siltstone. (WMCK) [WEST MELBURY CHALK FORMATION]			(6.10)			D 17 5.20-5.65 B 18 5.20-5.70 D 19 6.00 D 20 6.20-6.65 B 21 6.20-6.70 D 22 7.00 D 23 7.20-7.65 B 24 7.20-7.70 D 25 8.00 D 26 8.20-8.65 B 27 8.20-8.70 D 28 9.00 D 29 9.20-9.65 B 30 9.20-9.70 D 31 10.00						SPT(S) N=20 (3,4:4,5,5,6) 5.20 SPT(S) N=25 (3,5:6,6,7,6) 6.20 SPT(S) N=27 (4,5:6,7,7,7) 7.20 SPT(S) N=28 (5,5:7,6,7,8) 8.20 SPT(S) N=28 (4,5:5,7,8,8) 9.20	

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:56   Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_022B
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 3

Ground Level +8.51mOD Coordinates 549907.72E, 260768.09N Grid OSGB

Hole Type IP+CP Inclination 90° from horizontal

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
CHALK recovered as: Very stiff grey slightly gravelly CLAY with low cobble content. Gravel is subangular to subrounded fine to coarse of very weak medium density grey calcareous siltstone. Cobbles are subangular of very weak medium density calcareous siltstone. (WMCK) [WEST MELBURY CHALK FORMATION]													
						D 32 10.70-11.15						SPT(S) N=31 (4,5:6,8,9,8) 10.70	
						B 33 10.70-11.20							
Firm greenish grey slightly sandy slightly gravelly CLAY. Sand is fine. Gravel is subangular to subrounded fine to coarse of coprolite. (WMCK) [CAMBRIDGE GREENSAND MEMBER]			11.30	-2.79		D 34 11.30						K 11.30 - 11.70 K 11.30 - 11.70	
			(0.30)										
Very stiff fissured thinly laminated dark grey CLAY with rare nodules (<6mm x <6mm) of siltstone. Fissures are planar smooth and polished. (GLT) [GAULT FORMATION]			11.60	-3.09		D 35 11.60							
						D 36 12.20-12.65						SPT(S) N=32 (5,6:7,8,8,9) 12.20	
						B 37 12.20-12.70							
			(3.60)										
						D 38 13.70-14.15						SPT(S) N=33 (6,7:7,8,9,9) 13.70	
						B 39 13.70-14.20							
Very stiff fissured thinly laminated dark grey CLAY. Fissures are extremely closely spaced planar and smooth. Rare siltstone nodules (<6mm x <10mm). (GLT) [GAULT FORMATION]			15.20	-6.69		D 40 15.20-15.65						SPT(S) N=31 (5,6:7,7,8,9) 15.20	
						B 41 15.20-15.70							
						D 42 16.70-17.15						SPT(S) N=34 (5,7:7,8,9,10) 16.70	
						B 43 16.70-17.20							
						D 44 18.20-18.65						SPT(S) N=39 (6,7:8,9,10,12) 18.20	
						B 45 18.20-18.70							
						D 46 19.70-20.15						SPT(S) N=50 (6,8:10,11,13,16) 19.70	
						B 47 19.70-20.20							

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_022B
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 3 of 3

Ground Level	+8.51mOD	Coordinates	549907.72E, 260768.09N	Grid	OSGB
Hole Type	IP+CP	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very stiff fissured thinly laminated dark grey CLAY. Fissures are extremely closely spaced planar and smooth. Rare siltstone nodules (<6mm x <10mm). (GLT) [GAULT FORMATION]													
						D 48 21.20-21.65 B 49 21.20-21.70						SPT(S) 50/295mm (7,8:10,12,14,14/70mm) 21.20	
						D 50 22.70-23.14 B 51 22.70-23.20						SPT(S) 50/290mm (6,7:10,11,14,15/65mm) 22.70	
						D 52 24.20-24.63 B 53 24.20-24.70						SPT(S) 50/280mm (8,9:11,14,16,9/55mm) 24.20	
			(14.80)										
						D 54 25.70-26.13 B 55 25.70-26.20						SPT(S) 50/280mm (8,10:12,15,16,7/55mm) 25.70	
						D 56 27.20-27.63 B 57 27.20-27.70						SPT(S) 52/275mm (10,12:13,15,18,6/50mm) 27.20	
from 28.70m to 30.00m fissures are very closely spaced						D 58 28.70-29.12 B 59 28.70-29.20						SPT(S) 50/265mm (10,13:16,18,16,0/40mm) 28.70	
			30.00	21.49		D 60 30.00							
Complete at 30.00m. Termination Reason: Achieved Scheduled Depth													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:56   Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_023
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+10.66mOD	Coordinates	549686.60E, 260501.70N	Grid	OSGB
Date Started	20/07/2021	Date Completed	21/07/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	20/07/2021 12:30	20/07/2021 14:30	CB	DT	NA	NA	Insulated hand tools	None	Stable	
1.20	15.30	RC	20/07/2021 14:30	21/07/2021 17:30	CB	MM	Geobore S	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
20/07/2021 17:30	2.20	0.00	2.00	End of Shift
21/07/2021 07:30	2.20	0.00	1.80	Start of Shift
21/07/2021 12:00	15.30	3.00	2.60	Drilling Complete
21/07/2021 17:30	15.30	3.00	2.60	End of Shift
22/07/2021 07:30	15.30	3.00	2.35	Start of Shift
22/07/2021 10:30	0.00	0.00	2.35	Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	4.80	AIR/MIST	90	White	
4.80	15.30	AIR/MIST	90	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
15.30	146	3.00	150						
		15.30	146						

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type
14.50	S1	SP	2.00	14.50	Pipe 1	Pipe 1	0.00	2.00	50	PLAIN
						Pipe 1	2.00	14.00	50	SLOTTED
						Pipe 1	14.00	14.50	50	PLAIN

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
-0.50	0.00	Upstanding cover	
0.00	0.50	Concrete	
0.50	0.80	Gravel backfill	
0.80	2.00	Bentonite	
2.00	14.50	Gravel backfill	
14.50	15.30	Bentonite	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_023
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 2

Ground Level	+10.66mOD	Coordinates	549686.60E, 260501.70N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
TOPSOIL: Brown gravelly slightly clayey fine to coarse SAND. (TOP) [TOPSOIL]			(0.50) 0.50	10.16		D 1 0.05 B 3 0.05-0.30 ES 2 0.20							
Yellowish brown gravelly slightly silty fine to coarse SAND with low cobble content. Gravel is subangular to subrounded fine to coarse of flint. Cobbles are subangular to subrounded of flint. (SUPD) [SUPERFICIAL DEPOSITS]			(0.70) 1.20	9.46		D 4 0.50 ES 5 0.60 B 6 0.50-0.80 D 7 1.00 ES 8 1.20							
Structureless CHALK composed of light greyish brown stained orange slightly gravelly CLAY. Gravel is angular to subangular coarse of flint. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(0.50) 1.70	8.96		C 9 1.20-2.20	102	100					
Structureless CHALK composed of fissured light greyish white mottled orange with brown staining calcareous CLAY. Fissures are 50 degrees planar smooth closely spaced infilled (<1mm) with fine weak gravel of calcareous siltstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]			(0.50) 2.20	8.46									
Structureless CHALK composed of light greyish white mottled light orange calcareous CLAY. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]			(1.45) 3.65	7.01		C 10 2.20-3.65	102	100			NA		
Very weak to weak medium to high density yellowish white locally stained orange CHALK composed of calcareous MUDSTONE. Discontinuities 1) 5 to 30 degrees medium to widely spaced planar smooth. (CIRIA Grade - Unable to determine) (WMCK) [WEST MELBURY CHALK FORMATION] from 3.95m to 4.15m 3 No. randomly oriented closely spaced incipient discontinuities from 4.35m to 4.50m non intact core (recovered as subangular fine to coarse gravel sized fragments)			(1.15) 4.80	5.86		C 11 3.65-4.80	102	100	91	83			
Very weak medium density light greyish white CHALK composed of calcareous MUDSTONE. (CIRIA Grade - Unable to determine) (WMCK) [WEST MELBURY CHALK FORMATION] at 6.00m 1 No. discontinuity 5 degrees planar rough clean from 6.24m to 6.29m recovered as non intact core (clayey subangular fine to coarse gravel sized fragments)			(1.50) 6.30	4.36		C 12 4.80-6.30	102	100	97	97	NI 670 1200		
Very weak medium density yellowish brown mottled orange brown CHALK composed of calcareous MUDSTONE. Discontinuities 1) 5 to 15 degrees closely to medium spaced undulating rough stained orangish brown. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 6.95m to 7.00m recovered as non intact core (angular to subangular fine to coarse gravel sized fragments)	Grade B3		(0.75) 7.05	3.61		C 13 6.30-7.80	102	100	87	74	NI 110 340		
Very weak low density light greyish white CHALK composed of calcareous SILTSTONE with very closely spaced thin dark grey lenses of mudstone. Discontinuities 1) 20 to 40 degrees medium spaced undulating rough. (CIRIA Grade B2) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B2		(1.25) 8.30	2.36							NI 310 480		
Weak high density light greyish white CHALK composed of calcareous SILTSTONE with very closely spaced thin dark grey lenses of mudstone. Discontinuities 1) 20 to 40 degrees medium spaced undulating rough. (CIRIA Grade B2) (WMCK) [WEST MELBURY CHALK FORMATION] from 8.63m to 8.70m 2 No. discontinuities 30 to 40 degrees closely spaced planar rough with clay and gravel infill (<2mm) and 1 No. discontinuity 80 to 90 degrees undulating smooth			(0.85) 9.15	1.51		C 14 7.80-9.30	102	100	88	81			
Very weak to weak medium to high density grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 40 to 60 degrees closely to medium spaced planar and undulating smooth. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION]						EW 1 10.00							

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

soil engineering
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_023
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 2

Ground Level	+10.66mOD	Coordinates	549686.60E, 260501.70N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Depth (Thickness)	Datum Level
Very weak to weak medium to high density grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 40 to 60 degrees closely to medium spaced planar and undulating smooth. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 9.90m to 9.95m 1 No. discontinuity 50 degrees infilled with grey clay (<2mm) from 10.52m to 10.58m 1 No. incipient discontinuity 65 degrees planar smooth from 10.65m to 10.80m 1 No. incipient discontinuity 70 degrees undulating smooth from 10.80m to 11.00m extremely weak	Grade B3	(2.14) 11.29	-0.63
Extremely weak to weak low to medium density grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 10 to 30 degrees closely spaced planar and undulating smooth. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 11.40m to 11.75m 1 No. discontinuity 70 to 90 degrees undulating rough and smooth gravel infill (<2mm) from 11.75m to 11.80m recovered as non intact core (angular to subangular fine to coarse gravel sized fragments)	Grade B3	(0.71) 12.00	-1.34
Very weak to weak medium to high density grey CHALK composed of calcareous SILTSTONE locally with dark grey thin laminations of mudstone. Discontinuities 1) 10 to 40 degrees closely to medium spaced planar smooth clean. 2) 50 to 70 degrees closely to medium spaced undulating and stepped rough with gravel infill (<2mm). (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 12.07m to 12.18m recovered as non intact core (subangular fine to coarse gravel sized fragments)		(0.90) 12.90	-2.24
Weak high density CHALK composed of light grey calcareous SILTSTONE. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 12.95m to 12.97m 1 No. discontinuity 10 degrees planar smooth from 13.10m to 13.47m 1 No. discontinuity 70 degrees planar smooth locally with gravelly clay infill (<2mm) from 13.25m to 13.35m 2 No. discontinuities 20 to 40 degrees closely spaced planar rough gravel infill (<2mm) from 13.58m to 13.61m 1 No. discontinuity 20 degrees stepped rough clean from 13.80m to 13.95m recovered as non intact core (subangular coarse gravel sized fragments)	Grade B3	(1.35) 14.25	-3.59
Stiff to very stiff thinly laminated dark greenish grey CLAY. (WMCK) [CAMBRIDGE GREENSAND MEMBER] at 14.45m rounded medium and coarse gravel sized fragments of coprolites	Unweathered	(1.05) 15.30	-4.64

Complete at 15.30m Termination Reason: Achieved Scheduled Depth

Sampling Details	Dia	TCR/Sample Recovery %	SCR/Blows	RQD
C 15 9.30-10.80	102	100	72	72
C 16 10.80-12.30	102	100	52	47
C 17 12.30-13.80	102	100	75	65
C 18 13.80-15.30	102	98	89	89

IF
NI 180 360
NI 90 150
NI 80 300
NI 190 300
NA

Waterstrike | In Situ Test Details | Installation

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_024
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+7.99mOD	Coordinates	549995.10E, 260733.60N	Grid	OSGB
Date Started	30/07/2021	Date Completed	03/08/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	30/07/2021 10:30	30/07/2021 11:00	Colin Howard	MM	NA	NA	Insulated hand tools	None	Stable	
1.20	15.00	RC	30/07/2021 11:00	03/08/2021 17:00	Colin Howard	MM	Geobore S	PCD	Soilmec SM6			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
30/07/2021 12:00	2.80	0.00	Dry	End of Shift
02/08/2021 11:40	2.80	0.00	2.60	Start of Shift
02/08/2021 17:00	4.95	0.00	4.30	End of Shift
03/08/2021 07:30	4.95	0.00	4.00	Start of Shift
03/08/2021 15:30	15.00	2.70	2.70	Drilling Complete
03/08/2021 17:00	0.00	0.00	2.70	Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
03/08/2021 10:20	6.50	2.70		2.70	20	Fast

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	2.80	AIR/MIST	100	Brown	
2.80	4.80	AIR/MIST	100	Grey	
4.80	4.95	AIR/MIST	0	No return	
4.95	15.00	AIR/MIST	100	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
15.00	146	2.70	150						

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type
11.50	S1	SP	1.50	11.50	Pipe 1	Pipe 1	0.00	1.50	50	PLAIN
						Pipe 1	1.50	11.00	50	SLOTTED

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
-0.50	0.00	Upstanding cover	
0.00	0.50	Concrete	
0.50	0.70	Gravel backfill	
0.70	1.50	Bentonite	
1.50	11.50	Gravel backfill	
11.50	15.00	Bentonite	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL　Print date and time 12/09/2022 13:56　Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Form No. SIEXPHOLEHDR　Issue.Revision No. 2.02　Issue Date 22/06/2016

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_024 Sheet 1 of 2
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+7.99mOD	Coordinates	549995.10E, 260733.60N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata

TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and quartz. Occasional rootlets.
(TOP) [TOPSOIL]

Stiff brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of mudstone and flint.
(SUPD) [SUPERFICIAL DEPOSITS]

Structureless CHALK composed of firm yellowish brown slightly sandy slightly gravelly calcareous CLAY. Sand is fine. Gravel is angular to subangular fine to coarse of white flint. (CIRIA Grade Dm)
(WMCK) [WEST MELBURY CHALK FORMATION]

Structureless CHALK composed of firm to stiff greenish greyish brown sandy locally gravelly calcareous CLAY. Sand is fine. Gravel is angular to subangular fine to coarse of white flint. (CIRIA Grade Dm)
(WMCK) [WEST MELBURY CHALK FORMATION]

Assumed zone of core loss. White silty CLAY (Driller's description)
(WMCK) [WEST MELBURY CHALK FORMATION]
from 3.35m to 3.80m grey strongly stained orange

Structureless CHALK composed of firm to stiff fissured light greenish greyish brown with occasional orangish brown staining calcareous CLAY. Fissures are predominantly 0 to 20 degrees extremely closely spaced undulating smooth. (CIRIA Grade Dm)
(WMCK) [WEST MELBURY CHALK FORMATION]

Recovered as: Structureless CHALK composed of soft light greyish brown calcareous CLAY. (CIRIA Grade - unable to determine)
(WMCK) [WEST MELBURY CHALK FORMATION]

Assumed zone of core loss. White silty CLAY. (Driller's description)
(WMCK) [WEST MELBURY CHALK FORMATION]

Recovered as: Structureless CHALK composed of very soft light greyish brown calcareous silty CLAY. (Drilling disturbed) (CIRIA Grade - unable to determine)
(WMCK) [WEST MELBURY CHALK FORMATION]

Structureless CHALK composed of firm to stiff fissured light greyish yellow with occasional orangish brown staining calcareous CLAY. Fissures are randomly orientated extremely closely to very closely spaced planar and undulating smooth. (CIRIA Grade Dm)
(WMCK) [WEST MELBURY CHALK FORMATION]
from 5.39m to 5.45m assumed zone of core loss

Very weak medium density light grey locally stained orangish brown CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 85 degrees medium spaced stepped and undulating rough with gravel infill (<1mm) stained orangish brown. (Probably CIRIA Grade B2/3)
(WMCK) [WEST MELBURY CHALK FORMATION]
from 5.50m to 5.55m 1 No. discontinuity 50 degrees stepped rough
from 5.60m to 5.88m 1 No. discontinuity 35 to 40 degrees planar tight clean
from 5.60m to 5.95m with occasional subhorizontal lenses (<5mm) of dark greyish brown mudstone
from 5.80m to 5.95m recovered as non intact core (angular to subangular fine to coarse gravel sized fragments)

Very weak low to medium density light grey and grey CHALK composed of calcareous SILTSTONE. Generally recovered as non intact core (very gravelly silty clay). (CIRIA Grade - unable to determine)
(WMCK) [WEST MELBURY CHALK FORMATION]
from 6.05m to 6.23m intact core
from 6.14m to 6.16m 1 No. discontinuity 10 degrees undulating rough (possibly drilling induced)
from 6.16m to 6.23m 1 No. discontinuity 80 to 90 degrees undulating rough with clay smearing

Very weak to weak medium to high density light grey and grey CHALK composed of calcareous SILTSTONE. (CIRIA Grade - unable to determine).
(WMCK) [WEST MELBURY CHALK FORMATION]
from 6.90m to 7.00m recovered as non intact core (angular to subangular fine to coarse gravel sized fragments)
from 7.25m to 7.30m recovered as non intact core (subangular fine to coarse gravel sized fragments) (Drilling induced)

Very weak to weak medium to high density light grey mottled grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 0 to 10

Weathering

- Grade Dm
- Grade Dm
- Grade Dm
- Grade B2/3
- Grade B3/4

Depth (Thickness)	Datum Level
(0.35)	
0.35	7.64
(0.85)	
1.20	6.79
(1.00)	
2.20	5.79
(0.98)	
3.18	4.81
(0.37)	
3.55	4.44
3.80	4.19
3.92	4.07
(0.38)	
4.30	3.69
(0.50)	
4.80	3.19
(0.70)	
5.50	2.49
(0.45)	
5.95	2.04
(0.55)	
6.50	1.49
(0.80)	
7.30	0.69
(1.70)	
9.00	-1.01
(0.76)	
9.76	-1.77

Sampling Details	Dia	TCR/Sample Recovery %	SCR/Blows	RQD	IF
D 1 0.05-0.10					
ES 2 0.20-0.25					
B 3 0.10-0.40					
D 4 0.40-0.50					
ES 5 0.50-0.55					
B 6 0.40-0.80					
B 9 0.80-1.20					
D 7 1.00-1.10					
ES 8 1.10-1.20					
C 10 1.20-2.20	102	100			NA
C 11 2.20-2.80	102	100			
C 12 2.80-3.80	102	63			NR
					NA
C 13 3.80-4.30	102	24			NR
C 14 4.30-4.80	102	100			NA
C 15 4.80-4.95	102	100			
C 16 4.95-5.45	102	88			
C 17 5.45-5.95	102	100	60	44	NI 90 250
C 18 5.95-7.30	102	100	52	49	NI 90
					NI 300 400
C 19 7.30-8.80	102	85	75	67	40 200 450
C 20 8.80-10.20	102	100	71	44	NI 60 90
EW 1 10.00					

In Situ Test Details

Install-ation

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_024
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 2

Ground Level	+7.99mOD	Coordinates	549995.10E, 260733.60N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata

Very weak to weak medium to high density light grey mottled grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 0 to 10 degrees closely to medium spaced planar rough locally infilled with clay (<1mm). (CIRIA Grade B2/3)
(WMCK) [WEST MELBURY CHALK FORMATION]
- from 7.58m to 7.82m fractures of discontinuity set 1) are very closely spaced
- from 8.48m to 8.53m 1 No. discontinuity 45 degrees infilled with silty clay (<3mm)
- from 8.58m to 8.80m assumed zone of core loss

Very weak low to medium density light grey and grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) randomly orientated very closely to closely spaced planar and undulating smooth and infilled with fine to coarse gravel sized fragments and soft clay (<3mm). (CIRIA Grade B3/4)
(WMCK) [WEST MELBURY CHALK FORMATION]
- from 9.00m to 9.12m recovered as non intact core (subangular fine to coarse gravel sized fragments)

Very weak medium density light grey and grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 10 to 20 degrees closely to medium spaced planar smooth infilled with gravel and clay (<3mm). (CIRIA Grade B2/3)
(WMCK) [WEST MELBURY CHALK FORMATION]
- from 10.60m to 10.80m glauconitic with frequent subangular to subrounded fine to coarse gravel sized fragments of black coprolite
- from 10.77m to 10.80m with occasional subangular coarse gravel sized fragments of black coprolite

Dark greenish grey very gravelly glauconitic fine SAND. Gravel is subangular to subrounded fine to coarse of coprolite and 1 No. pyrite bearing nodule (<10mm).
(WMCK) [CAMBRIDGE GREENSAND MEMBER]

Firm to stiff laminated dark greenish grey CLAY with rare specks of pyrite and occasional lenticular pockets of fine glauconitic sand.
(GLT) [GAULT FORMATION]
- at 11.76m 1 No. fissure 20 degrees curved planar polished clean
- from 11.80m to 11.89m 1 No. discontinuity 30 to 70 degrees listric joint planar smooth polished and striated
- from 12.11m to 12.16m 1 No. fissure 30 degrees planar smooth
- from 12.25m to 12.28m 1 No. fissure 10 degrees infilled with soft clay (<1mm)
- at 13.00m 1 No. fissure 40 degrees planar smooth infilled with clay (<1mm) and some shell debris

Stiff to very stiff dark brownish grey CLAY.
(GLT) [GAULT FORMATION]
- at 14.00m 1 No. fissure 20 degrees planar smooth polished clean
- from 14.45m to 14.50m assumed zone of core loss

Complete at 15.00m. Termination Reason: Achieved Scheduled Dep h

Weathering	Depth (Thickness)	Datum Level
Grade B2/3	(1.04)	
	10.80	-2.81
	10.95	-2.96
Unweathered	(2.20)	
	13.15	-5.16
	(1.85)	
	15.00	-7.01

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF
C 21 10.20-11.50	102	100	75	65	60 90 300
C 22 11.50-13.15	102	100			NA
C 23 13.15-14.45	102	98			
C 24 14.45-15.00	102	91			

Waterstrike | In Situ Test Details | Install-ation

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

AGS

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_025
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+6.43mOD	Coordinates	549843.80E, 261395.30N	Grid	OSGB
Date Started	26/07/2021	Date Completed	27/07/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	26/07/2021 16:15	26/07/2021 16:45	Colin Howard		NA	NA	Insulated hand tools	None	Stable	
1.20	15.05	RC	27/07/2021 07:30	27/07/2021 17:30	Colin Howard	MV	Geobore S	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
26/07/2021 17:00	1.20	0.00	Dry	End of Shift
27/07/2021 07:30	1.20	0.00	1.20	Start of Shift
27/07/2021 17:30	15.05	2.70	2.40	Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
27/07/2021 10:45	5.00	2.70		2.40	20	Fast

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	2.70	AIR/MIST	100	Brown	
2.70	8.65	AIR/MIST	100	White	
8.65	15.05	AIR/MIST	100	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
15.05	146	2.70	150						

INSTALLATION DETAILS						PIPE CONSTRUCTION					
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type
9.00	S1	SP	2.00	9.00	Pipe 1	Pipe 1	0.00	2.00	50	PLAIN
						Pipe 1	2.00	8.50	50	SLOTTED

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
-0.50	0.00	Upstanding cover	
0.00	0.50	Concrete	
0.50	0.60	Gravel backfill	
0.60	2.00	Bentonite	
2.00	9.00	Gravel backfill	
9.00	15.05	Bentonite	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_025 Sheet 1 of 2
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+6.43mOD	Coordinates	549843.80E, 261395.30N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Depth (Thickness)	Datum Level
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular to subangular fine to coarse of flint. (TOP) [TOPSOIL]		(0.35) 0.35	6.08
Stiff brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of flint. Sand is fine to coarse. (SUPD) [SUPERFICIAL DEPOSITS]		(0.30) 0.65	5.78
Stiff light grey mottled brown slightly sandy CLAY. Sand is fine to medium. (SUPD) [SUPERFICIAL DEPOSITS]		(0.55) 1.20	5.23
Orangish brown clayey fine SAND. (SUPD) [SUPERFICIAL DEPOSITS] from 1.20m to 1.35m recovered as soft sandy clay (Drilling induced)		(0.55) 1.75	4.68
Structureless CHALK composed of light greyish brown gravelly calcareous CLAY. Gravel is angular to subangular fine to coarse of very weak medium density chalk. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(0.58) 2.33	4.10
Very weak medium density light greyish brown CHALK composed of calcareous SILTSTONE. Discontinuities 1) 5 to 15 degrees closely to medium spaced planar and undulating smooth locally stained orangish brown. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 2.33m to 2.83m locally mottled and stained orangish brown from 2.66m to 2.70m recovered as non intact core (subangular medium to coarse gravel sized fragments) (Drilling induced) from 3.60m to 3.64m recovered as non intact core (clayey subangular fine to coarse gravel sized fragments) from 3.72m to 3.78m recovered as non intact core (subangular fine to coarse gravel sized fragments) from 4.08m to 4.20m recovered as non intact core (subangular medium to coarse gravel and cobble sized fragments)	Grade B3	(1.87) 4.20	2.23
Structureless CHALK composed of light greyish brown mottled and stained orangish brown gravelly calcareous CLAY. Gravel is very weak medium density off white to light greyish brown chalk. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(0.30) 4.50	1.93
Very weak medium density light brownish grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 10 to 20 degrees medium spaced planar smooth locally infilled with clay (<3mm). (CIRIA Grade B2) (WMCK) [WEST MELBURY CHALK FORMATION] from 4.85m to 5.00m recovered as non intact core (very clayey subangular fine to coarse gravel sized fragments)	Grade B2	(1.20) 5.70	0.73
Weak high density light grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 0 to 10 degrees closely to medium spaced planar and undulating locally infilled with clay (<1mm). (CIRIA Grade B2/3) (WMCK) [WEST MELBURY CHALK FORMATION] from 6.18m to 6.31m recovered as non intact core (subangular fine to coarse gravel sized fragments) from 7.28m to 7.35m recovered as non intact core (clayey subangular medium to coarse gravel and cobble sized fragments) (Drilling induced)	Grade B2/3	(1.65) 7.35	-0.92
Very weak medium density grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 0 to 20 degrees closely to medium spaced planar smooth locally infilled with fine gravelly clay (<3mm). (CIRIA Grade B2/3) (WMCK) [WEST MELBURY CHALK FORMATION] from 7.80m to 7.86m recovered as non intact core (subangular fine to coarse gravel sized fragments) from 7.80m to 8.20m with very closely spaced thin beds of weak high density chalk composed of calcareous siltstone from 8.50m to 8.65m recovered as non intact core (weak medium density gravel of fine to coarse angular fragments) (Drilling induced) from 8.65m to 8.80m assumed zone of core loss from 8.65m to 8.85m recovered as non intact core (angular fine to coarse gravel and cobble sized fragments)		(1.65) 9.00	-2.57
Firm dark greenish grey slightly sandy slightly gravelly CLAY. Sand is fine. Gravel is subangular to subrounded fine to coarse of black coprolites. (WMCK) [CAMBRIDGE GREENSAND MEMBER]		9.25	-2.82
Very stiff dark greenish grey sandy glauconitic CLAY. (GLT) [GAULT FORMATION]			

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
D 1 0.10-0.15 D 2 0.20-0.25 ES 3 0.20-0.25 B 4 0.25-0.35 D 5 0.50-0.55 ES 6 0.50-0.55 B 7 0.55-0.65 D 8 1.00-1.10 ES 9 1.00-1.10 B 10 1.10-1.20							
C 11 1.20-2.20	102	95			NA		
C 12 2.20-2.70	102	100	74	74			
C 13 2.70-4.20	102	100	76	69	NI 120 300		
					NA		
C 14 4.20-5.70	102	100	70	70	NI 340 560		
C 15 5.70-7.35	102	98	90	76			
					NI 210 360		
C 16 7.35-8.65 EW 1 8.00	102	95	79	51			
C 17 8.65-9.90	102	88	0	0			

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:56   Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_025
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 2

Ground Level	+6.43mOD	Coordinates	549843.80E, 261395.30N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very stiff dark greenish grey sandy glauconitic CLAY. (GLT) [GAULT FORMATION] from 10.57m to 10.65m 1 No. fissure 40 degrees planar smooth polished at 10.75m with occasional shell fragments from 10.89m to 10.93m 1 No. fissure 15 degrees planar smooth polished from 10.95m to 10.98m 1 No. fissure 15 degrees smooth at 11.06m 1 No. fissure 10 degrees planar smooth	Unweathered		(3.20)			C 18 9.90-11.45	102	100			NA		▨
						C 19 11.45-12.95	102	99					
Stiff to very stiff fissured dark grey CLAY. Fissures are 0 to 20 degrees and 70 to 80 degrees closely spaced planar and undulating smooth. (GLT) [GAULT FORMATION] at 13.23m 1 No. fragment of coprolite (23mm) at 13.56m 1 No. fragment of coprolite (<8mm)			12.45 (2.60)	-6.02		C 20 12.95-14.45	102	99					
						C 21 14.45-15.05	102	100					
Complete at 15.05m. Termination Reason: Achieved Scheduled Depth			15.05	-8.62									

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_026 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+7.08mOD	Coordinates	550007.10E, 261165.50N	Grid	OSGB
Date Started	28/07/2021	Date Completed	29/07/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	28/07/2021 12:15	28/07/2021 13:00	Colin Howard	AL	NA	NA	Insulated hand tools	None	Stable	
1.20	15.00	RC	28/07/2021 13:00	29/07/2021 17:00	Colin Howard	MM	Geobore S	PCD	Soilmec SM6			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
28/07/2021 17:00	7.00	0.00	5.80	End of Shift
29/07/2021 07:30	7.00	2.70	4.80	Start of shift
29/07/2021 13:30	15.00	2.70	2.50	Drilling Complete
29/07/2021 16:00	0.00	0.00	2.50	Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	15.00	AIR/MIST	100	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
15.00	146	2.70	150						
		15.00	146						

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref
10.00	S1	SP	1.50	10.00	Pipe 1

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type
Pipe 1	0.00	1.50	50	PLAIN
Pipe 1	1.50	9.50	50	SLOTTED

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
-0.50	0.00	Upstanding cover	
0.00	0.50	Concrete	
0.50	0.70	Gravel backfill	
0.70	1.50	Bentonite	
1.50	10.00	Gravel backfill	
10.00	15.00	Bentonite	
15.00	15.00	Grout	Cement / Bentonite Grout

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_026
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 2

Ground Level	+7.08mOD	Coordinates	550007.10E, 261165.50N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata

TOPSOIL: Brown slightly gravelly sandy CLAY.
(TOP) [TOPSOIL]

Structureless CHALK composed of soft to firm light grey slightly gravelly silty calcareous CLAY. Gravel is subangular to subrounded fine to coarse of calcareous mudstone and flint. (CIRIA Grade Dm)
(WMCK) [WEST MELBURY CHALK FORMATION]

Structureless CHALK composed of firm light greyish brown locally stained orange gravelly calcareous CLAY. Gravel is angular to subangular medium to coarse of very weak medium density chalk. (CIRIA Grade Dm)
(WMCK) [WEST MELBURY CHALK FORMATION]

Weathering: Grade Dm

Very weak medium density yellowish brown CHALK composed of calcareous SILTSTONE. Discontinuities 1) 0 to 20 degrees closely spaced undulating smooth (Possibly CRIIA Grade A3)
(WMCK) [WEST MELBURY CHALK FORMATION]
from 3.85m to 4.00m recovered as non intact core (angular fine to coarse gravel sized fragments)

Weak high density light grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 0 to 20 degrees closely to medium spaced undulating smooth. (Possibly CIRIA Grade A3)
(WMCK) [WEST MELBURY CHALK FORMATION]
from 4.00m to 4.17m structureless chalk composed of firm light grey gravelly clay. Gravel is angular medium to coarse very weak medium density (CIRIA Grade Dm)
from 4.70m to 4.92m structureless chalk composed of firm light grey gravelly clay. Gravel is angular medium to coarse very weak medium density (CIRIA Grade Dm)
from 4.98m to 5.05m recovered as non intact core (subangular fine to coarse gravel sized fragments)

Assumed zone of core loss. Strata presumed to be CHALK.
(WMCK) [WEST MELBURY CHALK FORMATION]

Very weak medium density light grey CHALK composed of calcareous SILTSTONE. Generally recovered as non intact core (angular to subangular fine to coarse gravel and cobble sized fragments). (CIRIA Grade - unable to determine)
(WMCK) [WEST MELBURY CHALK FORMATION]
from 5.50m to 5.80m assumed zone of core loss
from 5.67m to 5.80m partially intact
from 6.00m to 6.17m partially intact
from 6.30m to 6.50m assumed zone of core loss

Recovered as: Structureless CHALK composed of light grey very gravelly CLAY. Gravel is angular medium to coarse very weak medium density. (Possibly drilling induced) (CIRIA Grade - unable to determine).
(WMCK) [WEST MELBURY CHALK FORMATION]

Weak high density grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 0 to 15 degrees closely spaced undulating rough unstained. 2) 70 to 80 degrees closely spaced planar and undulating rough with localised yellowish brown staining and fine gravel infill (<3mm). (Possibly CIRIA Grade B3)
(WMCK) [WEST MELBURY CHALK FORMATION]
from 7.00m to 7.19m recovered as non intact core (subangular medium to coarse gravel sized fragments)

Very weak medium density grey CHALK composed of calcareous SILTSTONE. Recovered as non intact core (clayey angular to subangular fine to coarse gravel sized fragments with low cobble content. Cobble sized fragments are angular). (CIRIA Grade - unable to determine)
(WMCK) [WEST MELBURY CHALK FORMATION]
from 7.55m to 7.80m assumed zone of core loss

Very weak low density light grey CHALK composed of calcareous MUDSTONE. Recovered as non intact core (angular coarse gravel and

Depth (Thickness)		Datum Level
(0.35)	0.35	6.73
(0.85)	1.20	5.88
(2.48)	3.68	3.40
(0.32)	4.00	3.08
(1.06)	5.06	2.02
(0.34)	5.40	1.68
(1.10)	6.50	0.58
(0.30)	6.80	0.28
(0.45)	7.25	-0.17
(0.85)	8.10	-1.02
(0.45)	8.55	-1.47
(0.65)	9.20	-2.12
(0.30)	9.50	-2.42

Sampling Details	Dia	TCR/Sample Recovery %	SCR/Blows	RQD	IF
D 1 0.05-0.10 ES 2 0.20-0.25 B 3 0.20-0.35 D 4 0.35-0.40 ES 5 0.50-0.55 B 6 0.40-1.00 D 7 1.00-1.10 ES 8 1.10-1.20					
C 9 1.20-2.20	102	100			NA
C 10 2.20-2.80	102	100			
C 11 2.80-4.00	102	97	11	0	
C 12 4.00-5.50	102	77	61	30	NI 80 220 NR
C 13 5.50-6.00	102	80	20	20	NI 170
C 14 6.00-6.50	102	60	34	34	
C 15 6.50-7.00	102	100	24	0	NA NI 60 80
C 16 7.00-7.60	102	92	0	0	NI
EW 1 8.00 C 17 7.60-8.55	102	95	0	0	
C 18 8.55-9.00	102	67	33	33	NI 150
C 19 9.00-9.50	102	100	68	54	300
C 20 9.50-10.00	102	100	76	64	

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_026 Sheet 2 of 2
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+7.08mOD	Coordinates	550007.10E, 261165.50N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very weak low density light grey CHALK composed of calcareous MUDSTONE. Recovered as non intact core (angular coarse gravel and angular cobble sized fragments locally with clay coating (<2mm)). (CIRIA Grade - unable to determine) (WMCK) [WEST MELBURY CHALK FORMATION] from 8.50m to 8.70m assumed zone of core loss			(1.28) 10.78	-3.70		C 21 10.00-11.50	102	97	59	54	NA		
Very weak medium density light grey CHALK composed of calcareous SILTSTONE. Recovered as non intact core (angular coarse gravel and angular cobble sized fragments). (CIRIA Grade - unable to determine) (WMCK) [WEST MELBURY CHALK FORMATION] from 8.85m to 9.00m intact core			(0.50) 11.28	-4.20							500 500 500		
Weak high density light yellowish grey CHALK composed of calcareous SILTSTONE. (CIRIA Grade - unable to determine) (WMCK) [WEST MELBURY CHALK FORMATION]													
Structureless CHALK composed of very stiff slightly sandy calcareous CLAY. Sand is fine. (Probable CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 10.00m to 10.28m very weak medium density chalk composed of siltstone, recovered as non intact core (clayey subangular fine to coarse gravel sized fragments)						C 22 11.50-13.15	102	100					
Very weak grey to dark greenish grey sandy glauconitic calcareous MUDSTONE with frequent angular to subrounded fragments of coprolites (<28mm) and with rare orangish brown angular fine to coarse flint. Sand is fine. (WMCK) [CAMBRIDGE GREENSAND MEMBER]			(3.72)								NA		
Very stiff fissured dark grey CLAY with rare angular to subrounded coarse fragments of coprolites (<10mm). Fissures are predominantly 0 to 20 degrees closely to medium spaced undulating smooth. (GLT) [GAULT FORMATION] from 11.28m to 12.00m dark greenish grey at 11.42m 1 No. pyritised belemnite shell (<25mm) from 11.50m to 11.62m 2 No. fissures 55 degrees closely spaced planar smooth			15.00	-7.92		C 23 13.15-14.35 C 24 14.35-15.00	102 102	100 100					

Complete at 15.00m. Termination Reason: Achieved Scheduled Depth

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:56   Log checked by David Howard

SOIL ENGINEERING

Form No. SIEXPHOLELOG   Issue.Revision No. 2.05   Issue Date 02/03/2018

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_031A Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+11.77mOD	Coordinates	549378.90E, 260815.60N	Grid	OSGB
Date Started	02/08/2021	Date Completed	04/08/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	02/08/2021 13:00	02/08/2021 14:00	PM	DT	NA	NA	Insulated hand tools	None	Stable	
1.20	15.00	RC	03/08/2021 07:30	04/08/2021 13:00	PM	MV	Geobore S	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
02/08/2021 14:00	1.20	0.00	Dry	End of IP
03/08/2021 07:30	1.20	0.00	Dry	Start of Shift
03/08/2021 17:30	8.40	3.00	Dry	End of Shift
04/08/2021 07:30	8.40	3.00	Dry	Start of Shift
04/08/2021 13:00	15.00	3.00	4.20	End of Hole

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	15.00	AIR/MIST	100	Grey/white	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
15.00	146	3.00	150						

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	15.00	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_031A Sheet 1 of 2
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+11.77mOD	Coordinates	549378.90E, 260815.60N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of flint. Occasional roots (2mm x 40mm). (TOP) [TOPSOIL]			(0.35) 0.35	11.42		D 1 0.05-0.10 ES 2 0.20-0.25 B 3 0.10-0.40							
Structureless CHALK composed of very stiff light yellowish brown slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of flint. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(0.85) 1.20	10.57		D 4 0.40-0.50 ES 5 0.50-0.55 B 6 0.40-0.80 B 9 0.80-1.20 D 7 1.00-1.10 ES 8 1.10-1.20							
Structureless CHALK composed of yellowish brown locally stained orangish brown slightly gravelly sandy calcareous CLAY. Sand is fine. Gravel is subangular fine to coarse of siltstone. Recovered as soft. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]			(0.50) 1.70	10.07		C 10 1.20-1.70	102	80			NA		
Structureless CHALK composed of firm to stiff yellowish brown sandy calcareous CLAY. Sand is fine. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]			(0.70) 2.40	9.37		C 11 1.70-2.40	102	100					
Extremely weak to very weak low density light yellowish brown locally stained orangish brown CHALK composed of SILTSTONE with randomly orientated very closely to closely spaced incipient fractures with frequent black surface speckling. (CIRIA Grade - unable to determine). (WMCK) [WEST MELBURY CHALK FORMATION] from 3.00m to 3.20m recovered as non intact core (subangular fine to coarse gravel sized fragments)			(0.80) 3.20	8.57		C 12 2.40-3.90	102	100	87	87	NI 600 700		
Very weak low density light yellowish brown and greyish brown locally stained orangish brown CHALK composed of calcareous SILTSTONE with randomly orientated closely to medium spaced incipient fractures. (CIRIA Grade - unable to determine) (WMCK) [WEST MELBURY CHALK FORMATION] from 3.75m to 3.85m recovered as non intact core (subangular to subrounded fine to coarse gravel sized fragments) (Drilling induced)			(0.70) 3.90	7.87									
Very weak medium density light yellowish greyish brown locally stained orangish brown CHALK composed of calcareous SILTSTONE. Discontinuities 1) 5 to 20 degrees medium spaced undulating rough locally with orangish brown staining (CIRIA Grade B2) (WMCK) [WEST MELBURY CHALK FORMATION] from 4.56m to 4.66m 1 No. discontinuity 70 degrees undulating rough with gravel infill (<2mm) from 4.66m to 4.72m recovered as non intact core (subangular to subrounded fine to coarse gravel sized fragments) from 4.72m to 4.90m extremely weak low density from 4.90m to 5.00m recovered as non intact core (subangular to subrounded fine to coarse gravel sized fragments) from 5.35m to 5.40m recovered as non intact core (subangular to subrounded fine to coarse gravel sized fragments) from 5.90m to 6.10m 1 No. discontinuity 75 to 90 degrees stepped undulating rough with abundant orangish brown staining from 6.20m to 6.35m 1 No. discontinuity 65 to 70 degrees undulating rough with abundant orangish brown staining from 6.60m to 7.50m greyish brown from 6.85m to 6.90m recovered as non intact core (subangular to subrounded fine to coarse gravel sized fragments) (Drilling induced)	Grade B2		(3.00) 6.90	4.87		C 13 3.90-5.40 C 14 5.40-6.90	102 102	100 97	94 75	92 75	NI 250 400		
Very weak medium density greyish brown with abundant orangish brown staining CHALK composed of calcareous SILTSTONE. Recovered as non intact core (clayey angular to subangular fine to coarse gravel sized fragments). (CIRIA Grade - unable to determine) (WMCK) [WEST MELBURY CHALK FORMATION] from 7.28m to 7.30m intact core from 7.30m to 7.50m assumed zone of core loss			(0.60) 7.50	4.27		C 15 6.90-7.50	102	67	3	0	NI		
Very weak medium density light grey locally grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 10 to 40 degrees very closely to closely spaced, rarely medium spaced, planar locally stepped rough generally unstained. (Probably CIRIA Grade B3/4) (WMCK) [WEST MELBURY CHALK FORMATION] from 7.50m to 7.90m with closely to medium spaced discontinuities 65 degrees planar rough with slight yellowish brown staining and with gravel infill (<1mm) at 7.75m 1 No. fracture of discontinuity set 1) infilled with fine gravel and silt (<3mm) from 7.75m to 7.90m weak high density with very closely spaced very thin beds of grey mudstone from 7.90m to 8.05m recovered as non intact core (subangular to subrounded fine to coarse gravel sized fragments) from 8.40m to 8.50m recovered as non intact core (subangular fine to coarse gravel sized fragments) from 8.50m to 9.40m fractures of discontinuity set 1) locally stained			(3.00)			C 16 7.50-8.40 C 17 8.40-10.00	102 102	100 100	87 75	78 19	NI 170 280 NI 20 60 NI 80 100		

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

SOIL ENGINEERING
Part of the Bachy Soletanche Group

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_031A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 2

Ground Level	+11.77mOD	Coordinates	549378.90E, 260815.60N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very weak medium density light grey locally grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 10 to 40 degrees very closely to closely spaced, rarely medium spaced, planar locally stepped rough generally unstained. (Probably CIRIA Grade B3/4) (WMCK) [WEST MELBURY CHALK FORMATION] from 8.50m to 9.40m fractures of discontinuity set 1) locally stained yellowish orange. Discontinuity set 2) 75 to 85 degrees extremely closely to very closely spaced planar rough with orangish brown surface staining from 10.00m to 10.20m assumed zone of core loss from 10.20m to 10.50m recovered as non intact core (subangular to subrounded fine to coarse gravel sized fragments)			10.50	1.27									
Very weak to weak medium to high density light grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 5 to 10 degrees very closely to medium spaced planar and undulating rough unstained locally infilled with fine gravel and silt (<1-2mm). (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 11.25m to 11.40m recovered as non intact core (subangular to subrounded fine to coarse gravel sized fragments) from 11.40m to 12.00m fractures of discontinuity set 1) are locally stained yellowish orange from 11.50m to 11.62m 1 No. discontinuity 65 degrees undulating rough stained orangish brown and infilled with fine gravel (<1-2mm) from 11.96m to 12.00m assumed zone of core loss	Grade B3		(1.50) 12.00	-0.23		C 18 10.00-11.50 C 19 11.50-12.00	102 102	87 92	58 68	53 50	NI 90 280		
Weak high density light grey locally grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 5 to 20 degrees closely to medium spaced planar smooth locally stained orangish brown and locally with gravel infill (<2mm). (CIRIA Grade B2/3) (WMCK) [WEST MELBURY CHALK FORMATION] from 12.12m to 12.21m fractures of discontinuity set 1) are very closely spaced	Grade B2/3		(1.50) 13.50	-1.73		C 20 12.00-13.50	102	96	96	83	20 110 300		
Dark greenish grey very clayey glauconitic fine SAND. (WMCK) [CAMBRIDGE GREENSAND MEMBER] from 13.50m to 13.57m with occasional subrounded to rounded fine to medium gravel sized fragments of black coprolite from 13.50m to 13.60m assumed zone of core loss from 13.73m to 13.75m with occasional subrounded to rounded fine to medium gravel sized fragments of black coprolite from 13.82m to 13.84m with occasional subrounded to rounded fine to medium gravel sized fragments of black coprolite			(0.37) 13.87	-2.10		C 21 13.50-15.00	102	93			NA		
Stiff to very stiff fissured dark grey CLAY. Fissures are closely spaced 5 to 15 degrees and 70 to 85 degrees planar smooth. (GLT) [GAULT FORMATION]			(1.13) 15.00	-3.23									

Complete at 15.00m. Termination Reason: Achieved Scheduled Dep h

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_031B
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+11.60mOD	Coordinates	549375.81E, 260819.51N	Grid	OSGB
Date Started	12/10/2021	Date Completed	14/10/2021	Inclination	90° f om horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	12/10/2021 12:00	12/10/2021 13:00	DC	DT			Insulated Hand Tools	None	Stable	
1.20	30.00	CP	12/10/2021 13:00	13/10/2021 17:30	DC	GL			Dando 2000			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
12/10/2021 17:30	8.00	8.00	6.40	End of Shift
13/10/2021 07:30	8.00	8.00	5.90	Start of shift
13/10/2021 17:30	23.20	14.70	Dry	End of Shift
14/10/2021 07:30	23.20	14.70	22.00	Start of shift
14/10/2021 14:00	0.00	0.00		Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
12/10/2021 17:10	8.00	8.00		6.40	20	Medium

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water
1.20	S	N=46 (6,8:12,12,11,11)	AR3501	75	1.20	Dry
2.20	S	N=28 (2,4:6,7,7,8)	AR3501	75	2.20	Dry
3.20	S	N=32 (4,5:7,8,8,9)	AR3501	75	3.20	Dry
4.20	S	N=36 (4,6:7,8,10,11)	AR3501	75	4.20	Dry
5.20	S	N=25 (4,5:6,6,7,6)	AR3501	75	5.20	Dry
6.20	S	N=22 (3,4:5,5,6,6)	AR3501	75	6.20	Dry
7.20	S	N=21 (3,4:4,5,5,7)	AR3501	75	7.20	Dry
8.20	S	N=28 (3,4:5,6,8,9)	AR3501	75	8.20	6.00
9.20	S	N=36 (4,6:7,9,10,10)	AR3501	75	9.20	6.20
10.70	S	N=39 (5,7:8,9,10,12)	AR3501	75	10.70	7.50
12.20	S	N=44 (6,8:9,10,12,13)	AR3501	75	12.20	7.50
13.70	S	N=27 (4,6:6,7,7,7)	AR3501	75	13.70	13.00
15.20	S	N=27 (4,5:6,6,7,8)	AR3501	75	14.70	Dry
16.70	S	N=33 (4,5:7,8,8,10)	AR3501	75	14.70	Dry
18.20	S	N=39 (6,7:8,9,10,12)	AR3501	75	14.70	Dry
19.70	S	N=43 (7,8:9,10,11,13)	AR3501	75	14.70	Dry
21.20	S	N=49 (6,8:10,12,12,15)	AR3501	75	14.70	Dry
22.70	S	50/290mm (8,9:11,12,14,13/65mm)	AR3501	75	14.70	Dry
24.20	S	50/280mm (7,8:13,15,16,6/55mm)	AR3501	75	14.70	Dry
25.70	S	50/280mm (8,9:12,16,16,6/55mm)	AR3501	75	14.70	Dry
27.20	S	50/275mm (8,10:13,15,17,5/50mm)	AR3501	75	14.70	Dry
28.70	S	50/275mm (7,9:13,16,18,3/50mm)	AR3501	75	14.70	Dry

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks

HOLE DIAMETER		CASING DIAMETER	
Depth Base	Diameter	Depth Base	Diameter
30.00	150	14.70	150

DYNAMIC SAMPLING

Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref
13.60	S1	SP	13.10	13.60	Pipe 1

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type
Pipe 1	0.00	13.10	50	PLAIN
Pipe 1	13.10	13.60	50	SLOTTED

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
-0.50	0.00	Upstanding cover	
0.00	0.50	Concrete	
0.50	0.70	Gravel backfill	
0.70	13.10	Bentonite	
13.10	13.60	Gravel backfill	
13.60	30.00	Bentonite	

LOCATION DETAILS

Remarks

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Form No. SIEXPHOLEHDR Issue.Revision No. 2.02 Issue Date 22/06/2016

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_031B
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 3

Ground Level	+11.60mOD	Coordinates	549375.81E, 260819.51N	Grid	OSGB		
Hole Type	IP+CP	Inclination	90° from horizontal				

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of flint. Occasional roots (2mm x 40mm). (TOP) [TOPSOIL]			(0.30) 0.30	11.30		D 1 0.10 B 2 0.20-0.30							
CHALK recovered as: Very stiff light grey slightly sandy slightly gravelly calcareous CLAY with occasional orange staining. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of flint and chert. (WMCK) [WEST MELBURY CHALK FORMATION] from 2.00m to 7.80m gravel is subangular to subrounded fine to coarse of extremely weak low density light grey calcareous siltstone			(7.50)		▽	D 3 0.35 B 4 0.40-0.70 B 5 0.90-1.10 D 6 1.20 D 7 1.20-1.65 B 8 1.20-1.70 D 9 2.00 D 10 2.20-2.65 B 11 2.20-2.70 D 12 3.00 D 13 3.20-3.65 B 14 3.20-3.70 D 15 4.00 D 16 4.20-4.65 B 17 4.20-4.70 D 18 5.00 D 19 5.20-5.65 B 20 5.20-5.70 D 21 6.00 D 22 6.20-6.65 B 23 6.20-6.70 D 24 7.00 D 25 7.20-7.65 B 26 7.20-7.70						SPT(S) N=46 (6,8:12,12,11,11) 1.20 SPT(S) N=28 (2,4:6,7,7,8) 2.20 SPT(S) N=32 (4,5:7,8,8,9) 3.20 SPT(S) N=36 (4,6:7,8,10,11) 4.20 SPT(S) N=25 (4,5:6,6,7,6) 5.20 SPT(S) N=22 (3,4:5,5,6,6) 6.20 SPT(S) N=21 (3,4:4,5,5,7) 7.20	
CHALK recovered as: Very stiff light grey slightly gravelly CLAY with occasional orange staining. Gravel is subangular to subrounded fine to coarse of very weak medium density calcareous siltstone. (WMCK) [WEST MELBURY CHALK FORMATION]			7.80	3.80	▼	D 27 8.00 D 28 8.20-8.65 B 29 8.20-8.70 D 30 9.00 D 31 9.20-9.65 B 32 9.20-9.70 D 33 10.00						SPT(S) N=28 (3,4:5,6,8,9) 8.20 SPT(S) N=36 (4,6:7,9,10,10) 9.20	

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL　Print date and time 12/09/2022 13:56　Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_STW_031B
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 3

Ground Level	+11.60mOD	Coordinates	549375.81E, 260819.51N	Grid	OSGB
Hole Type	IP+CP	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
CHALK recovered as: Very stiff light grey slightly gravelly CLAY with occasional orange staining. Gravel is subangular to subrounded fine to coarse of very weak medium density calcareous siltstone. (WMCK) [WEST MELBURY CHALK FORMATION]						D 34 10.70-11.15 B 35 10.70-11.20						SPT(S) N=39 (5,7:8,9,10,12) 10.70	
						D 36 11.50							
			(5.30)										
						D 37 12.20-12.65 B 38 12.20-12.70						SPT(S) N=44 (6,8:9,10,12,13) 12.20	
						D 39 13.00							
Very stiff greenish grey slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of coprolite. (WMCK) [CAMBRIDGE GREENSAND MEMBER]			13.10	-1.50		D 40 13.10						K 13.10 - 13.60	
			(0.40)										
Very stiff fissured dark grey CLAY with rare phosphatic nodules (10mm x 5mm). Fissures are extremely closely spaced planar and rough. (GLT) [GAULT FORMATION]			13.50	-1.90		D 41 13.50							
						D 42 13.70-14.15 B 43 13.70-14.20						SPT(S) N=27 (4,6:6,7,7,7) 13.70	
from 15.20m to 15.85m 1 No. pocket (2mm x 10mm) of pyritic fine sand						D 44 15.20-15.65 B 45 15.20-15.70						SPT(S) N=27 (4,5:6,6,7,8) 15.20	
			(4.70)										
						D 46 16.70-17.15 B 47 16.70-17.20						SPT(S) N=33 (4,5:7,8,8,10) 16.70	
Very stiff fissured thinly laminated dark grey CLAY with rare phosphatic nodules (5mm x 10mm). Fissures are very closely spaced planar and undulating, rough and occasionally polished. (GLT) [GAULT FORMATION]			18.20	-6.60		D 48 18.20-18.65 B 49 18.20-18.70						SPT(S) N=39 (6,7:8,9,10,12) 18.20	
						D 50 19.70-20.15 B 51 19.70-20.20						SPT(S) N=43 (7,8:9,10,11,13) 19.70	

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_STW_031B
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 3 of 3

Ground Level	+11.60mOD	Coordinates	549375.81E, 260819.51N	Grid	OSGB
Hole Type	IP+CP	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very stiff fissured thinly laminated dark grey CLAY with rare phosphatic nodules (5mm x 10mm). Fissures are very closely spaced planar and undulating, rough and occasionally polished. (GLT) [GAULT FORMATION]													
						D 52 21.20-21.65 B 53 21.20-21.70						SPT(S) N=49 (6,8:10,12,12,15) 21.20	
						D 54 22.70-23.14 B 55 22.70-23.20						SPT(S) 50/290mm (8,9:11,12,14,13/65mm) 22.70	
						D 56 24.20-24.63 B 57 24.20-24.70						SPT(S) 50/280mm (7,8:13,15,16,6/55mm) 24.20	
			(11.80)										
						D 58 25.70-26.13 B 59 25.70-26.20						SPT(S) 50/280mm (8,9:12,16,16,6/55mm) 25.70	
						D 60 27.20-27.63 B 61 27.20-27.70						SPT(S) 50/275mm (8,10:13,15,17,5/50mm) 27.20	
						D 62 28.70-29.13 B 63 28.70-29.20						SPT(S) 50/275mm (7,9:13,16,18,3/50mm) 28.70	
			30.00	18.40		D 64 30.00							
Complete at 30.00m. Termination Reason: Achieved Scheduled Depth													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TPS_001 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.14mOD	Coordinates	549471.40E, 260970.90N	Grid	OSGB
Date Started	23/08/2021	Date Completed	24/08/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	23/08/2021 12:00	23/08/2021 13:00	CB	DT	NA	NA	Insulated hand tools	None	Stable	
1.20	15.10	RC	23/08/2021 13:00	23/08/2021 17:30	CB	AY	Geobore S (146)	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
23/08/2021 17:30	15.10	2.75	3.50	End of Shift
24/08/2021 07:30	15.10	2.75	3.20	Start of shift
24/08/2021 10:00	0.00	0.00	Dry	Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	12.30	AIR/MIST	90	White	
12.30	15.10	AIR/MIST	90	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
15.10	146	2.75	150						
		15.10	146						

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type
13.00	S1	SP	0.00	13.00	Pipe 1	Pipe 1	0.00	3.10	100	PLAIN
						Pipe 1	3.10	13.00	100	SLOTTED

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	13.00	Gravel backfill	
13.00	15.10	Bentonite	

LOCATION DETAILS

Remarks

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TPS_001
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 2

Ground Level	+10.14mOD	Coordinates	549471.40E, 260970.90N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike
TOPSOIL: Dark brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and quartz. Occasional rootlets. (TOP) [TOPSOIL]			(0.30) 0.30	10.14	
Firm brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of mixed lithologies. Occasional flints. (SUPD) [SUPERFICIAL DEPOSITS]			(0.80) 1.10	10.14	
Structureless CHALK composed of firm greyish brown slightly sandy slightly gravelly calcareous CLAY. Sand is fine to coarse. Gravel is angular to subangular fine to medium of very weak calcareous siltstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(0.40) 1.50	10.14	
Structureless CHALK composed of firm greyish brown gravelly calcareous CLAY with medium spaced thin beds of extremely weak low density greyish brown CHALK composed of calcareous SILTSTONE. Gravel is angular to subangular medium to coarse of very weak chalk. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]			(3.00) 4.50	10.14	
Extremely weak to very weak medium density greyish brown CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 0 to 20 degrees closely to medium spaced undulating smooth and iron staining. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 4.94m to 5.20m structureless chalk composed of firm greyish brown gravelly calcareous clay. Gravel is angular to subangular medium to coarse of very weak chalk	Grade B2/3		(1.40) 5.90	10.14	
Structureless CHALK composed of firm greyish brown gravelly calcareous CLAY. Gravel is angular to subangular medium to coarse of very weak chalk. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 6.30m to 6.53m very weak medium density chalk composed of calcareous siltstone	Grade Dm		(1.37) 7.27	10.14	
Extremely weak to very weak medium density light grey CHALK composed of calcareous SILTSTONE with medium spaced thin beds of structureless CHALK composed of firm greyish brown gravelly calcareous CLAY. Gravel is angular to subangular medium to coarse of chalk. Discontinuities: 1) 0 to 20 degrees closely to medium spaced undulating smooth with iron staining. (CIRIA Grade B2/3) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B2/3		(3.03)		

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
D 1 0.05–0.10							
ES 2 0.20–0.25							
B 3 0.10–0.40							
D 4 0.40–0.50							
ES 5 0.50–0.55							
B 6 0.40–0.80							
B 9 0.80–1.20							
D 7 1.00–1.10							
ES 8 1.10–1.20							
C 10 1.20–2.20	102	48			NA		
C 11 2.20–2.70	102	90					
C 12 2.70–3.50	102	100					
C 13 3.50–4.80	102	100	19	0			
C 14 4.80–6.30	102	100	57	40	70 150 370		
C 15 6.30–7.80	102	100	51	44	NA		
C 16 7.80–9.30	102	100	53	48	NI 200 280		

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TPS_001
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 2

Ground Level +10.14mOD Coordinates 549471.40E, 260970.90N Grid OSGB

Hole Type IP+RC Inclination

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Extremely weak to very weak medium density light grey CHALK composed of calcareous SILTSTONE with medium spaced thin beds of structureless CHALK composed of firm greyish brown gravelly calcareous CLAY. Gravel is angular to subangular medium to coarse of chalk. Discontinuities: 1) 0 to 20 degrees closely to medium spaced undulating smooth with iron staining. (CIRIA Grade B2/3) (WMCK) [WEST MELBURY CHALK FORMATION]			10.30	10.14		C 17 9.30-10.80	102	97	43	25			
Weak high density light grey CHALK composed of calcareous SILTSTONE with frequent coprolites at base (<40mm x 30mm). Discontinuities: 1) 0 to 30 degrees medium spaced planar smooth with silt infill (<3mm). (CIRIA Grade B2/3) (WMCK) [WEST MELBURY CHALK FORMATION]			(1.56) 11.86	10.14		C 18 10.80-12.30	102	100	76	72	NI 200 290		
Stiff grey CLAY with frequent coprolites (<45mm x 30mm). (WMCK) [CAMBRIDGE GREENSAND MEMBER]			12.05	10.14									
Very stiff fissured dark grey CLAY. Fissures are horizontal to subangular closely spaced undulating smooth. (GLT) [GAULT FORMATION] at 12.18m subhorizontal undulating smooth with dustings of silt at 13.68m 45 degrees planar polished at 14.10m siltstone nodules (<10mm x 10mm)	Unweathered		(3.05) 15.10	10.14		C 19 12.30-13.80 C 20 13.80-15.10	102 102	100 100			NA		
Complete at 15.10m. Termination Reason: Achieved Scheduled Depth													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TPS_001b
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+10.09mOD	Coordinates	549425.67E, 261029.07N	Grid	OSGB
Date Started	07/10/2021	Date Completed	08/10/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	07/10/2021 08:00	07/10/2021 09:00	CB	DT	NA	NA	Insulated Hand Tools	None	Stable	
1.20	13.70	RC	07/10/2021 09:00	08/10/2021 15:00	CB	AL	Geobore S (146)	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
07/10/2021 17:30	13.70	1.60	6.25	End of Shift
08/10/2021 07:30	8.70	1.60	4.20	Start of Shift
08/10/2021 15:00	0.00			Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	7.70	AIR/MIST	90	White	
7.70	13.70	AIR/MIST	90	Grey	

HOLE DIAMETER

Depth Base	Diameter
1.60	150
13.70	146

CASING DIAMETER

Depth Base	Diameter
1.60	150
13.70	146

DYNAMIC SAMPLING

Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref
13.70	S1	SP	0.00	13.70	Pipe 1

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type
Pipe 1	0.00	4.00	100	PLAIN
Pipe 1	4.00	12.20	100	SLOTTED

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
8.70	13.70	Borehole collapsed to 8.70m after withdrawal of wireline casing.

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	13.70	Gravel backfill	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Form No. SIEXPHOLEHDR Issue.Revision No. 2.02 Issue Date 22/06/2016

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log
Project No.	TE8364	
Engineer	Mott MacDonald Bentley	
Employer	Barhale Limited	

Hole ID
BH_TPS_001b
Sheet 1 of 2

Ground Level	+10.09mOD	Coordinates	549425.67E, 261029.07N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Depth (Thick-ness)	Datum Level
TOPSOIL: Dark brown slightly gravelly sandy CLAY. Sand is fine to medium. Gravel is angular to subrounded fine to medium of flint. (TOP) [TOPSOIL]		(0.30) 0.30	9.79
Firm light brown slightly gravelly sandy CLAY. Sand is angular to subrounded. Gravel is angular to subrounded fine to medium. (SUPD) [SUPERFICIAL DEPOSITS]		0.55	9.54
Firm light brown greyish slightly gravelly sandy calcareous clay CHALK. Sand is angular to subangular of flint. Gravel is angular to subrounded fine to coarse. (WMCK) [WEST MELBURY CHALK FORMATION]		(0.65) 1.20	8.89
Structureless CHALK composed of firm yellowish brown slightly sandy slightly gravelly calcareous CLAY. Sand is fine. Gravel is subangular to subrounded fine to coarse of extremely weak chalk. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(2.50) 3.70	6.39
Structureless CHALK composed of stiff yellowish brown mottled orangish staining slightly gravelly calcareous CLAY. Gravel is subangular to subrounded fine to coarse of extremely weak chalk. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(0.65) 4.35	5.74
Very weak low density CHALK composed of yellowish brown calcareous SILTSTONE. Discontinuities: 1) 10-35 degrees medium spaced undulating rough with clay infill. (CIRIA Grade B2) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B2	(2.40) 6.75	3.34
Very weak medium density CHALK composed of grey calcareous SILTSTONE. Discontinuities: 1) 10-40 degrees medium spaced planar rough with clay infill. (CIRIA Grade B2) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B2	(2.65) 9.40	0.69
Weak high density CHALK composed of grey calcareous SILTSTONE with medium bed of stiff grey calcareous clay. Discontinuities: 1) 10-45 degrees/near vertical degrees medium spaced planar rough with silt infill. (CIRIA Grade B2)			

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF
D 1 0.05-0.10					NA
B 2 0.10-0.40					
D 3 0.40-0.50					
B 4 0.40-0.80					
B 6 0.80-1.20					
D 5 1.00-1.10					
C 7 1.20-2.20	102	100			
C 8 2.20-3.20	102	100			
C 9 3.20-4.70	102	99	23	23	
C 10 4.70-6.20	102	83	79	63	60 210 610
C 11 6.20-7.20	102	71	71	71	
C 12 7.20-7.70	102	100	100	100	120 383 400
C 13 7.70-9.20	102	100	93	93	
C 14 9.20-10.70	102	100	92	47	

In Situ Test Details

Install-ation

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TPS_001b
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 2

Ground Level	+10.09mOD	Coordinates	549425.67E, 261029.07N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Weak high density CHALK composed of grey calcareous SILTSTONE with medium bed of stiff grey calcareous clay. Discontinuities: 1) 10-45 degrees/near vertical degrees medium spaced planar rough with silt infill. (CIRIA Grade B2) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B2		(1.50)								200 216 490		
Stiff dark greenish grey slightly gravelly slightly sandy CLAY. Sand is fine. Gravel is subangular to subrounded fine to coarse of black coprolite. (WMCK) [CAMBRIDGE GREENSAND MEMBER]			10.90 (0.30)	-0.81									
Stiff fissured dark grey CLAY with occasional nodules of siltstone (20mm x >30mm). Fissures are 10-15 degrees closely spaced planar polished. (GLT) [GAULT FORMATION]	Unweathered		11.20 (2.50)	-1.11		C 15 10.70-12.20	102	100	13	13	NA		
						C 16 12.20-13.70	102	100					
Complete at 13.70m. Termination Reason: Achieved Scheduled Dep h			13.70	-3.61									

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:56   Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TPS_002
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+10.14mOD	Coordinates	549481.40E, 260971.00N	Grid	OSGB
Date Started	24/08/2021	Date Completed	25/08/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	24/08/2021 12:00	24/08/2021 13:00	Craig Blackett	DT	NA	NA	Insulated hand tools	None	Stable	
1.20	15.20	RC	24/08/2021 13:00	24/08/2021 17:30	Craig Blackett	AL	Geobore S (146)	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
24/08/2021 17:30	15.20	1.40	3.40	Drilling Complete
25/08/2021 07:30	15.20	1.40	3.20	Start of shift
25/08/2021 10:00	0.00	0.00		Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
24/08/2021 15:00	5.50	1.40		0.00	0	Rise not recorded. Flow increasing with depth.

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	7.70	AIR/MIST	90	White	
7.70	15.20	AIR/MIST	90	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
1.40	150	1.40	150						
15.20	146								

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type
13.00	S1	SP	3.30	13.00	Pipe 1	Pipe 1	0.00	3.30	100	PLAIN
						Pipe 1	3.30	13.00	100	SLOTTED

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	13.00	Gravel backfill	
13.00	15.20	Bentonite	

LOCATION DETAILS

Remarks

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TPS_002
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 2

Ground Level	+10.14mOD	Coordinates	549481.40E, 260971.00N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling		TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
						Details	Dia.						
TOPSOIL: Dark brown slightly sandy slightly gravelly clay. Gravel is angular to subrounded fine to medium of flint. Sand is fine to coarse. Occasional roots. (TOP) [TOPSOIL]			(0.30) 0.30	9.84		D 1 0.05-0.10 ES 2 0.20-0.25 B 3 0.10-0.40 D 4 0.40-0.50							
Firm brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine and medium of flint. (SUPD) [SUPERFICIAL DEPOSITS]	Grade Dm		0.55	9.59		ES 5 0.50-0.55 B 6 0.40-0.80							
Structureless CHALK composed of firm light greyish brown slightly gravelly sandy CLAY. Sand is fine to medium. Gravel is angular to subangular medium of flint. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]			(0.65) 1.20	8.94		B 9 0.80-1.20 D 7 1.00-1.10 ES 8 1.10-1.20							
Structureless CHALK composed of firm yellowish grey calcareous CLAY with occasional pockets (<10mm x 10mm) of orangish brown fine sand. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(0.50) 1.70	8.44		C 10 1.20-2.20	102	100			NA		
Structureless CHALK composed of firm yellowish grey calcareous CLAY with clasts of very weak to weak subangular to subrounded fine to coarse gravel sized fragments of chalk. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]			(0.50) 2.20	7.94									
Extremely weak low density light grey CHALK composed of calcareous SILTSTONE. With 0 to 20 degree closely spaced undulating incipient fractures. (CIRIA Grade - unable to determine) (WMCK) [WEST MELBURY CHALK FORMATION]			(1.00) 3.20	6.94		C 11 2.20-3.20	102	100	100	95			
Extremely weak low density light grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 20 to 40 degrees very closely to medium spaced undulating rough with orangish brown staining. (CIRIA Grade B2) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B2		(1.78) 4.98	5.16		C 12 3.20-4.70	102	100	97	80	40 255 470		
Very weak high density light grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 20 to 38 degrees extremely closely to medium spaced undulating rough with orangish brown staining. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B3		(2.22) 7.20	2.94	▽	C 13 4.70-6.20 C 14 6.20-7.70	102 102	99 100	87 83	77 53	10 170 320		
Very weak medium density light grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 15 to 40 degrees closely to medium spaced undulating rough with orangish brown staining. (CIRIA Grade B2) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B2		(1.85) 9.05	1.09		C 15 7.70-9.20	102	100	87	77	115 370 404		
Very weak medium density grey CHALK composed of calcareous SILTSTONE with medium spaced thin beds of extremely weak low density grey chalk composed of calcareous siltstone. Discontinuities 1) 15 to 40 degrees closely to medium spaced undulating rough with orangish brown staining. (CIRIA Grade B2) (WMCK) [WEST MELBURY CHALK FORMATION]						C 16 9.20-10.70	102	100	93	67			

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:56   Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TPS_002 Sheet 2 of 2
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.14mOD	Coordinates	549481.40E, 260971.00N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Depth (Thickness)	Datum Level
Very weak medium density grey CHALK composed of calcareous SILTSTONE with medium spaced thin beds of extremely weak low density grey chalk composed of calcareous siltstone. Discontinuities 1) 15 to 40 degrees closely to medium spaced undulating rough with orangish brown staining. (CIRIA Grade B2) (WMCK) [WEST MELBURY CHALK FORMATION]		(2.75) 11.80	-1.66
Firm dark grey slightly sandy clay. Sand is fine. (WMCK) [CAMBRIDGE GREENSAND MEMBER]		11.99	-1.85
Stiff fissured dark grey CLAY with occasional siltstone nodules (<5mm x 8mm). Fissures are 10 to 40 degrees extremely closely spaced planar smooth. (GLT) [GAULT FORMATION] at 11.99m Contact is at 60 degrees.	Unweathered	(3.21) 15.20	-5.06

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
C 17 10.70-12.20	102	100	59	53	70 343 440		
C 18 12.20-13.70	102	100			NA		
C 19 13.70-15.20	102	100					

Complete at 15.20m. Termination Reason: Achieved Scheduled Depth

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:56   Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TPS_002b
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+10.21mOD	Coordinates	549435.44E, 261029.23N	Grid	OSGB
Date Started	11/10/2021	Date Completed	11/10/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	11/10/2021 08:45	11/10/2021 09:30	Craig Blackett	CB			Insulated Hand tools	None	Stable	Inspection pit: Hand dug
1.20	13.30	RO	11/10/2021 09:30	11/10/2021 12:00	Craig Blackett	CB		Tricone Steel	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
11/10/2021 08:45	0.00			Start of shift
11/10/2021 12:00	0.00			Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	5.80	AIR/MIST	90	White	
5.80	13.30	AIR/MIST	90	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
13.30	150	1.60	150						

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type
13.30	S1	SP	0.00	13.30	Pipe 1	Pipe 1	0.00	4.00	100	PLAIN
						Pipe 1	4.00	12.00	100	SLOTTED

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	13.30	Gravel backfill	

LOCATION DETAILS

Remarks
Borehole formed for installation of pump well installation

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Part of the Bachy Soletanche Group

Form No. SIEXPHOLEHDR Issue.Revision No. 2.02 Issue Date 22/06/2016

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TPS_002b
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 2

Ground Level	+10.21mOD	Coordinates	549435.44E, 261029.23N	Grid	OSGB
Hole Type	IP+RO	Inclination			

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Sandy gravelly TOPSOIL (Driller's description) **(TOP) [TOPSOIL]**			(0.35) 0.35	10.21		D 1 0.05-0.10 B 2 0.10-0.40							
Light brown sandy gravelly (Driller's description) **(SUPD) [SUPERFICIAL DEPOSITS]**			0.55	10.21		D 3 0.40-0.50 B 4 0.40-0.80							
CHALK (Driller's description) **(WMCK) [WEST MELBURY CHALK FORMATION]**			(10.45)			B 6 0.80-1.20 D 5 1.00-1.10							

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TPS_002b
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 2

Ground Level	+10.21mOD	Coordinates	549435.44E, 261029.23N	Grid	OSGB
Hole Type	IP+RO	Inclination			

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
CHALK (Driller's description) (WMCK) [WEST MELBURY CHALK FORMATION]			11.00	10.21									
Grey CLAY (Driller's description) (GLT) [GAULT FORMATION]			(2.30) 13.30	10.21									
Complete at 13.30m. Termination Reason: Achieved Scheduled Depth													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL
Print date and time 12/09/2022 13:56
Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log
Project No.	TE8364	Hole ID
Engineer	Mott MacDonald Bentley	BH_TPS_003
Employer	Barhale Limited	Sheet 1 of 1

Ground Level	+10.28mOD	Coordinates	549471.40E, 260961.10N	Grid	OSGB
Date Started	25/08/2021	Date Completed	26/08/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	25/08/2021 12:00	25/08/2021 13:00	CB	DT	NA	NA	Insulated hand tools	None	Stable	
1.20	15.20	RC	25/08/2021 13:00	26/08/2021 11:45	CB	AY	Geobore S (146)	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
25/08/2021 17:30	15.20	1.70	3.60	End of Shift
26/08/2021 07:30	15.20	1.70	3.30	Start of shift
26/08/2021 11:45	0.00	0.00	Dry	Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	9.20	AIR/MIST	90	White	
9.20	15.20	AIR/MIST	90	Grey	

HOLE DIAMETER

Depth Base	Diameter
15.20	146

CASING DIAMETER

Depth Base	Diameter
1.70	150
15.20	146

DYNAMIC SAMPLING

Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref
13.20	S1	SP	3.20	13.20	Pipe 1

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type
Pipe 1	0.00	3.20	100	PLAIN
Pipe 1	3.20	13.20	100	SLOTTED

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	3.20	Bentonite	
3.20	13.20	Gravel backfill	
13.20	15.20	Bentonite	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TPS_003
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 2

Ground Level	+10.28mOD	Coordinates	549471.40E, 260961.10N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Depth (Thickness)	Datum Level
TOPSOIL: Dark brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and quartz. Occasional rootlets. (TOP) [TOPSOIL]		(0.30) 0.30	10.28
Firm brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of mixed lithologies. Occasional flints. (SUPD) [SUPERFICIAL DEPOSITS]		(0.50) 0.80	10.28
Structureless CHALK composed of firm greyish brown to light brown slightly gravelly sandy calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of extremely weak to very weak and flint. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(0.40) 1.20	10.28
	Grade Dm	(0.30) 1.50	10.28
Structureless CHALK composed of firm greyish brown calcareous CLAY with frequent pockets (<10mm x 10mm) of orange fine sand. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(0.48) 1.98	10.28
Structureless CHALK composed of firm greyish brown gravelly calcareous CLAY. Gravel is angular to subangular medium to coarse of extremely weak to very weak chalk. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B4/5	(0.38) 2.36	10.28
Very weak low density greyish brown CHALK composed of calcareous SILTSTONE. Recovered as non intact, highly fractured with frequent interlocking angular to subangular medium to coarse fragments with orangish brown staining on fracture surfaces. (Possible CIRIA Grade B4/5) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(0.54) 2.90	10.28
Structureless CHALK composed of firm greyish brown gravelly calcareous CLAY. Gravel is angular to subangular medium to coarse of extremely weak calcareous siltstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]			
Very weak to weak medium density light grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 0 to 30 degrees medium spaced undulating smooth. 2) 45 degrees medium spaced planar smooth. (CIRIA Grade A3) (WMCK) [WEST MELBURY CHALK FORMATION] from 3.70m to 3.75m structureless chalk composed of firm greyish brown gravelly calcareous clay. Gravel is angular to subangular medium to coarse extremely weak chalk from 4.44m to 4.52m structureless chalk composed of firm greyish brown gravelly calcareous clay. Gravel is angular to subangular medium extremely weak chalk from 5.52m to 5.74m structureless chalk composed of firm greyish brown gravelly calcareous clay. Gravel is angular to subangular medium extremely weak chalk	Grade A3	(3.50) 6.40	10.28
Very weak to weak medium density light grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 70 degrees closely spaced planar smooth with silt infill (>3mm). (CIRIA Grade C4) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade C4	(0.30) 6.70	10.28
Very weak to weak medium density light grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 0 to 30 degrees closely to medium spaced undulating smooth. 2) randomly orientated extremely closely spaced planar smooth with iron staining. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 6.85m to 7.06m structureless chalk composed of firm greyish brown gravelly calcareous clay. Gravel is angular to subangular medium extremely weak chalk from 7.34m to 7.43m 45 degrees very closely spaced undulating smooth with iron staining from 7.61m to 7.70m structureless chalk composed of firm greyish brown gravelly calcareous clay. Gravel is angular to subangular medium extremely weak chalk from 9.05m to 9.13m structureless chalk composed of firm greyish brown gravelly calcareous clay. Gravel is angular to subangular medium extremely weak chalk	Grade B3	(3.03) 9.73	10.28
Structureless CHALK composed of firm light grey gravelly calcareous CLAY. Gravel is angular medium extremely weak calcareous siltstone.	Grade Dm	(0.31)	

Sampling Details	Dia	TCR/Sample Recovery %	SCR/Blows	RQD
D 1 0.05-0.10				
ES 2 0.20-0.25				
B 3 0.10-0.40				
D 4 0.40-0.50				
ES 5 0.50-0.55				
B 6 0.40-0.80				
B 9 0.80-1.20				
D 7 1.00-1.10				
ES 8 1.10-1.20				
C 10 1.20-2.20	102	100	0	0
C 11 2.20-3.20	102	100	0	0
C 12 3.20-4.70	102	95	47	40
C 13 4.70-6.20	102	98	53	50
C 14 6.20-7.70	102	100	40	34
C 15 7.70-9.20	102	93	53	46
C 16 9.20-10.70	102	100	48	43

IF
NA
NI
NA
NI 150 220
NI
NI 180 270

In Situ Test Details

Install-ation

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TPS_003 Sheet 2 of 2
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.28mOD	Coordinates	549471.40E, 260961.10N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Depth (Thickness)	Datum Level	Waterstrike
		10.04	10.28	
Structureless CHALK composed of firm light grey gravelly calcareous CLAY. Gravel is angular medium extremely weak calcareous siltstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade A2			
Extremely weak to very weak medium density CHALK composed of calcareous SILTSTONE. Discontinuities 1) 0 - 30 degrees very closely to medium spaced undulating and smooth. (CIRIA Grade A2) (WMCK) [WEST MELBURY CHALK FORMATION]		(1.97)		
		12.01	10.28	
Stiff grey CLAY with frequent coprolites (<45mm x 30mm). (WMCK) [CAMBRIDGE GREENSAND MEMBER]				
		12.22	10.28	
Very stiff fissured dark grey CLAY. Fissures are horizontal to subhorizontal closely to medium spaced undulating and smooth. (GLT) [GAULT FORMATION]	Unweathered	(2.98)		
		15.20	10.28	

Complete at 15.20m. Termination Reason: Achieved Scheduled Depth

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
					35 240 380		
C 17 10.70-12.20	102	100	84	80			
C 18 12.20-13.70	102	100	0	0	NA		
C 19 13.70-15.20	102	100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TPS_003b
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+10.22mOD	Coordinates	549435.45E, 261019.05N	Grid	OSGB
Date Started	12/10/2021	Date Completed	12/10/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	12/10/2021 10:00	12/10/2021 10:30	Craig Blackett	CB			Insulated Hand tools	None	Stable	Inspection pit: Hand dug
1.20	13.30	RO	12/10/2021 10:30	12/10/2021 13:00	Craig Blackett	CB		Tricone Steel	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
12/10/2021 10:00	0.00			Start of Hole
12/10/2021 14:00	0.00			Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	8.80	AIR/MIST	90	White	
8.80	13.30	AIR/MIST	90	Grey	

HOLE DIAMETER

Depth Base	Diameter
13.30	150

CASING DIAMETER

Depth Base	Diameter
1.20	150

DYNAMIC SAMPLING

Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref
13.30	S1	SP	0.00	13.30	Pipe 1

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type
Pipe 1	0.00	4.00	100	PLAIN
Pipe 1	4.00	12.00	100	SLOTTED

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	13.30	Gravel backfill	

LOCATION DETAILS

Remarks
Borehole formed for installation of pump well installation

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TPS_003b
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 2

Ground Level	+10.22mOD	Coordinates	549435.45E, 261019.05N	Grid	OSGB		
Hole Type	IP+RO	Inclination					

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Sandy gravelly TOPSOIL (Driller's description) (TOP) [TOPSOIL]			(0.35) 0.35	10.22		D 1 0.05-0.10 B 2 0.10-0.40							
Light brown sandy gravelly CLAY (Driller's description) (SUPD) [SUPERFICIAL DEPOSITS]			0.55	10.22		D 3 0.40-0.50 B 4 0.40-0.80							
CHALK (Driller's description) (WMCK) [WEST MELBURY CHALK FORMATION]			(10.45)			B 6 0.80-1.20 D 5 1.00-1.10							

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TPS_003b Sheet 2 of 2
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.22mOD	Coordinates	549435.45E, 261019.05N	Grid	OSGB
Hole Type	IP+RO	Inclination			

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
CHALK (Driller's description) (WMCK) [WEST MELBURY CHALK FORMATION]			11.00	10.22									
Grey CLAY (Driller's description) (GLT) [GAULT FORMATION]			(2.30) 13.30	10.22									
Complete at 13.30m. Termination Reason: Achieved Scheduled Dep h													

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TPS_004 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.25mOD	Coordinates	549481.30E, 260960.90N	Grid	OSGB
Date Started	26/08/2021	Date Completed	27/08/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	26/08/2021 13:15	26/08/2021 14:00	Craig Blackett	DT	NA	NA	Insulated hand tools	None	Stable	
1.20	15.20	RC	26/08/2021 14:00	26/08/2021 17:30	Craig Blackett	AL	Geobore S (146)	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
26/08/2021 17:30	15.20	1.65	3.40	Drilling Complete
27/08/2021 07:30	15.20	1.65	3.20	Start of shift
27/08/2021 15:30	0.00	0.00		Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
26/08/2021 15:00	4.00	1.65		0.00	0	Seepage noted, increasing with depth. Rise not recorded, masked by flush.

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	10.70	AIR/MIST	90	White	
10.70	15.20	AIR/MIST	90	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
1.65	150	1.65	150						
15.20	146								

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type
13.00	S1	SP	0.00	13.00	Pipe 1	Pipe 1	0.00	3.10	100	PLAIN
						Pipe 1	3.10	13.00	100	SLOTTED

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	13.00	Gravel backfill	
13.00	15.20	Bentonite	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

SOIL ENGINEERING

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TPS_004
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 2

Ground Level	+10.25mOD	Coordinates	549481.30E, 260960.90N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint. Occasional roots. (TOP) [TOPSOIL]			(0.30) 0.30	9.95		D 1 0.05–0.10 ES 2 0.20–0.25 B 3 0.10–0.40							
Firm brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint. (SUPD) [SUPERFICIAL DEPOSITS]			0.45	9.80		D 4 0.40–0.50 ES 5 0.50–0.55 B 6 0.40–0.80							
Firm reddish brown slightly gravelly sandy CLAY. Gravel is angular to subrounded fine to coarse of flint. (SUPD) [SUPERFICIAL DEPOSITS]			(0.75) 1.20	9.05		B 9 0.80–1.20 D 7 1.00–1.10 ES 8 1.10–1.20							
Structureless CHALK composed of firm yellowish grey slightly gravelly calcareous CLAY. Gravel is subangular to subrounded fine to coarse of extremely weak low density chalk. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 1.20m to 1.40m slightly sandy. Sand is fine to medium. from 2.10m to 2.20m assumed zone of core loss	Grade Dm		(1.00) 2.20	8.05		C 10 1.20–2.20	102	90			NA		
Structureless CHALK composed of stiff yellowish grey calcareous CLAY with closely spaced thin beds of extremely weak low density yellowish grey chalk composed of calcareous siltstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 3.10m to 3.20m assumed zone of core loss from 4.20m to 4.70m with some fossilised broken shell fragments (<15mm x 10mm)			(2.33) 4.53	5.72	▽	C 11 2.20–3.20 C 12 3.20–4.70	102 102	90 97					
Weak high density light grey CHALK composed of calcareous SILTSTONE with medium spaced medium beds of structureless chalk composed of stiff brownish grey calcareous clay. Discontinuities 1) 5 to 20 degrees medium spaced undulating rough with infill of silt. (CIRIA Grade B2) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B2		(2.67) 7.20	3.05		C 13 4.70–6.20 C 14 6.20–7.70	102 102	100 95	80 79	73 75	90 296 570		
Weak high density light grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 15 to 40 degrees medium spaced undulating rough with orangish brown staining. (CIRIA Grade B2) (WMCK) [WEST MELBURY CHALK FORMATION] from 7.70m to 7.80m recovered as non intact core (subangular to subrounded fine to coarse gravel sized fragments)			(2.45) 9.65	0.60		C 15 7.70–9.20	102	99	70	60	200 408 502		
Weak high density grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 10 to 45 degrees medium spaced planar rough						C 16 9.20–10.70	102	100	90	67			

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TPS_004 Sheet 2 of 2
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.25mOD	Coordinates	549481.30E, 260960.90N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Weak high density grey CHALK composed of calcareous SILTSTONE. Discontinuities 1) 10 to 45 degrees medium spaced planar rough clean unstained. (CIRIA Grade B2) (WMCK) [WEST MELBURY CHALK FORMATION]			(2.20)			C 17 10.70-12.20	102	100	70	53	204 250 340		
			11.85	-1.60									
Stiff dark greenish grey slightly sandy slightly gravelly CLAY. Sand is fine. Gravel is subangular to subrounded fine to coarse of black coprolite. (WMCK) [CAMBRIDGE GREENSAND MEMBER]			12.00	-1.75									
Very stiff fissured dark grey CLAY with occasional nodules of siltstone (5mm x <10mm). Fissures are 10 to 30 degrees extremely closely spaced planar smooth. (GLT) [GAULT FORMATION] from 13.20m to 13.40m with rare nodules of pyrite (8mm x 10mm)	Unweathered		(3.20)			C 18 12.20-13.70	102	100			NA		
						C 19 13.70-15.20	102	100					
			15.20	-4.95									
Complete at 15.20m. Termination Reason: Achieved Scheduled Depth													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TPS_004b Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.14mOD	Coordinates	549425.40E, 261019.03N	Grid	OSGB
Date Started	11/10/2021	Date Completed	11/10/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	11/10/2021 14:15	11/10/2021 15:15	Craig Blackett	CB			Insulated Hand tools	None	Stable	Inspection pit: Hand dug
1.20	13.30	RO	11/10/2021 15:15	11/10/2021 17:30	Craig Blackett	CB		Tricone Steel	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
11/10/2021 14:15	0.00			Start of shift
11/10/2021 17:30	0.00			Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	8.80	AIR/MIST	90	White	
8.80	13.30	AIR/MIST	90	Grey	

HOLE DIAMETER

Depth Base	Diameter
13.30	150

CASING DIAMETER

Depth Base	Diameter
1.20	150

DYNAMIC SAMPLING

Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref
13.30	S1	SP	0.00	13.30	Pipe 1

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type
Pipe 1	0.00	3.85	100	PLAIN
Pipe 1	3.85	11.85	100	SLOTTED

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	13.30	Gravel backfill	

LOCATION DETAILS

Remarks
Borehole formed for installation of pump well installation

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

SOIL ENGINEERING
Part of the Bachy Soletanche Group

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Form No. SIEXPHOLEHDR Issue.Revision No. 2.02 Issue Date 22/06/2016

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TPS_004b Sheet 1 of 2
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.14mOD	Coordinates	549425.40E, 261019.03N	Grid	OSGB
Hole Type	IP+RO	Inclination			

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Sandy gravelly TOPSOIL (Driller's description) (TOP) [TOPSOIL]			(0.35) 0.35	10.14		D 1 0.05-0.10 B 2 0.10-0.40							
Light brown sandy gravelly (Driller's description) (SUPD) [SUPERFICIAL DEPOSITS]			0.55	10.14		D 3 0.40-0.50 B 4 0.40-0.80							
CHALK (Driller's description) (WMCK) [WEST MELBURY CHALK FORMATION]			(10.45)			B 6 0.80-1.20 D 5 1.00-1.10							

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:56   Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TPS_004b
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 2

Ground Level	+10.14mOD	Coordinates	549425.40E, 261019.03N	Grid	OSGB
Hole Type	IP+RO	Inclination			

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
CHALK (Driller's description) **(WMCK) [WEST MELBURY CHALK FORMATION]**			11.00	10.14									
Grey CLAY (Driller's description) **(GLT) [GAULT FORMATION]**			(2.30) 13.30	10.14									
Complete at 13.30m. Termination Reason: Achieved Scheduled Depth													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL | Print date and time 12/09/2022 13:56 | Log checked by David Howard

SOIL ENGINEERING

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_001A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+6.91mOD	Coordinates	547211.50E, 261504.20N	Grid	OSGB
Date Started	06/09/2021	Date Completed	10/09/2021	Inclination	90° f om horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	06/09/2021 08:30	06/09/2021 11:45	Mitch Maxey	DT	NA	NA	Insulated hand tools	None	Stable	
1.20	35.00	RC	06/09/2021 11:45	09/09/2021 14:30	Mitch Maxey	AY	Geobore S (146)	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
06/09/2021 17:30	6.00	6.00	5.80	End of Shift
07/09/2021 07:30	6.00	6.00	5.90	Start of shift
07/09/2021 17:30	24.00	6.00	23.95	End of Shift
08/09/2021 07:30	24.00	6.00	17.00	Start of shift
08/09/2021 17:30	24.00	6.00	23.90	End of Shift
09/09/2021 07:30	24.00	6.00	17.00	Start of shift
09/09/2021 14:30	35.00	6.00	0.82	Drilling Complete
09/09/2021 17:30	7.00	6.00	1.10	End of Shift
10/09/2021 07:30	8.00	6.00	1.00	Start of shift
10/09/2021 17:30	0.00	0.00		Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
09/09/2021 14:00	35.00	6.00		0.82	20	

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	2.20	AIR/MIST	60	Orange	
2.20	3.20	AIR/MIST	70	Orange	
3.20	4.20	AIR/MIST	80	Orange	
4.20	6.00	AIR/MIST	90	Brown	
6.00	33.00	AIR/MIST	90	Grey	
33.00	35.00	AIR/MIST	100	Green	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
6.00	150	6.00	150						
35.00	146								

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref
4.75	S1	SP	1.25	4.75	Pipe 1

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type
Pipe 1	0.00	1.25	50	PLAIN
Pipe 1	1.25	4.25	50	SLOTTED
Pipe 1	4.25	4.75	50	PLAIN

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
-0.50	0.00	Upstanding cover	
0.00	0.50	Concrete	
0.50	0.70	Gravel backfill	
0.70	1.25	Bentonite	
1.25	4.25	Gravel backfill	
4.25	7.00	Bentonite	
7.00	35.00	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_001A
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 4

Ground Level	+6.91mOD	Coordinates	547211.50E, 261504.20N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Depth (Thick-ness)	Datum Level	Waterstrike
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint. Occasional roots. (TOP) [TOPSOIL]		0.10 (0.50) 0.60	6.81 6.31	
MADE GROUND: Light brown slightly gravelly sandy clay. Sand is fine to coarse. Gravel sized fragments are angular to subrounded medium to coarse of sandstone, brick, flint, concrete and occasional mudstone. (MGR) [MADE GROUND]		0.80 (0.40) 1.20	6.11 5.71	▽
MADE GROUND: Three courses of brickwork. (MGR) [MADE GROUND]		(0.35) 1.55	5.36	
Reddish brown fine to coarse SAND and angular to subrounded medium to coarse GRAVEL of flint. (RTD) [SUPERFICIAL DEPOSITS]				
Brown sandy slightly clayey angular to rounded fine to coarse GRAVEL of flint. Sand is fine to coarse. (RTD) [SUPERFICIAL DEPOSITS]		(0.65) 2.20	4.71	
Assumed zone of core loss. SAND and GRAVEL (Driller's description) (RTD) [SUPERFICIAL DEPOSITS]		(0.50)		
Brown very sandy clayey angular to rounded fine to coarse GRAVEL of flint. Sand is fine to coarse. (RTD) [SUPERFICIAL DEPOSITS]		2.70	4.21	
Assumed zone of core loss. SAND and GRAVEL (Driller's description) (RTD) [SUPERFICIAL DEPOSITS]		(0.50) 3.20	3.71	
Brown sandy slightly clayey angular to rounded fine to coarse GRAVEL of flint. Sand is fine to coarse. (RTD) [SUPERFICIAL DEPOSITS]		(0.40) 3.60	3.31	
Assumed zone of core loss. SAND and GRAVEL (Driller's description)		(0.60) 4.20	2.71	
Soft dark grey CLAY. (GLT) [GAULT FORMATION]		(0.30) 4.50	2.41	
Assumed zone of core loss. Grey CLAY. (Driller's description) (GLT) [GAULT FORMATION]		(0.70) 5.20	1.71	
Soft dark grey CLAY (GLT) [GAULT FORMATION]		5.40	1.51	
Assumed zone of core loss. Grey CLAY (Driller's description) (GLT) [GAULT FORMATION]		(0.60) 6.00	0.91	
Stiff fissured dark grey CLAY with rare coprolites (<20mm x 10mm) and siltstone nodules (<10mm x 10mm). Fissures are randomly orientated extremely closely to very closely spaced undulating smooth and generally polished. (GLT) [GAULT FORMATION] at 6.44m with occasional siltstone nodules (<10mm x 10mm) from 7.40m to 7.50m assumed zone of core loss at 8.04m with occasional siltstone nodules (<10mm x 10mm) at 8.85m 1 No. fragment of coprolite (<20mm x 10mm) from 8.90m to 9.00m assumed zone of core loss at 9.57m 1 No. fissure 45 degrees undulating polished		(6.48)		

Sampling Details	Dia	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details
D 1 0.05-0.10 ES 2 0.20-0.25 B 3 0.10-0.40 D 4 0.40-0.50 ES 5 0.50-0.55 B 6 0.40-0.80 B 9 0.80-1.20 D 7 1.00-1.10 ES 8 1.10-1.20						
C 10 1.20-2.20	102	35			NA NR	
C 11 2.20-3.20	102	50			NA NR	K 2.92 - 3.42
C 12 3.20-4.20 EW 1 4.00	102	40			NA NR	
C 13 4.20-5.20	102	30			NA NR	
C 14 5.20-6.00	102	25			NA NR	
C 15 6.00-7.00	102	100				
C 16 7.00-7.50	102	80				
C 17 7.50-9.00	102	93				K 7.70 - 9.30 K 7.70 - 9.30 K 7.70 - 9.30 K 7.70 - 9.30 K 7.70 - 9.30

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_001A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 4

Ground Level	+6.91mOD	Coordinates	547211.50E, 261504.20N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Stiff fissured dark grey CLAY with rare coprolites (<20mm x 10mm) and siltstone nodules (<10mm x 10mm). Fissures are randomly orientated extremely closely to very closely spaced undulating smooth and generally polished. (GLT) [GAULT FORMATION]						C 18 9.00-12.00							
at 10.87m 1 No. fissure 45 degrees planar polished							102	100					
at 12.46m 1 No. thick lamination of dark grey fossilised shell fragments (<10mm x 10mm)			12.48	-5.57									
Very stiff fissured dark grey CLAY. Fissures are 1) 0 degrees closely to medium spaced planar smooth with occasional dusting of silt. 2) randomly orientated extremely closely to closely spaced undulating and planar smooth polished. (GLT) [GAULT FORMATION]						C 19 12.00-15.00	102	100					
from 14.37m to 14.43m with frequent fragments of coprolite (<20mm x 10mm) and fossilised shell fragments (<10mm x 10mm)			(3.96)										
											NA		
from 15.42m to 15.53m firm													
from 15.83m to 15.92m 1 No. fissure 90 degrees planar smooth													
Very stiff fissured dark grey CLAY with rare coprolites (<20mm x 10mm) and fossilised shell fragments (<10mm x 10mm). Fissures are 1) 0 degrees closely to medium spaced planar smooth occasionally polished. 2) 80 to 90 degrees medium to widely spaced planar smooth polished. (GLT) [GAULT FORMATION]			16.44	-9.53		C 20 15.00-18.00	102	100					
			(3.26)										
							102	95					
from 19.12m to 20.10m 1 No. fissure 45 degrees undulating polished													
						C 21 18.00-21.00							
Very stiff fissured dark grey CLAY with frequent belemnites (<30mm x 5mm), coprolites (<40mm x 30mm) and shell fragments (<10mm x			19.70	-12.79									

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_001A
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 3 of 4

Ground Level	+6.91mOD	Coordinates	547211.50E, 261504.20N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very stiff fissured dark grey CLAY with frequent belemnites (<30mm x 5mm), coprolites (<40mm x 30mm) and shell fragments (<10mm x 10mm). Fissures are 1) 0 to 15 degrees closely spaced planar occasionally undulating smooth polished. 2) 40 to 50 degrees medium to widely spaced planar and undulating smooth generally polished. (GLT) [GAULT FORMATION] from 20.85m to 21.00m assumed zone of core loss													
						C 22 21.00-24.00	102	100					
from 23.42m to 23.55m 1 No. fissure 70 degrees planar smooth polished													
						C 23 24.00-25.00	102	90					
from 24.90m to 25.00m assumed zone of core loss			(13.20)										
						C 24 25.00-28.00	102	97					
from 27.90m to 28.00m assumed zone of core loss													
						C 25 28.00-30.00	102	100					

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_001A
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 4 of 4

Ground Level	+6.91mOD	Coordinates	547211.50E, 261504.20N	Grid	OSGB		
Hole Type	IP+RC	Inclination	90° from horizontal				

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff fissured dark grey CLAY with frequent belemnites (<30mm x 5mm), coprolites (<40mm x 30mm) and shell fragments (<10mm x 10mm). Fissures are 1) 0 to 15 degrees closely spaced planar occasionally undulating smooth polished. 2) 40 to 50 degrees medium to widely spaced planar and undulating smooth generally polished. (GLT) [GAULT FORMATION] from 32.62m to 32.90m becomes gravelly. Gravel is subrounded to rounded fine of flint			32.90	-25.99		C 26 30.00-33.00	102	100					
Very stiff dark greenish grey slightly sandy gravelly CLAY. Sand is fine to medium. Gravel is subrounded to rounded fine to medium of flint. (LGF) [LOWER GREENSAND FORMATION]			33.00	-26.09									
Assumed zone of core loss. Green SAND (Driller's description) (LGF) [LOWER GREENSAND FORMATION] from 33.00m to 33.21m 1 No. medium bed of medium strong light grey gravelly medium grained sandstone. Gravels are subrounded to rounded fine of flint.			(1.50) 34.50	-27.59		C 27 33.00-35.00	102	25			NR		
Very stiff dark greenish grey slightly sandy gravelly CLAY. Sand is fine to medium. Gravel is subrounded to rounded fine to medium of flint. (LGF) [LOWER GREENSAND FORMATION]			(0.50) 35.00	-28.09	▼						NA		

Complete at 35.00m. Termination Reason: Achieved Scheduled Depth

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_001B
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+6.99mOD	Coordinates	547222.19E, 261524.17N	Grid	OSGB
Date Started	28/09/2021	Date Completed	30/09/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	28/09/2021 12:00	28/09/2021 13:00	DS	DT	NA	NA	Insulated Hand Tools	None	Stable	
1.20	35.00	CP	28/09/2021 13:00	30/09/2021 14:00	DS	AM	NA	NA	Dando 2000			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
28/09/2021 17:30	12.00	9.00	Dry	End of Shift
29/09/2021 07:30	12.00	9.00	Dry	Start of Shift
29/09/2021 17:30	30.00	9.00	Dry	End of Shift
30/09/2021 07:30	30.00	9.00	Dry	Start of Shift
30/09/2021 14:00	0.00			Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
28/09/2021 13:20	1.70	1.70	3.20	1.60	20	Very Slow
30/09/2021 09:50	33.30	9.00		16.60	20	Fast

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water
1.50	C	N=25 (4,5:6,6,6,7)	AR3501	75	1.50	Dry
2.50	C	N=28 (4,6:6,7,7,8)	AR3501	75	2.50	2.20
3.50	S	N=18 (2,3:4,4,5,5)	AR3501	75	3.50	Dry
4.50	S	N=13 (2,2:3,3,3,4)	AR3501	75	4.50	Dry
5.50	S	N=15 (3,3:3,4,4,4)	AR3501	75	5.50	Dry
6.50	S	N=14 (2,2:3,3,4,4)	AR3501	75	6.50	Dry
7.50	S	N=17 (3,3:4,4,4,5)	AR3501	75	7.50	Dry
8.50	S	N=17 (2,3:3,4,5,5)	AR3501	75	8.50	Dry
9.50	S	N=17 (3,4:4,4,4,5)	AR3501	75	9.00	Dry
11.00	S	N=20 (3,4:5,5,5,5)	AR3501	75	9.00	Dry
12.00	S	N=23 (4,4:5,6,6,6)	AR3501	75	9.00	Dry
13.50	S	N=26 (4,5:5,6,7,8)	AR3501	75	9.00	Dry
15.00	S	N=33 (5,6:6,8,9,10)	AR3501	75	9.00	Dry
17.00	S	N=32 (5,6:7,7,8,10)	AR3501	75	9.00	Dry
18.50	S	N=34 (6,7:8,8,9,9)	AR3501	75	9.00	Dry
20.00	S	N=35 (5,6:7,8,9,11)	AR3501	75	9.00	Dry
21.50	S	N=33 (5,5:6,8,9,10)	AR3501	75	9.00	Dry
23.00	S	N=26 (4,4:5,6,7,8)	AR3501	75	9.00	Dry
24.50	S	N=30 (4,5:6,7,8,9)	AR3501	75	9.00	Dry
26.00	S	N=34 (5,7:7,9,9,9)	AR3501	75	9.00	Dry
27.50	S	N=37 (5,6:8,9,10,10)	AR3501	75	9.00	Dry
29.00	S	N=31 (4,5:7,7,8,9)	AR3501	75	9.00	Dry
30.50	S	N=35 (5,6:7,8,10,10)	AR3501	75	9.00	Dry
32.00	S	N=35 (4,6:8,8,9,10)	AR3501	75	9.00	Dry
33.50	S	N=21 (3,4:4,5,6,6)	AR3501	75	9.00	17.20
34.50	S	N=22 (2,3:5,5,6,6)	AR3501	75	9.00	17.90

HOLE DIAMETER

Depth Base	Diameter
9.00	200
35.00	150

CASING DIAMETER

Depth Base	Diameter
3.00	200
9.00	150

DYNAMIC SAMPLING

Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
6.00	9.00	Bentonite Seal

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	35.00	Grout	

LOCATION DETAILS

Remarks

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_001B
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 4

Ground Level	+6.99mOD	Coordinates	547222.19E, 261524.17N	Grid	OSGB		
Hole Type	IP+CP	Inclination	90° from horizontal				

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
MADE GROUND: Light brown slightly gravelly sandy clay. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint. (MGR) [MADE GROUND]			0.10	6.89		D 1 0.05-0.10							
MADE GROUND: Brown gravel sized fragments of flint, sandstone, brick and concrete. (MGR) [MADE GROUND]			(0.60) 0.70	6.29		B 2 0.10-0.40 D 3 0.50-0.55 B 4 0.40-0.80							
Light brown reddish sandy GRAVEL. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint. (RTD) [SUPERFICIAL DEPOSITS]			(0.50) 1.20	5.79		B 6 0.80-1.20 D 5 1.00-1.10							
Medium dense brown fine to coarse SAND and GRAVEL. Gravel is angular to subrounded fine to coarse of flint and quartzite. (RTD) [SUPERFICIAL DEPOSITS]			(1.70) 2.90	4.09	▽ ▼	B 7 1.50-2.00 B 8 2.50-3.00						SPT(C) N=25 (4,5:6,6,6,7) 1.50 SPT(C) N=28 (4,6:6,7,7,8) 2.50	
Firm fissured thinly laminated dark grey CLAY. Fissures are randomly orientated undulating planar smooth. (GLT) [GAULT FORMATION]			(2.60) 5.50	1.49		D 9 3.50-3.95 B 10 3.50-4.00 D 11 4.50-4.95 B 12 4.50-5.00						SPT(S) N=18 (2,3:4,4,5,5) 3.50 SPT(S) N=13 (2,2:3,3,3,4) 4.50	
Stiff fissured thinly laminated dark grey CLAY. Fissures are randomly orientated undulating planar smooth. (GLT) [GAULT FORMATION]			(6.50)			D 13 5.50-5.95 B 14 5.50-6.00 D 15 6.50-6.95 B 16 6.50-7.00 D 17 7.50-7.95 B 18 7.50-8.00 D 19 8.50-8.95 B 20 8.50-9.00 D 21 9.50-9.95 B 22 9.50-10.00						SPT(S) N=15 (3,3:3,4,4,4) 5.50 SPT(S) N=14 (2,2:3,3,4,4) 6.50 SPT(S) N=17 (3,3:4,4,4,5) 7.50 SPT(S) N=17 (2,3:3,4,5,5) 8.50 SPT(S) N=17 (3,4:4,4,4,5) 9.50	

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Form No. SIEXPHOLELOG Issue.Revision No. 2.05 Issue Date 02/03/2018

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_001B Sheet 2 of 4
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+6.99mOD	Coordinates	547222.19E, 261524.17N	Grid	OSGB
Hole Type	IP+CP	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Stiff fissured thinly laminated dark grey CLAY. Fissures are randomly orientated undulating planar smooth. (GLT) [GAULT FORMATION]						D 23 11.00-11.45 B 24 11.00-11.50						SPT(S) N=20 (3,4:5,5,5,5) 11.00	
Stiff fissured thinly laminated dark grey CLAY. Fissures are extremely closely to closely spaced randomly orientated planar undulating smooth and polished. (GLT) [GAULT FORMATION]			12.00	-5.01		D 25 12.00-12.45 B 26 12.00-12.50						SPT(S) N=23 (4,4:5,6,6,6) 12.00	
			(3.00)			D 27 13.50-13.95 B 28 13.50-14.00						SPT(S) N=26 (4,5:5,6,7,8) 13.50	
Very stiff fissured thinly laminated dark grey CLAY. Fissures are extremely closely to closely spaced randomly orientated planar undulating smooth and polished. (GLT) [GAULT FORMATION]			15.00	-8.01		D 29 15.00-15.45 B 30 15.00-15.50						SPT(S) N=33 (5,6:6,8,9,10) 15.00	
					▽								
						D 31 17.00-17.45 B 32 17.00-17.50						SPT(S) N=32 (5,6:7,7,8,10) 17.00	
						D 33 18.50-18.95 B 34 18.50-19.00						SPT(S) N=34 (6,7:8,8,9,9) 18.50	
												SPT(S) N=35 (5,6:7,8,9,11) 20.00	

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_001B Sheet 3 of 4
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+6.99mOD	Coordinates	547222.19E, 261524.17N	Grid	OSGB
Hole Type	IP+CP	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very stiff fissured thinly laminated dark grey CLAY. Fissures are extremely closely to closely spaced randomly orientated planar undulating smooth and polished. (GLT) [GAULT FORMATION]						D 35 20.00-20.45 B 36 20.00-20.50							
						D 37 21.50-21.95 B 38 21.50-22.00						SPT(S) N=33 (5,5:6,8,9,10) 21.50	
from 23.00m to 32.90m frequent white shell fragments (<20mm)						D 39 23.00-23.45 B 40 23.00-23.50						SPT(S) N=26 (4,4:5,6,7,8) 23.00	
from 2.50m to 25.00m slightly sandy. Sand is fine			(17.90)			D 41 24.50-24.95 B 42 24.50-25.00						SPT(S) N=30 (4,5:6,7,8,9) 24.50	
						D 43 26.00-26.45 B 44 26.00-26.50						SPT(S) N=34 (5,7:7,9,9,9) 26.00	
						D 45 27.50-27.95 B 46 27.50-28.00						SPT(S) N=37 (5,6:8,9,10,10) 27.50	
						D 47 29.00-29.45 B 48 29.00-29.50						SPT(S) N=31 (4,5:7,7,8,9) 29.00	

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_001B
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 4 of 4

Ground Level	+6.99mOD	Coordinates	547222.19E, 261524.17N	Grid	OSGB
Hole Type	IP+CP	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very stiff fissured thinly laminated dark grey CLAY. Fissures are extremely closely to closely spaced randomly orientated planar undulating smooth and polished. (GLT) [GAULT FORMATION]						D 49 30.50-30.95 B 50 30.50-31.00						SPT(S) N=35 (5,6:7,8,10,10) 30.50	
						D 51 32.00-32.45 B 52 32.00-32.50						SPT(S) N=35 (4,6:8,8,9,10) 32.00	
Very stiff dark greenish grey mottled brown slightly gravelly very sandy CLAY. Sand is fine to medium. Gravel is subangular to subrounded fine of flint. (LGF) [LOWER GREENSAND FORMATION]			32.90	-25.91	▼								
			(2.10)			D 53 33.50-33.95 B 54 33.50-34.00						SPT(S) N=21 (3,4:4,5,6,6) 33.50	
						D 55 34.50-34.95 B 56 34.50-35.00						SPT(S) N=22 (2,3:5,5,6,6) 34.50	
Complete at 35.00m. Termination Reason: Achieved Scheduled Depth			35.00	-28.01									

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_001PM Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+7.13mOD	Coordinates	547214.10E, 261518.80N	Grid	OSGB
Date Started	10/09/2021	Date Completed	15/09/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	10/09/2021 12:40	10/09/2021 14:40	Mitch Maxey	MM			Insulated Hand tools	None	Stable	Inspection pit: Hand dug
1.20	18.00	RO	10/09/2021 14:40	15/09/2021 10:30	Mitch Maxey	MM		Drag Bit	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
10/09/2021 17:30	1.20	0.00	Dry	End of Shift
13/09/2021 07:30	1.20	0.00	Dry	Start of shift
13/09/2021 17:30	15.00	6.00	14.80	End of Shift
14/09/2021 07:30	15.00	6.00	14.20	Start of shift
14/09/2021 17:30	6.00	6.00	0.40	End of Shift
15/09/2021 07:30	6.00	6.00	0.45	Start of shift
15/09/2021 10:30	0.00			Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	6.00	AIR/MIST	70	Orange	
6.00	18.00	AIR/MIST	90	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
18.00	145	6.00	150						

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type
1.50	G1	SP	0.50	1.50	Pipe 1	Pipe 1	0.00	0.50	19	PLAIN
						Pipe 1	0.50	1.50	19	SLOTTED

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
12.50	12.50	Self Boring Pressuremeter Test
18.50	18.50	Self Boring Pressuremeter Test

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
-0.50	0.00	Upstanding cover	
0.00	0.30	Concrete	
0.30	0.50	Bentonite	
0.50	6.00	Gravel backfill	
6.00	18.00	Grout	

LOCATION DETAILS

Remarks
Borehole formed to facilitate in situ testing

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

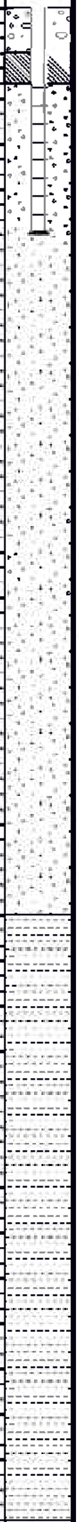
SOIL ENGINEERING
Part of the Bachy Soletanche Group

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_001PM
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 2

Ground Level	+7.13mOD	Coordinates	547214.10E, 261518.80N	Grid	OSGB
Hole Type	IP+RO	Inclination			

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
TOPSOIL (Driller's description) (TOP) [TOPSOIL]			(1.00) 1.00	7.13									
MADE GROUND: Brick fill (Driller's description) (MGR) [MADE GROUND]			1.20	7.13									
Orange SAND (Driller's description) (SUPD) [SUPERFICIAL DEPOSITS]				7.13									
SAND GRAVEL (Driller's description) (SUPD) [SUPERFICIAL DEPOSITS]			(3.90) 5.10	7.13									
Grey CLAY (Driller's description) (GLT) [GAULT FORMATION]													



AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_001PM Sheet 2 of 2
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+7.13mOD	Coordinates	547214.10E, 261518.80N	Grid	OSGB
Hole Type	IP+RO	Inclination			

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Grey CLAY (Driller's description) (GLT) [GAULT FORMATION]			(9.90)									SBP 12.00 WRSBP 12.50	
			15.00	7.13									
Grey CLAY (Driller's description) (GLT) [GAULT FORMATION]			(3.00)										
			18.00	7.13								SBP 18.00	
Complete at 18.00m. Termination Reason: Achieved Suitable Depth to Undertake In Situ Testing												WRSBP 18.50	

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_002
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+6.92mOD	Coordinates	547352.80E, 261488.70N	Grid	OSGB
Date Started	23/08/2021	Date Completed	25/08/2021	Inclination	90° f om horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	23/08/2021 08:30	23/08/2021 10:00	MM	DT	NA	NA	Insulated hand tools	None	Stable	
1.20	30.00	RC	23/08/2021 10:00	25/08/2021 11:30	MM	AY	Geobore S (146)	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
23/08/2021 17:30	16.00	16.00	15.70	End of Shift
24/08/2021 07:30	16.00	16.00	15.60	Start of shift
24/08/2021 17:30	30.00	30.00	29.80	End of Shift
25/08/2021 07:35	30.00	30.00	28.10	Start of shift
25/08/2021 11:30	0.00	0.00	Dry	Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	5.20	AIR/MIST	90	Orange	
5.20	30.00	AIR/MIST	90	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
16.00	146	5.00	150						
30.00	146								

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	30.00	Grout	

LOCATION DETAILS

Remarks

1. Inspection pit first formed on 09/08/2021 to 0.50m. Progress suspended until results of GPR survey made available from Client.

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Form No. SIEXPHOLEHDR Issue.Revision No. 2.02 Issue Date 22/06/2016

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_002
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 3

Ground Level	+6.92mOD	Coordinates	547352.80E, 261488.70N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
MADE GROUND: Grey rounded coarse gravel of flint. (Drainage stones) (MGR) [MADE GROUND]			0.10	6.82		D 1 0.05-0.10							
MADE GROUND: Grey slightly sandy gravelly clay. Sand is fine to coarse. Gravel is rounded fine to coarse of flint. (MGR) [MADE GROUND]			0.25	6.67		ES 2 0.20-0.25							
MADE GROUND: Dark brown slightly sandy gravel. Gravel is angular to subrounded fine to coarse of sandstone, mudstone, brick and concrete. Occasional nodules of light brown sandy clay. (MGR) [MADE GROUND]			(0.35) 0.60	6.32		B 3 0.10-0.40 D 4 0.40-0.50 ES 5 0.50-0.55 B 6 0.40-0.80							
MADE GROUND: Fine to coarse sand and angular to subrounded fine to medium gravel sized fragments of flint. (MGR) [MADE GROUND]			(0.60) 1.20	5.72		B 9 0.80-1.20 D 7 1.00-1.10 ES 8 1.10-1.20							
Orange slightly clayey gravelly fine to coarse SAND. Gravel is subangular to subrounded fine to coarse of flint and chalk. (RTD) [SUPERFICIAL DEPOSITS]			(0.45) 1.65	5.27		C 10 1.20-2.20	102	45			NA		
Assumed zone of core loss. Orange SAND and GRAVEL (Driller's description) (RTD) [SUPERFICIAL DEPOSITS]			(0.35) 2.00	4.92							NR		
Orangish brown very gravelly fine to coarse SAND. Gravel is subangular to rounded fine to coarse of flint and chalk. (RTD) [SUPERFICIAL DEPOSITS]			2.20	4.72							NA		
Orangish brown very gravelly fine to coarse SAND. Gravel is subangular to rounded fine to coarse of flint and chalk. (RTD) [SUPERFICIAL DEPOSITS]			(0.45) 2.65	4.27		C 11 2.20-3.20	102	45					
Assumed zone of core loss. Orange SAND and GRAVEL (Driller's description) (RTD) [SUPERFICIAL DEPOSITS]			(0.55) 3.20	3.72							NR		
Orangish brown very gravelly fine to coarse SAND. Gravel is subangular to rounded fine to coarse of flint and chalk. (RTD) [SUPERFICIAL DEPOSITS]			(0.40) 3.60	3.32		C 12 3.20-4.20	102	45			NA		
Assumed zone of core loss. Orange SAND and GRAVEL (Driller's description) (RTD) [SUPERFICIAL DEPOSITS]			(0.60) 4.20	2.72							NR		
Orangish brown very gravelly fine to coarse SAND. Gravel is subangular to rounded fine to coarse of flint and chalk. (RTD) [SUPERFICIAL DEPOSITS]			(0.30) 4.50	2.42		C 13 4.20-5.20	102	40			NA		
Soft dark grey slightly sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to rounded fine to medium of flint and chalk. (RTD) [SUPERFICIAL DEPOSITS]			4.60	2.32									
Assumed zone of core loss. SAND and GRAVEL (Driller's description). (RTD) [RIVER TERRACE DEPOSITS]			(0.60) 5.20	1.72							NR		
Stiff fissured thickly laminated dark grey CLAY. Fissures are randomly orientated extremely closely spaced planar smooth. (GLT) [GAULT FORMATION]	Partially Weathered		(0.73) 5.93	0.99		C 14 5.20-6.20	102	92					
Stiff fissured thickly laminated dark grey CLAY. Fissures are randomly orientated extremely closely to very closely spaced, generally planar smooth and occasionally undulating polished, with occasional dusting of silt. (GLT) [GAULT FORMATION] at 8.00m nodules of siltstone (<10mm x 10mm) and coprolite (10mm x 15mm)			(3.27) 9.20	-2.28		C 15 6.20-7.20 C 16 7.20-8.70	102 102	89 100					
Stiff fissured thickly laminated dark grey CLAY with rare nodules of siltstone (<10mm x 10mm). Fissures are horizontal to subhorizontal and vertical to subvertical extremely closely spaced planar smooth, with rare dusting of silt. (GLT) [GAULT FORMATION]						C 17 8.70-10.20	102	95					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_002 Sheet 2 of 3
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+6.92mOD	Coordinates	547352.80E, 261488.70N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Stiff fissured thickly laminated dark grey CLAY with rare nodules of siltstone (<10mm x 10mm). Fissures are horizontal to subhorizontal and vertical to subvertical extremely closely spaced planar smooth, with rare dusting of silt. (GLT) [GAULT FORMATION] from 10.90m to 11.10m fissures are undulating smooth						C 18 10.20-11.70	102	100					
			(6.06)			C 19 11.70-13.00	102	100					
						C 20 13.00-14.50	102	80					
from 14.20m to 14.50m assumed zone of core loss.													
Very stiff fissured dark grey CLAY. Fissures are randomly orientated very closely spaced undulating polished, occasionally planar and smooth. Frequent fossilised shell fragments (<8mm x 10mm) and occasional coprolite (<10mm x 10mm). (GLT) [GAULT FORMATION] from 15.26m to 15.36m very thin bed of weak siltstone	Unweathered		15.26	-8.34		C 21 14.50-16.00	102	97			NA		
						C 22 16.00-17.50	102	100					
						C 23 17.50-19.00	102	92					
						C 24 19.00-20.50	102	100					

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_002 Sheet 3 of 3
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		
Ground Level	+6.92mOD	Coordinates	547352.80E, 261488.70N
Grid	OSGB		
Hole Type	IP+RC	Inclination	90° from horizontal

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very stiff fissured dark grey CLAY. Fissures are randomly orientated very closely spaced undulating polished, occasionally planar and smooth. Frequent fossilised shell fragments (<8mm x 10mm) and occasional coprolite (<10mm x 10mm). (GLT) [GAULT FORMATION] at 19.95m one belemnite fossil (2mm x 5mm)													
						C 25 20.50-22.00	102	72					
						C 26 22.00-23.00	102	97					
						C 27 23.00-24.00	102	95					
			(14.74)			C 28 24.00-25.50	102	89					
from 25.72m to 25.94m 70 degrees planar polished fissure													
						C 29 25.50-27.00	102	96					
						C 30 27.00-28.50	102	100					
						C 31 28.50-30.00	102	100					
			30.00	23.08									
Complete at 30.00m. Termination Reason: Achieved Scheduled Depth													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_003
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+7.03mOD	Coordinates	547483.50E, 261491.40N	Grid	OSGB
Date Started	16/08/2021	Date Completed	20/08/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	16/08/2021 12:00	16/08/2021 14:00	Mitch Maxey	DT	NA	NA	Insulated hand tools	None	Stable	
1.20	30.00	RC	16/08/2021 14:00	18/08/2021 17:30	Mitch Maxey	SAN	Geobore S (146)	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
16/08/2021 17:30	1.20	0.00	Dry	End of Shift
17/08/2021 07:30	1.20	0.00	Dry	Start of shift
17/08/2021 17:30	6.00	6.00	3.20	End of Shift
18/08/2021 07:30	6.00	6.00	Dry	Start of shift
18/08/2021 17:30	16.50	6.00	16.45	End of Shift
19/08/2021 07:30	16.50	6.00	16.00	Start of shift
19/08/2021 17:30	30.00	6.00	29.40	Drilling Complete
20/08/2021 07:30	30.00	6.00	28.00	Start of shift
20/08/2021 17:30	0.00	0.00		Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	9.00	AIR/MIST	90	Brown	
9.00	30.00	AIR/MIST	90	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
6.00	150	6.00	150						
30.00	146								

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	30.00	Grout	

LOCATION DETAILS

Remarks

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL   Print date and time 12/09/2022 13:56   Log checked by David Howard

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_003
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 3

Ground Level	+7.03mOD	Coordinates	547483.50E, 261491.40N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Depth (Thickness)	Datum Level	Waterstrike
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint. Occasional roots. (TOP) [TOPSOIL]		0.10	6.93	
MADE GROUND: Multicoloured sandy angular to subangular fine to coarse gravel sized fragments of brick, flint, sandstone and shale with low cobble content. Sand is fine to coarse. Cobble sized fragments are angular of brick. (MGR) [MADE GROUND]		0.30	6.73	
MADE GROUND: Brown slightly gravelly sandy clay. Sand is fine to medium. Gravel is angular to rounded fine to coarse of flint, sandstone and shale. (MGR) [MADE GROUND]		(0.60) 0.90	6.13	
Firm brown slightly gravelly sandy CLAY. Sand is fine to medium. Gravel is subangular to subrounded fine to coarse of flint. (RTD) [RIVER TERRACE DEPOSITS]		(0.30) 1.20	5.83	
Brown fine to coarse SAND and angular to subrounded fine to coarse GRAVEL of flint. (RTD) [RIVER TERRACE DEPOSITS]		(0.60) 1.80	5.23	
Assumed zone of core loss. SAND and GRAVEL (Driller's description). (RTD) [RIVER TERRAVE DEPOSITS]		(0.40) 2.20	4.83	
Brown very gravelly fine to coarse SAND. Gravel is angular to subrounded fine to coarse of flint. (RTD) [RIVER TERRACE DEPOSITS]		(0.38) 2.58	4.45	
Assumed zone of core loss. SAND and GRAVEL (Driller's description). (RTD) [RIVER TERRACE DEPOSITS]		(0.42) 3.00	4.03	
Brown fine to coarse SAND and subangular to subrounded fine to coarse GRAVEL of flint. (RTD) [RIVER TERRACE DEPOSITS]		(0.40) 3.40	3.63	
Assumed zone of core loss. SAND and GRAVEL (Driller's description). (RTD) [RIVER TERRACE DEPOSITS]		(0.60) 4.00	3.03	
Greyish brown fine to coarse SAND and angular to subrounded fine to coarse GRAVEL of flint. (RTD) [RIVER TERRACE DEPOSITS] at 4.10m sandy gravel		(0.40) 4.40	2.63	
Assumed zone of core loss. SAND and GRAVEL (Driller's description). (RTD) [RIVER TERRACE DEPOSITS]		(0.60) 5.00	2.03	
No recovery. SAND and GRAVEL (Driller's description). (RTD) [SUPERFICIAL DEPOSITS]		(1.00) 6.00	1.03	
Very stiff fissured thinly laminated dark grey CLAY with occasional subrounded coarse gravel sized nodules of brown siltstone and occasional shell fragments. Fissures are 0 to 30 degrees very closely spaced undulating smooth polished. (GLT) [GAULT FORMATION]		(2.16) 8.16	-1.13	
Very stiff fissured thinly laminated dark grey CLAY with occasional subrounded medium to coarse gravel sized nodules of brown siltstone and occasional shell fragments. Fissures are 1) 0 to 30 degrees undulating smooth slightly polished. 2) 80 to 85 degrees closely to medium spaced planar smooth polished. (GLT) [GAULT FORMATION]		(2.27)		

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD
D 1 0.05-0.10				
ES 2 0.20-0.25				
B 3 0.10-0.40				
D 4 0.40-0.50				
ES 5 0.50-0.55				
B 6 0.40-0.80				
B 9 0.80-1.20				
D 7 1.00-1.10				
ES 8 1.10-1.20				
C 10 1.20-2.20	102	60		
C 11 2.20-3.00	102	48		
C 12 3.00-4.00	102	40		
C 13 4.00-5.00	102	40		
	102	0		
C 14 6.00-7.50	102	100		
C 15 7.50-9.00	102	100		
	102	100		
C 16 9.00-10.50				

IF
NA
NR
NA
NR
NA
NR
NA
NR
NA

In Situ Test Details	Install-ation

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_003
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 3

Ground Level	+7.03mOD	Coordinates	547483.50E, 261491.40N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff fissured thinly laminated dark grey CLAY with occasional subrounded medium to coarse gravel sized nodules of brown siltstone and occasional shell fragments. Fissures are 1) 0 to 30 degrees undulating smooth slightly polished. 2) 80 to 85 degrees closely to medium spaced planar smooth polished. (GLT) [GAULT FORMATION]			10.43	-3.40									
Very stiff fissured thinly laminated dark grey CLAY. Fissures are 1) 0 to 30 degrees very closely spaced undulating smooth and polished. 2) 80 to 90 degrees very closely to closely spaced planar smooth and polished. (GLT) [GAULT FORMATION] from 11.49m to 11.50m 1 No. fissure 30 degrees with soft gravelly clay infill. Gravel is angular fine of stiff clay.			(1.65) 12.08	-5.05		C 17 10.50-12.00	102	100					
Stiff fissured thinly laminated dark grey CLAY. Fissures are 0 to 30 degrees very closely spaced undulating rough. 2) 80 degrees very closely to closely spaced planar rough. (GLT) [GAULT FORMATION]			(0.44) 12.52	-5.49									
Very stiff fissured thinly laminated dark grey CLAY. Fissures are 1) 30 degrees closely spaced undulating rough. 2) 80 degrees closely spaced planar rough slightly polished. (GLT) [GAULT FORMATION]			(0.68) 13.20	-6.17		C 18 12.00-13.50	102	80					
Assumed zone of core loss. Grey CLAY. (Driller's description) (GLT) [GAULT FORMATION]			(0.30) 13.50	-6.47							NR		
Very stiff fissured thinly laminated dark grey CLAY. Fissures are 1) 0 to 40 degrees very closely spaced undulating rough. 2) 80 degrees closely spaced planar rough. (GLT) [GAULT FORMATION]			(1.24) 14.74	-7.71		C 19 13.50-14.50	102	100					
Very stiff fissured thinly laminated grey CLAY. Fissures are 1) 0 to 40 degrees very closely spaced undulating rough. 2) 80 degrees closely spaced planar rough. (GLT) [GAULT FORMATION] from 15.10m to 15.60m with closely spaced thick laminations of light grey clayey silt			(0.67) 15.41	-8.38		C 20 14.50-15.50	102	100			NA		
Very stiff fissured thinly laminated grey silty CLAY. Fissures are 1) 0 to 40 degrees very closely spaced undulating rough. 2) 80 degrees closely to medium spaced planar rough. (GLT) [GAULT FORMATION] from 16.07m to 16.21m with closely spaced thick laminations of light grey clayey silt			(1.19) 16.60	-9.57		C 21 15.50-16.50	102	100					
Very stiff thinly laminated grey silty CLAY with some subangular fine gravel of sandstone and occasional subrounded coarse gravel sized coprolites. (GLT) [GAULT FORMATION]			(0.50) 17.10	-10.07									
Assumed zone of core loss. Grey CLAY (Driller's description) (GLT) [GAULT FORMATION]			(0.90) 18.00	-10.97		C 22 16.50-18.00	102	40			NR		
Very stiff fissured thinly laminated grey silty CLAY with occasional subangular to subrounded fine to medium gravel sized nodules of siltstone and rare subrounded coarse gravel sized coprolites. Fissures are 0 to 40 degrees closely spaced undulating smooth. (GLT) [GAULT FORMATION]			(1.61) 19.61	-12.58		C 23 18.00-19.00 C 24 19.00-19.50	102 102	100 100					
Very stiff fissured thinly laminated grey silty CLAY with rare to occasional ammonites (15mm x 12mm) and belemnites (15mm x 5mm). Fissures are 0 to 40 degrees closely spaced undulating													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_003 Sheet 3 of 3
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+7.03mOD	Coordinates	547483.50E, 261491.40N	Grid	OSGB		
Hole Type	IP+RC	Inclination	90° from horizontal				

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very stiff fissured thinly laminated grey silty CLAY with rare to occasional ammonites (15mm x 12mm) and belemnites (15mm x 5mm). Fissures are 0 to 40 degrees closely spaced undulating smooth. (GLT) [GAULT FORMATION]			(1.73) 21.34	-14.31		C 25 19.50-22.50	102	100					
Very stiff fissured thinly laminated grey CLAY with occasional belemnites, shell fragments and a tooth (15mm x 20mm). Fissures are 1) 0 to 40 degrees closely spaced undulating smooth. 2) 85 degrees closely to medium spaced planar smooth. (GLT) [GAULT FORMATION]			(3.24) 24.58	-17.55		C 26 22.50-25.50	102	97					
Very stiff fissured thinly laminated grey silty CLAY with occasional to frequent fossils including belemnites, shell fragments, ammonites and echinoids. Fissures are 1) 0 to 40 degrees closely spaced undulating smooth 2) 85 degrees closely to medium spaced planar smooth. (GLT) [GAULT FORMATION] at 24.78m thick lamination of subangular to subrounded fine to coarse gravel of siltstone and fossil fragments.			(1.01) 25.59	-18.56							NA		
Very stiff fissured thinly laminated grey CLAY with rare subrounded coarse gravel sized nodules of siltstone and coprolites. Fissures are 0 to 5 degrees closely spaced planar smooth. (GLT) [GAULT FORMATION]			(1.21) 26.80	-19.77									
Very stiff fissured thinly laminated light grey silty CLAY with occasional coprolites and belemnites (5mm x 20mm). Fissures are 1) 0 to 20 degrees closely spaced planar smooth 2) 80 degrees closely spaced planar smooth. (GLT) [GAULT FORMATION]			(1.17) 27.97	-20.94		C 27 25.50-28.50	102	97					
Very stiff fissured thinly laminated grey silty CLAY with occasional light grey lenses (20mm x 10mm) and with occasional fossils. Fissures are randomly orientated closely spaced planar smooth. (GLT) [GAULT FORMATION]			(2.03) 30.00	-22.97		C 28 28.50-30.00	102	98					
Complete at 30.00m. Termination Reason: Achieved Scheduled Depth													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_004c
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+6.92mOD	Coordinates	547675.97E, 261517.36N	Grid	OSGB
Date Started	16/09/2021	Date Completed	21/09/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	16/09/2021 12:15	16/09/2021 13:45	MM	DT	NA	NA	Insulated Hand Tools	None	Stable	
1.20	30.00	RC	17/09/2021 07:30	21/09/2021 11:30	MM	AY	Geobore S	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
16/09/2021 17:30	1.20	0.00	Dry	End of Shift
17/09/2021 07:30	1.20	0.00	Dry	Start of Shift
17/09/2021 17:30	10.00	6.00	9.70	End of Shift
20/09/2021 07:30	10.00	6.00	9.90	Start of Shift
20/09/2021 17:30	30.00	6.00	29.90	End of Shift
21/09/2021 07:30	30.00	6.00	28.40	Start of Shift
21/09/2021 11:30	0.00			Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	4.20	AIR/MIST	90	Orange	
4.20	5.20	AIR/MIST	90	Brown	
5.20	30.00	AIR/MIST	90	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
6.00	150	6.00	150						
30.00	146	30.00	146						

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	30.00	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Form No. SIEXPHOLEHDR Issue.Revision No. 2.02 Issue Date 22/06/2016

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_004c
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 3

Ground Level	+6.92mOD	Coordinates	547675.97E, 261517.36N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
TOPSOIL: Dark brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of mixed lithologies including flint and sandstone. Occasional rootlets. (TOP) [TOPSOIL]			(0.32) 0.32	6.60		D 1 0.05-0.10 ES 2 0.20-0.25 B 3 0.10-0.40							
Firm light brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint. (RTD) [SUPERFICIAL DEPOSITS]			(0.58) 0.90	6.02		D 4 0.40-0.50 ES 5 0.50-0.55 B 6 0.40-0.80							
Reddish brown sandy GRAVEL. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of mixed lithologies. (RTD) [SUPERFICIAL DEPOSITS]			(0.30) 1.20	5.72		B 9 0.80-1.20 D 7 1.00-1.10 ES 8 1.10-1.20							
Orangish brown SAND and GRAVEL. Sand is fine to coarse. Gravel is angular to rounded fine to coarse of flint and chalk. (RTD) [SUPERFICIAL DEPOSITS]			(0.46) 1.66	5.26							NA		
Assumed zone of core loss. SAND GRAVEL. (Driller's Description) (RTD) [SUPERFICIAL DEPOSITS]			(0.54) 2.20	4.72		C 10 1.20-2.20	102	46			NR		
Orangish brown SAND and GRAVEL. Sand is fine to coarse. Gravel is angular to rounded fine to coarse of flint and chalk. (RTD) [SUPERFICIAL DEPOSITS]			(0.50) 2.70	4.22							NA		
Assumed zone of core loss. SAND GRAVEL. (Driller's Description) (RTD) [SUPERFICIAL DEPOSITS]			(0.50) 3.20	3.72		C 11 2.20-3.20	102	50			NR		
Orangish brown SAND and GRAVEL. Sand is fine to coarse. Gravel is angular to rounded fine to coarse of flint and chalk. (RTD) [SUPERFICIAL DEPOSITS]			(0.60) 3.80	3.12		C 12 3.20-4.20	102	60			NA		
Assumed zone of core loss. SAND GRAVEL. (Driller's Description) (RTD) [SUPERFICIAL DEPOSITS]			(1.05) 4.85	2.07		C 13 4.20-5.20	102	35			NR		
Stiff fissured dark grey CLAY with occasional siltstone nodules (<10mm x 10mm). Fissures are randomly orientated extremely closely to closely spaced undulating smooth and polished. (GLT) [GAULT FORMATION]			(2.05) 6.90	0.02		C 14 5.20-6.20 C 15 6.20-6.50	102 102	100 100			NA		
Assumed zone of core loss. Grey CLAY. (Driller's Description) (GLT) [GAULT FORMATION]			(1.10) 8.00	-1.08		C 16 6.50-8.00	102	27			NR		
No Recovery Grey CLAY. (Driller's Description) (GLT) [GAULT FORMATION]			(1.00) 9.00	-2.08			102	0					
Stiff fissured dark grey CLAY with occasional siltstone nodules (<10mm x 10mm). Fissures are randomly orientated extremely closely to very closely spaced planar undulating smooth occasionally polished. (GLT) [GAULT FORMATION]			(0.62) 9.62	-2.70		C 17 9.00-10.00	102	100					
Very stiff dark grey CLAY with occasional siltstone nodules (<30mm x 20mm) and phosphatic nodules (<40mm x 20mm). Fissures are 0-10													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_004c
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 3

Ground Level	+6.92mOD	Coordinates	547675.97E, 261517.36N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff dark grey CLAY with occasional siltstone nodules (<30mm x 20mm) and phosphatic nodules (<40mm x 20mm). Fissures are 0-10 degrees closely to medium spaced planar undulating smooth polished. (GLT) [GAULT FORMATION] from 10.00m to 10.28m band of soft clay with angular to subangular medium gravel size nodules of mudstone from 10.64m to 10.71m 1 No. 60 degree fissure undulating and polished			(1.54) 11.16	-4.24		C 18 10.00-11.00	102	100					
Very stiff fissured dark grey CLAY. Fissures are 0-15 degrees closely spaced planar undulating polished and 70-90 degrees closely to medium spaced planar undulating polished. (GLT) [GAULT FORMATION] from 12.52m to 12.68m 1 No. 45 degree fissure planar and polished at 12.95m shell fragments (<20mm x 2mm) from 13.09m to 13.18m soft clay			(2.91) 14.07	-7.15		C 19 11.00-13.00	102	100					
Very stiff fissured dark grey CLAY with occasional siltstone nodules (<15mm x 15mm). Fissures are randomly orientated very closely spaced planar undulating smooth. (GLT) [GAULT FORMATION]			(1.63) 15.70	-8.78		C 20 13.00-15.70	102	100			NA		
Very stiff fissured dark grey CLAY with occasional siltstone nodules (<15mm x 15mm). Fissures are 0-20 degrees closely spaced planar undulating smooth polished, 75-90 degrees closely spaced undulating planar polished. (GLT) [GAULT FORMATION]			(1.48) 17.18	-10.26									
Very stiff fissured dark grey CLAY with frequent siltstone nodules (<20mm x 20mm). Fissures are 0-20 degrees closely spaced planar undulating smooth occasionally polished, 45-50 degrees medium spaced planar polished. (GLT) [GAULT FORMATION]			(4.64)			C 21 15.70-18.70	102	100					
						C 22 18.70-21.20	102	100					

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_004c Sheet 3 of 3
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+6.92mOD	Coordinates	547675.97E, 261517.36N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff fissured dark grey CLAY with frequent siltstone nodules (<20mm x 20mm). Fissures are 0-20 degrees closely spaced planar undulating smooth occasionally polished, 45-50 degrees medium spaced planar polished. (GLT) [GAULT FORMATION]			21.82	-14.90									
Very stiff fissured dark grey CLAY with rare phosphate nodules (<10mm x 40mm). Fissures are randomly orientated extremely closely to closely spaced planar undulating smooth polished. (GLT) [GAULT FORMATION]						C 23 21.20-24.20	102	100					
at 23.11m shell fragments (<10mm x 10mm)			(2.64)										
at 24.35m 1 No. belemnite (<5mm x 30mm)			24.46	-17.54									
Very stiff fissured dark grey CLAY with frequent phosphate nodules (<20mm x 40mm), occasional siltstone nodules (<20mm x 20mm) and rare belemnite (<5mm x 30mm). Fissures are randomly orientated very closely spaced planar undulating smooth occasionally polished. (GLT) [GAULT FORMATION]						C 24 24.20-27.20	102	100					
			(5.54)										
						C 25 27.20-30.00	102	95					
from 29.58m to 29.85m thinly laminated													
from 29.85m to 30.00m assumed zone of core loss			30.00	-23.08									
Complete at 30.00m. Termination Reason: Achieved Scheduled Depth													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL — Print date and time 12/09/2022 13:56 — Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_005Ab
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+6.63mOD	Coordinates	547787.50E, 261490.60N	Grid	OSGB
Date Started	26/08/2021	Date Completed	01/09/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	26/08/2021 09:00	26/08/2021 12:00	Mitch Maxey	DT	NA	NA	Insulated hand tools	None	Stable	
1.20	30.00	RC	26/08/2021 12:00	01/09/2021 17:30	Mitch Maxey	CJ	Geobore S	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
26/08/2021 17:30	4.20	4.20	4.00	End of Shift
27/08/2021 07:30	4.20	4.00	3.90	Start of shift
27/08/2021 17:30	14.50	5.00	14.20	End of Shift
31/08/2021 07:30	14.50	5.00	14.45	Start of shift
31/08/2021 17:30	26.50	5.00	26.40	End of Shift
01/09/2021 07:30	26.50	5.00	26.00	Start of shift
01/09/2021 17:30	0.00			Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	5.20	AIR/MIST	90	Orange	
5.20	9.20	AIR/MIST	90	Brown	
9.20	14.50	AIR/MIST	90	Grey	
14.50	28.10	AIR/MIST	20	Grey	
28.10	30.00	AIR/MIST	30	Grey	

HOLE DIAMETER / CASING DIAMETER / DYNAMIC SAMPLING

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
30.00	146	5.00	150						
		30.00	146						

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	30.00	Bentonite	

LOCATION DETAILS

Remarks

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Form No. SIEXPHOLEHDR Issue.Revision No. 2.02 Issue Date 22/06/2016

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_005Ab
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 3

Ground Level	+6.63mOD	Coordinates	547787.50E, 261490.60N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	IF
MADE GROUND: Brown slightly sandy slightly gravelly clay. Gravel is angular to subangular fine to coarse of flint. Sand is fine to coarse. (MGR) [MADE GROUND]			0.20	6.63		
MADE GROUND: Brown slightly gravelly sandy clay. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint, brick and concrete. (MGR) [MADE GROUND]			0.32	6.63		
MADE GROUND: Brown slightly gravelly sandy clay. Sand is fine to coarse. Gravel sized fragments are angular to subrounded fine to coarse of mixed lithologies, flint, brick (cobbles) and concrete. (MGR) [MADE GROUND]			(0.68) 1.00	6.63		
Firm brown to reddish slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of mixed lithologies. (RTD) [SUPERFICIAL DEPOSITS]			1.20	6.63		
Orangish brown very gravelly fine to coarse SAND. Gravel is angular to rounded fine and medium of flint and chalk. (RTD) [SUPERFICIAL DEPOSITS]			(0.35) 1.55	6.63		NA
Assumed zone of core loss. Orange SAND and GRAVEL (Driller's description) (RTD) [SUPERFICIAL DEPOSITS]			(0.65) 2.20	6.63		NR
Orangish brown very gravelly fine to coarse SAND. Gravel is angular to rounded fine and medium of flint and chalk. (RTD) [SUPERFICIAL DEPOSITS]			(0.40) 2.60	6.63		NA
Assumed zone of core loss. Orange SAND and GRAVEL (Driller's description) (RTD) [SUPERFICIAL DEPOSITS]			(0.60) 3.20	6.63		NR
Orangish brown very gravelly fine to coarse SAND. Gravel is angular to rounded fine and medium of flint and chalk. (RTD) [SUPERFICIAL DEPOSITS]			(0.35) 3.55	6.63		NA
Assumed zone of core loss. Orange SAND and GRAVEL (Driller's description) (RTD) [SUPERFICIAL DEPOSITS]			(0.65) 4.20	6.63		NR
Orangish brown very gravelly fine to coarse SAND. Gravel is angular to rounded fine and medium of flint and chalk. (RTD) [SUPERFICIAL DEPOSITS]			(0.35) 4.55	6.63		NA
Assumed zone of core loss. Orange SAND and GRAVEL (Driller's description) (RTD) [SUPERFICIAL DEPOSITS]			(0.65) 5.20	6.63		NR
Assumed zone of core loss. Brown CLAY (Driller's description) (GLT) [GAULT FORMATION]			(0.75) 5.95	6.63		
Soft fissured dark grey CLAY. Fissures are randomly orientated undulating planar smooth polished. (GLT) [GAULT FORMATION]			(0.90) 6.85	6.63		NA
Assumed zone of core loss. Grey CLAY (Driller's description) (GLT) [GAULT FORMATION]			(0.35) 7.20	6.63		NR
Soft to firm fissured dark grey CLAY. Fissures are randomly orientated planar undulating smooth. (GLT) [GAULT FORMATION]			7.40	6.63		NA
Assumed zone of core loss. Grey CLAY (Driller's description) (GLT) [GAULT FORMATION]			(0.80) 8.20	6.63		NR
Firm fissured dark grey CLAY. Fissures are very closely spaced planar undulating smooth polished with closely spaced subvertical fissures, planar smooth polished. (GLT) [GAULT FORMATION]			(0.55) 8.75	6.63		NA
Assumed zone of core loss. Grey CLAY (Driller's description) (GLT) [GAULT FORMATION]			(0.45) 9.20	6.63		NR
Stiff fissured dark grey CLAY with rare fossilised coprolites (<11mm x 18mm). Subhorizontal to horizontal fissures are planar undulating smooth polished. Subvertical to vertical fissures are medium spaced planar polished. (GLT) [GAULT FORMATION]						

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	In Situ Test Details	Installation
D 1 0.05-0.10						
ES 2 0.20-0.25						
B 3 0.10-0.40						
D 4 0.40-0.50						
ES 5 0.50-0.55						
B 6 0.40-0.80						
B 9 0.80-1.20						
D 7 1.00-1.10						
ES 8 1.10-1.20						
C 10 1.20-2.20	102	35				
C 11 2.20-3.20	102	40				
C 12 3.20-4.20	102	35				
C 13 4.20-5.20	102	35				
C 14 5.20-6.20	102	25				
C 15 6.20-7.20	102	65				
C 16 7.20-8.20	102	20				
C 17 8.20-9.20	102	55				
C 18 9.20-10.70	102	87				

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_005Ab Sheet 2 of 3
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+6.63mOD	Coordinates	547787.50E, 261490.60N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Stiff fissured dark grey CLAY with rare fossilised coprolites (<11mm x 18mm). Subhorizontal to horizontal fissures are planar undulating smooth polished. Subvertical to vertical fissures are medium spaced planar undulating smooth polished. (GLT) [GAULT FORMATION] from 10.50m to 10.70m assumed zone of core loss													
from 11.25m to 11.50m assumed zone of core loss						C 19 10.70-11.50	102	69					
			(4.95)			C 20 11.50-13.00	102	93			NA		
from 12.90m to 13.00m assumed zone of core loss													
						C 21 13.00-14.50	102	77					
Assumed zone of core loss. Grey CLAY with very soft bands (Driller's description) (GLT) [GAULT FORMATION]			14.15 (0.35)	6.63							NR		
Soft locally stiff fissured dark grey CLAY with rare fossilised coprolites (5mm x 8mm). Fissures are randomly orientated extremely closely to very closely spaced planar undulating smooth polished. (GLT) [GAULT FORMATION]			14.50	6.63		C 22 14.50-15.50	102	50					
from 15.36m to 15.50m stiff													
from 15.80m to 16.00m assumed zone of core loss			(2.30)			C 23 15.50-16.00	102	60					
from 16.35m to 16.45m stiff from 16.45m to 16.50m assumed zone of core loss						C 24 16.00-16.50	102	90			NA		
						C 25 16.50-17.00	102	80					
Stiff locally soft fissured dark grey CLAY with rare fossilised coprolites (10mm x 15mm). Subhorizontal to horizontal fissures are planar undulating smooth polished. Subvertical to vertical fissures are medium spaced planar smooth polished. (GLT) [GAULT FORMATION] from 16.90m to 17.00m assumed zone of core loss from 17.40m to 17.50m assumed zone of core loss from 17.64m to 17.76m soft			16.80 (1.05)	6.63		C 26 17.00-17.50	102	80					
Assumed zone of core loss. Grey CLAY with very soft bands (Driller's description) (GLT) [GAULT FORMATION]			17.85 (0.65)	6.63		C 27 17.50-18.50	102	35			NR		
No recovery. Grey CLAY with very soft bands (Driller's description) (GLT) [GAULT FORMATION]			18.50 (0.50)	6.63			102	0					
Soft fissured dark grey CLAY with rare fossilised coprolites (<8mm x 12mm). Fissures are randomly orientated extremely closely to very closely spaced planar undulating smooth. (GLT) [GAULT FORMATION] from 19.30m to 19.50m assumed zone of core loss			19.00 (0.50)	6.63		C 28 19.00-19.50	102	60			NA		
No recovery. Grey CLAY with very soft bands (Driller's description) (GLT) [GAULT FORMATION]			19.50 (0.50)	6.63			102	0			NR		
			20.00	6.63									

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL　Print date and time 12/09/2022 13:56　Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_005Ab Sheet 3 of 3
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+6.63mOD	Coordinates	547787.50E, 261490.60N	Grid	OSGB
Hole Type	IP+RC	Inclination			

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Soft fissured dark grey CLAY with rare fossilised coprolites (<8mm x 9mm) and rare fossilised shell fragments (<5mm x 6mm). Fissures are randomly orientated extremely closely to very closely spaced planar undulating smooth. (GLT) [GAULT FORMATION]			(0.30) 20.30	6.63		C 29 20.00-20.50	102	100			NA		
Stiff fissured dark grey CLAY with rare fossilised coprolites (<11mm x 15mm) and rare fossilised shell fragments (<5mm x 8mm). Subhorizontal to horizontal fissures are extremely closely to very closely spaced undulating planar smooth polished. Vertical fissures are medium spaced planar smooth polished. (GLT) [GAULT FORMATION]			(1.20) 21.50	6.63		C 30 20.50-22.00	102	67					
Assumed zone of core loss. Grey CLAY with very soft bands (Driller's description) (GLT) [GAULT FORMATION] from 21.50m to 22.00m assumed zone of core loss			(0.50) 22.00	6.63							NR		
No recovery. Grey CLAY with very soft bands (Driller's description) (GLT) [GAULT FORMATION]			(1.00) 23.00	6.63			102	0					
Stiff locally soft fissured dark grey CLAY with rare fossilised coprolites (<14mm x 18mm). Subhorizontal to horizontal fissures are extremely closely to very closely spaced planar undulating smooth polished. Subvertical to vertical fissures are medium spaced planar smooth polished. (GLT) [GAULT FORMATION]			(1.55) 24.55	6.63		C 31 23.00-23.50 C 32 23.50-25.00	102 102	90 70			NA		
Assumed zone of core loss. Grey CLAY (Driller's description) (GLT) [GAULT FORMATION]			(0.45) 25.00	6.63							NR		
Stiff locally soft fissured dark grey CLAY with rare fossilised coprolites (<14mm x 18mm). Subhorizontal to horizontal fissures are extremely closely to very closely spaced planar undulating smooth polished. Subvertical to vertical fissures are medium spaced planar smooth polished. (GLT) [GAULT FORMATION] from 25.00m to 25.15m soft from 25.40m to 25.50m assumed zone of core loss from 26.50m to 26.73m soft to firm from 26.85m to 27.00m assumed zone of core loss from 27.00m to 27.10m soft			(5.00) 30.00	6.63		C 33 25.00-25.50 C 34 25.50-26.50 C 35 26.50-27.00 C 36 27.00-28.10 C 37 28.10-28.50 C 38 28.50-30.00	102 102 102 102 102 102	80 100 70 100 100 100			NA		
Complete at 30.00m. Termination Reason: Achieved Scheduled Dep h													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_005B
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+6.69mOD	Coordinates	547781.62E, 261488.18N	Grid	OSGB
Date Started	22/09/2021	Date Completed	28/09/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	22/09/2021 10:15	22/09/2021 11:15	Danny Cundill	AM			Insulated Hand Tools	None	Stable	Inspection pit: Hand dug
0.00	30.00	CP	22/09/2021 11:15	28/09/2021 09:30	Dale Sargeant	AM			Dando 2000			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
22/09/2021 17:30	10.00	4.20	Dry	End of Shift
23/09/2021 07:30	7.00	4.20	3.90	Start of shift
23/09/2021 17:30	21.20	10.70	Dry	End of Shift
24/09/2021 07:30	21.20	10.70	20.00	Start of shift
24/09/2021 17:30	30.00	10.70	Dry	End of Shift
27/09/2021 07:30	30.00	10.70	Dry	Start of shift
27/09/2021 17:30	10.00	10.00	Dry	End of Shift
28/09/2021 07:30	10.70	10.20	Dry	Start of shift
28/09/2021 09:30	0.00			Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
22/09/2021 12:30	2.50	2.50	3.80	2.00	20	Slow

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water
1.20	C	50/285mm (3,4:10,12,17,11/60mm)	AR3501	75	1.20	Dry
2.20	C	N=37 (4,6:8,9,10,10)	AR3501	75	2.20	Dry
3.20	C	N=26 (2,4:6,6,7,7)	AR3501	75	3.20	2.90
4.20	S	N=14 (2,2:3,3,3,5)	AR3501	75	4.20	Dry
5.20	S	N=23 (2,3:5,5,6,7)	AR3501	75	4.20	Dry
6.20	S	N=19 (2,2:4,4,6,5)	AR3501	75	4.20	Dry
7.20	S	N=17 (1,3:3,4,4,6)	AR3501	75	4.20	Dry
8.20	S	N=20 (2,3:4,5,5,6)	AR3501	75	4.20	Dry
9.20	S	N=21 (2,4:4,5,6,6)	AR3501	75	4.20	Dry
10.70	S	N=17 (2,3:3,4,4,6)	AR3501	75	10.70	Dry
12.20	S	N=22 (1,3:4,5,6,7)	AR3501	75	10.70	Dry
13.70	S	N=27 (1,3:5,6,8,8)	AR3501	75	10.70	Dry
15.20	S	N=33 (2,4:6,7,9,11)	AR3501	75	10.70	Dry
16.70	S	N=28 (2,3:5,7,7,9)	AR3501	75	10.70	Dry
18.20	S	N=31 (2,4:6,7,8,10)	AR3501	75	10.70	Dry
19.70	S	N=29 (3,4:5,6,8,10)	AR3501	75	10.70	Dry
21.20	S	N=30 (3,5:6,7,9,8)	AR3501	75	10.70	20.00
22.70	S	N=31 (4,5:6,8,8,9)	AR3501	75	10.70	Dry
24.20	S	N=33 (3,4:6,8,9,10)	AR3501	75	10.70	Dry
25.70	S	N=37 (5,6:7,9,10,11)	AR3501	75	10.70	Dry
27.20	S	N=41 (5,7:8,10,11,12)	AR3501	75	10.70	Dry
28.70	S	N=43 (6,7:9,10,11,13)	AR3501	75	10.70	Dry

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks

HOLE DIAMETER

Depth Base	Diameter
10.00	200
21.20	150
30.00	150

CASING DIAMETER

Depth Base	Diameter
4.20	200
10.70	150

DYNAMIC SAMPLING

Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref
10.00	S1	SP	7.00	10.00	Pipe 1

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type
Pipe 1	0.00	7.00	50	PLAIN
Pipe 1	7.00	10.00	50	SLOTTED

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
-0.50	0.00	Upstanding cover	
0.00	0.50	Concrete	
0.50	0.80	Gravel backfill	
0.80	7.00	Bentonite	
7.00	10.00	Gravel backfill	
10.00	30.00	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_005B Sheet 1 of 3
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+6.69mOD	Coordinates	547781.62E, 261488.18N	Grid	OSGB
Hole Type	IP+CP	Inclination			

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
MADE GROUND: Dark brown very clayey fine to coarse sand with frequent rootlets. Gravel sized fragments are angular to subrounded fine to medium of flint and quartzite (MGR) [MADE GROUND]			0.20 (0.50)	6.69		D 1 0.10 D 2 0.20 B 3 0.30-0.50							
MADE GROUND: Greyish brown very sandy gravelly clay. Gravel sized fragments are angular to subrounded fine to coarse of flint, quartzite, concrete and brick. (MGR) [MADE GROUND]			0.70 (0.50)	6.69		D 4 0.70 B 5 0.80-1.00							
Brown slightly clayey gravelly fine to coarse SAND. Gravel is angular to subrounded fine to coarse of flint and quartzite. (RTD) [SUPERFICIAL DEPOSITS]			1.20	6.69		D 6 1.20 B 7 1.20-1.70						SPT(C) 50/285mm (3,4:10,12,17,11/60mm) 1.20	
Medium dense to very dense brown fine to coarse SAND and GRAVEL. Gravel is angular to subrounded fine to coarse of flint and quartzite. (RTD) [SUPERFICIAL DEPOSITS]					▽	D 8 2.00							
					▼	B 9 2.20-2.70						SPT(C) N=37 (4,6:8,9,10,10) 2.20	
			(2.80)			D 10 3.00							
						B 11 3.20-3.70						SPT(C) N=26 (2,4:6,6,7,7) 3.20	
Firm fissured thinly laminated bluish grey CLAY. Fissures are 10-20 degrees randomly orientated extremely to closely spaced planar undulating smooth and 80-90 degrees planar smooth. (GLT) [GAULT FORMATION]			4.00	6.69		D 12 4.00							
						D 13 4.20-4.65 B 14 4.20-4.70						SPT(S) N=14 (2,2:3,3,3,5) 4.20	
						D 15 5.20-5.65 B 16 5.20-5.70						SPT(S) N=23 (2,3:5,5,6,7) 5.20	
						D 17 6.20-6.65 B 18 6.20-6.70						SPT(S) N=19 (2,2:4,4,6,5) 6.20	
			(6.70)									K 7.00 - 10.00 K 7.00 - 10.00	
from 7.20m to 7.50m slightly sandy. Sand is fine						D 19 7.20-7.65 B 20 7.20-7.70						SPT(S) N=17 (1,3:3,4,4,6) 7.20	
						D 21 8.20-8.65 B 22 8.20-8.70						SPT(S) N=20 (2,3:4,5,5,6) 8.20	
						D 23 9.20-9.65 B 24 9.20-9.70						SPT(S) N=21 (2,4:4,5,6,6) 9.20	

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:56   Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Form No. SIEXPHOLELOG   Issue.Revision No. 2.05   Issue Date 02/03/2018

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_005B
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 3

Ground Level +6.69mOD Coordinates 547781.62E, 261488.18N Grid OSGB

Hole Type IP+CP Inclination

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Firm fissured thinly laminated bluish grey CLAY. Fissures are 10-20 degrees randomly orientated extremely to closely spaced planar undulating smooth and 80-90 degrees planar smooth. (GLT) [GAULT FORMATION]													
Stiff fissured thinly laminated bluish grey CLAY. Fissures are 10-20 degrees and 40-50 degrees extremely closely to very closely spaced undulating planar smooth. (GLT) [GAULT FORMATION]			10.70	6.69		D 25 10.70-11.15 B 26 10.70-11.20						SPT(S) N=17 (2,3:3,4,4,6) 10.70	
			(3.00)			D 27 12.20-12.65 B 28 12.20-12.70						SPT(S) N=22 (1,3:4,5,6,7) 12.20	
Very stiff fissured thinly laminated bluish grey CLAY. Fissures are 10-20 degrees and 40-50 degrees extremely closely to very closely spaced undulating planar smooth. (GLT) [GAULT FORMATION]			13.70	6.69		D 29 13.70-14.15 B 30 13.70-14.20						SPT(S) N=27 (1,3:5,6,8,8) 13.70	
						D 31 15.20-15.65 B 32 15.20-15.70						SPT(S) N=33 (2,4:6,7,9,11) 15.20	
from 16.70m to 17.20m slightly sandy. Sandy is fine and medium						D 33 16.70-17.15 B 34 16.70-17.20						SPT(S) N=28 (2,3:5,7,7,9) 16.70	
						D 35 18.20-18.65 B 36 18.20-18.70						SPT(S) N=31 (2,4:6,7,8,10) 18.20	
						D 37 19.70-20.15 B 38 19.70-20.20						SPT(S) N=29 (3,4:5,6,8,10) 19.70	

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_005B Sheet 3 of 3
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+6.69mOD	Coordinates	547781.62E, 261488.18N	Grid	OSGB		
Hole Type	IP+CP	Inclination					

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff fissured thinly laminated bluish grey CLAY. Fissures are 10-20 degrees and 40-50 degrees extremely closely to very closely spaced undulating planar smooth. (GLT) [GAULT FORMATION]													
						D 39 21.20-21.65 B 40 21.20-21.70						SPT(S) N=30 (3,5:6,7,9,8) 21.20	
						D 41 22.70-23.15 B 42 22.70-23.20						SPT(S) N=31 (4,5:6,8,8,9) 22.70	
						D 43 24.20-24.65 B 44 24.20-24.70						SPT(S) N=33 (3,4:6,8,9,10) 24.20	
			(16.30)										
						D 45 25.70-26.15 B 46 25.70-26.20						SPT(S) N=37 (5,6:7,9,10,11) 25.70	
						D 47 27.20-27.65 B 48 27.20-27.70						SPT(S) N=41 (5,7:8,10,11,12) 27.20	
						D 49 28.70-29.15 B 50 28.70-29.20						SPT(S) N=43 (6,7:9,10,11,13) 28.70	
			30.00	6.69		D 51 30.00							
Complete at 30.00m. Termination Reason: Achieved Scheduled Depth													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_006
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+9.15mOD	Coordinates	547879.70E, 261513.90N	Grid	OSGB
Date Started	21/09/2021	Date Completed	28/09/2021	Inclination	90° f om horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	21/09/2021 11:30	21/09/2021 12:30	DC	DT	NA	NA	Insulated Hand Tools	None	Stable	
1.20	7.50	CP	21/09/2021 12:30	21/09/2021 17:00	DC	AM	NA	NA	Dando 2000			
7.50	40.00	RC	22/09/2021 07:30	28/09/2021 09:30	MM	AA	Geobore S (146)	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
21/09/2021 17:30	7.50	6.90	7.00	End of Shift
22/09/2021 07:30	7.50	7.50	7.20	Start of Shift
22/09/2021 09:15	7.50	6.90	5.00	End of Shift
22/09/2021 17:30	18.00	7.50	2.80	End of Shift
23/09/2021 07:30	18.00	7.50	7.40	Start of Shift
23/09/2021 17:30	21.00	21.00	20.80	End of Shift
24/09/2021 07:30	21.00	21.00	19.00	Start of Shift
24/09/2021 17:30	31.50	21.00	31.00	End of Shift
27/09/2021 07:30	31.50	21.00	30.50	Start of Shift
27/09/2021 17:30	8.00	7.00	8.00	End of Shift
28/09/2021 07:30	8.00	7.00	8.00	Start of Shift
28/09/2021 09:30	0.00			Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
21/09/2021 13:40	5.20	5.20		3.60	20	Medium

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	2.20	AIR/MIST	0	No return	
7.50	9.00	WATER	90	Grey	
9.00	18.00	WATER	70	Grey	
18.00	21.00	AIR/MIST	40	Grey	
21.00	40.00	AIR/MIST	90	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
7.50	200	6.90	200						
40.00	146	21.00	150						

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref
6.00	S1	SP	1.50	6.00	Pipe 1
6.00	G1	SP	1.50	6.00	Pipe 2

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type
Pipe 1	0.00	1.50	50	PLAIN
Pipe 2	0.00	1.50	19	PLAIN
Pipe 2	1.50	6.00	19	SLOTTED
Pipe 1	1.50	5.50	50	SLOTTED
Pipe 1	5.50	6.00	50	PLAIN

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
-0.50	0.00	Upstanding cover	
0.00	0.50	Concrete	
0.50	1.50	Bentonite	
1.50	6.00	Gravel backfill	
6.00	8.00	Bentonite	
8.00	40.00	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Form No. SIEXPHOLEHDR Issue.Revision No. 2.02 Issue Date 22/06/2016

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_006
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 5

Ground Level	+9.15mOD	Coordinates	547879.70E, 261513.90N	Grid	OSGB		
Hole Type	IP+CP+RC	Inclination	90° from horizontal				

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
MADE GROUND: Dark brown slightly gravelly sandy clay. Gravel sized fragments are angular to subrounded fine to coarse of mixed lithologies including flint, sandstone and rootlets. Occasional nodules of grey clay. (MGR) [MADE GROUND]			(1.20) 1.20	7.95		D 1 0.05-0.10 ES 2 0.20-0.25 B 3 0.10-0.40 D 4 0.40-0.50 ES 5 0.50-0.55 B 6 0.40-0.80 B 9 0.80-1.20 D 7 1.00-1.10 ES 8 1.10-1.20							
MADE GROUND: Dark grey mottled brown sandy gravelly clay. Sand sized fragments are fine to coarse. Gravel sized fragments are angular to subrounded fine to coarse of flint, quartzite, coal ash, sandstone and concrete. (MGR) [MADE GROUND]			(2.80) 4.00	5.15		ES 10 1.50 B 11 1.50-2.00 EW 1 2.00 ES 12 2.50 B 13 2.50-3.00 ES 14 3.50 B 15 3.50-4.00							
Brown fine to coarse SAND and GRAVEL. Gravel is angular to subrounded fine to coarse of flint and quartzite. (RTD) [SUPERFICIAL DEPOSITS]			(2.50) 6.50	2.65		ES 16 4.50 B 17 4.50-5.00 B 18 5.50-6.00						K 5.20	
Firm fissured thinly laminated bluish grey CLAY. Fissures are randomly orientated extremely closely spaced planar undulating smooth. (GLT) [GAULT FORMATION]			(1.00) 7.50	1.65		B 19 6.50-7.00							
Firm and stiff fissured bluish grey CLAY with rare brown phosphatic nodules (<10mm x 10mm). Fissures are 0-10 degrees and 15-55 degrees extremely closely and very closely spaced planar and undulating smooth and polished. (GLT) [GAULT FORMATION]						C 20 7.50-8.50	102	100					
from 9.62m to 9.85m recovered as very soft			(3.95)			C 21 8.50-9.00	102	100					

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

SOIL ENGINEERING
Part of the Bachy Soletanche Group

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_006
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 5

Ground Level	+9.15mOD	Coordinates	547879.70E, 261513.90N	Grid	OSGB
Hole Type	IP+CP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Firm and stiff fissured bluish grey CLAY with rare brown phosphatic nodules (<10mm x 10mm). Fissures are 0-10 degrees and 15-55 degrees extremely closely and very closely spaced planar and undulating smooth and polished. (GLT) [GAULT FORMATION]						C 22 9.00-12.00	102	90					
			11.45	-2.30									
Stiff fissured bluish grey CLAY with occasional brown phosphatic nodules (<10mm x 20mm). Fissures are 0-10 degrees, 20-60 degrees and 85-90 degrees very closely and closely spaced planar smooth and polished. (GLT) [GAULT FORMATION] from 11.70m to 12.00m assumed zone of core loss						C 23 12.00-13.00	102	100					
			(3.55)										
						C 24 13.00-15.00	102	100					
from 14.80m to 15.00m very stiff											NA		
			15.00	-5.85									
Firm and stiff fissured bluish grey CLAY with occasional brown phosphatic nodules (<10mm x 20mm). Fissures are randomly orientated extremely closely and very closely spaced planar and undulating smooth and polished. (GLT) [GAULT FORMATION]			(1.70)										
						C 25 15.00-18.00	102	100					
			16.70	-7.55									
Very stiff fissured bluish grey CLAY with occasional brown phosphatic nodules (<10mm x 20mm). Fissures are 0-10 degrees, 20-75 degrees and 85-90 degrees very closely and closely spaced planar smooth and polished. (GLT) [GAULT FORMATION]			(3.10)										
from 19.00m to 19.80m with rare shell fragments (<5mm x 10mm)							102	62					
from 19.55m to 19.80m firm and stiff. Fissures are extremely closely to very closely spaced						C 26 18.00-21.00							
			19.80	-10.65									
Assumed zone of core loss. Grey CLAY. (Driller's description)													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_006
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 3 of 5

Ground Level	+9.15mOD	Coordinates	547879.70E, 261513.90N	Grid	OSGB
Hole Type	IP+CP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Assumed zone of core loss. Grey CLAY. (Driller's description) (GLT) [GAULT FORMATION]			(1.20)								NR		
Stiff and very stiff fissured bluish grey CLAY with occasional dark brown and brown phosphatic nodules (<10mm x 20mm) and rare shell fragments (<3mm x 15mm). Fissures are 0-10 degrees, 20-65 degrees and 85-90 degrees very closely and closely spaced planar smooth and polished. (GLT) [GAULT FORMATION]			21.00	-11.85									
						C 27 21.00-22.00	102	100					
			(2.00)										
						C 28 22.00-23.50	102	97					
Recovered as: Very soft bluish grey CLAY with occasional to frequent fragments (<20mm x 30mm) of stiff bluish grey clay. (GLT) [GAULT FORMATION]			23.00	-13.85									
from 23.45m to 23.50m assumed zone of core loss													
						C 29 23.50-24.00	102	100					
			(1.70)										
Very stiff fissured bluish grey CLAY with occasional dark brown and brown phosphatic nodules (<10mm x 20mm) and rare shell fragments (<3mm x 10m). Fissures are 0-10 degrees, 20-75 degrees and 85-90 degrees very closely and closely spaced planar smooth and polished. (GLT) [GAULT FORMATION]			24.70	-15.55		C 30 24.00-25.50	102	100					
						C 31 25.50-28.50	102	92					
			(7.10)										
from 27.50m to 31.80m with occasional coprolite (<26mm x 25mm) and occasional belemnite shells (<5mm x 20mm)													
from 28.25m to 28.50m assumed zone of core loss													
						C 32 28.50-31.50							

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_006
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 4 of 5

Ground Level	+9.15mOD	Coordinates	547879.70E, 261513.90N	Grid	OSGB
Hole Type	IP+CP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very stiff fissured bluish grey CLAY with occasional dark brown and brown phosphatic nodules (<10mm x 20mm) and rare shell fragments (<3mm x 10m). Fissures are 0-10 degrees, 20-75 degrees and 85-90 degrees very closely and closely spaced planar smooth and polished. (GLT) [GAULT FORMATION] from 30.66m to 30.80m 1 No. fissure 60 degrees planar smooth tight and polished from 31.50m to 31.60m assumed zone of core loss			31.80	-22.65			102	100					
Very stiff fissured dark grey silty CLAY with occasional phosphatic nodules (<20mm x 30mm) and rare shell fragments (<5mm x 25mm). Fissures are 0-40 degrees, 20-55 degrees and 85-90 degrees very closely and closely spaced planar smooth and polished. (GLT) [GAULT FORMATION] from 37.00m to 37.30m assumed zone of core loss from 37.30m to 37.47m recovered as very soft grey clay with dark brown fine sand at 37.55m with parting (<2mm) and lenses (<2mm x 40mm) of dark brown fine sand from 37.55m to 37.60m with frequent shell fragments (<5mm x 15mm) and 1 No. belemnite (5mm x 20mm) at 37.70m with parting (<2mm) of dark brown fine sand			(6.20) 38.00	-28.85		C 33 31.50-34.50 C 34 34.50-37.00 C 35 37.00-38.00	102 102 102	97 100 70			NA		
Very stiff fissured dark grey slightly sandy to sandy CLAY with occasional pockets (<20mm x 30mm) of green glauconitic sandy clay and occasional phosphatic nodules (<25mm x 40mm) and with occasional to frequent belemnite shells (<5mm x 25mm) and shell fragments (<5mm x 20mm). Sand is fine and medium. Fissures are 0-10 degrees, 50-65 degrees and 90 degrees possibly closely to medium spaced planar and undulating smooth and rough and locally polished. (GLT) [GAULT FORMATION]			(0.80) 38.80	-29.65		C 36 38.00-39.00	102	100					
Dark greyish brown locally mottled yellowish brown glauconitic clayey slightly gravelly to gravelly SAND. Sand is fine to coarse. Gravel is subangular to rounded fine and medium predominantly fine of flint. (LGF) [LOWER GREENSAND FORMATION] from 39.80m to 40.00m dark greyish brown mottled yellowish brown fine			(1.20) 40.00	-30.85		C 37 39.00-40.00	102	100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_006 Sheet 5 of 5
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+9.15mOD	Coordinates	547879.70E, 261513.90N	Grid	OSGB
Hole Type	IP+CP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling		TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
						Details	Dia.						
Dark greyish brown locally mottled yellowish brown glauconitic clayey slightly gravelly to gravelly SAND. Sand is fine to coarse. Gravel is subangular to rounded fine and medium predominantly fine of flint. (LGF) [LOWER GREENSAND FORMATION] from 39.80m to 40.00m dark greyish brown mottled yellowish brown fine sand													
Complete at 40.00m. Termination Reason: Achieved Scheduled Depth													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_006PM Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+5.59mOD	Coordinates	547838.54E, 261494.75N	Grid	OSGB
Date Started	28/09/2021	Date Completed	30/09/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	28/09/2021 14:30	28/09/2021 15:00	Mitch Maxey	MM			Insulated Hand tools	None	Stable	Inspection pit: Hand dug
1.20	18.00	RO	28/09/2021 15:00	30/09/2021 17:30	Mitch Maxey	MM		PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
28/09/2021 17:30	12.00	6.00	11.70	End of Shift
29/09/2021 07:30	12.00	6.00	11.50	Start of shift
29/09/2021 17:30	19.00	6.00	12.00	End of Shift
30/09/2021 07:30	19.00	6.00	8.50	Start of shift
30/09/2021 17:30	0.00			Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	6.00	AIR/MIST	90	Orange	
6.00	18.00	AIR/MIST	90	Grey	

HOLE DIAMETER

Depth Base	Diameter
6.00	150
18.00	146

CASING DIAMETER

Depth Base	Diameter
6.00	150

DYNAMIC SAMPLING

Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
12.20	12.20	Self Boring Pressuremeter Test attempted
12.90	12.90	Self Boring Pressuremeter Test
14.00	14.00	Packer Test
18.50	18.50	Self Boring Pressuremeter Test

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	18.00	Grout	

LOCATION DETAILS

Remarks
Borehole formed to facilitate in situ testing

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

SOIL ENGINEERING

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Form No. SIEXPHOLEHDR Issue.Revision No. 2.02 Issue Date 22/06/2016

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_006PM Sheet 1 of 2
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+5.59mOD	Coordinates	547838.54E, 261494.75N	Grid	OSGB
Hole Type	IP+RO	Inclination			

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
MADE GROUND: Soil (Driller's description) (MGR) [MADE GROUND]			(0.70) 0.70	5.59									
MADE GROUND: Sand and Gravel (Driller's description) (MGR) [MADE GROUND]			(3.50) 4.20	5.59									
Grey CLAY (Driller's description) (GLT) [GAULT FORMATION]			(7.80)										

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_006PM Sheet 2 of 2
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+5.59mOD	Coordinates	547838.54E, 261494.75N	Grid	OSGB	
Hole Type	IP+RO	Inclination				

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Grey CLAY (Driller's description) (GLT) [GAULT FORMATION]			12.00	5.59								SBP 12.00	
Grey CLAY (Driller's description) (GLT) [GAULT FORMATION]			(6.00) 18.00	5.59								WRSBP 12.90 K 14.40 - 16.00 K 14.40 - 16.00 K 14.40 - 16.00 K 14.40 - 16.00 K 14.40 - 16.00 SBP 18.00	
Complete at 18.00m. Termination Reason: Achieved Suitable Depth to Undertake In Situ Testing												WRSBP 18.50	

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL | Print date and time 12/09/2022 13:56 | Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_007 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+4.66mOD	Coordinates	548013.92E, 261466.60N	Grid	OSGB
Date Started	13/10/2021	Date Completed	15/10/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	13/10/2021 14:00	13/10/2021 15:00	CB	DT	NA	NA	Insulated Hand Tools	None	Stable	
1.20	30.20	RC	13/10/2021 15:00	15/10/2021 13:00	CB	AY	Geobore S (146)	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
13/10/2021 17:30	7.70	2.90	7.30	End of Shift
14/10/2021 07:30	7.70	2.90	6.90	Start of Shift
14/10/2021 17:30	25.70	2.90	25.25	End of Shift
15/10/2021 07:30	25.70	2.90	25.10	Start of Shift
15/10/2021 13:00	30.20			Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	30.20	AIR/MIST	90	Grey	

HOLE DIAMETER		CASING DIAMETER	
Depth Base	Diameter	Depth Base	Diameter
2.90	150	2.90	150
30.20	146	30.20	146

DYNAMIC SAMPLING

Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	30.20	Grout	

LOCATION DETAILS

Remarks

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Form No. SIEXPHOLEHDR Issue.Revision No. 2.02 Issue Date 22/06/2016

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_007 Sheet 1 of 4
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+4.66mOD	Coordinates	548013.92E, 261466.60N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
TOPSOIL: Dark brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint. (TOP) [TOPSOIL]			(0.30) 0.30	4.36		D 1 0.05-0.10 ES 2 0.20-0.25 B 3 0.10-0.40							
Reddish brown slightly gravelly sandy CLAY. Gravel is angular to subrounded fine to coarse of flint. Sand is fine to coarse. (SUPD) [SUPERFICIAL DEPOSITS] from 0.70m to 1.20m light brown and greyish white CLAY.			(0.90) 1.20	3.46		D 4 0.40-0.50 ES 5 0.50-0.55 B 6 0.40-0.80 B 9 0.80-1.20 D 7 1.00-1.10 ES 8 1.10-1.20							
Firm fissured thinly and thickly laminated dark grey mottled green CLAY with occasional rootlets (<1mm). Fissures are randomly orientated extremely closely spaced undulating smooth. (GLT) [GAULT FORMATION] from 1.20m to 1.37m soft dark grey and orange sandy gravelly clay. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of flint from 2.10m to 2.20m assumed zone of core loss from 3.02m to 3.20m assumed zone of core loss			(2.05) 3.25	1.41		C 10 1.20-2.20 C 11 2.20-3.20	102 102	90 82					
Stiff fissured thickly laminated dark grey CLAY with occasional phosphate nodules (<10mm x 30mm). Fissures are randomly orientated very closely spaced planar undulating smooth polished. (GLT) [GAULT FORMATION] from 4.59m to 4.70m assumed zone of core loss at 4.95m frequent brown shell fragments (<3mm x 3mm)			(1.74) 4.99	-0.33		C 12 3.20-4.70	102	93					
Very stiff fissured thinly laminated dark grey CLAY. Fissures are randomly orientated extremely closely to very closely spaced planar undulating smooth polished and 45 degrees closely to medium spaced planar polished. (GLT) [GAULT FORMATION] from 7.05m to 7.16m 1 No. fissure 45 degrees planar polished from 7.84m to 8.09m 2 No. fissures very closely spaced 45 degrees planar polished from 8.81m to 8.98m 2 No. fissures very closely spaced planar polished			(4.32) 9.31	-4.65		C 13 4.70-6.20 C 14 6.20-7.70 C 15 7.70-9.20	102 102 102	97 100 97					
Very stiff fissured dark grey CLAY with occasional phosphate nodules (<20mm x 30mm). Fissures are 0-30 degrees closely spaced planar undulating smooth occasionally polished, 45 degrees closely spaced planar polished and 70-90 degrees planar undulating smooth polished.						C 16 9.20-10.70	102	100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:56   Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_007 Sheet 2 of 4
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+4.66mOD	Coordinates	548013.92E, 261466.60N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very stiff fissured dark grey CLAY with occasional phosphate nodules (<20mm x 30mm). Fissures are 0-30 degrees closely spaced planar undulating smooth occasionally polished, 45 degrees closely spaced planar polished and 70-90 degrees planar undulating smooth polished. (GLT) [GAULT FORMATION]													
from 11.50m to 11.70m 2 No. fissures 45 degrees very closely spaced planar polished			(3.84)			C 17 10.70-12.20	102	100					
			13.15	-8.49		C 18 12.20-13.70	102	100					
Very stiff fissured thinly laminated dark grey CLAY with rare siltstone nodules (<15mm x 15mm). Fissures are randomly orientated very closely spaced planar occasionally undulating smooth and 70-90 degrees planar polished. (GLT) [GAULT FORMATION]			(1.00)										
			14.15	-9.49									
Very stiff fissured dark grey CLAY with rare phosphate nodules (<10mm x 25mm). Fissures are 0-30 degrees extremely closely to closely spaced planar occasionally undulating smooth occasionally polished and 60-90 degrees planar occasionally undulating smooth polished. (GLT) [GAULT FORMATION]						C 19 13.70-15.20	102	100			NA		
						C 20 15.20-16.70	102	100					
			(11.26)			C 21 16.70-18.20	102	100					
						C 22 18.20-19.70	102	100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_007 Sheet 3 of 4
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+4.66mOD	Coordinates	548013.92E, 261466.60N	Grid	OSGB		
Hole Type	IP+RC	Inclination	90° from horizontal				

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff fissured dark grey CLAY with rare phosphate nodules (<10mm x 25mm). Fissures are 0-30 degrees extremely closely to closely spaced planar occasionally undulating smooth occasionally polished and 60-90 degrees planar occasionally undulating smooth polished. (GLT) [GAULT FORMATION] from 20.81m to 21.08m thinly laminated						C 23 19.70-21.20	102	100					
						C 24 21.20-22.70	102	100					
from 23.87m to 24.07m 2 No. fissures 50 degrees undulating polished						C 25 22.70-24.20	102	100					
at 24.49m 1 No. belemnite (5mm x 25mm) at 24.57m light brown shell fragments (<5mm x 5mm)						C 26 24.20-25.70	102	100					
Very stiff fissured dark grey CLAY with rare phosphate nodules (<10mm x 20mm). Fissures are randomly orientated closely spaced planar undulating smooth. (GLT) [GAULT FORMATION]			25.41 (1.27)	-20.75		C 27 25.70-27.20	102	100					
Very stiff dark grey CLAY. (GLT) [GAULT FORMATION]			26.68 (0.52)	-22.02									
Very stiff fissured dark grey CLAY with rare phosphate nodules (<10mm x 20mm), belemnites (<2mm x 15mm) and light brown shell fragments (<3mm x 3mm). (GLT) [GAULT FORMATION]			27.20 (3.00)	-22.54		C 28 27.20-28.70	102	100					
						C 29 28.70-30.20	102	97					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation		Exploratory Hole Log		Hole ID BH_TUN_007 Sheet 4 of 4
Project No.	TE8364				
Engineer	Mott MacDonald Bentley				
Employer	Barhale Limited				
Ground Level	+4.66mOD	Coordinates	548013.92E, 261466.60N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff fissured dark grey CLAY with rare phosphate nodules (<10mm x 20mm), belemnites (<2mm x 15mm) and light brown shell fragments (<3mm x 3mm). (GLT) [GAULT FORMATION] from 30.15m to 30.20m assumed zone of core loss			30.20	-25.54									
Complete at 30.20m. Termination Reason: Achieved Scheduled Dep h													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_011
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+6.57mOD	Coordinates	548423.41E, 261302.28N	Grid	OSGB
Date Started	05/10/2021	Date Completed	12/10/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	05/10/2021 14:30	05/10/2021 15:30	TW	DT	NA	NA	Insulated Hand Tools	None	Stable	
1.20	42.50	RC	05/10/2021 15:30	12/10/2021 15:30	TW	AL	Geobore S (146)	PCD	T46 Beretta			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
05/10/2021 17:30	5.20	2.20	3.20	End of Shift
06/10/2021 07:30	5.20	2.20	2.70	Start of Shift
06/10/2021 17:30	9.20	6.00	Dry	End of Shift
07/10/2021 07:30	9.20	6.00	Dry	Start of Shift
07/10/2021 17:30	22.70	12.70	Dry	End of Shift
08/10/2021 07:30	22.70	12.70	Dry	Start of Shift
08/10/2021 17:30	24.70	12.70	Dry	End of Shift
11/10/2021 07:30	24.70	12.70	Dry	Start of Shift
11/10/2021 17:30	36.70	12.70	Dry	End of Shift
12/10/2021 07:30	36.70	12.70	Dry	Start of Shift
12/10/2021 15:30	0.00			Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
05/10/2021 16:00	4.10	2.20		3.20	20	
12/10/2021 12:10	42.50	12.70		0.55	60	

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	39.50	AIR/MIST	100	Grey	
39.50	42.50	AIR/MIST	100	Green	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
5.00	200	5.00	200						
12.70	150	12.70	150						
42.50	146	42.50	146						

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref
5.00	G1	SP	1.50	5.00	Pipe 2
5.00	S1	SP	1.50	5.00	Pipe 1

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type
Pipe 1	0.00	1.50	50	PLAIN
Pipe 2	0.00	1.50	19	PLAIN
Pipe 2	1.50	2.50	19	SLOTTED
Pipe 1	1.50	4.50	50	SLOTTED

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
-0.50	0.00	Upstanding cover	
0.00	0.50	Concrete	
0.50	1.50	Bentonite	
1.50	5.00	Gravel backfill	
5.00	42.50	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL   Print date and time 12/09/2022 13:56   Log checked by David Howard

soil engineering
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_011
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 5

Ground Level	+6.57mOD	Coordinates	548423.41E, 261302.28N	Grid	OSGB		
Hole Type	IP+RC	Inclination	90° from horizontal				

Description of Strata	Weathering	Depth (Thickness)	Datum Level
TOPSOIL: Dark brown slightly silty CLAY with abundant rootlets (<3mm x 10mm). (TOP) [TOPSOIL]		0.10	6.47
Firm brown slightly gravelly slightly silty CLAY. Gravel is subangular to subrounded fine to medium of flint. (SUPD) [SUPERFICIAL DEPOSITS]		(0.65) 0.75	5.82
Very weak low density CHALK. Recovered as firm brownish grey slightly silty slightly gravelly calcareous CLAY. Gravel is subangular to subrounded fine to coarse of chalk. (WMCK) [WEST MELBURY CHALK FORMATION]		(0.45) 1.20	5.37
Structureless CHALK composed of soft yellowish brown gravelly calcareous CLAY. Gravel is subangular to subrounded fine to coarse of extremely weak low density calcareous siltstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(0.44) 1.64	4.93
Very weak medium density CHALK composed of yellowish brown calcareous SILTSTONE with closely spaced thinly bedded structureless CHALK composed of firm calcareous CLAY. Discontinuities are 10 to 25 degrees medium spaced undulating rough with infill of clay and silt. (CIRIA Grade B2) (WMCK) [WEST MELBURY CHALK FORMATION] from 2.20m to 2.85m non intact core (recovered as yellowish brown gravelly calcareous clay. Gravel is subangular to subrounded fine to coarse of calcareous siltstone)	Grade B2	(2.36) 4.00	2.57
Stiff dark greenish grey slightly gravelly slightly sandy CLAY. Gravel is subangular to subrounded fine to coarse of black coprolite. Sand is fine. (WMCK) [CAMBRIDGE GREENSAND MEMBER]		4.20	2.37
Stiff fissured dark grey CLAY. Fissures are 0 to 20 degrees extremely closely spaced planar polished. (GLT) [GAULT FORMATION] from 6.38m to 6.42m with rare nodule of pyrite (40mm x 30mm)		(2.60) 6.80	-0.23
Very stiff fissured dark grey CLAY with occasional nodules of siltstone (>20mm x 30mm). Fissures are 10 to 25 degrees very closely spaced planar polished (GLT) [GAULT FORMATION] from 7.80m to 7.85m with rare shell fragment (20mm x 15mm)		(5.90)	

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details
D 1 0.10						
D 2 0.10-0.25						
B 3 0.25-0.75						
D 4 0.75-0.90						
B 5 0.90-1.20						
D 6 1.20						
C 7 1.20-2.20	102	100	80	70	NA	
EW 1 2.00						K 2.00 - 5.00
C 8 2.20-3.70	102	100	73	57	NI 200 300	
EW 2 4.00						
C 9 3.70-5.20	102	100				
C 10 5.20-6.20	102	100				
C 11 6.20-6.70	102	100				
C 12 6.70-7.70	102	100				
C 13 7.70-9.20	102	100				
C 14 9.20-10.70	102	100				

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING

Form No SIEXPHOLELOG Issue.Revision No. 2.05 Issue Date 02/03/2018

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_011
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 5

Ground Level	+6.57mOD	Coordinates	548423.41E, 261302.28N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff fissured dark grey CLAY with occasional nodules of siltstone (>20mm x 30mm). Fissures are 10 to 25 degrees very closely spaced planar polished. (GLT) [GAULT FORMATION]													
						C 15 10.70-11.20	102	100					
from 11.50m to 12.70m fissures are 0 to 12 degrees very closely spaced planar polished													
						C 16 11.20-12.70	102	100					
Very stiff fissured dark grey CLAY with rare nodules of siltstone (20mm x 30mm). Fissures are randomly orientated very closely spaced planar smooth. (GLT) [GAULT FORMATION]			12.70 (0.50)	-6.13									
Very stiff fissured dark grey CLAY with rare nodules of siltstone (>20mm x 30mm). Fissures are 0 to 20 degrees very closely spaced planar smooth. (GLT) [GAULT FORMATION]			13.20	-6.63									
						C 17 12.70-14.20	102	100					
						C 18 14.20-15.70	102	100					
from 16.30m to 16.35m with rare nodules of pyrite (<10mm x 10mm)													
			(8.80)			C 19 15.70-17.20	102	100					
						C 20 17.20-18.20	102	100					
						C 21 18.20-19.70	102	100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL | Print date and time 12/09/2022 13:56 | Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_011 Sheet 3 of 5
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+6.57mOD	Coordinates	548423.41E, 261302.28N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff fissured dark grey CLAY with rare nodules of siltstone (>20mm x 30mm). Fissures are 0 to 20 degrees very closely spaced planar smooth. (GLT) [GAULT FORMATION] from 20.30m to 22.00m with occasional nodules of siltstone (>20mm x 30mm)	Unweathered					C 22 19.70-21.20	102	100			NA		
			22.00	-15.43		C 23 21.20-22.70	102	100					
Very stiff fissured dark grey silty CLAY with occasional nodules of siltstone (>20mm x 40mm). Fissures are 0 to 25 degrees very closely spaced planar polished. (GLT) [GAULT FORMATION]						C 24 22.70-23.20	102	100					
						C 25 23.20-24.70	102	100					
						C 26 24.70-26.20	102	100					
from 26.30m to 30.00m with occasional fragment of belemnite (10mm x 20mm)						C 27 26.20-27.70	102	100					
						C 28 27.70-29.20	102	100					
						C 29 29.20-30.70	102	100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Form No. SIEXPHOLELOG Issue.Revision No. 2.05 Issue Date 02/03/2018

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_011
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 4 of 5

Ground Level	+6.57mOD	Coordinates	548423.41E, 261302.28N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff fissured dark grey silty CLAY with occasional nodules of siltstone (>20mm x 40mm). Fissures are 0 to 25 degrees very closely spaced planar polished. (GLT) [GAULT FORMATION]													
						C 30 30.70-32.20	102	100					
						C 31 32.20-33.70	102	100					
						C 32 33.70-35.20	102	100					
from 35.00m to 35.20m with rare nodules of siltstone (>30mm x 50mm)			(18.00)										
						C 33 35.20-36.70	102	100					
from 37.00m to 40.00m with occasional shell fragments (<5mm x 5mm)													
						C 34 36.70-38.20	102	100					
						C 35 38.20-39.50	102	100					
			40.00	33.43									

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_011 Sheet 5 of 5
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+6.57mOD	Coordinates	548423.41E, 261302.28N	Grid	OSGB		
Hole Type	IP+RC	Inclination	90° from horizontal				

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff fissured slightly sandy CLAY with rare belemnite fragments (<5mm x 8mm). Sand is fine. Fissures are 0 to 20 degrees closely spaced planar rough. (GLT) [GAULT FORMATION]			(0.89) 40.89	-34.32		C 36 39.50-41.00	102	100					
Very stiff dark greenish grey slightly gravelly slightly sandy glauconitic CLAY. Sand is fine to medium. Gravel is subrounded to rounded fine of flint. (LGF) [LOWER GREENSAND FORMATION]			(0.46) 41.35	-34.78									
Very stiff dark greenish grey sandy CLAY. Sand is fine. (LGF) [LOWER GREENSAND FORMATION]			(1.15) 42.50	-35.93	▼	C 37 41.00-42.50	102	67					
Complete at 42.50m. Termination Reason: Achieved Scheduled Dep h													

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_011PM Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+6.57mOD	Coordinates	548428.85E, 261303.96N	Grid	OSGB
Date Started	13/10/2021	Date Completed	15/10/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	13/10/2021 11:00	13/10/2021 12:00	TW	TW			Insulated Hand Tools	None	Stable	
1.20	25.50	RO	13/10/2021 12:00	15/10/2021 09:30	TW			PCD	T46 Beretta			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
13/10/2021 17:30	20.00	5.50		End of Shift
14/10/2021 07:30	20.00	5.50		Start of shift
14/10/2021 17:30	25.50	5.50		End of Shift
15/10/2021 07:30	25.50	5.50		Start of shift
15/10/2021 09:30	0.00			Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	25.50	AIR/MIST	100	Grey	

HOLE DIAMETER / CASING DIAMETER / DYNAMIC SAMPLING

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
5.50	150	5.50	150						
25.50	146								

INSTALLATION DETAILS / PIPE CONSTRUCTION

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
6.00	6.00	Self Boring Pressuremeter Test
24.95	24.95	Self Boring Pressuremeter Test

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	25.50	Grout	

LOCATION DETAILS

Remarks
Borehole formed to facilitate in situ testing

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL   Print date and time 12/09/2022 13:56   Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_011PM Sheet 1 of 3
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+6.57mOD	Coordinates	548428.85E, 261303.96N	Grid	OSGB
Hole Type	IP+RO	Inclination			

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
TOPSOIL (Driller's description) (TOP) [TOPSOIL]			(0.50) 0.50	6.57									
CHALK (Driller's description) (WMCK) [WEST MELBURY CHALK FORMATION]			(3.80) 4.30	6.57									
CLAY (Driller's description) (GLT) [GAULT FORMATION]												WRSBP 6.00	

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:56   Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_011PM Sheet 2 of 3
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+6.57mOD	Coordinates	548428.85E, 261303.96N	Grid	OSGB
Hole Type	IP+RO	Inclination			

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
CLAY (Driller's description) (GLT) [GAULT FORMATION]			(21.20)										

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL　Print date and time 12/09/2022 13:56　Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_011PM Sheet 3 of 3
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+6.57mOD	Coordinates	548428.85E, 261303.96N	Grid	OSGB
Hole Type	IP+RO	Inclination			

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling		TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
						Details	Dia.						
CLAY (Driller's description) (GLT) [GAULT FORMATION]												WRSBP 24.95	
			25.50	6.57									

Complete at 25.50m. Termination Reason: Achieved Suitable Depth to Undertake In Situ Testing

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_015
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+11.61mOD	Coordinates	548994.00E, 261055.59N	Grid	OSGB
Date Started	28/09/2021	Date Completed	30/09/2021	Inclination	90° f om horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	28/09/2021 15:15	28/09/2021 15:45	TW	DT			Insulated Hand Tools	None	Stable	
1.20	30.20	RC	28/09/2021 15:45	30/09/2021 16:00	TW	AY	Geobore S (146)	PCD	T46 Beretta			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
28/09/2021 17:30	1.20	0.00	Dry	End of Shift
29/09/2021 07:30	1.20	0.00	Dry	Start of Shift
29/09/2021 17:30	23.20	2.20	7.34	End of Shift
30/09/2021 07:30	23.20	2.20	7.92	Start of Shift
30/09/2021 16:00	0.00			Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
29/09/2021 12:20	7.80	2.20		4.60	20	

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	30.20	AIR/MIST	100	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
2.20	150	2.20	150						
30.20	146	30.20	146						

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	30.20	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

SOIL ENGINEERING

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_015 Sheet 1 of 4
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+11.61mOD	Coordinates	548994.00E, 261055.59N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Depth (Thickness)	Datum Level
TOPSOIL: Dark brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flints. (TOP) [TOPSOIL]		(0.30) 0.30	11.31
Firm light brown, reddish blue slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flints. (SUPD) [SUPERFICIAL DEPOSITS]		(0.75) 1.05	10.56
CHALK recovered as firm light greyish brown slightly gravelly sandy calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flints. (WMCK) [WEST MELBURY CHALK FORMATION]		1.20	10.41
Structureless CHALK composed of soft yellowish brown gravelly calcareous CLAY. Gravel is angular to subangular fine to coarse extremely weak low density calcareous siltstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(1.26) 2.46	9.15
Very weak medium density yellowish brown CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 0 to 20 degrees closely to medium spaced undulating rough with silt infill and black specks. 2) 80 to 90 degrees closely to medium spaced undulating rough with black specks. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 2.46m to 2.72m extremely weak low density from 6.09m to 6.16m 45 degrees undulating rough with black specks fracture from 7.06m to 7.09m 45 degrees undulating rough with orange staining fracture	Grade B3	(4.88) 7.34	4.27
Extremely weak and very weak low density yellowish brown CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 0 to 25 degrees closely spaced undulating rough with orange staining. 2) 85 to 90 degrees closely to medium spaced planar undulating rough smooth with orange staining. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 7.94m to 8.13m extremely weak low density with randomly orientated extremely closely spaced planar undulating smooth with orange staining from 8.46m to 8.63m extremely weak low density from 9.07m to 9.26m extremely weak low density from 9.64m to 9.70m extremely weak low density (possibly drilling induced)	Grade B3	(2.36) 9.70	1.91

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD
D 1 0.05-0.10				
B 2 0.10-0.40				
D 3 0.40-0.50				
B 4 0.40-0.80				
B 6 0.80-1.20				
D 5 1.00-1.10				
C 7 1.20-2.20		100		
C 8 2.20-3.70		100	87	81
C 9 3.70-5.20		100	89	79
C 10 5.20-6.70		100	93	88
C 11 6.70-8.20		100	76	54
C 12 8.20-9.70		100	52	49

Depth range	IF
1.20-2.46	NA
2.46-7.34	80 170 400
7.34-9.70	10 160 230

In Situ Test Details

Install-ation

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:56   Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_015 Sheet 2 of 4
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+11.61mOD	Coordinates	548994.00E, 261055.59N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very weak to weak medium to high density light grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 0 to 15 degrees closely spaced planar undulating rough with orange staining. 2) conjugate fractures 40 to 50 degrees very closely to closely spaced planar undulating rough with orange staining. (CIRIA Grade B3) (WMCK) [WEST MELBURY CHALK FORMATION] from 9.82m to 9.95m extremely weak to very weak low density with conjugate fractures of 45 & 60 degrees undulating rough with orange staining from 10.06m to 10.20m extremely weak to very weak low density with randomly orientated extremely closely spaced planar smooth with orange staining (possibly drilling induced) from 10.59m to 10.96m extremely weak to very weak with conjugate fracture sets of 45 & 65 degrees very closely spaced planar smooth rough with orange staining	Grade B3		(1.36) 11.06	0.55		C 13 9.70-11.20		100	45	31	10 90 250		
Weak high density CHALK composed of calcareous SILTSTONE. Discontinuities are 0 to 10 degrees medium spaced planar smooth with orange staining. (CIRIA Grade B2) (WMCK) [WEST MELBURY CHALK FORMATION] from 11.20m to 11.29m extremely weak to very weak low density (possibly drilling induced) from 11.89m to 12.05m 86 degrees undulating smooth fracture from 12.06m to 12.16m extremely weak low density from 12.16m to 12.20m 80 degrees undulating smooth fracture at 12.63m very weak medium density with frequent phosphate nodules (<20mm x 30mm)	Grade B2		(1.64) 12.70	-1.09		C 14 11.20-12.70		100	87	73	50 240 400		
Stiff dark greenish grey gravelly slightly sandy CLAY. Gravel is subangular to subrounded fine to coarse of black coprolite. Sand is fine. (WMCK) [CAMBRIDGE GREENSAND MEMBER]			12.90	-1.29		C 15 12.70-14.20		100					
Stiff fissured dark grey CLAY with rare nodules of siltstone (<10mm x 20mm). Fissures are 5 to 30 degrees extremely closely spaced planar polished. (GLT) [GAULT FORMATION] from 14.50m to 14.60m with rare nodule of pyrite (20mm x 45mm) from 17.20m to 20.20m with occasional nodules of siltstone (>20mm x 40mm)			(7.30)			C 16 14.20-15.70		100					
						C 17 15.70-17.20		100					
						C 18 17.20-18.70		100					
						C 19 18.70-20.20		100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_015 Sheet 3 of 4
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+11.61mOD	Coordinates	548994.00E, 261055.59N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Stiff fissured dark grey CLAY with rare nodules of siltstone (<10mm x 20mm). Fissures are 5 to 30 degrees extremely closely spaced planar polished. (GLT) [GAULT FORMATION]	Unweathered		20.20	-8.59							NA		
Very stiff dark grey CLAY with rare nodules of siltstone (<20mm x 35mm). (GLT) [GAULT FORMATION]			(1.80)			C 20 20.20-21.70		100					
			22.00	-10.39		C 21 21.70-23.20		100					
Very stiff fissured dark grey CLAY with rare nodules of siltstone (<20mm x 40mm). Fissures are 10 to 30 degrees closely spaced planar polished. (GLT) [GAULT FORMATION]						C 22 23.20-24.70		100					
			(7.00)			C 23 24.70-26.20		100					
						C 24 26.20-27.70		100					
						C 25 27.70-29.20		100					
			29.00	-17.39									
Very stiff brownish dark grey slightly sandy CLAY with rare nodules of siltstone (<20mm x 40mm). Sand is fine. (GLT) [GAULT FORMATION]			(1.20)			C 26 29.20-30.20		100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:56   Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_015
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 4 of 4

Ground Level	+11.61mOD	Coordinates	548994.00E, 261055.59N	Grid	OSGB	
Hole Type	IP+RC	Inclination	90° from horizontal			

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff brownish dark grey slightly sandy CLAY with rare nodules of siltstone (<20mm x 40mm). Sand is fine. (GLT) [GAULT FORMATION]			30.20	-18.59									
Complete at 30.20m. Termination Reason: Achieved Scheduled Depth													

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_016 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.19mOD	Coordinates	549145.90E, 261043.10N	Grid	OSGB
Date Started	15/09/2021	Date Completed	20/09/2021	Inclination	90° f om horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	15/09/2021 15:15	15/09/2021 16:00	Craig Blackett	DT			Insulated Hand tools	None	Stable	
1.20	30.20	RC	15/09/2021 16:00	20/09/2021 10:00	Craig Blackett	AY	Geobore S (146)	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
15/09/2021 17:30	6.20	2.80	2.20	End of Shift
16/09/2021 07:30	6.20	2.80	1.45	Start of shift
16/09/2021 17:30	27.20	4.00	5.10	End of Shift
17/09/2021 07:30	27.20	4.00	4.85	Start of shift
17/09/2021 15:30	30.20	4.00	4.10	End of Shift
20/09/2021 07:30	12.00	4.00	3.80	Start of shift
20/09/2021 10:00	0.00			Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	10.70	AIR/MIST	90	White	
10.70	30.20	AIR/MIST	90	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
4.00	150	4.00	150						
30.20	146	30.20	146						

INSTALLATION DETAILS						PIPE CONSTRUCTION					
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type
10.80	S1	SP	1.50	10.80	Pipe 1	Pipe 1	0.00	1.50	50	PLAIN
						Pipe 1	1.50	10.30	50	SLOTTED

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
-0.50	0.00	Upstanding cover	
0.00	0.50	Concrete	
0.50	1.50	Bentonite	
1.50	10.80	Gravel backfill	
10.80	12.00	Bentonite	
12.00	30.20	Grout	

LOCATION DETAILS

Remarks

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL   Print date and time 12/09/2022 13:56   Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_016 Sheet 1 of 4
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.19mOD	Coordinates	549145.90E, 261043.10N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
TOPSOIL: Dark brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of mixed lithologies. (TOP) [TOPSOIL]			(0.30) 0.30	9.89		D 1 0.05-0.10 B 2 0.10-0.40							
Firm light greyish brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of mixed lithologies. (SUPD) [SUPERFICIAL DEPOSITS]			(0.90) 1.20	8.99		D 3 0.40-0.50 B 4 0.40-0.80 B 6 0.80-1.20 D 5 1.00-1.10							
Extremely weak and very weak low density yellowish brown CHALK composed of calcareous SILTSTONE with rare shell fragments (<5mm x 5mm). Discontinuities: 1) randomly orientated extremely closely to very closely spaced planar and undulating smooth with silt infill (<3mm) orange staining and occasional black specks. (CIRIA Grade B4) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B4					C 7 1.20-2.20	102	100	60	0		K 1.50 - 10.80 K 1.50 - 10.80	
						C 8 2.20-3.20	102	100	70	0			
			(4.65)								10 30 40		
from 4.60m to 4.70m assumed zone of core loss.						C 9 3.20-4.70	102	93	50	0			
						C 10 4.70-6.20	102	93	49	7			
			5.85	4.34									
Very weak low density yellowish brown CHALK composed of calcareous SILTSTONE. Discontinuities: 1) randomly orientated extremely closely to closely spaced planar and undulating smooth with silt infill (<3mm) and orange staining. (CIRIA Grade B4) (WMCK) [WEST MELBURY CHALK FORMATION] from 6.10m to 6.20m assumed zone of core loss.	Grade B4		(2.25)			C 11 6.20-7.70	102	100	67	0	10 50 100		
			8.10	2.09									
Very weak medium density light grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 0-20 degrees closely spaced planar smooth with silt infill (>3mm) 2) 60-90 degrees closely to medium spaced planar and undulating smooth clean. (CIRIA Grade C3) (WMCK) [WEST MELBURY CHALK FORMATION] from 8.20m to 8.39m extremely weak low density CHALK with very closely spaced discontinuities randomly orientated planar smooth with orange staining	Grade C3		(2.10)			C 12 7.70-9.20	102	100	44	37	30 110 260		
						C 13 9.20-10.70	102	100	67	63			

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Form No. SIEXPHOLELOG Issue.Revision No. 2.05 Issue Date 02/03/2018

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_016
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 4

Ground Level	+10.19mOD	Coordinates	549145.90E, 261043.10N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very weak medium density light grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 0-20 degrees closely spaced planar smooth with silt infill (>3mm) 2) 60-90 degrees closely to medium spaced planar and undulating smooth clean. (CIRIA Grade C3) (WMCK) [WEST MELBURY CHALK FORMATION]			10.20	-0.01									
Very weak to weak medium density light grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 0-10 degrees closely spaced planar smooth clean. (CIRIA Grade A3) (WMCK) [WEST MELBURY CHALK FORMATION] from 10.98m to 11.15m recovered as non intact core (subangular to angular medium to coarse gravel sized fragments of very weak to weak medium density light grey calcareous siltstone) from 11.52m to 11.75m frequent phosphatic nodules (30mm x 10mm)	Grade A3		(1.55) 11.75	-1.56		C 14 10.70-12.20	102	100	44	42	NI 130 220		
Stiff and very stiff fissured light bluish grey CLAY with rare to occasional dark brown and brown phosphatic nodules (<15mm x 25mm). Fissures are 0-10 degrees, 20-40 degrees and 90 degrees very closely and closely spaced planar smooth tight and polished. (GLT) [GAULT FORMATION] from 11.75m to 11.85m occasional light grey burrows (<1mm x 3mm) from 11.85m to 13.70m very stiff			(1.95) 13.70	-3.51		C 15 12.20-13.70	102	100					
Very stiff fissured dark grey CLAY with rare dark brown and brown phosphatic nodules (<10mm x 25mm). Fissures are 0-10 degrees, 20-35 degrees and 90 degrees very closely and closely spaced planar smooth tight and polished. (GLT) [GAULT FORMATION]						C 16 13.70-15.20	102	100					
						C 17 15.20-16.70	102	100					
						C 18 16.70-18.20	102	100					
at 18.12m 1 No. pyrite nodule (<5mm x 10mm)						C 19 18.20-19.70	102	100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_016 Sheet 3 of 4
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.19mOD	Coordinates	549145.90E, 261043.10N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff fissured dark grey CLAY with rare dark brown and brown phosphatic nodules (<10mm x 25mm). Fissures are 0-10 degrees, 20-35 degrees and 90 degrees very closely and closely spaced planar smooth tight and polished. (GLT) [GAULT FORMATION]						C 20 19.70-21.20	102	100					
from 21.41m to 21.59m 1 No. 65 degree fissure planar smooth and polished						C 21 21.20-22.70	102	100					
						C 22 22.70-24.20	102	100					
from 24.05m to 24.08m very thin bed of soft grey clay	Unweathered		(15.06)			C 23 24.20-25.70	102	100			NA		
						C 24 25.70-27.20	102	100					
						C 25 27.20-28.70	102	100					
Very stiff dark grey CLAY with occasional phosphatic nodules (<15mm x 40mm). (GLT) [GAULT FORMATION]			28.76 (1.44)	-18.57		C 26 28.70-30.20	102	100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_016
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 4 of 4

Ground Level	+10.19mOD	Coordinates	549145.90E, 261043.10N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling		TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
						Details	Dia.						
Very stiff dark grey CLAY with occasional phosphatic nodules (<15mm x 40mm). (GLT) [GAULT FORMATION]			30.20	-20.01									
Complete at 30.20m. Termination Reason: Achieved Scheduled Depth													

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_017
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+11.34mOD	Coordinates	549288.00E, 261031.50N	Grid	OSGB
Date Started	13/09/2021	Date Completed	14/09/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	13/09/2021 09:00	13/09/2021 10:00	CB		NA	NA	Insulated hand tools	None	Stable	
1.20	30.20	RC	13/09/2021 10:00	14/09/2021 17:30	CB	AL	Geobore S (146)	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
13/09/2021 17:30	24.20	2.75	7.40	End of Shift
14/09/2021 07:30	24.20	2.75	5.65	Start of Shift
14/09/2021 17:30	30.20	2.75	6.00	Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	9.20	AIR/MIST	90	White	
9.20	30.20	AIR/MIST	90	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
30.20	146	2.75	150						

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	30.20	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

SOIL ENGINEERING
Part of the Bachy Soletanche Group

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_017
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 4

Ground Level	+11.34mOD	Coordinates	549288.00E, 261031.50N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
TOPSOIL: Dark brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and quartzite. (TOP) [TOPSOIL]			(0.30) 0.30	11.04		D 1 0.05-0.10 B 2 0.10-0.40							
CHALK recovered as very stiff light grey mottled brown slightly sandy slightly gravelly calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of very weak medium density calcareous siltstone. (WMCK) [WEST MELBURY CHALK FORMATION]			(0.90) 1.20	10.14		D 3 0.40-0.50 B 4 0.40-0.80 B 6 0.80-1.20 D 5 1.00-1.10							
Structureless CHALK composed of firm yellowish grey slightly gravelly calcareous CLAY. Gravel is subangular to subrounded fine to coarse of extremely weak low density calcareous siltstone. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 1.85m to 2.20m recovered as subangular to subrounded fine to coarse gravel sized fragments of extremely weak low density calcareous siltstone	Grade Dm		(3.40) 4.60	6.74		C 7 1.20-2.20	102	100			NA		
						C 8 2.20-3.20	102	100					
						C 9 3.20-3.90	102	100					
						C 10 3.90-4.70	102	100					
Very weak low density CHALK composed of yellowish grey calcareous SILTSTONE with medium spaced thin beds of stiff yellowish grey calcareous clay. Discontinuities: 1) 5-40 degrees medium spaced undulating rough with slight orangish iron staining. (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B2		(2.10) 6.70	4.64		C 11 4.70-6.20	102	100	100	97	300 435 570		
Very weak medium density CHALK composed of grey calcareous SILTSTONE. Discontinuities: 1) 10-45 degrees closely to medium spaced undulating with clay infill (<3mm). (WMCK) [WEST MELBURY CHALK FOMRATION]	Grade B3		(2.90) 9.60	1.74		C 12 6.20-7.70	102	100	90	79	110 170 300		
						C 13 7.70-9.20	102	100	93	93			
Weak high density CHALK composed of grey calcareous SILTSTONE. Discontinuities: 1) 10-50 degrees closely to medium locally widely spaced undulating rough with slight orangish iron staining.						C 14 9.20-10.70	102	100	93	83			

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_017 Sheet 2 of 4
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+11.34mOD	Coordinates	549288.00E, 261031.50N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Weak high density CHALK composed of grey calcareous SILTSTONE. Discontinuities: 1) 10-50 degrees closely to medium locally widely spaced undulating rough with slight orangish iron staining. (WMCK) [WEST MELBURY CHALK FORMATION]	Grade B2		(3.55)			C 15 10.70-12.20	102	100	100	79	70 310 700		
						C 16 12.20-13.70	102	100	100	60			
Stiff dark greenish grey slightly sandy slightly gravelly CLAY. Sand is fine. Gravel is subangular to subrounded fine to coarse of black coprolites. (WMCK) [CAMBRIDGE GREENSAND MEMBER]			13.15	-1.81									
Stiff fissured dark grey CLAY with occasional nodules of siltstone (<15mm x 10mm). Fissures are 5-15 degrees closely spaced planar polished. (GLT) [GAULT FORMATION] from 13.70m to 14.00m with rare nodule of pyrite (10mm x 40mm)			13.43	-2.09		C 17 13.70-15.20	102	100					
			(4.57)			C 18 15.20-16.70	102	100					
from 16.50m to 16.60m with rare nodule of pyrite (8mm x 20mm)						C 19 16.70-18.20	102	100					
Very stiff fissured dark grey CLAY with rare nodules of siltstone (<15mm x 20mm). Fissures are 0-25 degrees closely spaced planar polished. (GLT) [GAULT FORMATION]			18.00	-6.66		C 20 18.20-19.70	102	100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_017
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 3 of 4

Ground Level	+11.34mOD	Coordinates	549288.00E, 261031.50N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff fissured dark grey CLAY with rare nodules of siltstone (<15mm x 20mm). Fissures are 0-25 degrees closely spaced planar polished. (GLT) [GAULT FORMATION]	Unweathered					C 21 19.70-21.20	102	100			NA		
						C 22 21.20-22.70	102	100					
						C 23 22.70-24.20	102	100					
			(10.20)										
						C 24 24.20-25.70	102	100					
						C 25 25.70-27.20	102	100					
						C 26 27.20-28.70	102	100					
Very stiff fissured thinly laminated dark grey CLAY with rare nodules of siltstone (<15mm x 15mm). Fissures are 0-25 degrees closely spaced planar polished. (GLT) [GAULT FORMATION]			28.20	-16.86									
			(2.00)										
						C 27 28.70-30.20	102	100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_017 Sheet 4 of 4
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+11.34mOD	Coordinates	549288.00E, 261031.50N	Grid	OSGB		
Hole Type	IP+RC	Inclination	90° from horizontal				

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff fissured thinly laminated dark grey CLAY with rare nodules of siltstone (<15mm x 15mm). Fissures are 0-25 degrees closely spaced planar polished. (GLT) [GAULT FORMATION]			30.20	-18.86									

Complete at 30.20m. Termination Reason: Achieved Scheduled Depth

AGS	Notes: All depth in metres, all diameters in millimetres. See header sheet for details of boring, progress and water. For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_018
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+10.28mOD	Coordinates	549445.42E, 260999.33N	Grid	OSGB
Date Started	20/09/2021	Date Completed	29/09/2021	Inclination	90° from horizontal

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	20/09/2021 14:00	20/09/2021 15:00	CB	DT	NA	NA	Insulated Hand Tools	None	Stable	
1.20	49.50	RC	20/09/2021 15:00	29/09/2021 12:00	CB	AY	Geobore S (146)	PCD	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
20/09/2021 17:30	6.20	2.80	4.90	End of Shift
21/09/2021 07:30	6.20	2.80	3.73	Start of Shift
21/09/2021 17:30	12.20	2.00	4.50	End of Shift
22/09/2021 07:30	12.20	2.00	3.75	Start of Shift
22/09/2021 17:30	12.20	9.00	4.10	End of Shift
23/09/2021 07:30	12.20	9.00	4.10	Start of Shift
23/09/2021 17:30	21.00	12.30	20.50	End of Shift
24/09/2021 07:30	21.00	12.30	20.10	Start of Shift
24/09/2021 15:30	30.00	12.30	29.20	End of Shift
27/09/2021 07:30	30.00	12.30	27.15	Start of Shift
27/09/2021 17:30	46.50	12.30	46.00	End of Shift
28/09/2021 07:30	46.50	12.30	45.75	Start of Shift
28/09/2021 17:30	49.50	12.30	0.00	End of Shift
29/09/2021 07:30	49.50	12.30	0.80	Start of Shift
29/09/2021 12:00	0.00			Installation Complete, Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks
20/09/2021 16:40	6.20	2.80	6.20	4.91	20	Slow

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	10.70	AIR/MIST	90	White	
10.70	46.50	AIR/MIST	90	Grey	
46.50	49.50	AIR/MIST	90	Green	

HOLE DIAMETER

Depth Base	Diameter
12.20	248
12.30	200
49.50	146

CASING DIAMETER

Depth Base	Diameter
12.30	200
49.50	146

DYNAMIC SAMPLING

Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference

INSTALLATION DETAILS

Distance	ID	Type	Response Top	Response Base	Pipe Ref
10.20	S1	SP	1.50	10.20	Pipe 1

PIPE CONSTRUCTION

Pipe Ref	Top	Base	Diameter	Pipe Type
Pipe 1	0.00	1.50	50	PLAIN
Pipe 1	1.50	9.70	50	SLOTTED

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
2.00	1.90	Geophysics testing
9.50	12.20	Bentonite Seal

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
-0.50	0.00	Upstanding cover	
0.00	0.50	Concrete	
0.50	1.50	Bentonite	
1.50	10.20	Gravel backfill	
10.20	12.30	Bentonite	
12.30	49.50	Grout	

LOCATION DETAILS

Remarks

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Form No. SIEXPHOLEHDR Issue.Revision No. 2.02 Issue Date 22/06/2016

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_018
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 5

Ground Level	+10.28mOD	Coordinates	549445.42E, 260999.33N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Depth (Thickness)	Datum Level
TOPSOIL: Soft dark brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium. (TOP) [TOPSOIL]		(0.30) 0.30	9.98
Firm brown slightly gravelly sandy CLAY. Gravel is angular to subrounded fine to coarse of mixed lithologies and flint. (SUPD) [SUPERFICIAL DEPOSITS]		0.40	9.88
Firm light brown greyish slightly gravelly sandy calcareous clay CHALK. Gravel is angular to subrounded fine to coarse of mixed lithologies and flint. (WMCK) [WEST MELBURY CHALK FORMATION]		(0.80) 1.20	9.08
Structureless CHALK composed of firm yellowish brown gravelly calcareous CLAY. Gravel is angular to subangular fine to coarse of extremely weak low density calcareous siltstone with occasional black specks. (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm	(2.24) 3.44	6.84
Extremely weak to very weak low density yellowish brown CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 0-10 degrees closely to widely spaced undulating rough with silt infill and occasional black specks. (WMCK) [WEST MELBURY CHALK FORMATION] from 4.87m to 5.17m 2 No. discontinuities 80-90 degrees undulating rough with black specks	Grade B2	(2.37) 5.81	4.47
Extremely weak to very weak low to medium density yellowish brown CHALK composed of calcareous SILTSTONE with medium spaced thin beds of structureless chalk composed of firm yellowish brown gravelly calcareous clay. Gravel is subangular medium to coarse of extremely weak low density calcareous chalk. Discontinuities: 1) randomly orientated extremely closely to very closely spaced planar undulating rough with orange staining. (WMCK) [WEST MELBURY CHALK FORMATION] from 6.75m to 6.84m 1 No. discontinuity 80 degrees planar smooth clean	Grade B4	(1.89) 7.70	2.58
Very weak to weak medium to high density light grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 0-20 degrees medium to widely spaced planar undulating rough with orange staining. (WMCK) [WEST MELBURY CHALK FORMATION] from 9.20m to 9.35m 1 No. discontinuity 90 degrees planar smooth	Grade B2	(1.65) 9.35	0.93
Weak high density light grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 60-90 degrees undulating rough clean. 2) 0-25 degrees closely to medium spaced undulating rough clean. (WMCK) [WEST MELBURY CHALK FORMATION]			

Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details
D 1 0.05-0.10						
ES 2 0.20-0.25						
B 2 0.10-0.40						
D 3 0.40-0.50						
ES 5 0.50-0.55						
B 4 0.40-0.80						
B 6 0.80-1.20						
D 5 1.00-1.10						
ES 8 1.10-1.20						
C 7 1.20-2.20	102	100			NA	K 1.50 - 10.20 K 1.50 - 10.20 K 1.50 - 10.20
C 8 2.20-3.20	102	100				K 2.60 - 6.00
C 9 3.20-4.70	102	100	83	83	90 415 740	
C 10 4.70-6.20	102	100	49	49		
C 11 6.20-7.70	102	100	69	69	10 25 40	
C 12 7.70-9.20	102	100	73	67	200 310 620	
C 13 9.20-10.70	102	100	100	100		

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_018
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 2 of 5

Ground Level	+10.28mOD	Coordinates	549445.42E, 260999.33N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Weak high density light grey CHALK composed of calcareous SILTSTONE. Discontinuities: 1) 60-90 degrees undulating rough clean. 2) 0-25 degrees closely to medium spaced undulating rough clean. (WMCK) [WEST MELBURY CHALK FORMATION]	Grade A2		(1.53) 10.88	-0.60							90 240 400		
Stiff grey CLAY with frequent phosphatic nodules (<40mm x 40mm) (WMCK) [CAMBRIDGE GREENSAND MEMBER] from 10.88m to 11.20m frequent phosphatic nodules (<40mm x 40mm)			(0.32) 11.20	-0.92									
Very stiff fissured dark grey CLAY with rare dustings of silt. Fissures are 0-10 degrees very closely to closely spaced planar polished clean and randomly orientated extremely closely spaced planar undulating polished smooth. (GLT) [GAULT FORMATION]			(1.40) 12.60	-2.32		C 14 10.70-12.20	102	100	17	13			
Very stiff fissured dark grey CLAY with occasional phosphate nodules (<20mm x 30mm). Fissures are 0-15 degrees closely spaced planar polished smooth clean and randomly orientated very closely spaced planar undulating polished smooth. (GLT) [GAULT FORMATION] from 13.20m to 13.48m thinly laminated randomly orientated extremely closely spaced planar smooth fissures from 13.50m to 13.67m 1 No. fissure 85 degrees planar polished from 14.00m to 14.15m 1 No. fissure 75 degrees undulating smooth from 16.94m to 17.08m 1 No. fissure 50 degrees planar polished from 17.75m to 17.83m 1 No. fissure 60 degrees planar polished			(7.95)			C 15 12.20-13.50	102	100					
						C 16 13.50-15.00	102	100					
						C 17 15.00-16.50	102	100					
						C 18 16.50-18.00	102	100					
						C 19 18.00-19.50	102	100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_018
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 3 of 5

Ground Level	+10.28mOD	Coordinates	549445.42E, 260999.33N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff fissured dark grey CLAY with occasional phosphate nodules (<20mm x 30mm). Fissures are 0-15 degrees closely spaced planar polished smooth clean and randomly orientated very closely spaced planar undulating polished smooth. (GLT) [GAULT FORMATION]			20.55	-10.27		C 20 19.50-21.00	102	100					
Very stiff fissured dark grey CLAY with occasional phosphate nodules (<20mm x 30mm). Fissures are 0-30 degrees very closely to closely spaced planar smooth polished clean, 75-90 degrees planar polished clean. (GLT) [GAULT FORMATION]						C 21 21.00-22.50	102	100					
			(4.71)			C 22 22.50-24.00	102	100					
			25.26	-14.98		C 23 24.00-25.50	102	100					
Very stiff fissured dark grey CLAY with occasional phosphate nodules (<20mm x 30mm) and shell fragments (<10mm x 10mm). Fissures are 0-10 degrees closely to medium spaced planar undulating polished smooth clean and randomly orientated very closely to closely spaced undulating polished smooth clean. (GLT) [GAULT FORMATION]						C 24 25.50-27.00	102	100					
			(4.52)			C 25 27.00-28.50	102	100					
			29.78	-19.50		C 26 28.50-30.00	102	100					
Very stiff fissured dark grey CLAY with occasional phosphate nodules													

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

SOIL ENGINEERING
Part of the Bachy Soletanche Group

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_018
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 4 of 5

Ground Level	+10.28mOD	Coordinates	549445.42E, 260999.33N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Very stiff fissured dark grey CLAY with occasional phosphate nodules (<20mm x 40mm) and shell fragments (<10mm x 10mm). Fissures are 0-15 degrees closely spaced planar smooth occasionally polished and randomly orientated extremely closely to very closely spaced planar occasionally undulating smooth. (GLT) [GAULT FORMATION] from 32.31m to 32.64m fissures are 85 degrees planar polished clean.			(2.86) 32.64	-22.36		C 27 30.00-31.50 C 28 31.50-33.00	102 102	100 100			NA		
Very stiff fissured dark grey CLAY with frequent phosphate nodules (<20mm x 50mm). Fissures are 0-15 degrees very closely to closely spaced planar occasionally undulating smooth polished and randomly orientated very closely spaced planar occasionally undulating smooth occasionally polished. (GLT) [GAULT FORMATION] from 35.00m to 35.12m 1 No. fissure 55 degrees undulating polished			(2.89) 35.53	-25.25		C 29 33.00-34.50 C 30 34.50-36.00	102 102	100 100					
Very stiff fissured dark grey CLAY. Fissures are 75-90 degrees planar polished smooth clean. (GLT) [GAULT FORMATION]			(1.39) 36.92	-26.64		C 31 36.00-37.50	102	100					
Very stiff fissured dark grey CLAY with occasional phosphate nodules (<10mm x 20mm). Fissures are randomly orientated very closely to closely spaced planar occasionally undulating polished smooth. (GLT) [GAULT FORMATION] from 38.81m to 38.89m 1 No. fissure 85 degrees planar polished at 38.91m 1 No. belemnite (5mm x 40mm) from 39.23m to 39.45m 1 No. fissure 90 degrees undulating polished			(4.66)			C 32 37.50-39.00 C 33 39.00-40.50	102 102	100 100					

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID
Project No.	TE8364		BH_TUN_018
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 5 of 5

Ground Level	+10.28mOD	Coordinates	549445.42E, 260999.33N	Grid	OSGB
Hole Type	IP+RC	Inclination	90° from horizontal		

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Very stiff fissured dark grey CLAY with occasional phosphate nodules (<10mm x 20mm). Fissures are randomly orientated very closely to closely spaced planar occasionally undulating polished smooth. (GLT) [GAULT FORMATION]													
						C 34 40.50-42.00	102	100					
Very stiff dark grey CLAY with occasional fossilised belemnite (<5mm x 40mm) and rare phosphate nodules (<20mm x 30mm) occasional shell fragments (<10mm x 10mm). (GLT) [GAULT FORMATION]			41.58	-31.30									
						C 35 42.00-43.50	102	100					
			(3.23)										
from 43.76m to 43.82m fissures are randomly orientated extremely closely spaced planar undulating smooth occasionally polished													
						C 36 43.50-45.00	102	100					
Very stiff fissured dark grey CLAY with occasional belemnite (<5mm x 30mm) phosphate nodules (<20mm x 20mm) and shell fragments (<10mm x 10mm). Fissures are 80-90 degrees planar undulating polished. (GLT) [GAULT FORMATION]			44.81	-34.53									
			(1.83)			C 37 45.00-46.50	102	100					
Very stiff dark grey slightly sandy slightly gravelly CLAY with frequent shell fragments (<10mm x 10mm. Sand is fine to coarse. Gravel is rounded fine of flint. (LGF) [LOWER GREENSAND FORMATION] at 46.82m 1 No. ammonite (45mm x 45mm) and 1 No. phosphate nodule (20mm x 45mm)			46.64	-36.36									
			(0.57)										
Dark greenish grey slightly gravelly clayey fine to medium SAND. Gravel is subrounded to rounded fine to medium of flint. (LGF) [LOWER GREENSAND FORMATION]			47.21	-36.93		C 38 46.50-48.00	102	100					
			(0.77)										
Soft dark greenish grey slightly sandy gravelly CLAY. Sand is fine to medium. Gravel is subrounded to rounded fine to medium of flint. (LGF) [LOWER GREENSAND FORMATION]			47.98	-37.70									
			(0.39)										
Dark greenish grey slightly gravelly slightly clayey fine to medium SAND. Gravel is subrounded to rounded fine to medium of flint. (LGF) [LOWER GREENSAND FORMATION]			48.37	-38.09									
						C 39 48.00-49.50	102	100					
			(1.13)										
			49.50	-39.22									
Complete at 49.50m. Termination Reason: Achieved Scheduled Depth													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_018PM Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.24mOD	Coordinates	549441.46E, 261003.15N	Grid	OSGB
Date Started	29/09/2021	Date Completed	05/10/2021	Inclination	

Top	Base	Type	Date Time Start	Date Time End	Rig Crew	Logger	Barrel Type	Drill Bit	Plant Used	Shoring Used	Pit Stability	Remarks
0.00	1.20	IP	29/09/2021 16:00	29/09/2021 17:00	Craig Blackett	CB			Insulated Hand tools	None	Stable	Inspection pit: Hand dug
1.20	31.00	RO	30/09/2021 07:30	05/10/2021 16:30	Craig Blackett	CB		Tricone Steel	Soilmec SM8			

PROGRESS

Date Time	Depth	Depth Casing	Depth Water	Remarks
29/09/2021 17:30	1.20	0.00	Dry	End of Shift
30/09/2021 07:30	1.20	0.00	Dry	Start of shift
30/09/2021 17:30	26.50	2.80	4.00	End of Shift
01/10/2021 07:30	26.50	2.80	4.00	Start of shift
01/10/2021 15:30	27.50	2.80	4.00	End of Shift
04/10/2021 07:30	27.50	2.80	4.00	Start of shift
04/10/2021 17:30	31.00	2.80	3.80	End of Shift
05/10/2021 07:30	31.00	2.80	4.00	Start of shift
05/10/2021 16:30	0.00			Backfill Complete; Borehole Complete

WATER STRIKES

Date Time	Depth Strike	Depth Casing	Depth Sealed	Water Rose To	Time Elapsed	Remarks

CABLE PERCUSSION DETAILS

Depth Top	Depth Base	Time Start	Duration	Tool	Remarks

SPT DETAILS

Depth Top	Test Type	Reported Result	Hammer Serial Number	Energy Ratio	Depth Casing	Depth Water

ROTARY FLUSH DETAILS

Depth Top	Depth Base	Flush Type	Flush Return	Flush Colour	Remarks
1.20	8.50	AIR/MIST	90	White	
8.50	31.00	AIR/MIST	90	Grey	

HOLE DIAMETER		CASING DIAMETER		DYNAMIC SAMPLING					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Diameter	Duration	Sample Recovery	Run Reference
2.80	200	2.80	200						
31.00	146								

INSTALLATION DETAILS						PIPE CONSTRUCTION				
Distance	ID	Type	Response Top	Response Base	Pipe Ref	Pipe Ref	Top	Base	Diameter	Pipe Type

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
27.00	27.00	Self Boring Pressuremeter Test attempted
28.00	28.00	Self Boring Pressuremeter Test attempted
28.70	28.70	Self Boring Pressuremeter Test attempted
30.40	30.40	High Pressure Dilatometer Test
32.20	32.20	High Pressure Dilatometer Test

BACKFILL DETAILS

Depth Top	Depth Base	Description	Remarks
0.00	31.00	Grout	

LOCATION DETAILS

Remarks
Borehole formed to facilitate in situ testing

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations see key.

FINAL   Print date and time 12/09/2022 13:56   Log checked by David Howard

Form No. SIEXPHOLEHDR   Issue.Revision No. 2.02   Issue Date 22/06/2016

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_018PM Sheet 1 of 4
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.24mOD	Coordinates	549441.46E, 261003.15N	Grid	OSGB		
Hole Type	IP+RO	Inclination					

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Installation
Sandy gravelly TOPSOIL (Driller's description) (TOP) [TOPSOIL]			(0.30) 0.30	10.24									
Light brown sandy gravelly CLAY (Driller's description) (SUPD) [SUPERFICIAL DEPOSITS]			0.40	10.24									
CHALK (Driller's description) (WMCK) [WEST MELBURY CHALK FORMATION]			(0.80) 1.20	10.24									
CHALK (Driller's description) (WMCK) [WEST MELBURY CHALK FORMATION]			(9.80)										

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_018PM Sheet 2 of 4
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.24mOD	Coordinates	549441.46E, 261003.15N	Grid	OSGB
Hole Type	IP+RO	Inclination			

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
CHALK (Driller's description) (WMCK) [WEST MELBURY CHALK FORMATION]			11.00	10.24									
Grey CLAY (Driller's description) (GLT) [GAULT FORMATION]													

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_018PM Sheet 3 of 4
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.24mOD	Coordinates	549441.46E, 261003.15N	Grid	OSGB
Hole Type	IP+RO	Inclination			

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Grey CLAY (Driller's description) (GLT) [GAULT FORMATION]			(20.00)										

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Exploratory Hole Log	Hole ID BH_TUN_018PM Sheet 4 of 4
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.24mOD	Coordinates	549441.46E, 261003.15N	Grid	OSGB
Hole Type	IP+RO	Inclination			

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	Sampling Dia.	TCR/Sample Recovery %	SCR/Blows	RQD	IF	In Situ Test Details	Install-ation
Grey CLAY (Driller's description) (GLT) [GAULT FORMATION]			31.00	10.24								HPD 30.40	
Complete at 31.00m. Termination Reason: Achieved Suitable Depth to Undertake In Situ Testing												HPD 32.10	

AGS

Notes: All depth in metres, all diameters in millimetres.
See header sheet for details of boring, progress and water.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:56 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

SOIL ENGINEERING

SUPPORTING FACTUAL DATA

SECTION A
Exploratory Hole Records and Field Data

EXCAVATION RECORDS

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID IP_TUN_001 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+7.03mOD	Coordinates	547220.70E, 261514.80N	Grid	OSGB
Hole Type	IP	Method/Equipment	Insulated Hand Tools		
Date Started	30/07/2021	Date Completed	30/07/2021	Logged By	DT

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Installation
TOPSOIL: Dark brown slightly sandy slightly gravelly clay. Sand is fine to coarse. Gravel is subangular to round fine to coarse of flint. (TOP) [TOPSOIL]			0.15	7.03		D 1 0.05-0.10		
MADE GROUND: Grey chalk clay. Occasional rootlets. (MGR) [MADE GROUND]			0.30	7.03		ES 2 0.20-0.25		
MADE GROUND: Brownish red sandy gravel. Sand is fine to coarse. Gravel sized fragments are angular to subrounded fine to coarse of sandstone, flint, brick and concrete. (MGR) [MADE GROUND]			(0.50) 0.80	7.03		B 3 0.30-0.40 B 6 0.40-0.80 D 4 0.40-0.50 ES 5 0.50-0.55		
MADE GROUND: Reddish brown sandy gravel. Sand is fine to coarse. Gravel sized fragments are angular to subrounded fine to coarse of sandstone, flint, brick and concrete. (MGR) [MADE GROUND]			(0.70) 1.50	7.03		B 9 0.80-1.20 D 7 1.00-1.10 ES 8 1.10-1.20		
End of excavation at 1.50m. Termination Reason: Buried service encountered at base of inspection pit								

Stability	Stable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	0.40m
Length (Sides B and D)	0.90m
Depth	1.50m
	°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
1.50	1.50	Strong signal on CAT. Borehole abandoned at base of inspection pit.

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	WATER STRIKES DETAIL Depth Water	Time Elapsed

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	1.50	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks

GENERAL NOTES

Remarks
1. No groundwater observed during excavation.

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID IP_TUN_004 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+6.89mOD	Coordinates	547670.90E, 261485.20N	Grid	OSGB
Hole Type	IP	Method/Equipment	Insulated hand tools		
Date Started	28/07/2021	Date Completed	28/07/2021	Logged By	DT

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Install-ation
TOPSOIL: Dark brown slightly sandy slightly gravelly clay. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of flint. (TOP) [MADE GROUND]			0.10	6.79		D 1 0.05-0.10 B 3 0.10-0.50 ES 2 0.20-0.25		
MADE GROUND: Light brown slightly sandy angular to subrounded fine to coarse gravel sized fragments of sandstone, flint, mudstone, brick and concrete. Sand is fine to coarse. (MGR) [MADE GROUND]			(1.10) 1.20	5.69		B 6 0.50-0.90 D 4 0.50-0.55 ES 5 0.50-0.55 B 9 0.90-1.20 D 7 1.10-1.20 ES 8 1.10-1.20		
End of excavation at 1.20m. Termination Reason: Strong CAT signal at base of inspection pit								

Stability	Stable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	0.50m
Length (Sides B and D)	0.50m
Depth	1.20m
	°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
1.20	1.20	Strong signal on CAT. Borehole abandoned at base of inspection pit.

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	WATER STRIKES DETAIL Depth Water	Time Elapsed

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	1.20	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks

GENERAL NOTES

Remarks

1. No groundwater observed during excavation.

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:59   Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID
Project No.	TE8364		IP_TUN_004a
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+6.95mOD	Coordinates	547671.30E, 261482.90N	Grid	OSGB
Hole Type	IP	Method/Equipment	Insulated Hand Tools		
Date Started	28/07/2021	Date Completed	28/07/2021	Logged By	DT

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Installation
TOPSOIL: Dark brown slightly gravelly sandy CLAY. Gravel is angular to subrounded fine to medium of flint. (TOP) [TOPSOIL]			0.10	6.95				
MADE GROUND: Light brown slightly sandy gravel. Gravel sized fragments are angular to subangular fine to coarse of sandstone, flint, mudstone, brick and concrete. Occasional cobble sized fragments of concrete and brick. (MGR) [MADE GROUND]			(0.70) 0.80	6.95				
MADE GROUND: Brown slightly gravelly medium sand. (MGR) [MADE GROUND]			(0.40) 1.20	6.95				
End of excavation at 1.20m. Termination Reason: Strong CAT signal at base of inspection pit								

Stability	Stable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	0.40m
Length (Sides B and D)	0.40m
Depth	1.20m
	°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
1.20	1.20	Strong signal on CAT. Borehole abandoned at base of inspection pit.

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	Depth Water	Time Elapsed

WATER STRIKES DETAIL

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	1.20	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks

GENERAL NOTES

Remarks

1. No groundwater observed during excavation.

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log		Hole ID
Project No.	TE8364			IP_TUN_004b
Engineer	Mott MacDonald Bentley			
Employer	Barhale Limited			Sheet 1 of 1

Ground Level	+6.96mOD	Coordinates	547664.60E, 261482.20N	Grid	OSGB
Hole Type	IP	Method/Equipment	Insulated hand tools		
Date Started	01/09/2021	Date Completed	01/09/2021	Logged By	

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Install-ation
TOPSOIL: Dark brown slightly gravelly sandy CLAY. Gravel is angular to subrounded fine to medium of flint. (TOP) [TOPSOIL]		▨	0.10	6.96		ES 2 0.20-0.25		▨
MADE GROUND: Brickwork over concrete. (MGR) [MADE GROUND]		▨	(0.45) 0.55	6.96				▨
End of excavation at 0.55m. Termination Reason: Buried obstruction at base of excavation. Location abandoned.								

Stability Stable

Shoring None

Excavation Dimensions and Orientation

Length (Sides A and C)	0.90m
Length (Sides B and D)	0.80m
Depth	0.55m
	°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.10	0.55	Buried structure encountered.

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	WATER STRIKES DETAIL Depth Water	Time Elapsed

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	0.55	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks

GENERAL NOTES

Remarks
1. No groundwater observed during excavation.

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID IP_TUN_004R1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+6.95mOD	Coordinates	547664.56E, 261481.85N	Grid	OSGB
Hole Type	IP	Method/Equipment	Insulated hand tools		
Date Started	02/07/2021	Date Completed	28/07/2021	Logged By	DT

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Installation
TOPSOIL: Dark brown slightly sandy slightly gravelly clay. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of flint. (TOP) [MADE GROUND]		▨	0.10	6.85		D 1 0.05-0.10 B 3 0.10-0.40 ES 2 0.20-0.25		
MADE GROUND: Light brown slightly sandy angular to subrounded fine to coarse gravel sized fragments of sandstone, flint, mudstone, brick and concrete with low cobble content. Sand is fine to coarse. Cobble sized fragments are subangular of brick and concrete. (MGR) [MADE GROUND]		▨	(0.70) 0.80	6.15		B 6 0.40-0.80 D 4 0.50-0.55 ES 5 0.50-0.55		
MADE GROUND: Light brown slightly gravelly fine to coarse sand. Gravel sized fragments are subangular fine of sandstone and mudstone. (MGR) [MADE GROUND]		▨	(0.40) 1.20	5.75		B 9 0.80-1.20 D 7 1.10-1.20 ES 8 1.10-1.20		
End of excavation at 1.20m. Termination Reason: Strong CAT signal at base of inspection pit								

Stability	Stable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	0.50m
Length (Sides B and D)	0.50m
Depth	1.20m
	°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
1.20	1.20	Strong signal on CAT. Borehole abandoned at base of inspection pit.

WATER STRIKES / WATER STRIKES DETAIL

Date Time	Depth Strike	Depth Sealed	Depth Water	Time Elapsed

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	1.20	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks

GENERAL NOTES

Remarks

1. No groundwater observed during excavation.

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL | Print date and time 12/09/2022 13:59 | Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID IP_TUN_004TT1 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+6.96mOD	Coordinates	547664.00E, 261481.80N	Grid	OSGB
Hole Type	IP	Method/Equipment	Insulated Hand Tools		
Date Started	01/09/2021	Date Completed	01/09/2021	Logged By	DT

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Install-ation
TOPSOIL: Dark brown slightly sandy slightly gravelly clay. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of flint. (TOP) [MADE GROUND]			0.10	6.96				
MADE GROUND: Light brown slightly sandy angular to subrounded fine to coarse gravel sized fragments of sandstone, flint, mudstone, brick and concrete with low cobble content. Sand is fine to coarse. Cobble sized fragments are subangular of brick and concrete. (MGR) [MADE GROUND]			0.30	6.96				
End of excavation at 0.30m. Termination Reason: Buried obstruction at base of excavation. Location abandoned.								

Stability	Stable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	0.90m
Length (Sides B and D)	0.80m
Depth	0.30m
	°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.30	0.30	Concrete obstruction

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	Depth Water	Time Elapsed

WATER STRIKES DETAIL

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	0.30	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks

GENERAL NOTES

Remarks
1. No groundwater observed during excavation.

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID
Project No.	TE8364		IP_TUN_004TT2
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+6.93mOD	Coordinates	547665.20E, 261481.90N	Grid	OSGB
Hole Type	IP	Method/Equipment	Insulated Hand Tools		
Date Started	01/09/2021	Date Completed	01/09/2021	Logged By	DT

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Install-ation
TOPSOIL: Dark brown slightly sandy slightly gravelly clay. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse of flint. (TOP) [MADE GROUND]			0.10	6.93				
MADE GROUND: Light brown slightly sandy angular to subrounded fine to coarse gravel sized fragments of sandstone, flint, mudstone, brick and concrete with low cobble content. Sand is fine to coarse. Cobble sized fragments are subangular of brick and concrete. (MGR) [MADE GROUND]			0.30	6.93				
End of excavation at 0.30m. Termination Reason: Buried obstruction at base of excavation. Location abandoned.								

Stability Stable

Shoring None

Excavation Dimensions and Orientation

Length (Sides A and C)	0.90m
Length (Sides B and D)	0.80m
Depth	0.30m
	°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.30	0.30	Concrete obstruction

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	Depth Water	Time Elapsed

WATER STRIKES DETAIL

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	0.30	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks

GENERAL NOTES

Remarks

1. No groundwater observed during excavation.

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

SOIL ENGINEERING

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID IP_TUN_005A Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+6.64mOD	Coordinates	547782.20E, 261490.90N	Grid	OSGB
Hole Type	IP	Method/Equipment	Insulated hand tools		
Date Started	29/07/2021	Date Completed	29/07/2021	Logged By	DT

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Installation
MADE GROUND: Brown slightly sandy angular to subrounded fine and medium gravel sized fragments of sandstone and flint. Sand is fine to coarse. (MGR) [MADE GROUND]		▨	0.28	6.36		D 1 0.05-0.10 B 3 0.10-0.40 ES 2 0.20-0.25		
MADE GROUND: Brown slightly sandy angular to subrounded medium and coarse gravel sized fragments of sandstone, flint, shale, mudstone, brick, porcelain and concrete. Sand is fine to coarse. (MGR) [MADE GROUND]		▨	(0.37) 0.65	5.99		B 6 0.40-0.60 D 4 0.40-0.50 ES 5 0.50-0.55		
End of excavation at 0.65m. Termination Reason: Buried obstruction at base of excavation. Location abandoned.								

Stability	Stable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	0.50m
Length (Sides B and D)	0.50m
Depth	0.65m
	°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.00	0.65	Concrete at base of excavation.

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	WATER STRIKES DETAIL Depth Water	Time Elapsed

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	0.65	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks

GENERAL NOTES

Remarks

1. No groundwater observed during excavation.

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID IP_TUN_006 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+9.04mOD	Coordinates	547879.65E, 261518.76N	Grid	OSGB
Hole Type	IP	Method/Equipment	Insulated Hand Tools		
Date Started	20/10/2021	Date Completed	20/10/2021	Logged By	PS

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Installation
MADE GROUND: Dark brown slightly gravelly sandy clay. Sand is fine to coarse. Gravel is angular to rounded fine to coarse of flint and sandstone. (MGR) [MADE GROUND]		▨	(1.20) 1.20	9.04		LB 1 0.50-0.55 LB 2 1.15-1.20		▨
End of excavation at 1.20m. Termination Reason: Achieved Scheduled Depth								

Stability Stable

Shoring None

Excavation Dimensions and Orientation

Length (Sides A and C)	0.30m
Length (Sides B and D)	0.30m
Depth	1.20m
	°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	Depth Water	Time Elapsed

WATER STRIKES DETAIL

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	1.20	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks
0.000	1.200	1. Groundwater not encountered to base of excavation.

GENERAL NOTES

Remarks
1. No groundwater observed during excavation.

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

SOIL ENGINEERING

Form No. SIEXPHOLETPLOG Issue.Revision No. 2.05 Issue Date 04/01/2019

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID IP_TUN_010
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+4.27mOD	Coordinates	548364.22E, 261324.87N	Grid	OSGB
Hole Type	IP	Method/Equipment	Insulated Hand Tools		
Date Started	15/10/2021	Date Completed	15/10/2021	Logged By	DT

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Installation
TOPSOIL: Dark brown slightly gravelly sandy CLAY. Gravel is angular to subrounded fine to medium of flint. (TOP) [TOPSOIL]			0.20	4.27		D 1 0.05-0.10 B 3 0.10-0.40 ES 2 0.20-0.25		
Firm grey slightly gravelly sandy CLAY. Sand is fine to medium. Gravel is angular to subrounded fine to medium of flint. (SUPD) [SUPERFICIAL DEPOSITS]			(0.30) 0.50	4.27		B 6 0.40-0.80 D 4 0.40-0.50		
Firm brown mottled grey and red slightly gravelly sandy CLAY. Sand is fine to medium. Gravel is fine to medium of flint. (SUPD) [SUPERFICIAL DEPOSITS]			(0.70) 1.20	4.27		ES 5 0.50-0.55 B 9 0.80-1.20 D 7 1.00-1.10 ES 8 1.10-1.20		
End of excavation at 1.20m. Termination Reason: Exploratory hole abandoned due to site instruction to stop intrusive works								

Stability	Stable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	0.40m
Length (Sides B and D)	0.40m
Depth	1.20m
	°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	Depth Water	Time Elapsed

WATER STRIKES DETAIL

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	1.20	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks
0.000	1.200	1. No groundwater encountered to base of excavation.

GENERAL NOTES

Remarks
1. No groundwater observed during excavation.

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

Form No. SIEXPHOLETPLOG Issue.Revision No. 2.05 Issue Date 04/01/2019

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID TP_FE_001
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+3.84mOD	Coordinates	548433.30E, 261624.10N	Grid	OSGB
Hole Type	TP	Method/Equipment	JCB 3CX		
Date Started	20/09/2021	Date Completed	23/09/2021	Logged By	AM/DT

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Install-ation
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular to subangular fine of flint and quartzite. Occasional rootlets. (TOP) [TOPSOIL]			(0.30) 0.30	3.54		B 1 0.30-0.35	HV 0.00	
Firm brown mottled grey CLAY with frequent white shell fragments (<5mm). (SUPD) [SUPERFICIAL DEPOSITS]			(0.90) 1.20	2.64		B 2 1.00-1.10 B 3 1.20-1.30	CBR 0.50 HV 0.50 HV 1.00	
Firm light grey slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint. (SUPD) [SUPERFICIAL DEPOSITS]			(1.00) 2.20	1.64	∇	B 4 2.20-2.30		
Light brown slightly sandy GRAVEL. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint, sandstone and mudstone. (SUPD) [SUPERFICIAL DEPOSITS]			2.40	1.44		LB 5 2.40-2.50		
Firm dark grey slightly gravelly sandy CLAY. Sand is fine. Gravel is angular to subrounded fine to medium of siltstone. (SUPD) [SUPERFICIAL DEPOSITS]			2.50	1.34				
End of excavation at 2.50m. Termination Reason: Terminated early due to groundwater ingress								

Stability Stable

Shoring None

Excavation Dimensions and Orientation

Length (Sides A and C)	1.70m
Length (Sides B and D)	0.60m
Depth	2.50m
Bearing along Side A toward Side B	13°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.50	0.50	CBR test undertaken

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	WATER STRIKES DETAIL Depth Water	Time Elapsed
22/09/2021 09:45	2.20			

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	2.50	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks
0.000	2.500	1. Soakaway test carried out.

GENERAL NOTES

Remarks

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

SOIL ENGINEERING

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID TP_FE_002
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+4.14mOD	Coordinates	548562.50E, 261617.10N	Grid	OSGB
Hole Type	TP	Method/Equipment	JCB 3CX		
Date Started	21/09/2021	Date Completed	21/09/2021	Logged By	AM

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Install-ation
Firm dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine of flint and quartzite. (SUPD) [SUPERFICIAL DEPOSITS]			(0.30) 0.30	3.84		B 1 0.30-0.55	HV 0.00	
Firm brown mottled grey CLAY with frequent white shell fragments (<5mm). (SUPD) [SUPERFICIAL DEPOSITS]			(0.40) 0.70	3.44		B 2 0.70-0.75	CBR 0.50 HV 0.50	
Firm brown mottled grey sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and quartzite. (SUPD) [SUPERFICIAL DEPOSITS]			(0.30) 1.00	3.14		B 3 1.00-1.05	HV 1.00	
Brown fine to coarse SAND and GRAVEL. Gravel is angular to subrounded fine to coarse of flint and quartzite. (SUPD) [SUPERFICIAL DEPOSITS]			(1.00) 2.00	2.14	▽ ▼	LB 4 2.00-2.05		
Firm grey CLAY. (GLT) [GAULT FORMATION]			2.20	1.94				
End of excavation at 2.20m. Termination Reason: Pits walls unstable								

Stability	Unstable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	2.20m
Length (Sides B and D)	0.60m
Depth	2.20m
Bearing along Side A towa d Side B	67°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.50	0.50	CBR test undertaken

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	WATER STRIKES DETAIL Depth Water	 Time Elapsed
21/09/2021 10:00	1.30		1.25	5
			1.20	10
			1.15	15
			1.10	20

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	2.20	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks
0.000	2.200	1. Trial pit terminated at 2.20m due to groundwater and instability. 2. Bucket width reduced to 300mm from 1.00m to base of excavation. 3. Soakaway test undertaken.

GENERAL NOTES

Remarks

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

SOIL ENGINEERING

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID TP_FE_003 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+6.23mOD	Coordinates	548800.40E, 261588.10N	Grid	OSGB
Hole Type	TP	Method/Equipment	JCB 3CX		
Date Started	24/08/2021	Date Completed	24/08/2021	Logged By	AM

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Installation
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY with frequent rootlets and roots (<6mm). Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint and quartz. (TOP) [TOPSOIL]			(0.30) 0.30	5.93		B 2 0.25 ES 1 0.25		
Structureless CHALK composed of very stiff light grey locally stained brown slightly sandy slightly gravelly calcareous CLAY. Gravel is angular to subangular fine to medium of calcareous siltstone. (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(0.50) 0.80	5.43		B 4 0.50 ES 3 0.50	CBR 0.50 HV 0.50	
Structureless CHALK composed of very stiff light grey locally stained brown very sandy calcareous GRAVEL with high cobble content. Gravel is angular to subangular fine to coarse of calcareous siltstone and silt. Cobbles are angular to subangular of calcareous siltstone. (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dc		(0.80) 1.60	4.63		B 5 1.00	HV 1.00	
Structureless CHALK composed of light grey locally stained brown slightly sandy gravelly calcareous CLAY. Gravel is angular to subangular fine to coarse of extremely weak calcareous siltstone. (WMCK) [WEST MELBURY CHALK FORMATION] from 2.50m to 2.80m frequent thickly laminated loose brown SAND lenses. Sand is fine to coarse.	Grade Dm		(1.20) 2.80	3.43	∇	B 7 2.00 ES 6 2.00 B 9 2.80 ES 8 2.80		
End of excavation at 2.80m. Termination Reason: Pits walls unstable								

Stability	Sidewalls unstable below 2.50m
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	2.50m
Length (Sides B and D)	0.60m
Depth	2.80m
Bearing along Side A toward Side B	106°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.50	0.50	CBR test undertaken

WATER STRIKES / WATER STRIKES DETAIL

Date Time	Depth Strike	Depth Sealed	Depth Water	Time Elapsed
24/08/2021 15:00	2.00			

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	2.80	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks
0.000	2.800	1. Excavation terminated at 2.80m due to unstable ground

GENERAL NOTES

Remarks

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID
Project No.	TE8364		TP_FE_004
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+6.76mOD	Coordinates	548964.60E, 261556.20N	Grid	OSGB
Hole Type	TP	Method/Equipment	JCB 3CX		
Date Started	25/08/2021	Date Completed	25/08/2021	Logged By	AM

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Install-ation
TOPSOIL: Greyish brown slightly gravelly sandy CLAY with frequent rootlets and roots. Sand is fine to coarse. Gravel is angular to subangular fine to medium of flint and quartz. (TOP) [TOPSOIL]			(0.30) 0.30	6.46				
MADE GROUND: Brown slightly sandy slightly gravelly clay. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of brick flint and quartz (MGR) [MADE GROUND]			(1.50) 1.80	4.96		B 1 0.40 B 2 1.00	CBR 0.50 HV 0.50 HV 1.00	
Structureless CHALK composed of firm light grey mottled brown and grey slightly sandy slightly gravelly calcareous CLAY. Gravel is angular to sub rounded, fine to medium of extremely weak calcareous siltstone flint and quartz. Sand is fine to coarse. occasional brown staining. (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(0.70) 2.50	4.26		B 3 2.00		
Structureless CHALK composed of firm light grey mottled brown slightly sandy gravelly calcareous CLAY. Gravel is angular to subangular fine to coarse of extremely weak calcareous siltstone. Sand is fine to coarse. (WMCK) [WEST MELBURY CHALK FORMATION]			(0.50) 3.00	3.76	▽	B 4 3.00		

End of excavation at 3.00m. Termination Reason: Achieved Scheduled Depth

Stability	Stable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	2.50m
Length (Sides B and D)	0.60m
Depth	3.00m
Bearing along Side A towa d Side B	113°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.50	0.50	CBR test undertaken

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	WATER STRIKES DETAIL Depth Water	Time Elapsed
25/08/2021 12:30	2.70			

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	3.00	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks

GENERAL NOTES

Remarks

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID TP_FE_005 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+7.00mOD	Coordinates	549133.30E, 261520.70N	Grid	OSGB
Hole Type	TP	Method/Equipment	JCB 3CX		
Date Started	26/08/2021	Date Completed	26/08/2021	Logged By	AM

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Install-ation
MADE GROUND: Dark brown slightly sandy slightly gravelly clay. Sand is fine to coarse. Gravel angular to subrounded fine to medium of flint quartz and brick. Occasional rootlets. (MGR) [MADE GROUND]			(0.30) 0.30	6.70		ES 1 0.20		
Stiff brown slightly sandy slightly gravelly CLAY. Gravel is angular to subrounded fine to medium of flint and quartz. Sand is fine to coarse. (SUPD) [SUPERFICIAL DEPOSITS]			(0.40) 0.70	6.30		B 3 0.50 ES 2 0.50	CBR 0.50 HV 0.50	
Structureless CHALK composed of very stiff light greyish brown slightly gravelly sandy calcareous CLAY. Gravel is angular to subangular fine to medium of extremely weak calcareous siltstone and flint (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(1.40) 2.10	4.90		B 5 1.00 ES 4 1.00 ES 6 1.50 B 7 2.00	HV 1.00	
Structureless CHALK composed of very stiff light grey mottled brown slightly sandy slightly gravelly calcareous CLAY. Gravel is angular to subangular fine to coarse extremely weak calcareous siltstone. Sand is fine to coarse. (WMCK) [WEST MELBURY CHALK FORMATION]			(0.90) 3.00	4.00	▽	B 8 3.00		
End of excavation at 3.00m. Termination Reason: Achieved Scheduled Depth								

Stability Stable

Shoring None

Excavation Dimensions and Orientation

Length (Sides A and C)	2.60m
Length (Sides B and D)	0.60m
Depth	3.00m
Bearing along Side A towa d Side B	106°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.50	0.50	CBR test undertaken
1.50	3.00	Reduced bucket width to 300mm to complete excavation to scheduled depth

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	WATER STRIKES DETAIL Depth Water	Time Elapsed
26/08/2021 12:00	3.00			

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	3.00	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks

GENERAL NOTES

Remarks

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID TP_FE_006 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+9.59mOD	Coordinates	549318.30E, 261496.00N	Grid	OSGB
Hole Type	TP	Method/Equipment	JCB 3CX		
Date Started	26/08/2021	Date Completed	26/08/2021	Logged By	AM

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Installation
MADE GROUND: Dark brown slightly sandy slightly gravelly clay. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint quartz and brick. (MGR) [MADE GROUND]			(0.30) 0.30	9.29				
Stiff brown slightly sandy slightly gravelly CLAY. Gravel is angular to subrounded fine to coarse of flint and quartz. Sand is fine to coarse. (SUPD) [SUPERFICIAL DEPOSITS]			(0.30) 0.60	8.99		B 1 0.50	CBR 0.50 HV 0.50	
Structureless CHALK composed of very stiff light greyish brown slightly gravelly sandy calcareous CLAY. Gravel is angular to subangular fine to medium of extremely weak calcareous siltstone and flint. (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(1.20) 1.80	7.79		B 2 1.20	HV 1.00	
Structureless CHALK composed of very stiff light grey mottled brown slightly gravelly sandy CLAY. Gravel is angular to subangular extremely weak to very weak calcareous siltstone and flint. (WMCK) [WEST MELBURY CHALK FORMATION]			(1.20) 3.00	6.59		B 3 2.00 B 4 3.00		

End of excavation at 3.00m. Termination Reason: Achieved Scheduled Depth

Stability	Stable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	2.60m
Length (Sides B and D)	0.60m
Depth	3.00m
Bearing along Side A toward Side B	130°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.50	0.50	CBR test undertaken
1.50	3.00	Bucket width reduced to 300mm width to complete excavation to scheduled depth.

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	Depth Water	Time Elapsed

WATER STRIKES DETAIL

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	3.00	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks
0.000	3.000	Excavation remained dry to 3.00m depth.

GENERAL NOTES

Remarks

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID TP_STW_003 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.10mOD	Coordinates	549443.30E, 261353.20N	Grid	OSGB
Hole Type	TP	Method/Equipment	JCB 3CX		
Date Started	02/09/2021	Date Completed	02/09/2021	Logged By	AM

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Installation
TOPSOIL: Dark brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel angular to subrounded fine to coarse of flint quartz and brick. (TOP) [TOPSOIL]			(0.50) 0.50	9.60		B 1 0.40	HV 0.00 CBR 0.50 HV 0.50	
Structureless CHALK composed of very stiff light greyish brown slightly gravelly slightly sandy calcareous CLAY. Gravel is angular to subrounded fine to coarse of extremely weak calcareous siltstone flint and quartz. Sand is fine to coarse. (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(1.30) 1.80	8.30		B 2 1.00	HV 1.00	
Structureless CHALK composed of very stiff light grey mottled brown slightly gravelly slightly sandy calcareous CLAY. Gravel is angular to subrounded fine to coarse of extremely weak calcareous siltstone flint and quartz. Sand is fine to coarse. (WMCK) [WEST MELBURY CHALK FORMATION]			(1.20) 3.00	7.10		B 3 2.00 LB 4 3.00		
End of excavation at 3.00m. Termination Reason: Achieved Scheduled Depth								

Stability	Stable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	2.50m
Length (Sides B and D)	0.60m
Depth	3.00m
Bearing along Side A towa d Side B	145°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.50	0.50	CBR test undertaken
3.00	3.00	Soakaway test undertaken

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	Depth Water	Time Elapsed

WATER STRIKES DETAIL

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	3.00	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks
0.000	3.000	1. No groundwater encountered to base of excavation. 2. Bucket width reduced to 300mm from 1.00m depth in order to achieve scheduled depth.

GENERAL NOTES

Remarks

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID TP_STW_004 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.51mOD	Coordinates	549402.80E, 261143.90N	Grid	OSGB
Hole Type	TP	Method/Equipment	JCB 3CX		
Date Started	27/08/2021	Date Completed	27/08/2021	Logged By	AM

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Install-ation
MADE GROUND: Dark brown slightly sandy slightly gravelly clay with occasional rootlets. Sand sized fragments are fine to coarse. Gravel sized fragments are angular to subrounded fine to medium of flint, brick and quartz. (MGR) [MADE GROUND]			(0.30) 0.30	10.21			HV 0.00	
Stiff brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and quartz. (SUPD) [SUPERFICIAL DEPOSITS]			(0.30) 0.60	9.91		B 1 0.40	CBR 0.50 HV 0.50	
Structureless CHALK composed of very stiff light greyish brown slightly gravelly sandy calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint, quartz, siltstone. (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(1.10) 1.70	8.81		B 2 1.00	HV 1.00	
Structureless CHALK composed of stiff light grey mottled brown slightly gravelly sandy calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to course of siltstone. (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(1.30) 3.00	7.51		B 3 2.00 LB 4 3.00		
End of excavation at 3.00m. Termination Reason: Achieved Scheduled Depth								

Stability	Stable
Shoring	None

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.50	0.50	CBR test undertaken
1.00	1.00	HV unsuitable too stiff

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	3.00	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks
0.000	3.000	1. No groundwater encountered to base of excavation. 2. Bucket width reduced to 300mm from 1.50m depth in order to achieve scheduled depth.

Excavation Dimensions and Orientation

Length (Sides A and C)	2.50m
Length (Sides B and D)	0.60m
Depth	3.00m
Bearing along Side A toward Side B	170°

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	Depth Water	Time Elapsed

WATER STRIKES DETAIL

GENERAL NOTES

Remarks

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID
Project No.	TE8364		TP_STW_005
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+9.35mOD	Coordinates	549540.90E, 261123.20N	Grid	OSGB
Hole Type	TP	Method/Equipment	JCB 3CX		
Date Started	03/09/2021	Date Completed	03/09/2021	Logged By	AM

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Install-ation
MADE GROUND: Friable dark brown slightly gravelly sandy clay with occasional rootlets. Sand sized fragments are fine to coarse. Gravel sized fragments are angular to subrounded fine to medium of flint, quartz and brick. (MGR) [MADE GROUND]			(0.30) 0.30	9.05			HV 0.00	
Structureless CHALK composed of very stiff light greyish brown sandy gravelly calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to course of flint, quartz and calcareous siltstone. (WMCK) [WEST MELBURY CHALK FORMATION] from 0.35m to 0.55m with occasional lenses of brown fine to coarse sand (<500m)	Grade Dm		(1.20) 1.50	7.85		B 1 0.50 B 2 1.00	CBR 0.50 CBR 0.50 HV 0.50 HV 1.00	
Structureless CHALK composed of very stiff light grey mottled brown slightly sandy slightly gravelly calcareous CLAY with low cobble content. Sand is fine to coarse. Gravel is angular to subrounded fine to course of calcareous siltstone. Cobbles are subrounded of calcareous siltstone. (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(1.50) 3.00	6.35		B 3 2.00 LB 4 3.00		
End of excavation at 3.00m. Termination Reason: Achieved Scheduled Depth								

Stability	Stable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	2.50m
Length (Sides B and D)	0.60m
Depth	3.00m
Bearing along Side A toward Side B	10°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.50	0.50	CBR test undertaken

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	Depth Water	Time Elapsed

WATER STRIKES DETAIL

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	3.00	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks
0.000	3.000	1. No groundwater encountered to base of excavation. 2. Bucket width reduced to 300mm from 1.40m depth in order to achieve scheduled depth.

GENERAL NOTES

Remarks

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID TP_STW_006 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+9.38mOD	Coordinates	549502.80E, 261257.30N	Grid	OSGB
Hole Type	TP	Method/Equipment	JCB 3CX		
Date Started	31/08/2021	Date Completed	31/08/2021	Logged By	AM

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Installation
TOPSOIL: Dark brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and quartz. (TOP) [TOPSOIL]			(0.30) 0.30	9.08			HV 0.00	
Stiff brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint and quartz. (SUPD) [SUPERFICIAL DEPOSITS]			(0.40) 0.70	8.68		B 1 0.50	CBR 0.50 HV 0.50	
Structureless CHALK composed of very stiff light greyish brown slightly gravelly sandy calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint, calcareous siltstone and quartz. (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(1.00) 1.70	7.68		B 2 1.00	HV 1.00	
Structureless CHALK composed of very stiff light grey mottled brown slightly gravelly sandy calcareous CLAY with low cobble content. Sand is fine to coarse. Gravel is angular to subrounded fine to course of calcareous siltstone. Cobbles are subrounded of calcareous siltstone. (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(1.30) 3.00	6.38		B 3 2.00 LB 4 3.00		
End of excavation at 3.00m. Termination Reason: Achieved Scheduled Depth								

Stability	Stable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	2.50m
Length (Sides B and D)	0.60m
Depth	3.00m
Bearing along Side A towa d Side B	105°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.50	0.50	CBR test undertaken

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	Depth Water	Time Elapsed

WATER STRIKES DETAIL

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	3.00	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks
0.000	3.000	1. No groundwater encountered to base of excavation. 2. Bucket width reduced to 450mm from 1.50m depth in order to achieve scheduled depth.

GENERAL NOTES

Remarks

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

SOIL ENGINEERING
Part of the Bachy Soletanche Group

FINAL   Print date and time 12/09/2022 13:59   Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID TP_STW_007 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+9.14mOD	Coordinates	549646.00E, 261316.90N	Grid	OSGB
Hole Type	TP	Method/Equipment	JCB 3CX		
Date Started	31/08/2021	Date Completed	31/08/2021	Logged By	AM

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Install-ation
TOPSOIL: Dark brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint and quartzite. (TOP) [TOPSOIL]			(0.30) 0.30	8.84		ES 1 0.20	HV 0.00	
Stiff brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and quartzite. (SUPD) [SUPERFICIAL DEPOSITS]			(0.80) 1.10	8.04		B 2 0.50 ES 3 0.50 B 4 1.00 ES 5 1.00	CBR 0.50 HV 0.50 HV 1.00	
Light brown gravelly fine to coarse calcareous SAND with low cobble content. Gravel is angular to subrounded of flint, calcareous siltstone. Cobbles are subangular to subrounded of extremely weak low density calcareous siltstone. (SUPD) [SUPERFICIAL DEPOSITS]			(0.80) 1.90	7.24		B 6 1.50 ES 7 1.50		
Structureless CHALK composed of light grey mottled brown slightly sandy slightly gravelly calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of siltstone. (Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(1.10) 3.00	6.14		B 8 2.00 LB 9 3.00		
End of excavation at 3.00m. Termination Reason: Achieved Scheduled Depth								

Stability	Stable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	2.50m
Length (Sides B and D)	0.60m
Depth	3.00m
Bearing along Side A toward Side B	110°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.00	0.00	HV unsuitable too friable
0.50	0.50	CBR test undertaken
1.00	1.00	HV unsuitable too gravelly

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	WATER STRIKES DETAIL Depth Water	 Time Elapsed

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	3.00	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks
0.000	3.000	1. No groundwater encountered to base of excavation. 2. Bucket width reduced to 300mm from 1.20m depth in order to achieve scheduled depth.

GENERAL NOTES

Remarks

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

SOIL ENGINEERING
Part of the Bachy Soletanche Group

FINAL   Print date and time 12/09/2022 13:59   Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID TP_STW_010 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.06mOD	Coordinates	549495.10E, 261033.30N	Grid	OSGB
Hole Type	TP	Method/Equipment	JCB 3CX		
Date Started	01/09/2021	Date Completed	01/09/2021	Logged By	AM

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Install-ation
TOPSOIL: Dark brown slightly gravelly sandy CLAY with occasional rootlets. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and quartzite. (TOP) [TOPSOIL]			(0.30) 0.30	9.76			HV 0.00	
Stiff brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint and quartzite. (SUPD) [SUPERFICIAL DEPOSITS]			(0.40) 0.70	9.36		B 1 0.50	CBR 0.50 HV 0.50	
Structureless CHALK composed of very stiff light greyish brown slightly gravelly sandy calcareous CLAY. Gravel is angular to subrounded fine to coarse of flint, quartzite and extremely weak low density calcareous siltstone. (Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(1.70) 2.40	7.66		B 2 1.00 B 3 2.00	HV 1.00	
Structureless CHALK composed of very stiff light grey mottled brown slightly sandy slightly gravelly CLAY with low cobble content. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of extremely weak low density calcareous siltstone. (Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]			(0.60) 3.00	7.06		LB 4 3.00		
End of excavation at 3.00m. Termination Reason: Achieved Scheduled Depth								

Stability	Stable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	2.50m
Length (Sides B and D)	0.60m
Depth	3.00m
Bearing along Side A toward Side B	12°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.00	0.00	HV unsuitable too friable
0.50	0.50	CBR test undertaken
1.00	1.00	HV unsuitable too gravelly

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	Depth Water	Time Elapsed

WATER STRIKES DETAIL

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	3.00	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks
0.000	3.000	1. No groundwater encountered to base of excavation. 2. Bucket width reduced to 300mm from 1.50m depth in order to achieve scheduled depth.

GENERAL NOTES

Remarks

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL　Print date and time 12/09/2022 13:59　Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID TP_STW_011 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+8.93mOD	Coordinates	549642.50E, 261120.50N	Grid	OSGB
Hole Type	TP	Method/Equipment	JCB 3CX		
Date Started	01/09/2021	Date Completed	01/09/2021	Logged By	AM

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Installation
MADE GROUND: Dark brown slightly gravelly sandy clay. Sand sized fragments are fine to coarse. Gravel sized fragments are angular to subrounded fine to coarse of brick, flint and quartzite. (MGR) [MADE GROUND]			(0.30) 0.30	8.63			HV 0.00	
Stiff brown sandy gravelly CLAY. Gravel is angular to subrounded fine to coarse of flint and quartzite. (SUPD) [SUPERFICIAL DEPOSITS]			(0.30) 0.60	8.33		B 1 0.50	CBR 0.50 HV 0.50	
Structureless CHALK composed of very stiff light greyish brown slightly gravelly sandy calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint, quartzite and extremely weak low density calcareous siltstone. (Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(1.90) 2.50	6.43		B 2 1.00 B 3 2.00	HV 1.00	
Structureless CHALK composed of very stiff light grey mottled brown slightly sandy slightly gravelly calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of extremely weak to very weak low density calcareous siltstone. (Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]			(0.50) 3.00	5.93		LB 4 3.00		
End of excavation at 3.00m. Termination Reason: Achieved Scheduled Depth								

Stability Stable

Shoring None

Excavation Dimensions and Orientation	
Length (Sides A and C)	2.60m
Length (Sides B and D)	0.60m
Depth	3.00m
Bearing along Side A towa d Side B	75°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.50	0.50	CBR test undertaken. HV unsuitable too stiff and gravelly
1.00	1.00	HV unsuitable too stiff

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	Depth Water	Time Elapsed

WATER STRIKES DETAIL

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	3.00	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks
0.000	3.000	1. No groundwater encountered to base of excavation. 2. Bucket width reduced to 300mm from 1.50m depth in order to achieve scheduled depth.

GENERAL NOTES

Remarks

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

SOIL ENGINEERING

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID
Project No.	TE8364		TP_STW_012
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+8.12mOD	Coordinates	549707.60E, 261185.50N	Grid	OSGB
Hole Type	TP	Method/Equipment	JCB 3CX		
Date Started	03/09/2021	Date Completed	03/09/2021	Logged By	AM

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Install-ation
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY with frequent rootlets. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and quartzite. (TOP) [TOPSOIL]			(0.30) 0.30	7.82			HV 0.00	
Stiff brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and quartzite. (SUPD) [SUPERFICIAL DEPOSITS]			(0.30) 0.60	7.52		B 1 0.50	CBR 0.50 HV 0.50	
Brown fine to coarse SAND and angular to subrounded fine to coarse GRAVEL of flint and quartzite. (SUPD) [SUPERFICIAL DEPOSITS]			(0.40) 1.00	7.12		B 2 0.80	HV 1.00	
Structureless CHALK composed of very stiff light grey mottled brown slightly sandy slightly gravelly calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of extremely weak to very weak low density calcareous siltstone. (Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 2.50m to 3.00m low cobble content. Cobbles are subrounded of extremely weak to very weak low density calcareous siltstone	Grade Dm		(2.00) 3.00	5.12		B 3 1.20 B 4 2.00 LB 5 3.00		
End of excavation at 3.00m. Termination Reason: Achieved Scheduled Depth								

Stability	Stable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	2.50m
Length (Sides B and D)	0.60m
Depth	3.00m
Bearing along Side A towa d Side B	165°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.50	0.50	CBR test undertaken
1.00	1.00	HV unsuitable too stiff

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	Depth Water	Time Elapsed

WATER STRIKES DETAIL

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	3.00	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks
0.000	3.000	1. No groundwater encountered to base of excavation. 2. Bucket width reduced to 300mm from 1.30m depth in order to achieve scheduled depth.

GENERAL NOTES

Remarks

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID
Project No.	TE8364		TP_STW_013
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+7.09mOD	Coordinates	549814.50E, 261278.00N	Grid	OSGB
Hole Type	TP	Method/Equipment	JCB 3CX		
Date Started	06/09/2021	Date Completed	06/09/2021	Logged By	AL

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Installation
TOPSOIL: Brown slightly clayey slightly gravelly fine to medium SAND. Gravel is subangular to subrounded of flint. (TOP) [TOPSOIL]			(0.40) 0.40	6.69		B 1 0.10-0.40	HV 0.00	
Structureless CHALK composed of firm light grey calcareous CLAY with pockets (10mm x 20mm) of orangish fine sand. (Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(1.10) 1.50	5.59		B 2 0.50-1.00	CBR 0.50 HV 0.50 HV 1.00	
Structureless CHALK composed of firm light grey calcareous CLAY. (Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]			(1.50) 3.00	4.09		B 3 1.50-2.00 B 4 2.00-2.50 LB 5 2.80-3.00		
End of excavation at 3.00m. Termination Reason: Achieved Scheduled Depth								

Stability	Stable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	2.50m
Length (Sides B and D)	0.60m
Depth	3.00m
Bearing along Side A towa d Side B	0°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.50	0.50	CBR test undertaken
2.50	2.50	Very slow seepage encountered from sides A and C

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	Depth Water	Time Elapsed

WATER STRIKES DETAIL

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	3.00	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks
0.000	3.000	1. Bucket width reduced to 300mm from 1.20m to achieve scheduled depth

GENERAL NOTES

Remarks

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID
Project No.	TE8364		TP_STW_014
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+10.62mOD	Coordinates	549541.96E, 260866.17N	Grid	OSGB
Hole Type	TP	Method/Equipment	JCB 3CX		
Date Started	07/09/2021	Date Completed	07/09/2021	Logged By	AM

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Install-ation
Stiff dark brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and quartzite. (SUPD) [SUPERFICIAL DEPOSITS]			(0.30) 0.30	10.32		ES 1 0.30	HV 0.00	
Stiff brown slightly gravelly sandy CLAY. Gravel is angular to subrounded fine to coarse of flint and quartzite. (SUPD) [SUPERFICIAL DEPOSITS]			(0.70) 1.00	9.62		B 2 0.50 ES 3 0.80	CBR 0.50 HV 0.50 HV 1.00	
Structureless CHALK composed of very stiff light greyish brown slightly gravelly sandy calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of extremely weak low density calcareous siltstone. (Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 1.05m to 1.15m lens of brown fine to coarse sand from 1.70m to 2.00m lens of brown fine to coarse sand	Grade Dm		(1.10) 2.10	8.52		B 5 1.20 ES 4 1.20 B 6 2.00		
Structureless CHALK composed of very stiff light grey mottled brown slightly gravelly sandy calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of extremely weak low density calcareous siltstone. (Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]			(0.90) 3.00	7.62		LB 7 3.00		
End of excavation at 3.00m. Termination Reason: Achieved Scheduled Depth								

Stability	Stable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	2.50m
Length (Sides B and D)	0.60m
Depth	3.00m
Bearing along Side A towa d Side B	163°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.50	0.50	CBR test undertaken
1.00	1.00	HV unsuitable too stiff

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	Depth Water	Time Elapsed

WATER STRIKES DETAIL

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	3.00	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks
0.000	3.000	1. No groundwater encountered to base of excavation. 2. Bucket width reduced to 300mm from 1.20m depth then extended using 600mm bucket.

GENERAL NOTES

Remarks

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID TP_STW_015 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.08mOD	Coordinates	549663.10E, 260980.10N	Grid	OSGB
Hole Type	TP	Method/Equipment	JCB 3CX		
Date Started	07/09/2021	Date Completed	07/09/2021	Logged By	AM

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Installation
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and quartzite. (TOP) [TOPSOIL]			(0.30) 0.30	9.78			HV 0.00	
Stiff brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and quartzite. (SUPD) [SUPERFICIAL DEPOSITS]			(0.40) 0.70	9.38		B 1 0.50	CBR 0.50 HV 0.50	
Structureless CHALK composed of very stiff light greyish brown slightly gravelly sandy calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and quartzite. (Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 1.40m to 1.60m 1 No. thin bed of brown gravelly fine to coarse sand	Grade Dm		(1.10) 1.80	8.28		B 2 1.00	HV 1.00	
Structureless CHALK composed of very stiff light grey mottled brown slightly sandy slightly gravelly calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of extremely weak to very weak low density calcareous siltstone. (Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 2.50m to 3.00m low cobble content. Cobbles are angular to subrounded of extremely weak to very weak low density calcareous siltstone			(1.20) 3.00	7.08		B 3 2.00 LB 4 3.00		
End of excavation at 3.00m. Termination Reason: Achieved Scheduled Depth								

Stability	Stable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	2.60m
Length (Sides B and D)	0.60m
Depth	3.00m
Bearing along Side A towa d Side B	85°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.50	0.50	CBR test undertaken
1.00	1.00	HV unsuitable too stiff

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	Depth Water	Time Elapsed

WATER STRIKES DETAIL

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	3.00	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks
0.000	3.000	1. No groundwater encountered to base of excavation. 2. Bucket width reduced to 300mm from 1.20m depth then extended using 600mm bucket.

GENERAL NOTES

Remarks

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID TP_STW_016 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+8.50mOD	Coordinates	549801.90E, 261086.00N	Grid	OSGB
Hole Type	TP	Method/Equipment	JCB 3CX		
Date Started	08/09/2021	Date Completed	08/09/2021	Logged By	AM

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Install-ation
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint and quartzite. (TOP) [TOPSOIL]			(0.30) 0.30	8.20			HV 0.00	
Stiff brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint and quartzite. (SUPD) [SUPERFICIAL DEPOSITS]			(0.70) 1.00	7.50		B 1 0.50	CBR 0.50 HV 0.50	
Brown slightly gravelly fine to coarse SAND. Gravel is angular to subrounded fine to coarse of flint and quartzite. (SUPD) [SUPERFICIAL DEPOSITS]			(0.40) 1.40	7.10		B 2 1.10	HV 1.00	
Structureless CHALK composed of very stiff light grey mottled brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of siltstone. (Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 2.00m to 3.10m low cobble content. Cobbles are subangular to subrounded of siltstone			(1.70) 3.10	5.40		B 3 2.00 LB 4 3.00		
End of excavation at 3.10m. Termination Reason: Achieved Scheduled Depth								

Stability Stable

Shoring None

Excavation Dimensions and Orientation

Length (Sides A and C)	2.50m
Length (Sides B and D)	0.60m
Depth	3.10m
Bearing along Side A towa d Side B	8°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.50	0.50	CBR test undertaken
2.90	2.90	Water seepage

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	Depth Water	Time Elapsed

WATER STRIKES DETAIL

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	3.10	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks
0.000	3.100	1. Bucket width reduced to 300mm from 1.00m depth in order to achieve scheduled depth.

GENERAL NOTES

Remarks

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Form No. SIEXPHOLETPLOG Issue.Revision No. 2.05 Issue Date 04/01/2019

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID TP_STW_017
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+7.38mOD	Coordinates	549943.81E, 261114.30N	Grid	OSGB
Hole Type	TP	Method/Equipment	JCB 3CX		
Date Started	10/09/2021	Date Completed	10/09/2021	Logged By	AM

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Installation
Stiff dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint and quartzite. (SUPD) [SUPERFICIAL DEPOSITS]			(0.30) 0.30	7.08			HV 0.00	
Stiff brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and quartzite. (SUPD) [SUPERFICIAL DEPOSITS]			(0.30) 0.60	6.78		B 1 0.50	CBR 0.50 HV 0.50	
Structureless CHALK composed of stiff light grey mottled brown slightly gravelly very sandy calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of siltstone. (Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(1.30) 1.90	5.48		B 2 1.00	HV 1.00	
Structureless CHALK composed of light greyish brown gravelly fine to coarse calcareous SAND. Gravel is angular to subrounded fine to medium of flint and quartzite. (Grade Dc) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dc		(0.70) 2.60	4.78	▽	B 3 2.00		
Structureless CHALK composed of firm grey slightly sandy slightly gravelly calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and quartzite. (Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(0.40) 3.00	4.38		LB 4 3.00		
End of excavation at 3.00m. Termination Reason: Achieved Scheduled Depth								

Stability	Stable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	2.60m
Length (Sides B and D)	0.60m
Depth	3.00m
Bearing along Side A towa d Side B	64°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.50	0.50	CBR test undertaken
1.00	1.00	HV unsuitable too stiff

WATER STRIKES / WATER STRIKES DETAIL

Date Time	Depth Strike	Depth Sealed	Depth Water	Time Elapsed
10/09/2021 13:00	2.50			

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	3.00	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks
0.000	3.000	600mm bucket used from ground level to base of excavation.

GENERAL NOTES

Remarks

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL   Print date and time 12/09/2022 13:59   Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID TP_STW_018 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+10.47mOD	Coordinates	549669.10E, 260779.50N	Grid	OSGB
Hole Type	TP	Method/Equipment	JCB 3CX		
Date Started	09/09/2021	Date Completed	09/09/2021	Logged By	AM

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Installation
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY with occasional rootlets. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and quartzite. (TOP) [TOPSOIL]			(0.30) 0.30	10.17		ES 1 0.20	HV 0.00	
Stiff brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and quartzite. (SUPD) [SUPERFICIAL DEPOSITS]			(0.60) 0.90	9.57		B 2 0.50 ES 3 0.50	CBR 0.50 HV 0.50	
Structureless CHALK composed of very stiff light greyish brown sandy gravelly calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint, quartzite and siltstone. (WMCK) [WEST MELBURY CHALK FORMATION] from 2.00m to 2.50m lens of brown fine to coarse sand	Grade Dm		(1.60) 2.50	7.97		B 4 1.00 ES 5 1.00 ES 6 1.50 B 7 2.00	HV 1.00	
Structureless CHALK composed of very stiff light grey mottled brown slightly sandy slightly gravelly calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of siltstone. (WMCK) [WEST MELBURY CHALK FORMATION]			(0.50) 3.00	7.47		LB 8 3.00		
End of excavation at 3.00m. Termination Reason: Achieved Scheduled Depth								

Stability	Stable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	2.50m
Length (Sides B and D)	0.60m
Depth	3.00m
Bearing along Side A towa d Side B	100°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.50	0.50	CBR test undertaken
1.00	1.00	HV unsuitable too stiff

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	WATER STRIKES DETAIL Depth Water	Time Elapsed

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	3.00	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks
0.000	3.000	1. No groundwater encountered to base of excavation. 2. Bucket width reduced to 300mm from 0.90m depth in order to achieve scheduled depth.

GENERAL NOTES

Remarks

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID TP_STW_019 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+9.47mOD	Coordinates	549787.50E, 260875.50N	Grid	OSGB
Hole Type	TP	Method/Equipment	JCB 3CX		
Date Started	10/09/2021	Date Completed	10/09/2021	Logged By	AM

Description of Strata	Weathering	Legend	Depth (Thickness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Installation
TOPSOIL: Brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and quartzite. Occasional rootlets. (TOP) [TOPSOIL]			(0.60) 0.60	8.87		B 1 0.40	HV 0.00 CBR 0.50	
Structureless CHALK composed of light greyish brown slightly gravelly fine to coarse calcareous SAND. Gravel is angular to subrounded fine to medium of flint and quartzite. (Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(0.90) 1.50	7.97		B 2 1.00	HV 0.50 HV 1.00	
Structureless CHALK composed of very stiff light grey mottled brown slightly sandy slightly gravelly calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of siltstone. (Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]			(1.50) 3.00	6.47		B 3 2.00 LB 4 3.00		
End of excavation at 3.00m. Termination Reason: Achieved Scheduled Depth								

Stability	Stable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	2.60m
Length (Sides B and D)	0.60m
Depth	3.00m
Bearing along Side A towa d Side B	170°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.50	0.50	CBR test undertaken
1.00	1.00	HV unsuitable too stiff

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	Depth Water	Time Elapsed

WATER STRIKES DETAIL

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	3.00	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks
0.000	3.000	1. No groundwater encountered to base of excavation.

GENERAL NOTES

Remarks

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

SOIL ENGINEERING

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID TP_STW_020
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+8.27mOD	Coordinates	549892.30E, 260972.30N	Grid	OSGB
Hole Type	TP	Method/Equipment	JCB 3CX		
Date Started	13/09/2021	Date Completed	13/09/2021	Logged By	AM

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Install-ation
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Gravel is angular to subrounded fine to medium of flint. Sand is fine to coarse. Occasional roots. (TOP) [TOPSOIL]			(0.30) 0.30	7.97		B 1 0.40-0.45	HV 0.00	
Stiff brown slightly gravelly sandy CLAY. Gravel is angular to subrounded fine to medium of flint. Sand is fine to coarse. (SUPD) [SUPERFICIAL DEPOSITS]			0.50	7.77		B 2 0.50-0.55	CBR 0.50 HV 0.50	
Structureless CHALK composed of light greyish brown slightly gravelly sandy calcareous CLAY. Gravel is angular to subrounded fine to medium of extremely weak low density calcareous siltstone and flint. Sand is fine to coarse. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(1.00) 1.50	6.77		B 3 1.20-1.25	HV 1.00	
Structureless CHALK composed of light greyish brown slightly gravelly sandy calcareous CLAY. Gravel is angular to subrounded fine to coarse of very weak medium density calcareous siltstone and flint. Sand is fine to coarse. (CIRIA Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]			(1.50) 3.00	5.27	▽	B 4 1.50-1.55 B 5 2.50-2.55 LB 6 2.95-3.00		
End of excavation at 3.00m. Termination Reason: Achieved Scheduled Depth								

Stability	Stable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	2.60m
Length (Sides B and D)	0.60m
Depth	3.00m
Bearing along Side A towa d Side B	6°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.50	0.50	CBR test undertaken
1.00	1.00	HV unsuitable too stiff

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	Depth Water	Time Elapsed
			WATER STRIKES DETAIL	
13/09/2021 10:15	2.80		2.80	

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	3.00	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks
0.000	3.000	Bucket width reduced to 300mm from 1.50m then extended using 600mm bucket.

GENERAL NOTES

Remarks

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID
Project No.	TE8364		TP_STW_021
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+11.01mOD	Coordinates	549640.40E, 260669.50N	Grid	OSGB
Hole Type	TP	Method/Equipment	JCB 3CX		
Date Started	13/09/2021	Date Completed	13/09/2021	Logged By	AM

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Install-ation
MADE GROUND: Dark brown slightly sandy slightly gravelly clay. Sand sized fragments are fine to coarse. Gravel sized fragments are angular to subrounded fine to medium of flint, quartzite and brick. (MGR) [MADE GROUND]			(0.30) 0.30	10.71		B 1 0.30-0.35	HV 0.00	
Stiff brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint and quartzite. (SUPD) [SUPERFICIAL DEPOSITS]			(0.50) 0.80	10.21		B 2 0.80-0.85	CBR 0.50 HV 0.50	
Structureless CHALK composed of very stiff light grey mottled brown slightly gravelly very sandy calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint, quartzite and extremely weak low density calcareous siltstone. (Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(1.20) 2.00	9.01		B 3 1.50-1.55 B 4 2.00-2.05	HV 1.00	
Structureless CHALK composed of very stiff light grey mottled brown slightly gravelly sandy calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of very weak medium density calcareous siltstone. (Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]			(1.00) 3.00	8.01		LB 5 2.95-3.00		
End of excavation at 3.00m. Termination Reason: Achieved Scheduled Depth								

Stability	Stable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	2.50m
Length (Sides B and D)	0.60m
Depth	3.00m
Bearing along Side A towa d Side B	115°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.50	0.50	CBR test undertaken
1.00	1.00	HV unsuitable too stiff

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	Depth Water	Time Elapsed

WATER STRIKES DETAIL

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	3.00	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks
0.000	3.000	1. No groundwater encountered to base of excavation. 2. Bucket width reduced to 300mm from 1.50m and widened with 600mm bucket.

GENERAL NOTES

Remarks

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID TP_STW_022 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+8.61mOD	Coordinates	549903.10E, 260771.40N	Grid	OSGB
Hole Type	TP	Method/Equipment	JCB 3CX		
Date Started	14/09/2021	Date Completed	14/09/2021	Logged By	AM

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Install-ation
Soft to firm dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to medium of flint and quartzite. (SUPD) [SUPERFICIAL DEPOSITS]			(0.30) 0.30	8.31			HV 0.00	
Stiff brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and quartzite. (SUPD) [SUPERFICIAL DEPOSITS]			(0.30) 0.60	8.01		B 1 0.40-0.45	CBR 0.50 HV 0.50	
Structureless CHALK composed of very stiff light greyish brown slightly gravelly sandy calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint, quartzite and extremely weak low density calcareous siltstone. (Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(1.40) 2.00	6.61		B 2 0.60-0.65 B 3 1.50-1.55	HV 1.00	
Structureless CHALK composed of stiff light grey mottled brown slightly sandy slightly gravelly calcareous CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of very weak medium density calcareous siltstone. (Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]			(1.00) 3.00	5.61		B 4 2.00-2.05 LB 5 2.95-3.00		

End of excavation at 3.00m. Termination Reason: Achieved Scheduled Depth

Stability	Stable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	2.50m
Length (Sides B and D)	0.60m
Depth	3.00m
Bearing along Side A toward Side B	135°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.50	0.50	CBR test undertaken
1.00	1.00	HV unsuitable too stiff
3.00	3.00	Soakaway test undertaken

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	Depth Water	Time Elapsed

WATER STRIKES DETAIL

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	3.00	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks
0.000	3.000	1. No groundwater observed, wet weather conditions 2. Bucket width reduced to 300mm from 1.20m and widened with 600mm bucket.

GENERAL NOTES

Remarks

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

SOIL ENGINEERING

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID TP_STW_031 Sheet 1 of 1
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Ground Level	+11.77mOD	Coordinates	549375.40E, 260811.90N	Grid	OSGB
Hole Type	TP	Method/Equipment	JCB 3CX		
Date Started	15/09/2021	Date Completed	15/09/2021	Logged By	AM

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Install-ation
TOPSOIL: Dark brown slightly sandy slightly gravelly CLAY. Gravel is angular to subrounded fine to medium of flint. Sand is fine to coarse. Occasional roots. (TOP) [TOPSOIL]			(0.50) 0.50	11.27		B 1 0.30-0.35 B 2 0.50-0.55	HV 0.00 CBR 0.50	
Structureless CHALK composed of very stiff light greyish brown slightly gravelly sandy calcareous CLAY. Gravel is angular to subrounded fine to coarse of flint and extremely weak low density calcareous siltstone. Sand is fine to coarse. (WMCK) [WEST MELBURY CHALK FORMATION]	Grade Dm		(1.50) 2.00	9.77		B 3 1.40-1.45 B 4 2.00-2.05	HV 0.50 HV 1.00	
Extremely weak to very weak medium density light grey mottled brown CHALK composed of calcareous SILTSTONE. Discontinuities are generally very closely spaced, randomly orientated, occasionally stained brown with black speckling. (Probably CIRIA Grade B3/4) (WMCK) [WEST MELBURY CHALK FORMATION]			(1.00) 3.00	8.77		LB 5 2.95-3.00		
End of excavation at 3.00m. Termination Reason: Achieved Scheduled Depth								

Stability	Stable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	2.50m
Length (Sides B and D)	0.60m
Depth	3.00m
Bearing along Side A towa d Side B	120°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.50	0.50	CBR test undertaken
3.00	3.00	Soakaway test undertaken

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	Depth Water	Time Elapsed

WATER STRIKES DETAIL

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	3.00	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks
0.000	3.000	1. Groundwater not encountered to base of excavation 2. Bucket width reduced to 300mm from 1.00m to base of excavation and then widened with a 600mm bucket

GENERAL NOTES

Remarks

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Excavation Log	Hole ID
Project No.	TE8364		TP_STW_032
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		Sheet 1 of 1

Ground Level	+11.43mOD	Coordinates	549285.50E, 261019.20N	Grid	OSGB
Hole Type	TP	Method/Equipment	JCB 3CX		
Date Started	13/09/2021	Date Completed	13/09/2021	Logged By	AM

Description of Strata	Weathering	Legend	Depth (Thick-ness)	Datum Level	Waterstrike	Sampling Details	In Situ Test Details	Install-ation
TOPSOIL: Dark brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of flint and quartzite. (TOP) [TOPSOIL]			(0.30) 0.30	11.13		B 1 0.30-0.35	HV 0.00	
Structureless CHALK composed of very stiff light grey mottled brown slightly sandy slightly gravelly calcareous CLAY with frequent lenses of brown fine to coarse sand (<40mm). Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of very weak medium density calcareous siltstone. (Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION] from 1.20m to 2.00m no sand lenses	Grade Dm		(1.70) 2.00	9.43		B 2 1.00-1.05 B 3 2.00-2.05	CBR 0.50 CBR 0.50 HV 0.50 HV 1.00	
Structureless CHALK composed of very stiff light grey mottled brown slightly sandy very gravelly calcareous CLAY with medium cobble content. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse of very weak medium density calcareous siltstone. Cobbles are subangular of very weak medium density calcareous siltstone. (Grade Dm) (WMCK) [WEST MELBURY CHALK FORMATION]			(1.00) 3.00	8.43		LB 4 2.95-3.00		
End of excavation at 3.00m. Termination Reason: Achieved Scheduled Depth								

Stability	Stable
Shoring	None

Excavation Dimensions and Orientation

Length (Sides A and C)	2.50m
Length (Sides B and D)	0.60m
Depth	3.00m
Bearing along Side A towa d Side B	90°

DEPTH RELATED REMARKS

Depth Top	Depth Base	Remarks
0.50	0.50	CBR test undertaken. HV unsuitable too stiff
1.00	1.00	HV unsuitable too stiff

WATER STRIKES

Date Time	Depth Strike	Depth Sealed	Depth Water	Time Elapsed

WATER STRIKES DETAIL

BACKFILL

Depth Top	Depth Base	Description	Remarks
0.00	3.00	Arisings	

DEPTH RELATED EXPLORATORY HOLE REMARKS

Depth Top	Depth Base	Remarks
0.000	3.000	1. No groundwater encountered to base of excavation. 2. Bucket width reduced to 300mm from 1.00m and widened with 600mm bucket to 2.00m. Too stiff to widen to base.

GENERAL NOTES

Remarks

AGS

Notes: All depth in metres, all soil strengths are average in kPa. For in situ test results, see accompanying records.
All bearings given relate to magnetic North.
For details of abbreviations, see key.

FINAL Print date and time 12/09/2022 13:59 Log checked by David Howard

SOIL ENGINEERING

SOIL ENGINEERING

SUPPORTING FACTUAL DATA

SECTION A

Exploratory Hole Records and Field Data

IN SITU TEST DATA

REPORT ON THE

GEOPHYSICAL LOGGING

OF

THREE BOREHOLES

AT

CAMBRIDGE WATER TREATMENT WORKS

Prepared For:

Henderson House
Langley Place
Higgins Lane,
Burscough
Lancashire
L40 8JS

SEPTEMBER2021/SENG2111_CAMBRIDGE_WTW_Rpt/TL46

	Name	Date
Logged by:	K. Clark	22.09.2021
Report by:	K. Clark	14.10.2021
Checked by:	M. Kynaston	18.10.2021

CONTENTS

LIST OF FIGURES

1.0 INTRODUCTION

At the request of Soil Engineering Geoservices limited, optical and acoustic imaging, and geophysical logging was carried out in three boreholes for the Cambridge Water Treatment Works ground investigation

The work was carried out by European Geophysical Services on the 23rd of August, and 17th & 22nd September 2021.

The following logs were run:-

BH	Logs	From (m)	To (m)
BH_STW_013A	Optical Borehole Imager (OBI) Acoustic Borehole Imager (ABI)	1.5	11.0
BH_STW_018	Optical Borehole Imager (OBI) Acoustic Borehole Imager (ABI) 3-arm Caliper (CAL3) Natural Gamma (GAM)	3	28.9
BH_TUN_018	Optical Borehole Imager (OBI) Acoustic Borehole Imager (ABI) 3-arm Caliper (CAL3) Natural Gamma (GAM)	2	11.9

2.0 THE GEOPHYSICAL LOGGING METHODS

The Equipment and Field Procedure

A fully digital logging system with a 600m capacity motorised winch mounted in a 4x4 van was used.

All logging data was recorded digitally for reprocessing and archiving purposes.

The optical imager survey was carried out first to avoid the disturbance of the fluid by the geophysical logs which may affect water clarity.

Acoustic Borehole Imager (Amplitude and Travel Time)

This tool scans the borehole wall through 360 degrees and records the acoustic reflection of the resulting signal in terms of amplitude and transit time (the travel time from the tool to the borehole wall). This technique requires a fluid filled borehole with a minimum of suspended solids, polymers or muds within the fluid column.

This sensitive technique responds to small diameter changes, rugosity and the acoustic nature of the borehole wall. It is primarily used for detecting fractures and other discontinuities. The resultant images are orientated (to magnetic North) 0° through 90°, 180° and 270° back to 0°.

The logging tool is centralised during data acquisition by two sets of bow springs. The bow springs are adjusted to a variety of borehole diameters prior to acquisition. The image is viewed on the way down the borehole to allow fine tuning of the acquisition parameters. The settings are then adjusted and the image recorded on the way up the borehole which ensures a constant line speed during acquisition.

Images and associated data are viewed in real time during the data acquisition.

The orientation system employs a flux gate magnetometer and therefore the recorded data within approximately one metre of magnetic steel casing is un-orientated. This is corrected manually during the post-processing stage

2.0 THE GEOPHYSICAL LOGGING METHODS

Optical Borehole Imager (Optical)

A precision-machined prism and CCD camera assembly permits a high-definition video image of the borehole wall to be captured in a variety of horizontal and vertical resolutions. The resulting image is digitised in the sonde for transmission to the surface acquisition system.

The image is then orientated to Magnetic North and displayed as an unwrapped image log. This enables a detailed structural interpretation to be made if required.

For the best results the optical imager should be run above the water level or in clean, clear fluid. The logging tool is centralised during data acquisition by two sets of bow springs. The bow springs are adjusted to a variety of borehole diameters prior to acquisition. The image is recorded on the way down the borehole to limit disturbance to the clarity of the water in the borehole by the logging tool.

Images and associated data are viewed in real time during the data acquisition.

The orientation system employs a flux gate magnetometer and therefore the recorded data within approximately one metre of magnetic steel casing is un-orientated. This is corrected manually during the post-processing stage

Natural Gamma (Gam)

The tool measures the naturally occurring gamma radiation found in rocks and sediments. It is mainly used to detect the clays that contain potassium K^{40}, though the U^{238} and the Th^{232} series of elements present in certain rocks also emit gamma radiation. The higher the concentration of these clay minerals the greater the responses on the natural gamma log. Natural Gamma radiation is expressed in counts per second (CPS).

Caliper (Cal3)

This tool measures 3 diameters of the borehole. It is used to check the integrity of the borehole lining, and where the borehole is unlined to identify zones of washout, breakout or fissures.

3.0 SITE DETAILS

Cambridge water treatment works, Horningsea, Cambridgeshire
OS Grid Reference: TL 4976 6159

Figure 3.1 OS Map showing approximate area of investigation highlighted by red oval. © Crown copyright 2021 OS100057099.

Figure 3.2 Aerial Image showing site compound and approximate borehole locations. © Google 2021

4.0 PROCESSING AND PRESENTATION OF IMAGER RESULTS

Detailed logs of the imager data have been produced at a vertical scale of 1:20.

Constructional details and information on each borehole are given in the headers of each log.

All images have been referenced to Magnetic North.

The borehole's azimuth and tilt are plotted alongside the images.

The image of the borehole wall is presented in an unwrapped form with a horizontal scale marked 0° - North, through 90° - East, 180° - South, 270° - West, back to North.

Structural features and discontinuities have been picked from the images in the form of colour coded sinusoidal projections - see Appendix 1 for details. This 'Discontinuities' log is also presented with a horizontal scale marked 0° - North, through 90° - East, 180° - South, 270° - West, back to North.

Structure picking is not a definitive analysis of all the features within a borehole. Only the discontinuities that have a linear dip and direction are 'picked' and used in the analysis of the discontinuities. Features that do not have a regular sinusoidal shape do not have a linear dip and direction, 'best fit' picking of these features is done if approximately 80% coverage of the sinusoid can be achieved. Below this percentage the inaccuracy of the picking is too great and if included in any structural analysis may adversely skew the results. Vughs, solution holes, and angular break outs are examples of features not picked.

The apparent azimuth and apparent dip (i.e. relative to the borehole's azimuth and tilt) of the discontinuities are calculated using the diameter of the borehole and the geometric parameters of the sinusoids overlaid on the discontinuities. The final processing stage is to correct these apparent values to true azimuth (in relation to Magnetic North) and true dip (from horizontal) by correcting for the borehole's azimuth and tilt.

The final results are presented as a 'tadpole' plot (Discontinuities - True°). The horizontal position of the tadpole's head gives the defect's true dip angle and its tail points in the direction of the defect's azimuth. These logs are presented with a horizontal scale in degrees. By convention the top of the page is North (Magnetic) and the right hand edge of the paper is East.

The true structural data has been presented in digital format as an excel file (xls).

5.0 BOREHOLE LOGGING CONSTRAINTS

- **Vehicle access restrictions**
  Farmland, 4x4 required.

- **Tool access restrictions**
  None

- **Borehole conditions / risk to equipment**
  Larger diameter on BHSTW13A prevented good centralisation of the acoustic imager.

- **Lack of fluid filled column / cloudy fluid**
  Boreholes required acoustic imager logs due to cloudy fluid.

- **Time constraint**
  None

- **Borehole construction / casing**
  Overburden cased off with steel casing, rotary cored to total depth.

Appendix 1

Discontinuity Classification.

Discontinuity	**Colour**	**Classification Parameters**
Major Fracture or Fissure	Blue	An open break in the formation, that is **continuous** across the entire image.
Minor Fracture or Fissure	Turquoise	A thin or closed break in the formation, that is **continuous or discontinuous** across the image.
Vein	Green	That may be **continuous or discontinuous** across the entire image.
Fabric	Red	Defines a feature generally metamorphic, igneous or sedimentary in origin that may be **continuous or discontinuous** across the image, such as bedding and cross-bedding, schistosity or gneissosity.
Intrusions	Purple	Intrusive features such as dykes and sills, generally **continuous** across the image
Unknown	Black	Faint features which **can not** be classified.

Appendix 2

Geophysical Logs

EUROPEAN GEOPHYSICAL SERVICES LTD

Client:	**Soil Engineering**	Log Type:
Borehole:	**BH_STW_013A**	***Image***

Location: **TE8364** Area: **Cambridge** Grid Ref: Elevation:

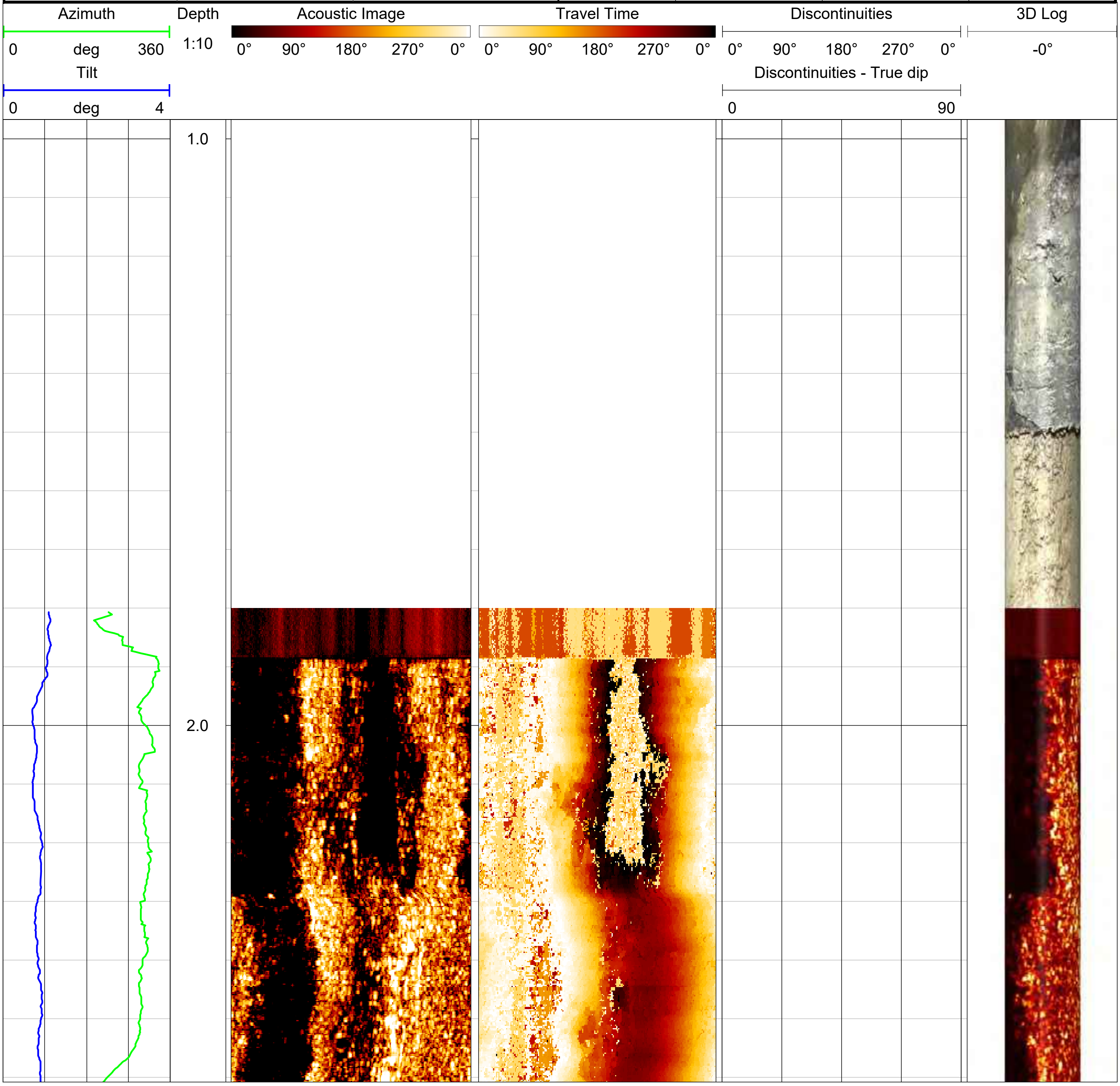
Drilled Depth: (m)	**13.0**	Date:	**23.08.2021**
Logged Depth: (m)	**11.0**	Recorded By:	**K. Clark**
Logging Datum:	**Ground Level**	Remarks:	Logs run immediately after casing pull. Optical log stopped due to poor fluid visibility and not presented. Large diameter and poor centralisation affects acoustic image logs
Logged Interval: (m)	**1.13 - 11.0**		
Fluid Level: (m)	**1.86**		

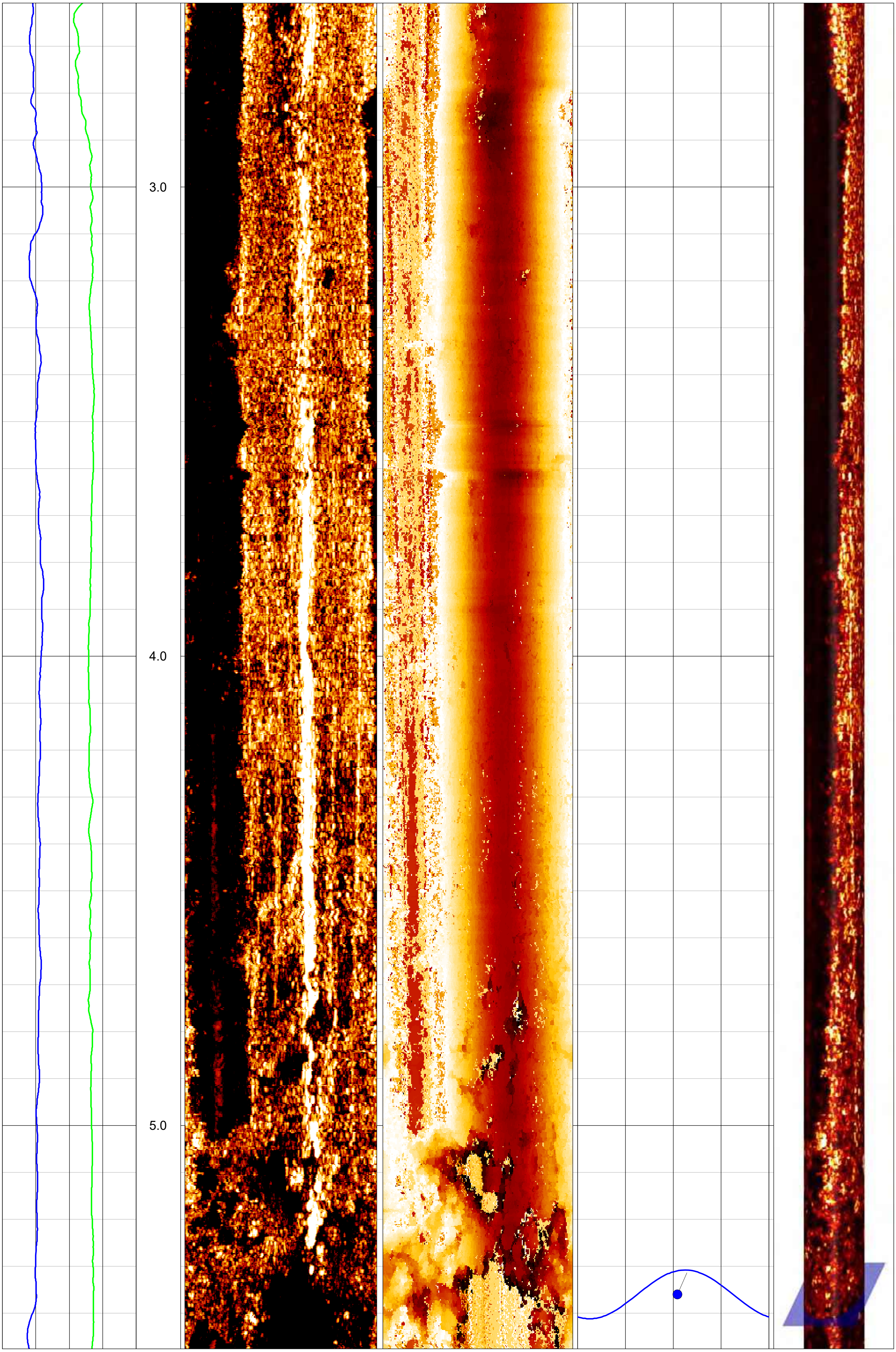
BOREHOLE RECORD

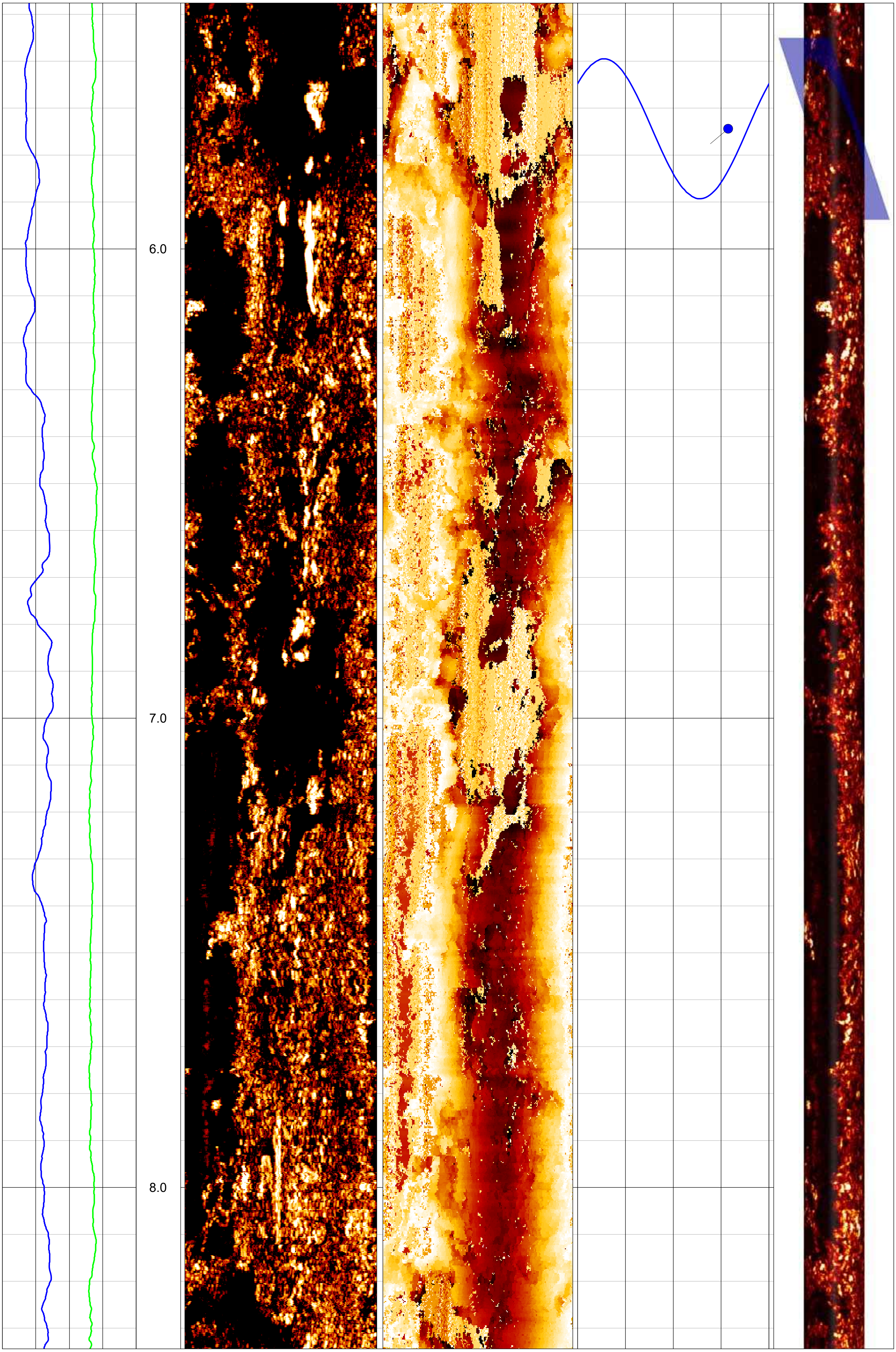
Bit: (mm)	From: (m)	To: (m)
203	**1.5**	**11**

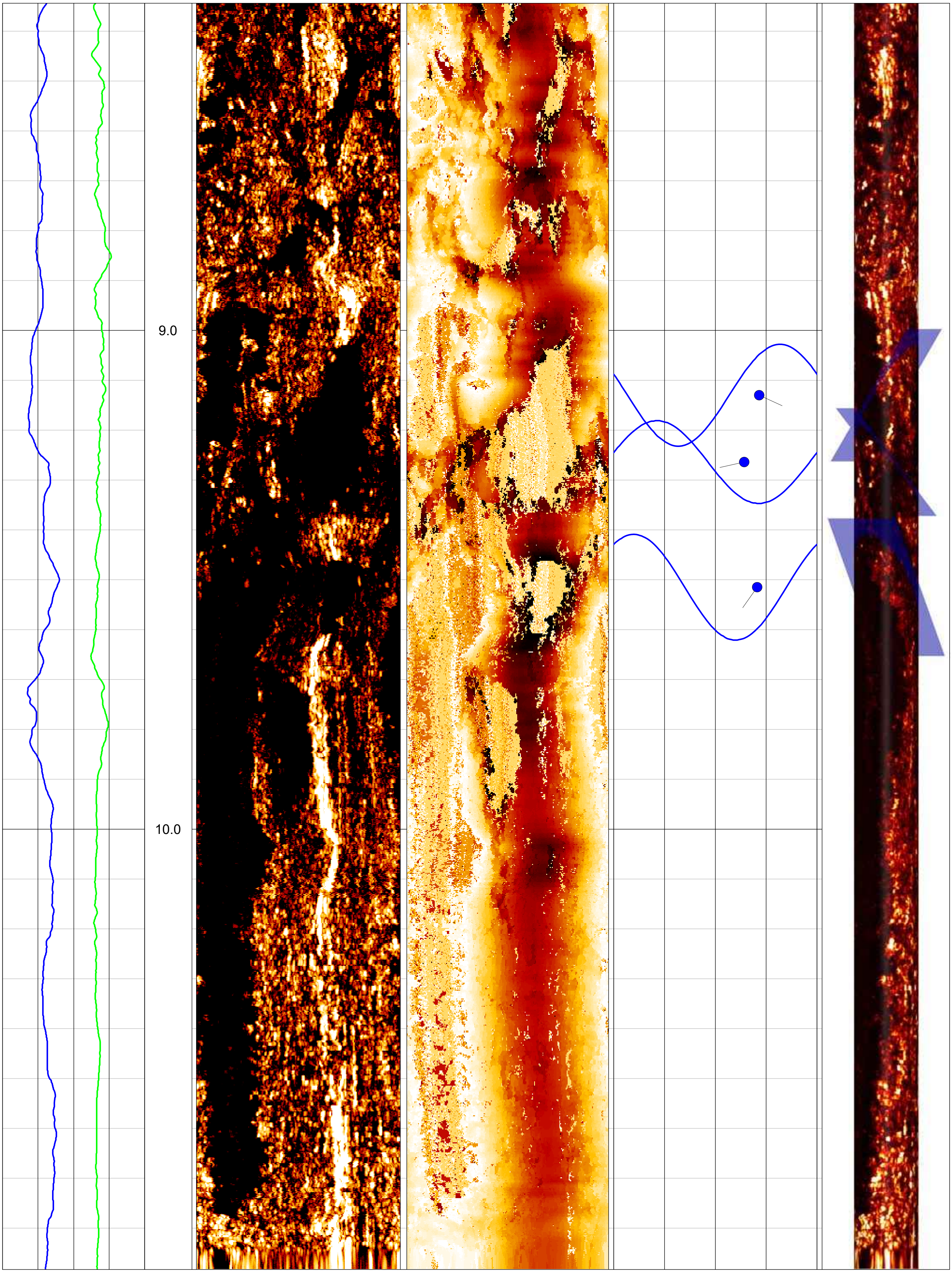
CASING RECORD

Type	Size: (mm)	From: (m)	To: (m)
Steel	**203**	**-0.50**	**1.5**




3.0
4.0
5.0


6.0
7.0
8.0


9.0
10.0

EUROPEAN GEOPHYSICAL SERVICES LTD

Client:	**Soil Engineering**	Log Type: *Image*
Borehole:	**BH_STW_018**	

Location: **TE8364** Area: **Cambridge** Grid Ref: Elevation:

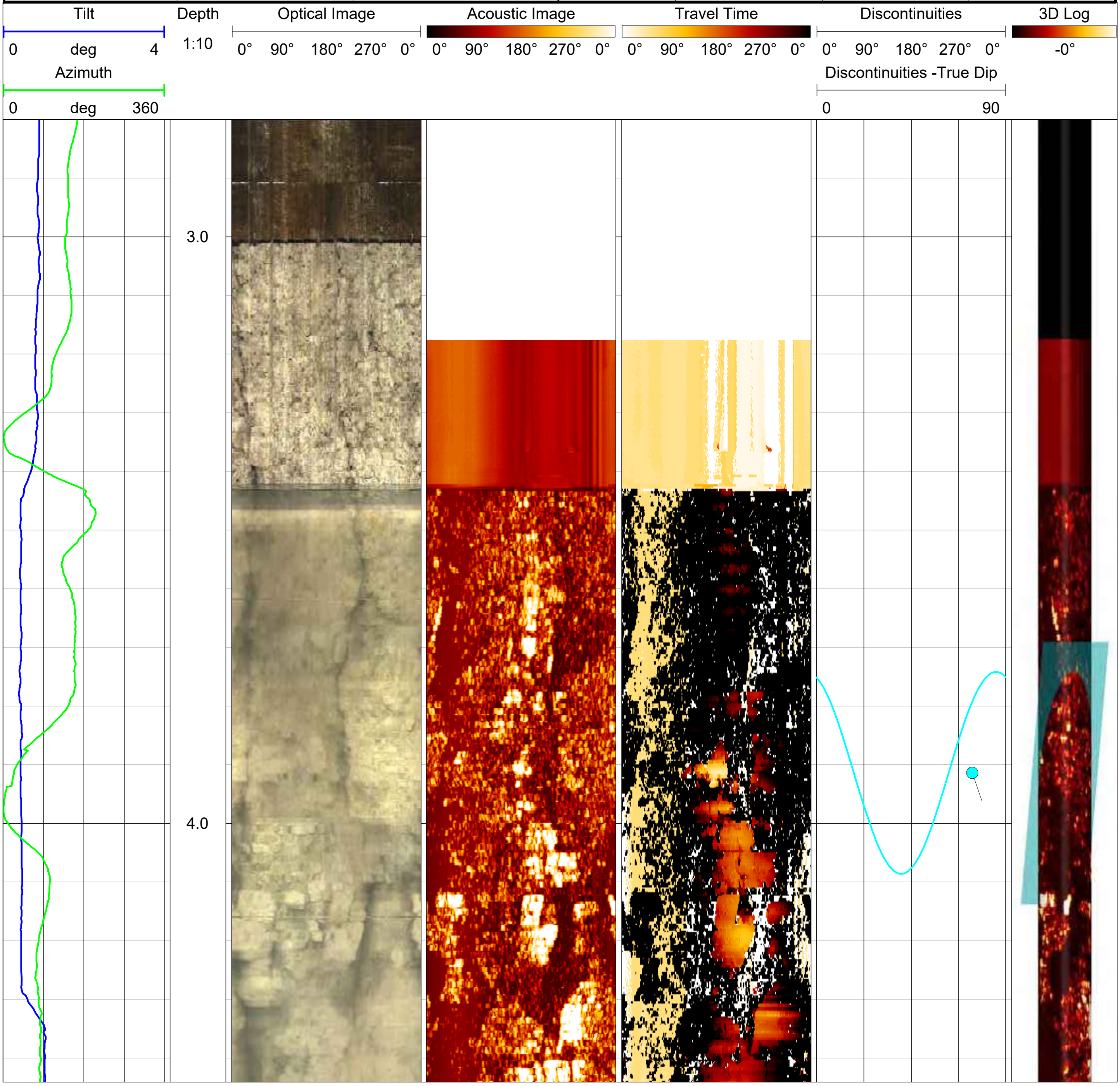
Drilled Depth: (m)	**30.0**	Date:	**17.09.2021**
Logged Depth: (m)	**28.9**	Recorded By:	**K. Clark**
Logging Datum:	**Ground Level**	Remarks:	Fluid left for ~12hrs. Still cloudy below ~12m for optical log. Acoustic log taken.
Logged Interval: (m)	**3 - 28.9**		
Fluid Level: (m)	**3.42**		

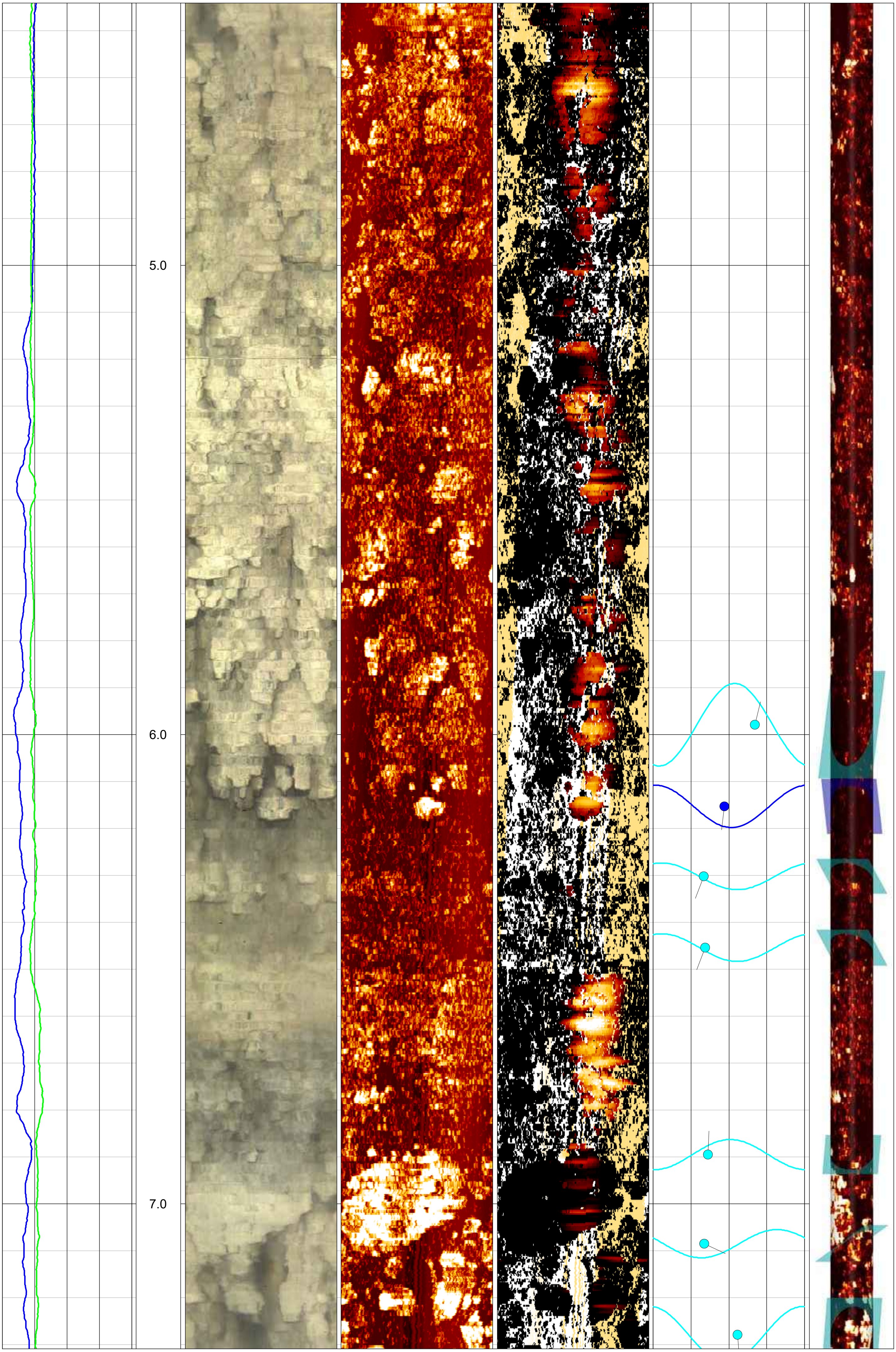
BOREHOLE RECORD

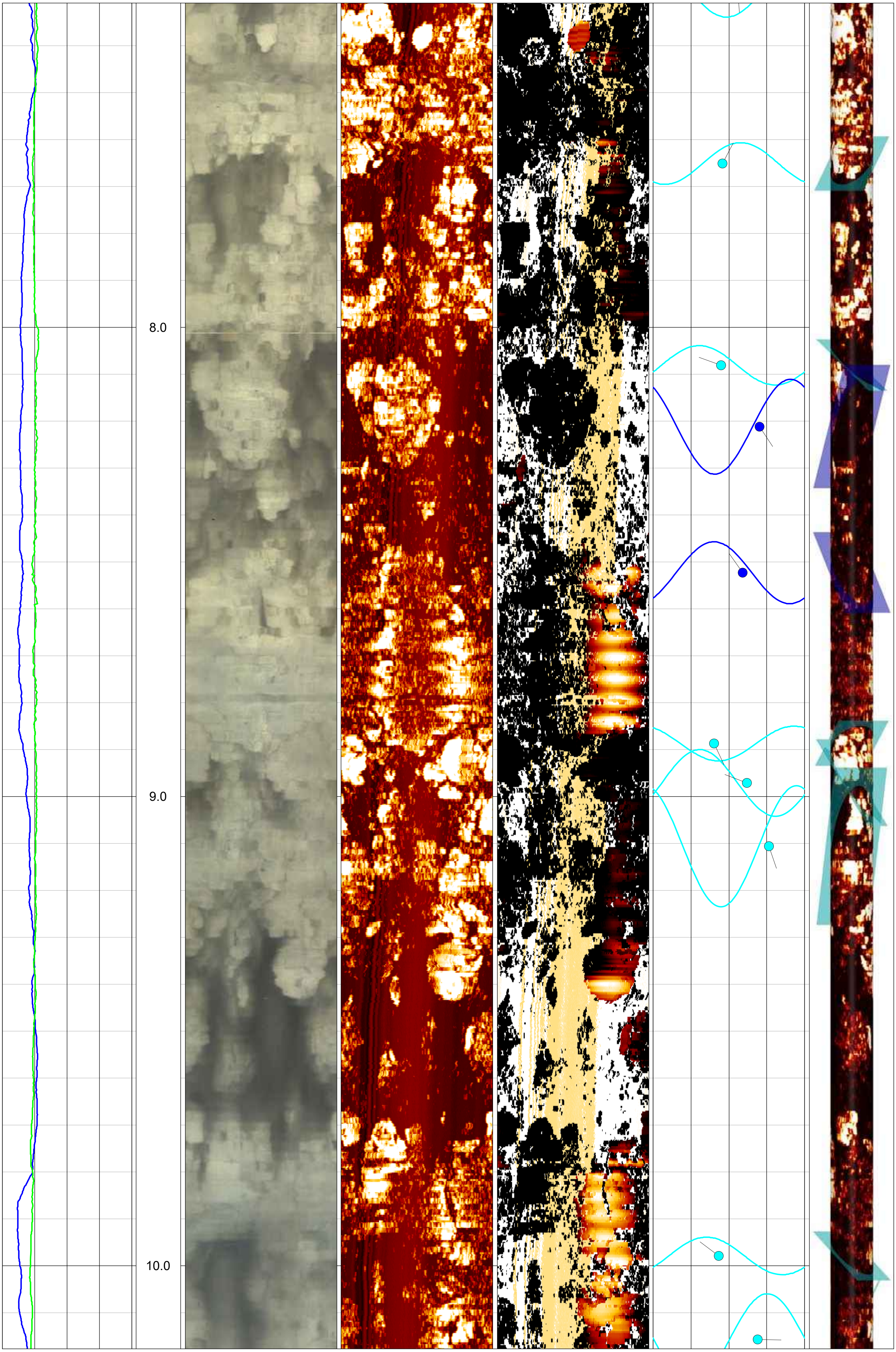
Bit: (mm)	From: (m)	To: (m)
150	**3.0**	**28.9**

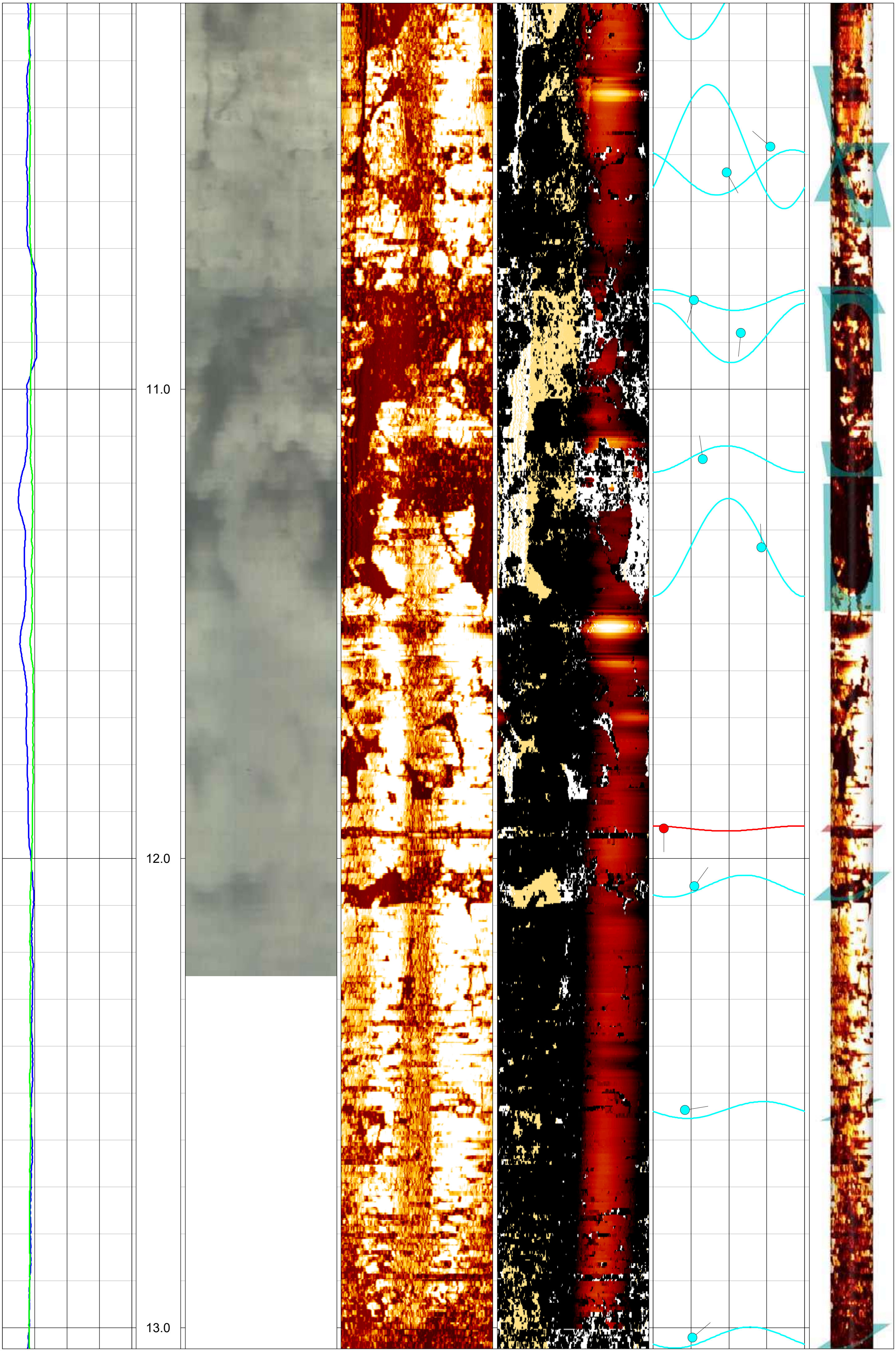
CASING RECORD

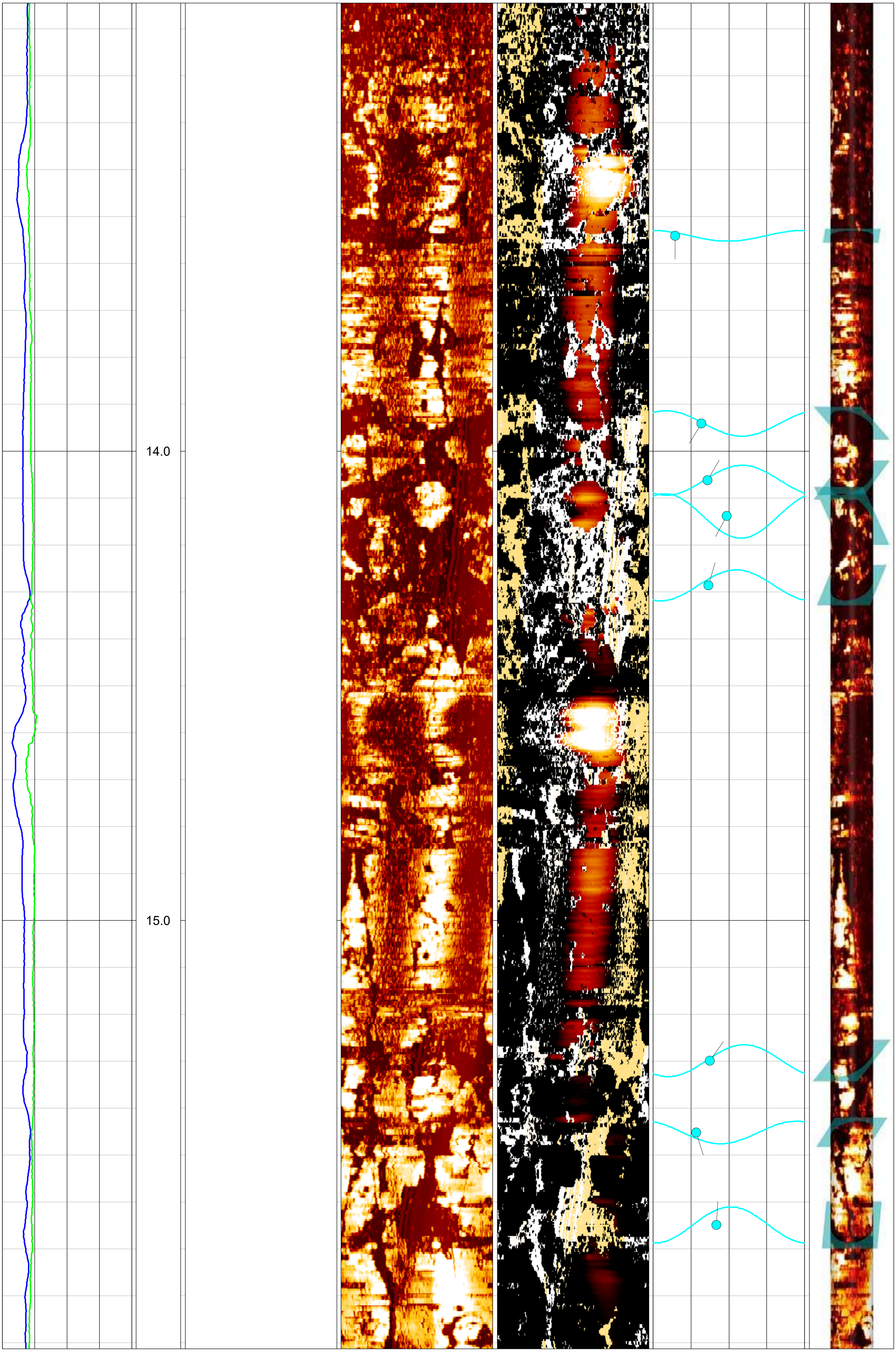
Type	Size: (mm)	From: (m)	To: (m)
Steel	**147**	**-0.94**	**3.0**

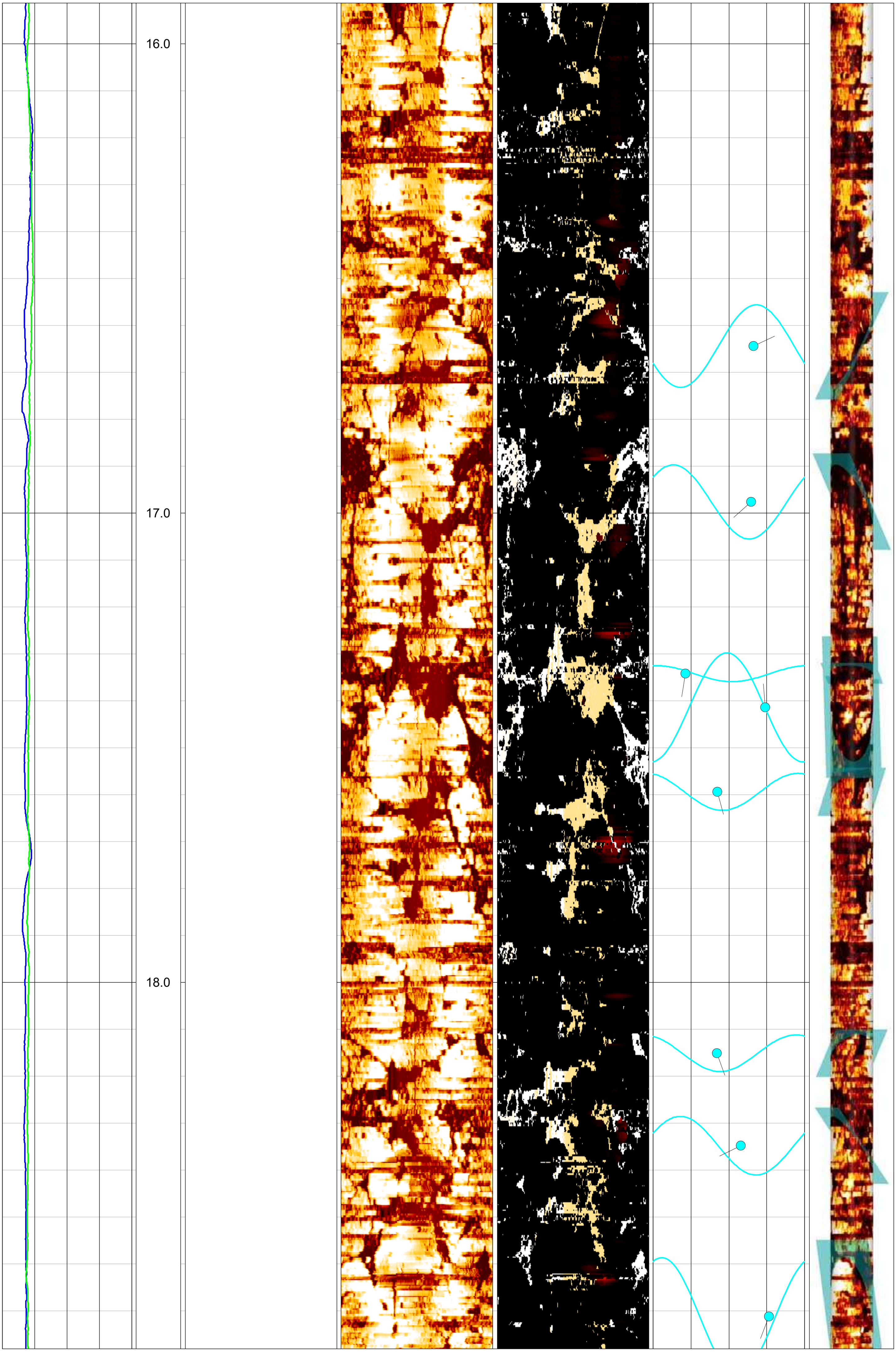


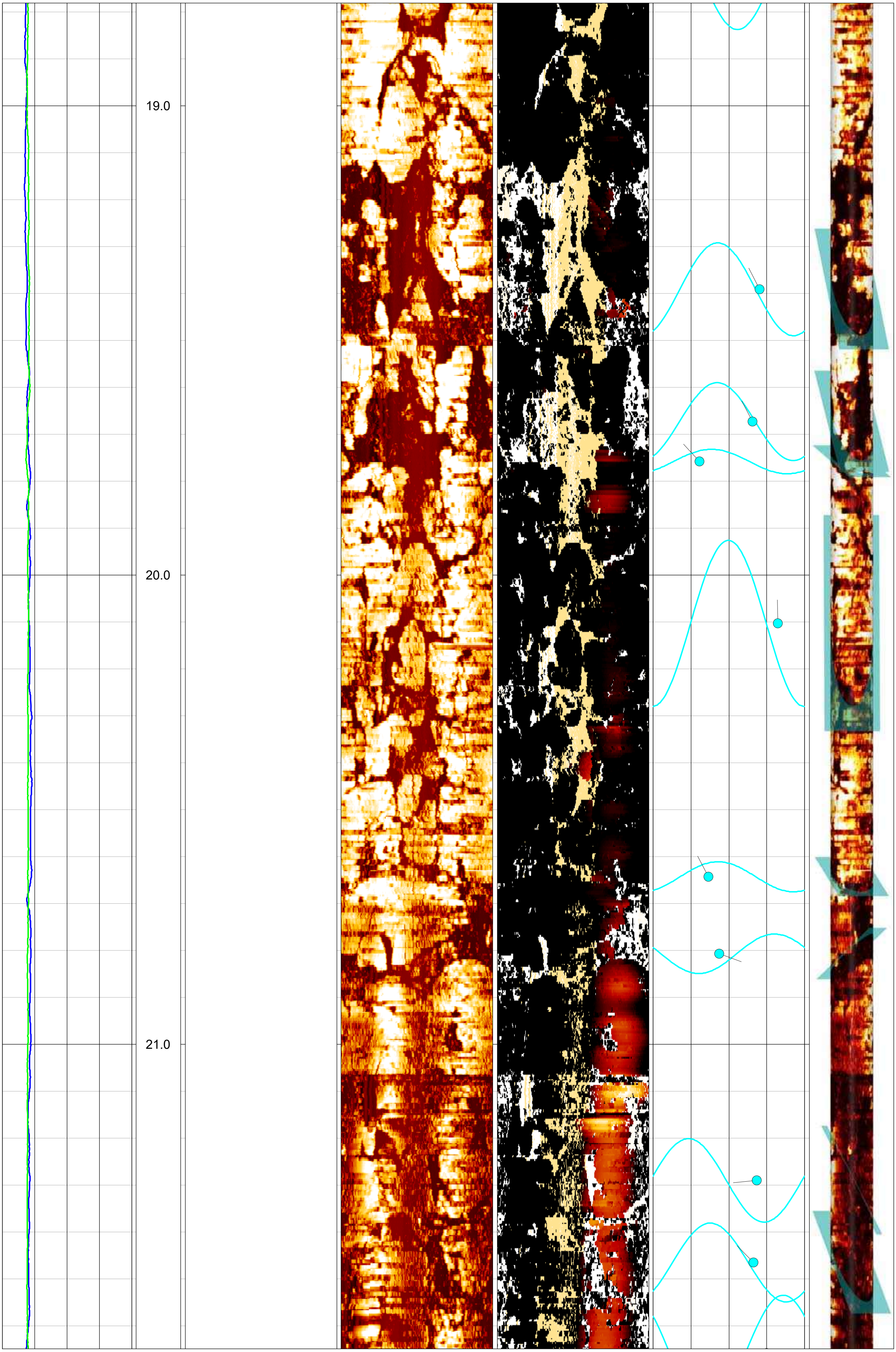

5.0
6.0
7.0

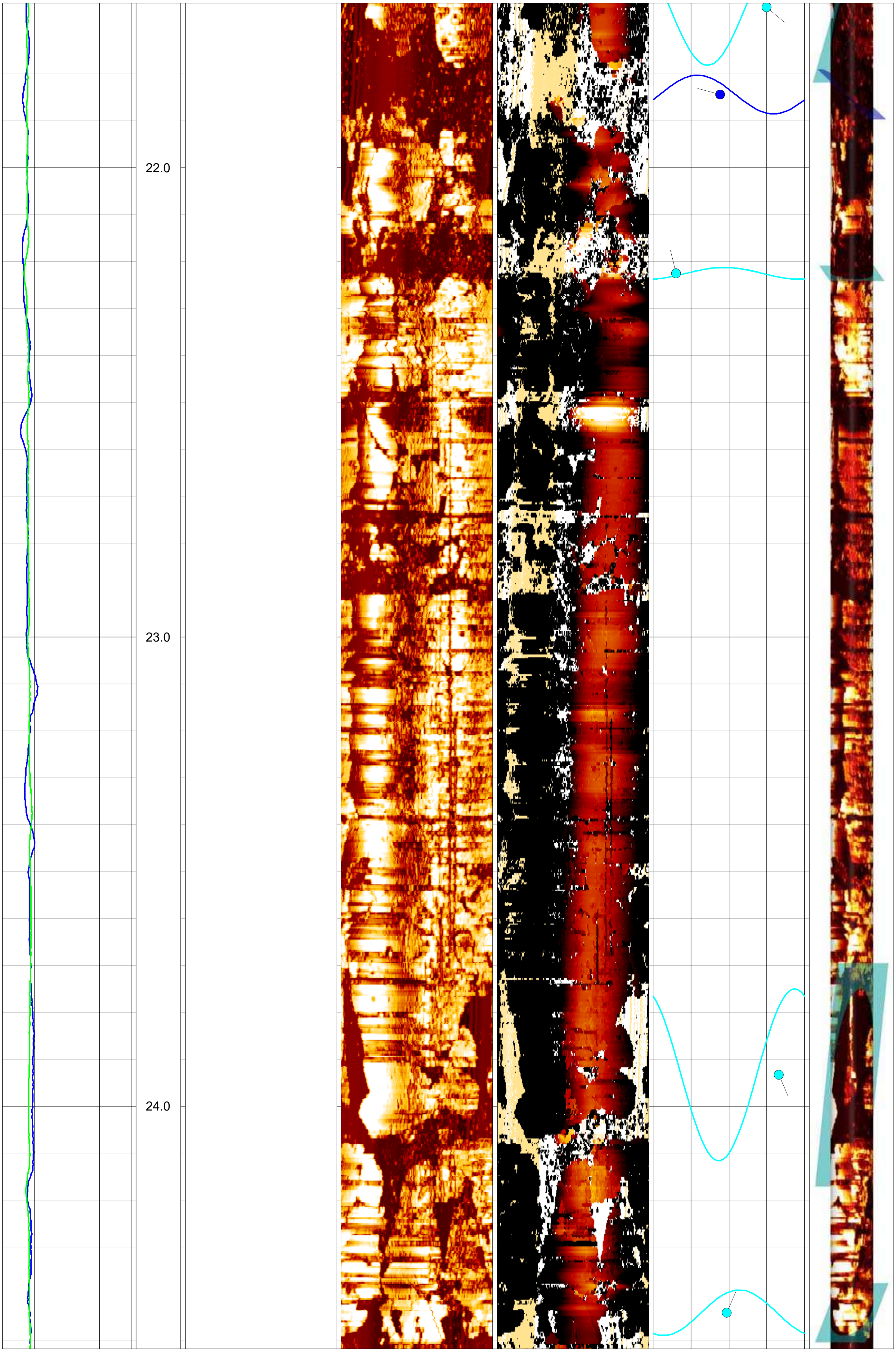

8.0
9.0
10.0

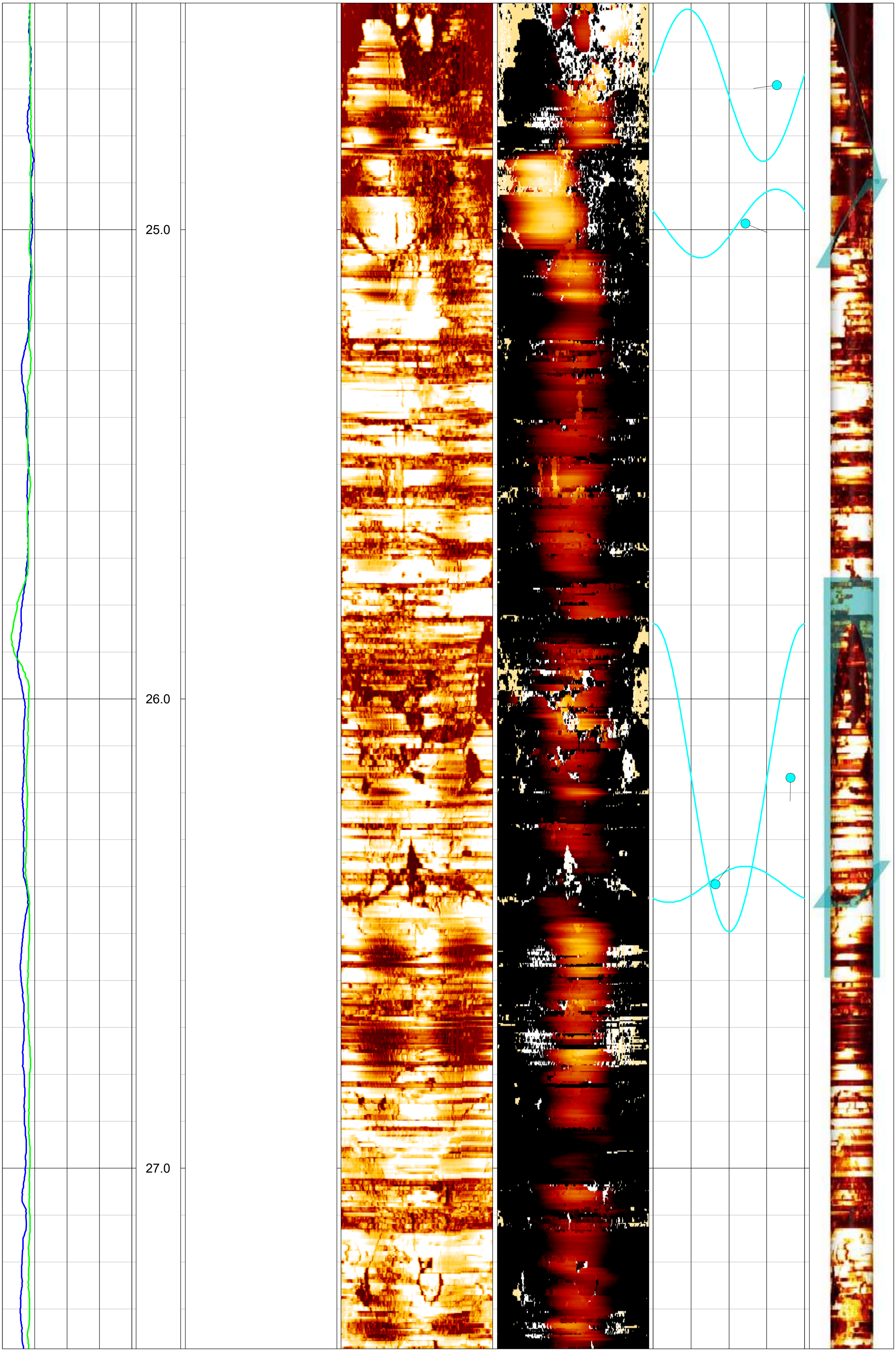

11.0
12.0
13.0

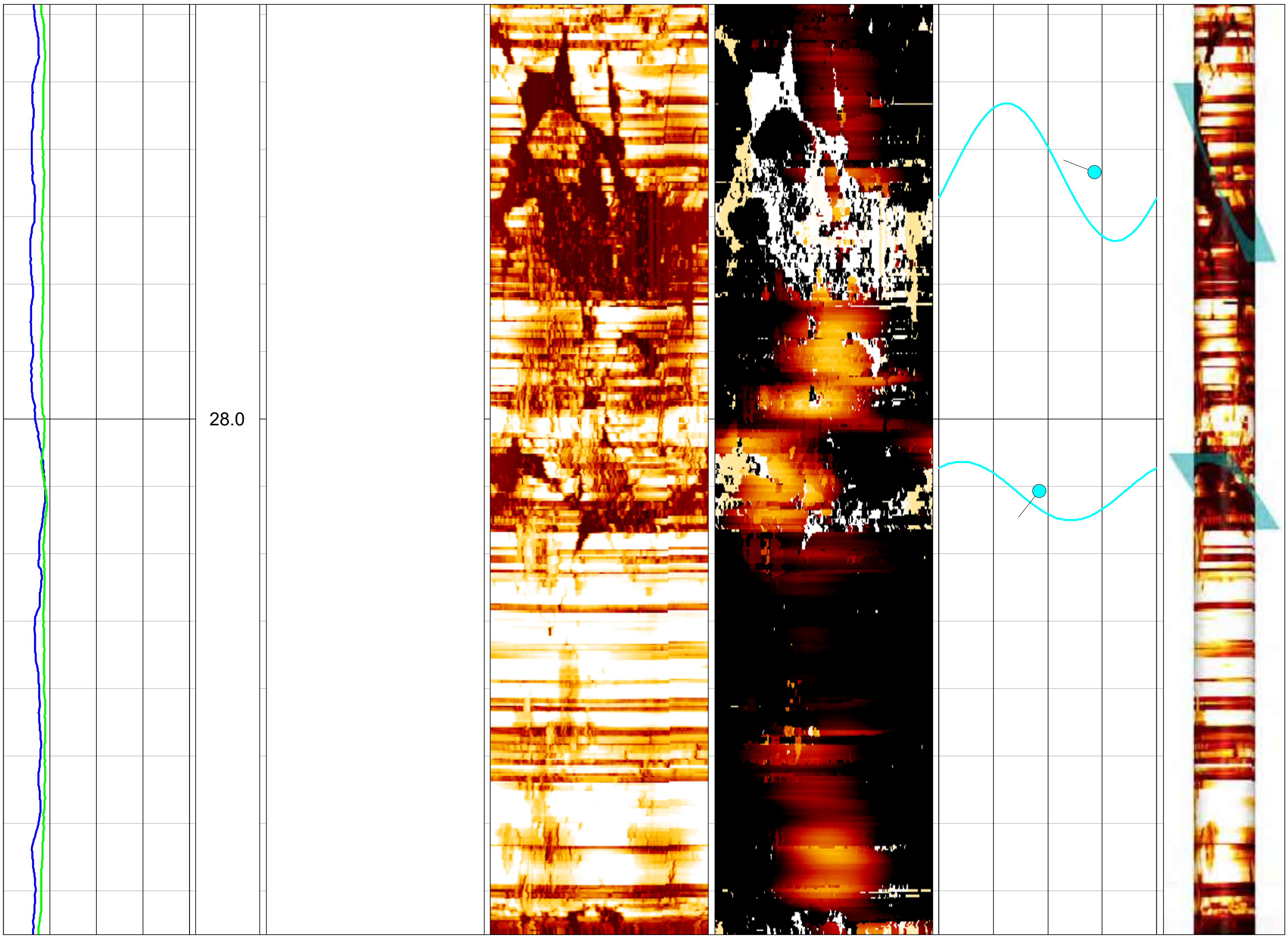

14.0
15.0


16.0
17.0
18.0


19.0
20.0
21.0


22.0
23.0
24.0


25.0
26.0
27.0


28.0

EUROPEAN GEOPHYSICAL SERVICES LTD

Client:	**Soil Engineering**	Log Type: ***Composite***
Borehole:	**BH_STW_018**	

Location: **TE8364** Area: **Cambridge** Grid Ref: Elevation:

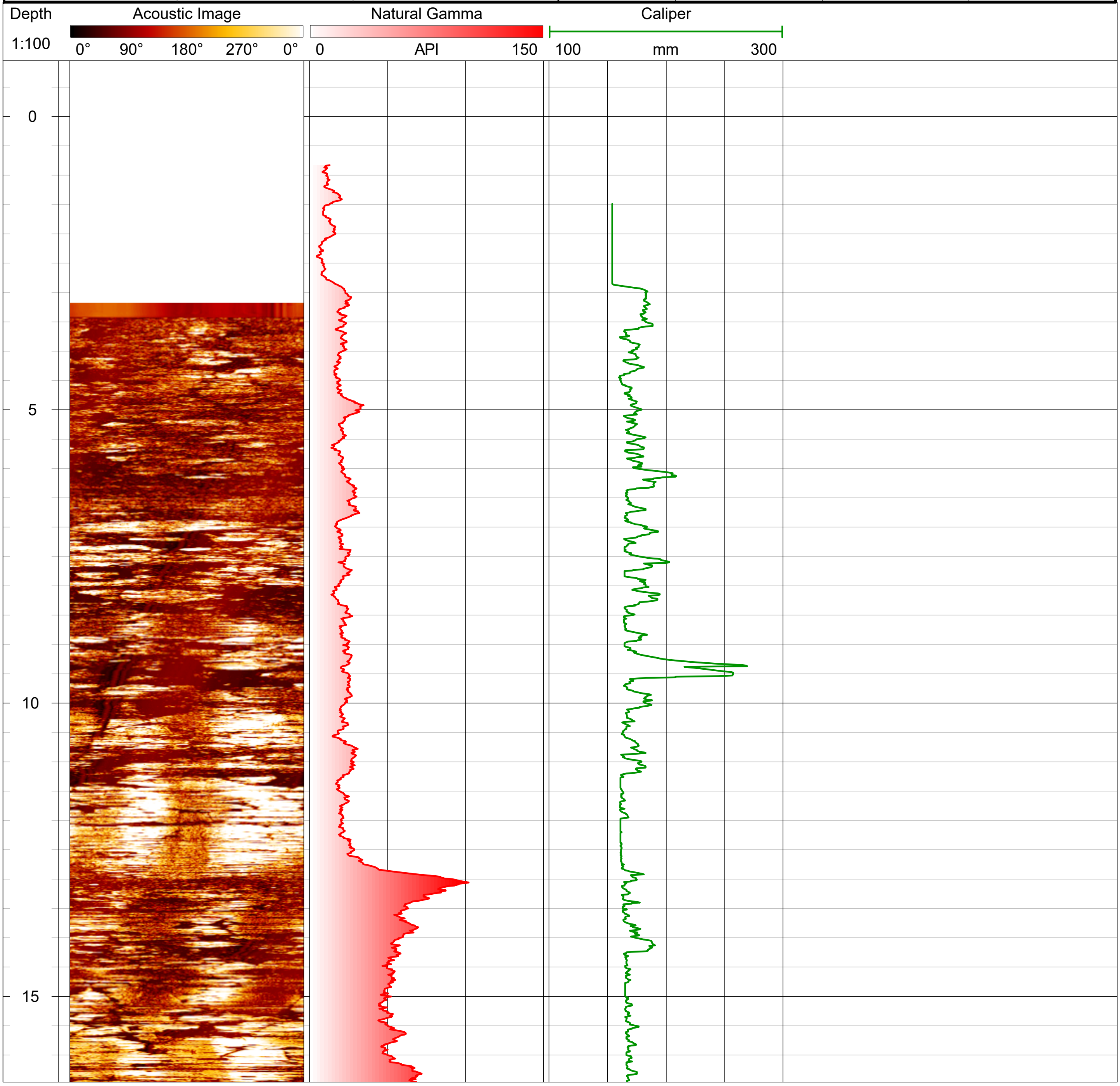
Drilled Depth: (m)	**30.0**	Date:	**17.09.2021**
Logged Depth: (m)	**28.9**	Recorded By:	**K. Clark**
Logging Datum:	**Ground Level**	Remarks:	
Logged Interval: (m)	**0.9 - 28.9**		
Fluid Level: (m)	**3.42**		

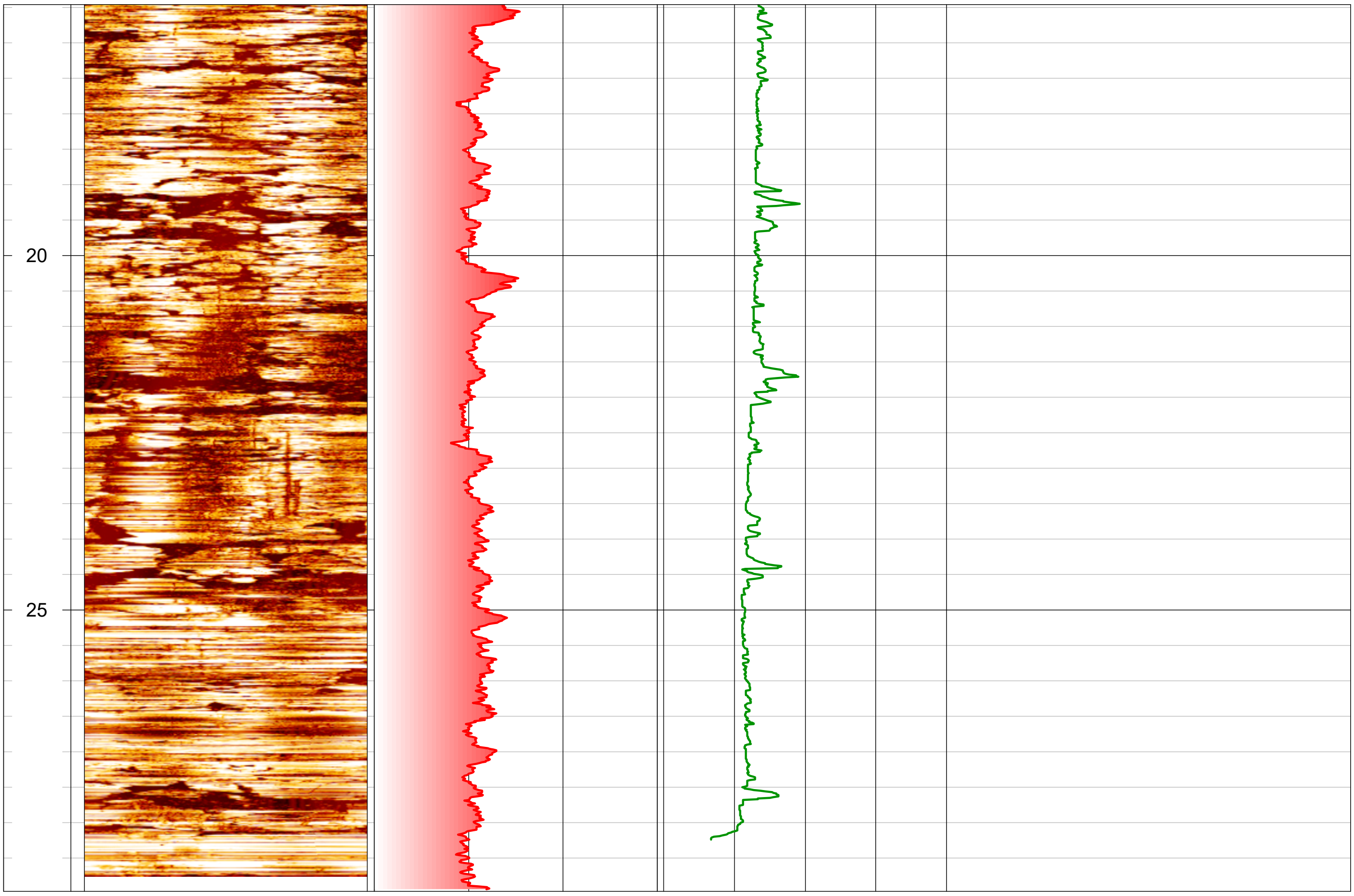
BOREHOLE RECORD

Bit: (mm)	From: (m)	To: (m)
150	**3.0**	**28.9**

CASING RECORD

Type	Size: (mm)	From: (m)	To: (m)
Steel	**147**	**-0.94**	**3.0**




20
25

EUROPEAN GEOPHYSICAL SERVICES LTD

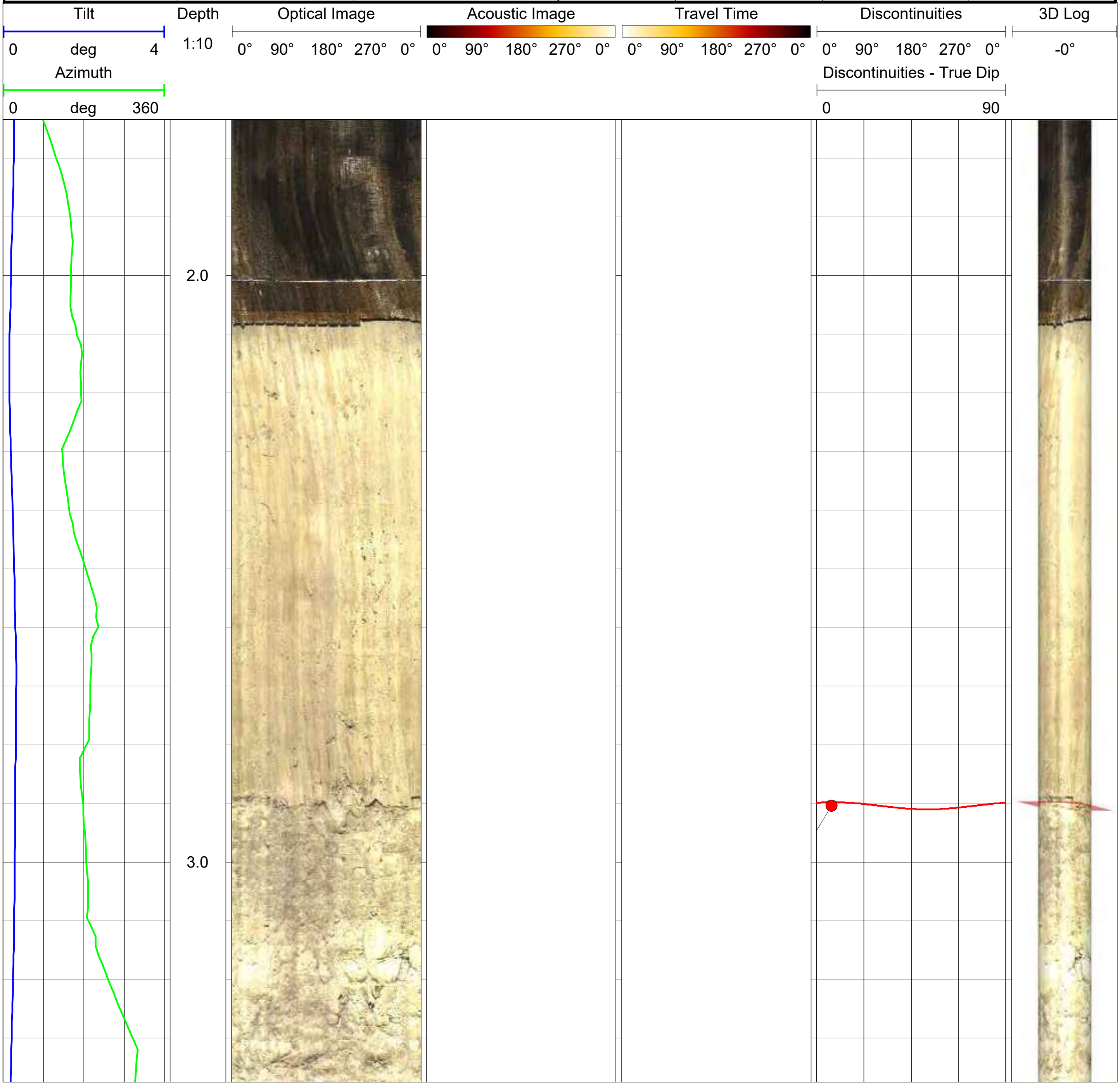
Client:	**Soil Engineering**	Log Type: ***Image***
Borehole:	**BH_TUN_018**	

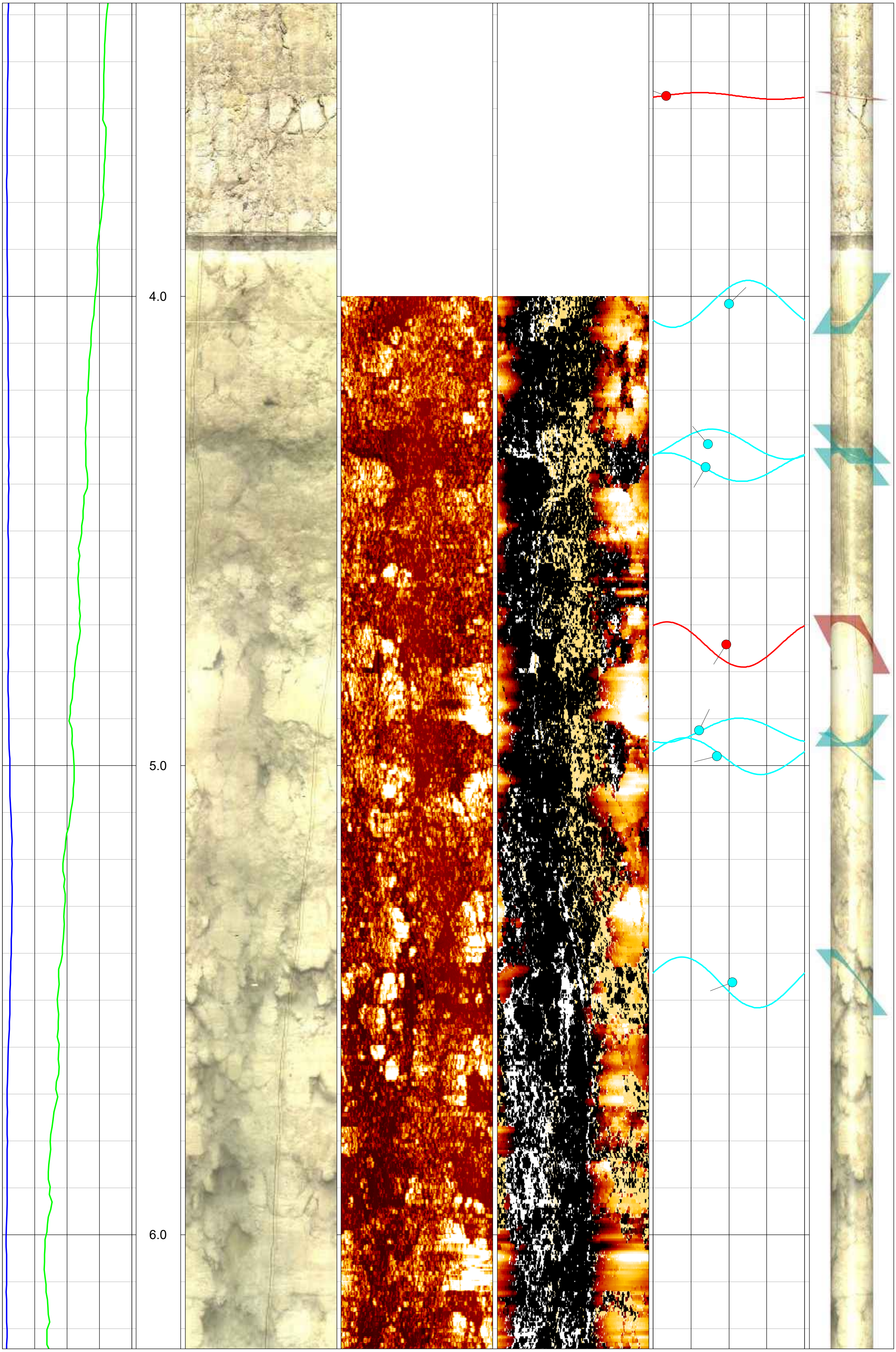
Location: **TE8364** Area: **Cambridge** Grid Ref: Elevation:

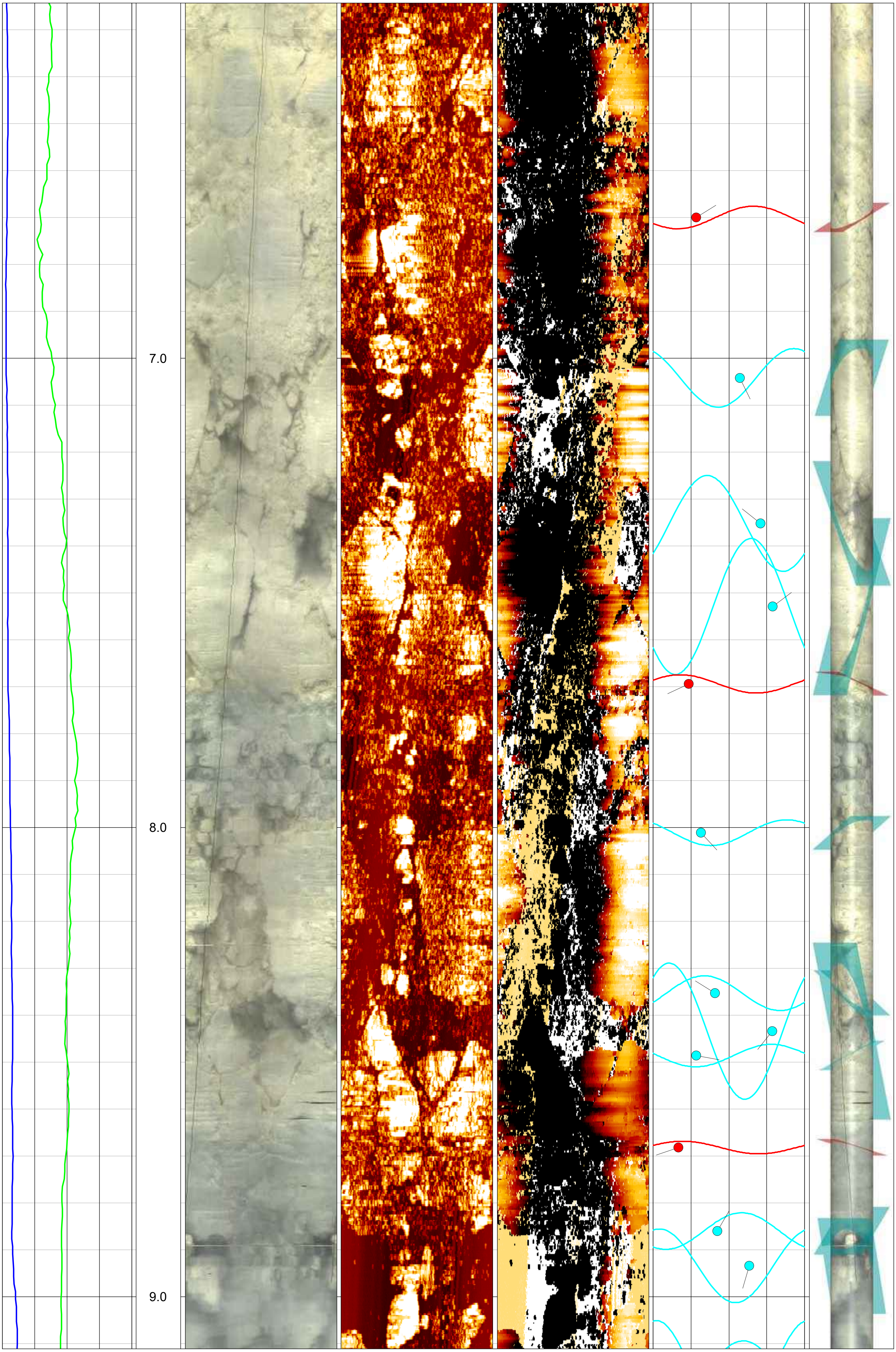
Drilled Depth: (m)	**12.2**	Date:	**22.09.2021**
Logged Depth: (m)	**11.9**	Recorded By:	**K. Clark**
Logging Datum:	**Ground Level**	Remarks:	
Logged Interval: (m)	**2.0 - 11.9**		
Fluid Level: (m)	**3.9**		

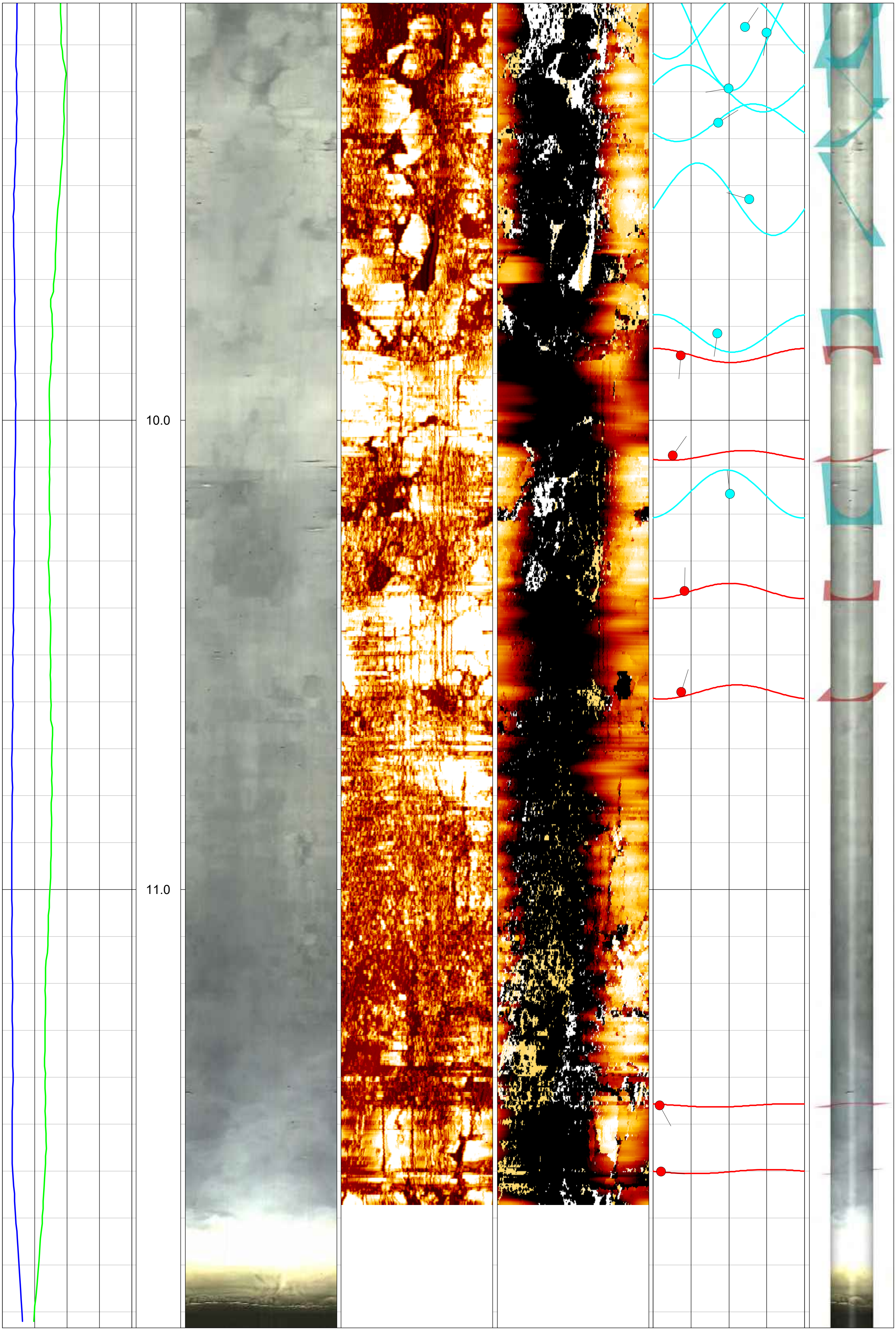
BOREHOLE RECORD		
Bit: (mm)	From: (m)	To: (m)
150	**2.07**	**11.9**

CASING RECORD			
Type	Size: (mm)	From: (m)	To: (m)
Steel	**147**	**-0.94**	**2.07**




4.0
5.0
6.0


7.0
8.0
9.0


10.0
11.0

EUROPEAN GEOPHYSICAL SERVICES LTD

Client:	**Soil Engineering**	Log Type: ***Composite***
Borehole:	**BH_TUN_018**	

Location: **TE8364** Area: **Cambridge** Grid Ref: Elevation:

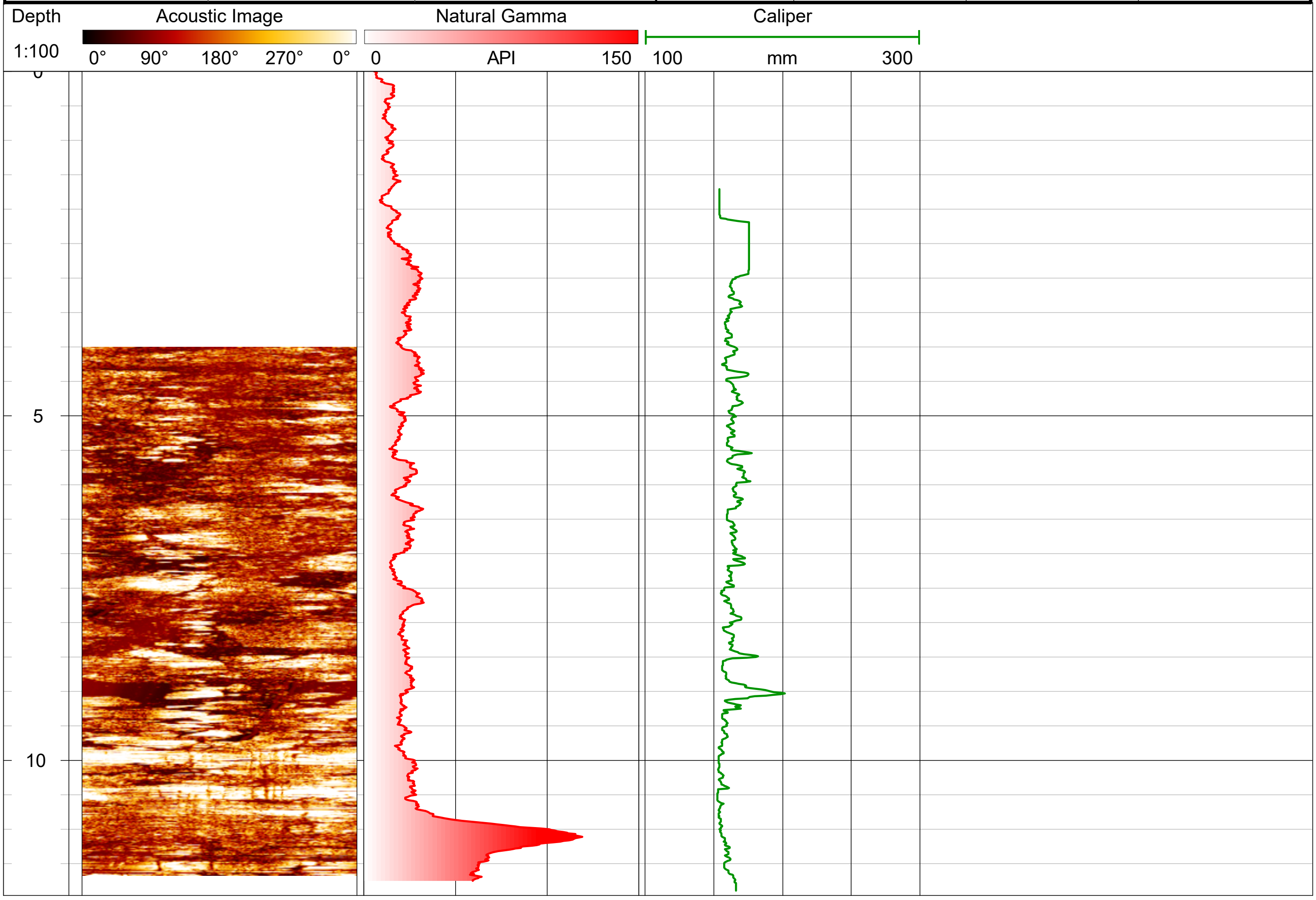
Drilled Depth: (m)	**12.2**	Date:	**22.09.2021**
Logged Depth: (m)	**11.9**	Recorded By:	**K. Clark**
Logging Datum:	**Ground Level**	Remarks:	
Logged Interval: (m)	**0 - 11.8**		
Fluid Level: (m)	**3.9**		

BOREHOLE RECORD

Bit: (mm)	From: (m)	To: (m)
150	**2.07**	**11.8**

CASING RECORD

Type	Size: (mm)	From: (m)	To: (m)
Steel	**147**	**-0.94**	**2.07**



Project Name	Cambridge Waste Water Treatment Plant Relocation	**Packer or Lugeon Test Record**	Hole ID BH_STW_003A
Project No.	TE8364		Ground Level 10.248 mAOD
Engineer	Mott MacDonald Bentley		Date 31/08/2021
Client	Barhale Limited	BS 5930: 1999: Clause 25.5	Page 1 of 2

Test no.		1	Depth below ground level to			
Packer type	Double - using initial groundwater level			Top of test section	m	6.20
Packer pressure	bar	10		Bottom of test section	m	7.80
Diameter of hole in test area	mm	146		Centre of test section	m	7.00
Weather	Cloudy			Bottom of hole at time of test	m	10.00
Type of rock	Chalk			Bottom of casing	m	1.60
				Initial ground water level	m	5.70
				Assumed standing water level	m	5.70
				Length of test section	m	1.60
			Gauge height above ground level		m	0.00

1st period			Gauge Pressure	bar	8.6 m head	Friction head loss	m	0.0				Average Flow l/min
Time	mins	0	2	4	6	8	10	12	14	16		
Readings	litres	45646	45714	45779	45838	45894	45953	46006	46058	46128		30.13
Take	litres		68	65	59	56	59	53	52	70		
2nd period			Gauge Pressure	bar		Friction head loss	m					Average Flow l/min
Time	mins											
Readings	litres											
Take	litres											
3rd period			Gauge Pressure	bar		Friction head loss	m					Average Flow l/min
Time	mins											
Readings	litres											
Take	litres											
4th period			Gauge Pressure	bar		Friction head loss	m					Average Flow l/min
Time	mins											
Readings	litres											
Take	litres											
5th period			Gauge Pressure	bar		Friction head loss	m					Average Flow l/min
Time	mins											
Readings	litres											
Take	litres											

Pipework and Drill String Details

Type of drill rod		2 7/8	Total length of drill rod (including 'stick up')	m	7.50
Diameter of delivery hose	mm	24	Total length of delivery hose in metres	m	5.00

Remarks

Bypass top packer. Test Cancelled.

Crew/Operator			soil engineering Part of the Bachy Soletanche Group

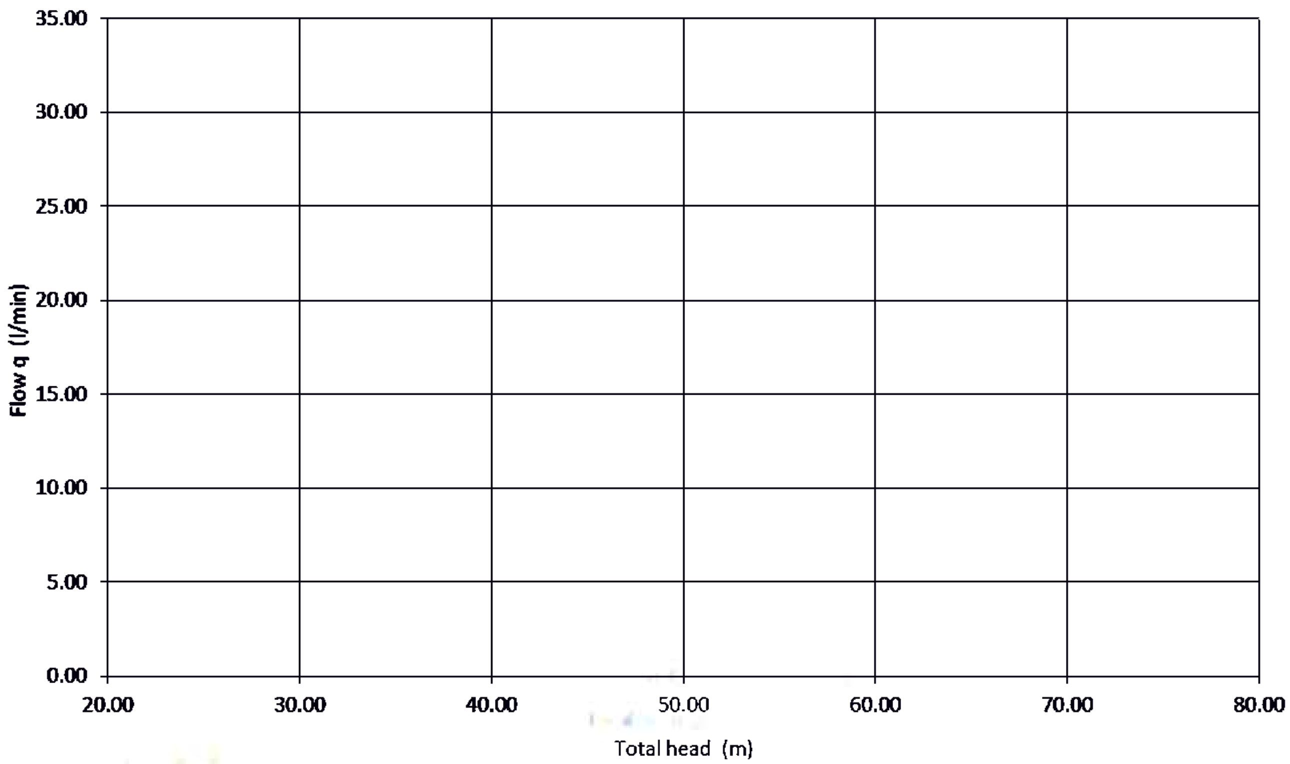
Form No. SE-PGR-F-009 Revision No. 2.04 Issue Date 24/01/2014

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Packer or Lugeon Test Record**	Hole ID BH_STW_003A
Project No.	TE8364		Ground Level 10.248 mAOD
Engineer	Mott MacDonald Bentley		Date 31/08/2021
Client	Barhale Limited	BS 5930: 1999: Clause 25.5	Page 2 of 2

Test no.			1
Packer type	Double - using initial groundwater level		
Packer pressure		bar	10
Diameter of hole in test area		mm	146
Weather	Cloudy		
Type of rock	Chalk		

Depth below ground level to		
Top of test section	m	6.20
Bottom of test section	m	7.80
Centre of test section	m	7.00
Bottom of hole at time of test	m	10.00
Bottom of casing	m	1.60
Initial ground water level	m	5.70
Assumed standing water level	m	5.70
Length of test section	m	1.60
Gauge height above ground level	m	0.00

Period	Flow l/min	Gauge Pressure bar	Head of water m	Friction head loss m	Total head m	Incremental Lugeon Value	Incremental permeability m/s
1st	30.13	8.6 m head	#VALUE!	0.00	#VALUE!	#VALUE!	#VALUE!
2nd							
3rd							
4th							
5th							



Determined from graph:

Slope of graph #VALUE! =

L, from (100/l)(q/h) (where l is the length of the test section in metres) = #VALUE! Lugeons

k, assuming 1 Lugeon unit is equal to a permeability of 10^{-7}m/s #VALUE! m/s

Crew/Operator			SOIL ENGINEERING
Form No. SE-PGR-F-010	Revision No. 2.04	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Project Name Cambridge Waste Water Treatment Plant Relocation
Project No. TE8364
Engineer Mott MacDonald Bentley
Client Barhale Limited

Packer or Lugeon Test Record

BS 5930: 1999: Clause 25.5

Hole ID
BH_STW_003A
Ground Level
10.248 mAOD
Date
31/08/2021
Page
1 of 2

Test no.		2
Packer type		Double - using initial groundwater level
Packer pressure	bar	7
Diameter of hole in test area	mm	146
Weather		Cloudy
Type of rock		Chalk

Depth below ground level to

Top of test section	m	3.70
Bottom of test section	m	5.30
Centre of test section	m	4.50
Bottom of hole at time of test	m	10.00
Bottom of casing	m	1.60
Initial ground water level	m	5.70
Assumed standing water level	m	5.70
Length of test section	m	1.60
Gauge height above ground level	m	0.00

1st period Gauge Pressure bar 0.52 Friction head loss m 0.0

												Average Flow l/min
Time	mins	0	2	4	6	8	10	12	14	16		
Readings	litres	46245	46281	46319	46357	46395	46432	46469	46506	46543		18.63
Take	litres		36	38	38	38	37	37	37	37		

2nd period Gauge Pressure bar 0.67 Friction head loss m 0.0

												Average Flow l/min
Time	mins	0	2	4	6	8	10	12	14	16		
Readings	litres	46621	46659	46699	46738	46778	46813	46852	46891	46931		19.38
Take	litres		38	40	39	40	35	39	39	40		

3rd period Gauge Pressure bar 0.71 Friction head loss m 0.0

												Average Flow l/min
Time	mins	0	2	4	6	8	10	12	14	16		
Readings	litres	47023	47054	47085	47121	47155	47188	47221	47255	47292		16.81
Take	litres		31	31	36	34	33	33	34	37		

4th period Gauge Pressure bar 0.64 Friction head loss m 0.0

												Average Flow l/min
Time	mins	0	2	4	6	8	10	12	14	16		
Readings	litres	47342	47373	47405	47438	47471	47503	47534	47566	47597		15.94
Take	litres		31	32	33	33	32	31	32	31		

5th period Gauge Pressure bar 0.55 Friction head loss m 0.0

												Average Flow l/min
Time	mins	0	2	4	6	8	10	12	14	16		
Readings	litres	47619	47644	47670	47699	47720	47755	47783	47812	47840		13.81
Take	litres		25	26	29	21	35	28	29	28		

Pipework and Drill String Details

Type of drill rod		2 3/8	Total length of drill rod (including 'stick up')	m	5.00
Diameter of delivery hose	mm	50.8	Total length of delivery hose in metres	m	5.00

Remarks

Crew/Operator
Tom Walton / Ace Drilling

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Form No. SE-PGR-F-009 Revision No. 2.04 Issue Date 24/01/2014

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Packer or Lugeon Test Record**	Hole ID BH_STW_003A
Project No.	TE8364		Ground Level 10.248 mAOD
Engineer	Mott MacDonald Bentley		Date 31/08/2021
Client	Barhale Limited	BS 5930: 1999: Clause 25.5	Page 2 of 2

Test no. 2

Packer type Double - using initial groundwater level

Packer pressure bar 7

Diameter of hole in test area mm 146

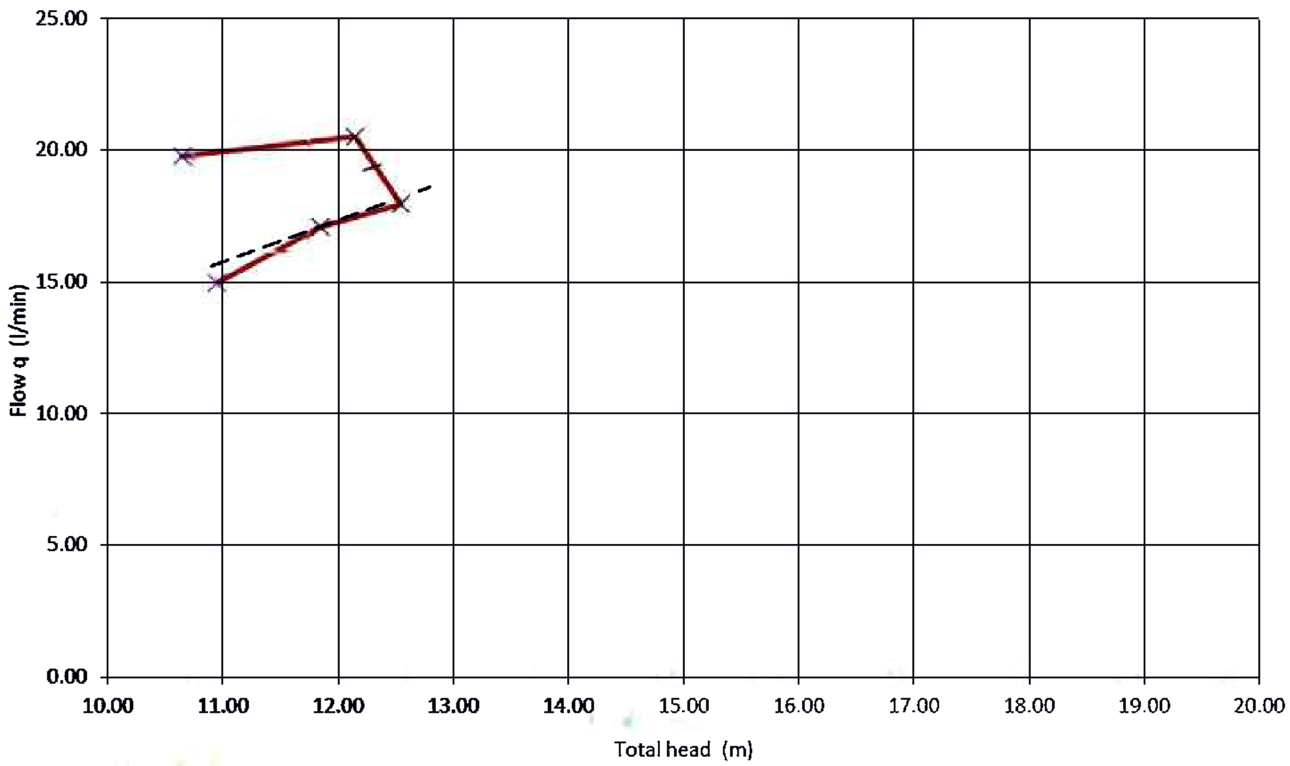
Weather Cloudy

Type of rock Chalk

Depth below ground level to

Top of test section	m	3.70
Bottom of test section	m	5.30
Centre of test section	m	4.50
Bottom of hole at time of test	m	10.00
Bottom of casing	m	1.60
Initial ground water level	m	5.70
Assumed standing water level	m	5.70
Length of test section	m	1.60
Gauge height above ground level	m	0.00

Period	Flow l/min	Gauge Pressure bar	Head of water m	Friction head loss m	Total head m	Incremental Lugeon Value	Incremental permeability m/s
1st	18.63	0.52	5.20	0.00	10.90	106.8	1.1E-05
2nd	19.38	0.67	6.70	0.00	12.40	97.7	9.8E-06
3rd	16.81	0.71	7.10	0.00	12.80	82.1	8.2E-06
4th	15.94	0.64	6.40	0.00	12.10	82.3	8.2E-06
5th	13.81	0.55	5.50	0.00	11.20	77.1	7.7E-06



Determined from graph:

Slope of graph 1.579 =

L, from (100/l)(q/h) (where l is the length of the test section in metres) = 98.7 Lugeons

k, assuming 1 Lugeon unit is equal to a permeability of 10^{-7}m/s 9.9E-06 m/s

Crew/Operator			
Tom Walton / Ace Drilling			SOIL ENGINEERING Part of the Bachy Soletanche Group

Form No. SE-PGR-F-010 Revision No. 2.04 Issue Date 24/01/2014

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Packer or Lugeon Test Record**	Hole ID BH_STW_013C
Project No.	TE8364		Ground Level 7.012 mAOD
Engineer	Mott MacDonald Bentley		Date 25/08/2021
Client	Barhale Limited	BS 5930: 1999: Clause 25.5	Page 1 of 2

Test no.		1	Depth below ground level to			
Packer type	Double - using assumed groundwater level			Top of test section	m	8.65
Packer pressure	bar	8.5		Bottom of test section	m	10.25
Diameter of hole in test area	mm	146		Centre of test section	m	9.45
Weather	Cloudy			Bottom of hole at time of test	m	13.10
Type of rock	Chalk			Bottom of casing	m	1.60
				Initial ground water level	m	
				Assumed standing water level	m	
				Length of test section	m	1.60
			Gauge height above ground level		m	0.00

1st period			Gauge Pressure	bar			Friction head loss m					Average Flow l/min
Time	mins											
Readings	litres											
Take	litres											
2nd period			Gauge Pressure	bar			Friction head loss m					Average Flow l/min
Time	mins											
Readings	litres											
Take	litres											
3rd period			Gauge Pressure	bar			Friction head loss m					Average Flow l/min
Time	mins											
Readings	litres											
Take	litres											
4th period			Gauge Pressure	bar			Friction head loss m					Average Flow l/min
Time	mins											
Readings	litres											
Take	litres											
5th period			Gauge Pressure	bar			Friction head loss m					Average Flow l/min
Time	mins											
Readings	litres											
Take	litres											

Pipework and Drill String Details

Type of drill rod		2 3/8	Total length of drill rod (including 'stick up')	m	9.50
Diameter of delivery hose	mm	50.8	Total length of delivery hose in metres	m	5.00

Remarks

Bled system Attempt to build pressure - injecting 130 l/min. Bypass of top packer - cancelled.

Crew/Operator			SOIL ENGINEERING Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Packer or Lugeon Test Record**	Hole ID BH_STW_013C
Project No.	TE8364		Ground Level 7.012 mAOD
Engineer	Mott MacDonald Bentley		Date 25/08/2021
Client	Barhale Limited	BS 5930: 1999: Clause 25.5	Page 1 of 2

Test no.		2	Depth below ground level to			
Packer type	Double - using assumed groundwater level			Top of test section	m	6.80
Packer pressure	bar	10		Bottom of test section	m	8.40
Diameter of hole in test area	mm	146		Centre of test section	m	7.60
Weather	Cloudy			Bottom of hole at time of test	m	13.10
Type of rock	Chalk			Bottom of casing	m	1.60
				Initial ground water level	m	
				Assumed standing water level	m	
				Length of test section	m	1.60
			Gauge height above ground level		m	0.00

1st period		Gauge Pressure	bar		Friction head loss m	0.0					Average Flow l/min
Time	mins										
Readings	litres										
Take	litres										

2nd period		Gauge Pressure	bar		Friction head loss m						Average Flow l/min
Time	mins										
Readings	litres										
Take	litres										

3rd period		Gauge Pressure	bar		Friction head loss m						Average Flow l/min
Time	mins										
Readings	litres										
Take	litres										

4th period		Gauge Pressure	bar		Friction head loss m						Average Flow l/min
Time	mins										
Readings	litres										
Take	litres										

5th period		Gauge Pressure	bar		Friction head loss m						Average Flow l/min
Time	mins										
Readings	litres										
Take	litres										

Pipework and Drill String Details

Type of drill rod		Total length of drill rod (including 'stick up')	m	
Diameter of delivery hose mm		Total length of delivery hose in metres	m	

Remarks

Bled system Attempt to build pressure - injecting 170 l/min. Bypass of top packer - cancelled.

Crew/Operator			SOIL ENGINEERING Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	# Packer or Lugeon Test Record	Hole ID BH_STW_013C
Project No.	TE8364		Ground Level 7.012 mAOD
Engineer	Mott MacDonald Bentley		Date 25/08/2021
Client	Barhale Limited	BS 5930: 1999: Clause 25.5	Page 1 of 2

Test no.		3	Depth below ground level to			
Packer type	Double - using assumed groundwater level			Top of test section	m	8.65
Packer pressure	bar	10		Bottom of test section	m	10.25
Diameter of hole in test area	mm	146		Centre of test section	m	9.45
Weather	Cloudy			Bottom of hole at time of test	m	13.10
Type of rock	Chalk			Bottom of casing	m	1.60
				Initial ground water level	m	
				Assumed standing water level	m	
				Length of test section	m	1.60
			Gauge height above ground level		m	0.00

1st period		Gauge Pressure	bar		Friction head loss m	0.0					Average Flow l/min
Time	mins										
Readings	litres										
Take	litres										

2nd period		Gauge Pressure	bar		Friction head loss m						Average Flow l/min
Time	mins										
Readings	litres										
Take	litres										

3rd period		Gauge Pressure	bar		Friction head loss m						Average Flow l/min
Time	mins										
Readings	litres										
Take	litres										

4th period		Gauge Pressure	bar		Friction head loss m						Average Flow l/min
Time	mins										
Readings	litres										
Take	litres										

5th period		Gauge Pressure	bar		Friction head loss m						Average Flow l/min
Time	mins										
Readings	litres										
Take	litres										

Pipework and Drill String Details

Type of drill rod		Total length of drill rod (including 'stick up')	m	
Diameter of delivery hose mm		Total length of delivery hose in metres	m	

Remarks

Attempt to build pressure - injecting 170 l/min Bypass of top packer - cancelled.

Crew/Operator			SOIL ENGINEERING
TW/CH			

Form No. SE-PGR-F-009 Revision No. 2.04 Issue Date 24/01/2014

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	Packer or Lugeon Test Record	Hole ID BH_STW_013C
Project No.	TE8364		Ground Level 7.012 mAOD
Engineer	Mott MacDonald Bentley		Date 25/08/2021
Client	Barhale Limited	BS 5930: 1999: Clause 25.5	Page 1 of 2

Test no.		4	Depth below ground level to			
Packer type	Double - using assumed groundwater level			Top of test section	m	6.80
Packer pressure	bar	10		Bottom of test section	m	8.40
Diameter of hole in test area	mm	146		Centre of test section	m	7.60
Weather	Cloudy			Bottom of hole at time of test	m	13.10
Type of rock	CHALK			Bottom of casing	m	1.60
				Initial ground water level	m	
				Assumed standing water level	m	
				Length of test section	m	1.60
			Gauge height above ground level		m	0.00

1st period			Gauge Pressure	bar		Friction head loss	m	0.0				Average Flow l/min
Time	mins											
Readings	litres											
Take	litres											
2nd period			Gauge Pressure	bar		Friction head loss	m					Average Flow l/min
Time	mins											
Readings	litres											
Take	litres											
3rd period			Gauge Pressure	bar		Friction head loss	m					Average Flow l/min
Time	mins											
Readings	litres											
Take	litres											
4th period			Gauge Pressure	bar		Friction head loss	m					Average Flow l/min
Time	mins											
Readings	litres											
Take	litres											
5th period			Gauge Pressure	bar		Friction head loss	m					Average Flow l/min
Time	mins											
Readings	litres											
Take	litres											

Pipework and Drill String Details

Type of drill rod			Total length of drill rod (including 'stick up')	m	
Diameter of delivery hose	mm		Total length of delivery hose in metres	m	

Remarks

Attempt to reach 1st test pressure, bypass of bottom packer - injecting 160 l/min. Test failed.

Crew/Operator			SOIL ENGINEERING
TW/CH			
Form No. SE-PGR-F-009	Revision No. 2.04	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation		Hole ID BH_STW_022A
Project No.	TE8364		Ground Level 8.462 mAOD
Engineer	Mott MacDonald Bentley		Date 07/09/2021
Client	Barhale Limited	BS 5930: 1999: Clause 25.5	Page 1 of 2

Packer or Lugeon Test Record

Test no.			1
Packer type	Double - using initial groundwater level		
Packer pressure		bar	9
Diameter of hole in test area		mm	146
Weather	Sunny		
Type of rock	Chalk		

Depth below ground level to

Top of test section	m	7.20
Bottom of test section	m	8.80
Centre of test section	m	8.00
Bottom of hole at time of test	m	14.10
Bottom of casing	m	3.00
Initial ground water level	m	1.94
Assumed standing water level	m	1.94
Length of test section	m	1.60
Gauge height above ground level	m	0.00

1st period			Gauge Pressure	bar			Friction head loss	m	0.0			Average Flow l/min
Time	mins											
Readings	litres											
Take	litres											
2nd period			Gauge Pressure	bar			Friction head loss	m				Average Flow l/min
Time	mins											
Readings	litres											
Take	litres											
3rd period			Gauge Pressure	bar			Friction head loss	m				Average Flow l/min
Time	mins											
Readings	litres											
Take	litres											
4th period			Gauge Pressure	bar			Friction head loss	m				Average Flow l/min
Time	mins											
Readings	litres											
Take	litres											
5th period			Gauge Pressure	bar			Friction head loss	m				Average Flow l/min
Time	mins											
Readings	litres											
Take	litres											

Pipework and Drill String Details

Type of drill rod			Total length of drill rod (including 'stick up')	m	
Diameter of delivery hose	mm		Total length of delivery hose in metres	m	

Remarks

Failed test bypassing top packer 130 l/min.

Crew/Operator		
TW		

soil engineering

Part of the Bachy Soletanche Group

Form No. SE-PGR-F-009 Revision No. 2.04 Issue Date 24/01/2014

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Packer or Lugeon Test Record**	Hole ID BH_STW_022A
Project No.	TE8364		Ground Level 8.462 mAOD
Engineer	Mott MacDonald Bentley		Date 07/09/2021
Client	Barhale Limited	BS 5930: 1999: Clause 25.5	Page 1 of 2

Test no.			1	Depth below ground level to			
Packer type	Double - using initial groundwater level				Top of test section	m	7.20
Packer pressure		bar	9		Bottom of test section	m	8.80
Diameter of hole in test area		mm	146		Centre of test section	m	8.00
Weather	Sunny				Bottom of hole at time of test	m	14.10
Type of rock	Chalk				Bottom of casing	m	3.00
					Initial ground water level	m	1.94
					Assumed standing water level	m	1.94
					Length of test section	m	1.60
				Gauge height above ground level		m	0.00

1st period			Gauge Pressure	bar			Friction head loss m		0.0			Average Flow l/min
Time	mins											
Readings	litres											
Take	litres											

2nd period			Gauge Pressure	bar			Friction head loss m					Average Flow l/min
Time	mins											
Readings	litres											
Take	litres											

3rd period			Gauge Pressure	bar			Friction head loss m					Average Flow l/min
Time	mins											
Readings	litres											
Take	litres											

4th period			Gauge Pressure	bar			Friction head loss m					Average Flow l/min
Time	mins											
Readings	litres											
Take	litres											

5th period			Gauge Pressure	bar			Friction head loss m					Average Flow l/min
Time	mins											
Readings	litres											
Take	litres											

Pipework and Drill String Details					
Type of drill rod			Total length of drill rod (including 'stick up')	m	
Diameter of delivery hose	mm		Total length of delivery hose in metres	m	

Remarks

Test failed - bypassing top and bottom packer 135 l/min.

Crew/Operator			SOIL ENGINEERING
Form No. SE-PGR-F-009	Revision No. 2.04	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Packer or Lugeon Test Record**	Hole ID BH_TUN_001A
Project No.	TE8364		Ground Level 6.908 mAOD
Engineer	Mott MacDonald Bentley		Date 08/09/2021
Client	Barhale Limited	BS 5930: 1999: Clause 25.5	Page 1 of 2

Test no.		1	Depth below ground level to		
Packer type	Double - using initial groundwater level		Top of test section	m	7.70
Packer pressure	bar	10	Bottom of test section	m	9.30
Diameter of hole in test area	mm	146	Centre of test section	m	8.50
Weather	Sunny and Hot		Bottom of hole at time of test	m	27.30
Type of rock	Gault Clay		Bottom of casing	m	6.00
			Initial ground water level	m	16.98
			Assumed standing water level	m	16.98
			Length of test section	m	1.60
			Gauge height above ground level	m	0.00

1st period			Gauge Pressure	bar	1.33		Friction head loss	m	0.0		Average Flow l/min
Time	mins	0	2	4	6	8	10	12	14	16	
Readings	litres	50277	50277	50277	50277	50277	50277	50277	50277	50278	0.06
Take	litres		0	0	0	0	0	0	0	1	
2nd period			Gauge Pressure	bar	1.50		Friction head loss	m	0.0		Average Flow l/min
Time	mins	0	2	4	6	8	10	12	14	16	
Readings	litres	50282	50282	50282	50282	50282	50282	50283	50283	50283	0.06
Take	litres		0	0	0	0	0	1	0	0	
3rd period			Gauge Pressure	bar	1.67		Friction head loss	m	0.0		Average Flow l/min
Time	mins	0	2	4	6	8	10	12	14	16	
Readings	litres	50284	50284	50284	50284	50284	50284	50285	50285	50285	0.06
Take	litres		0	0	0	0	0	1	0	0	
4th period			Gauge Pressure	bar	1.50		Friction head loss	m	0.0		Average Flow l/min
Time	mins	0	2	4	6	8	10	12	14	16	
Readings	litres	50285	50285	50285	50285	50285	50285	50285	50285	50285	0.00
Take	litres		0	0	0	0	0	0	0	0	
5th period			Gauge Pressure	bar	1.33		Friction head loss	m	0.0		Average Flow l/min
Time	mins	0	2	4	6	8	10	12	14	16	
Readings	litres	50285	50285	50285	50285	50285	50285	50285	50285	50285	0.00
Take	litres		0	0	0	0	0	0	0	0	

Pipework and Drill String Details

Type of drill rod		2 3/8	Total length of drill rod (including 'stick up')	m	7.50
Diameter of delivery hose	mm	50.8	Total length of delivery hose in metres	m	5.00

Remarks

Water supply tanks observed for loss of water during test. No loss observed.

Crew/Operator			SOIL ENGINEERING
MM / DT			Part of the Bachy Soletanche Group

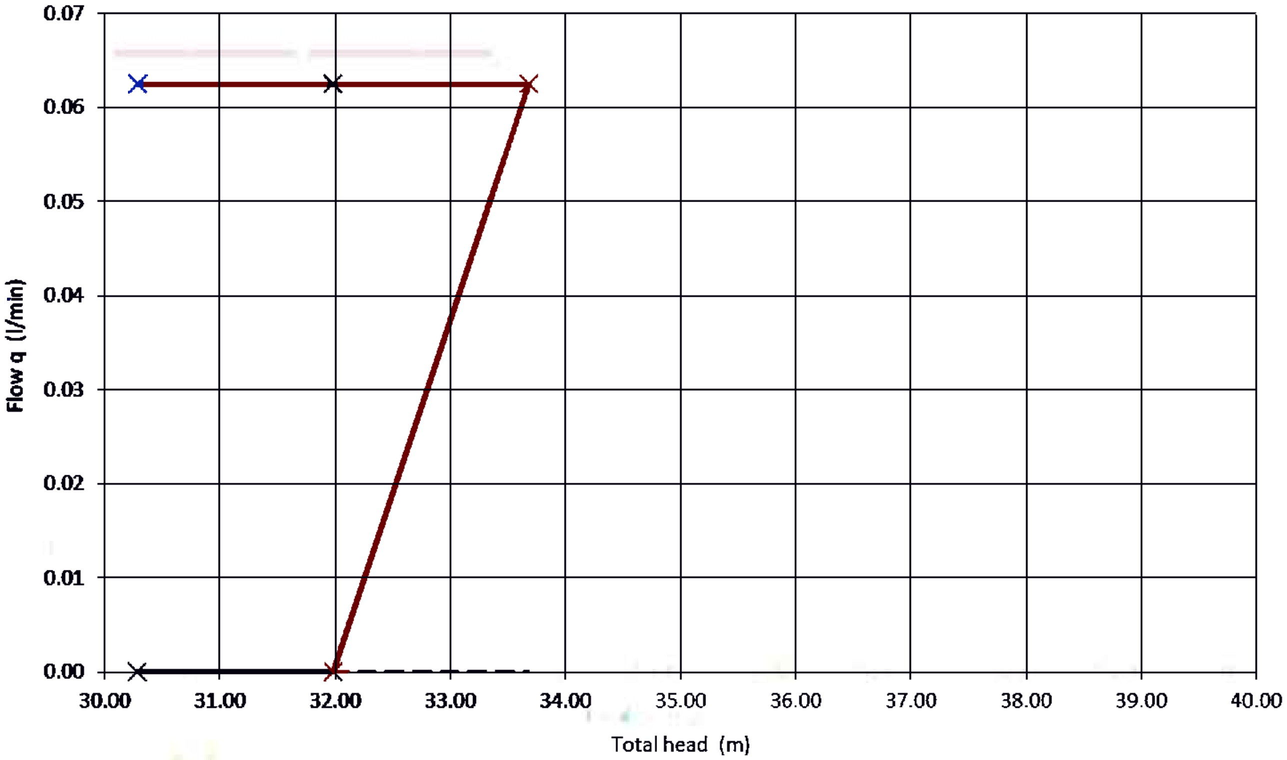
Form No. SE-PGR-F-009 Revision No. 2.04 Issue Date 24/01/2014

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Packer or Lugeon Test Record**	Hole ID BH_TUN_001A
Project No.	TE8364		Ground Level 6.908 mAOD
Engineer	Mott MacDonald Bentley		Date 08/09/2021
Client	Barhale Limited	BS 5930: 1999: Clause 25.5	Page 2 of 2

Test no.			1
Packer type	Double - using initial groundwater level		
Packer pressure		bar	10
Diameter of hole in test area		mm	146
Weather	Sunny and Hot		
Type of rock	Gault Clay		

Depth below ground level to		
Top of test section	m	7.70
Bottom of test section	m	9.30
Centre of test section	m	8.50
Bottom of hole at time of test	m	27.30
Bottom of casing	m	6.00
Initial ground water level	m	16.98
Assumed standing water level	m	16.98
Length of test section	m	1.60
Gauge height above ground level	m	0.00

Period	Flow l/min	Gauge Pressure bar	Head of water m	Friction head loss m	Total head m	Incremental Lugeon Value	Incremental permeability m/s
1st	0.06	1.33	13.30	0.00	30.28	0.1	1.3E-08
2nd	0.06	1.50	15.00	0.00	31.98	0.1	1.2E-08
3rd	0.06	1.67	16.70	0.00	33.68	0.1	1.2E-08
4th	0.00	1.50	15.00	0.00	31.98	0.0	0.0E+00
5th	0.00	1.33	13.30	0.00	30.28	0.0	0.0E+00



Determined from graph:

Slope of graph 0.000

L, from (100/l)(q/h) (where l is the length of the test section in metres) = 0.0 Lugeons

k, assuming 1 Lugeon unit is equal to a permeability of 10^{-7}m/s = 0.0E+00 m/s

Crew/Operator			**SOIL ENGINEERING** Part of the Bachy Soletanche Group
MM / DT			
Form No. SE-PGR-F-010	Revision No. 2.04	Issue Date 24/01/2014	

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Packer or Lugeon Test Record**	Hole ID BH_TUN_006PM
Project No.	TE8364		Ground Level 6.585 mAOD
Engineer	Mott MacDonald Bentley		Date 30/09/2021
Client	Barhale Limited	BS 5930: 1999: Clause 25.5	Page 1 of 2

Test no.		1	Depth below ground level to		
Packer type	Double - using initial groundwater level		Top of test section	m	14.40
Packer pressure	bar	16	Bottom of test section	m	16.00
Diameter of hole in test area	mm	146	Centre of test section	m	15.20
Weather	Overcast, rain		Bottom of hole at time of test	m	18.00
Type of rock	Clay		Bottom of casing	m	11.50
			Initial ground water level	m	8.54
			Assumed standing water level	m	8.54
			Length of test section	m	1.60
			Gauge height above ground level	m	0.00

1st period		Gauge Pressure	bar	2.52		Friction head loss m		0.0			Average Flow l/min
Time	mins	0	2	4	6	8	10	12	14	16	
Readings	litres	50569	50569	50569	50569	50569	50569	50569	50569	50569	0.00
Take	litres		0	0	0	0	0	0	0	0	

2nd period		Gauge Pressure	bar	2.72		Friction head loss m		0.0			Average Flow l/min
Time	mins	0	2	4	6	8	10	12	14	16	
Readings	litres	50569	50569	50569	50569	50569	50569	50569	50569	50569	0.00
Take	litres		0	0	0	0	0	0	0	0	

3rd period		Gauge Pressure	bar	2.92		Friction head loss m		0.0			Average Flow l/min
Time	mins	0	2	4	6	8	10	12	14	16	
Readings	litres	50567	50567	50567	50567	50567	50567	50567	50567	50567	0.00
Take	litres		0	0	0	0	0	0	0	0	

4th period		Gauge Pressure	bar	2.72		Friction head loss m		0.0			Average Flow l/min
Time	mins	0	2	4	6	8	10	12	14	16	
Readings	litres	50557	50557	50557	50557	50557	50557	50557	50557	50557	0.00
Take	litres		0	0	0	0	0	0	0	0	

5th period		Gauge Pressure	bar	2.52		Friction head loss m		0.0			Average Flow l/min
Time	mins	0	2	4	6	8	10	12	14	16	
Readings	litres	50557	50557	50557	50557	50557	50557	50557	50557	50557	0.00
Take	litres		0	0	0	0	0	0	0	0	

Pipework and Drill String Details

Type of drill rod		2 3/8	Total length of drill rod (including 'stick up')	m	12.00
Diameter of delivery hose	mm	50.8	Total length of delivery hose in metres	m	5.00

Remarks

Crew/Operator			SOIL ENGINEERING
MM			Part of the Bachy Soletanche Group

Form No. SE-PGR-F-009 Revision No. 2.04 Issue Date 24/01/2014

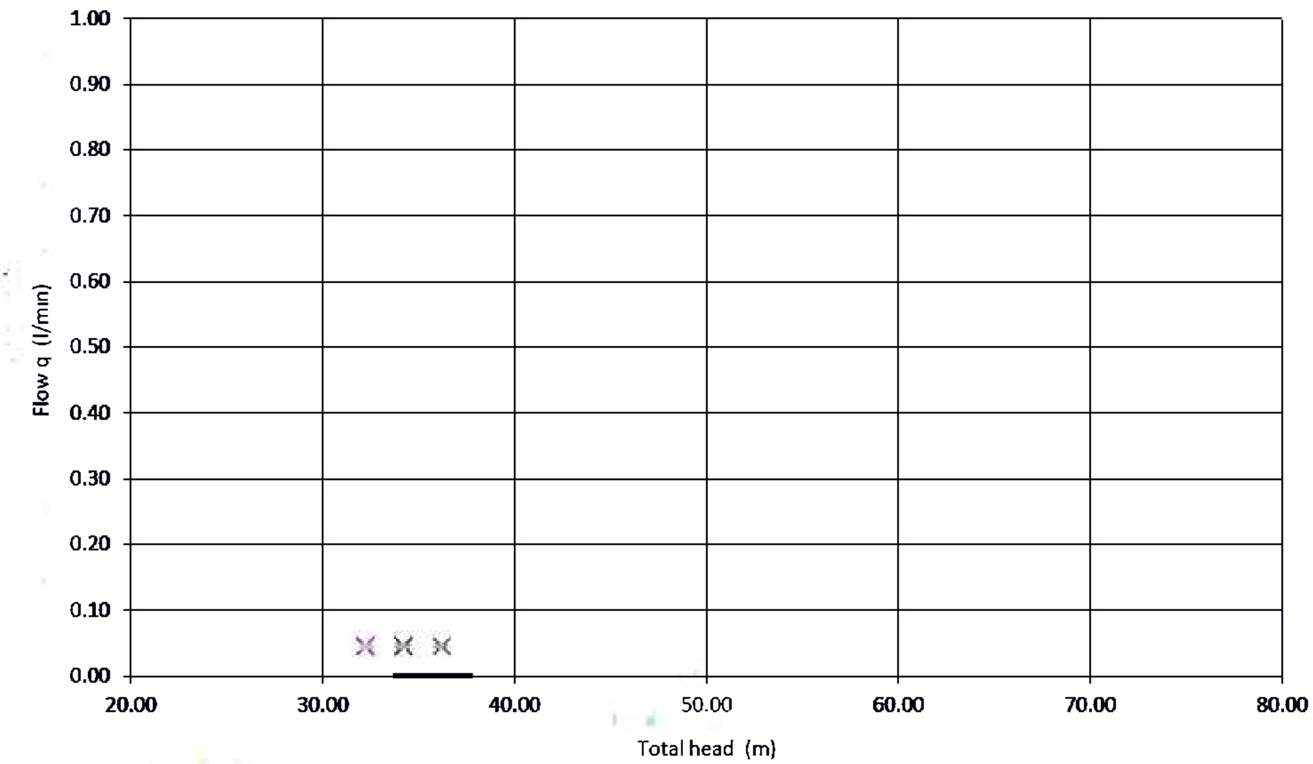
Project Name	Cambridge Waste Water Treatment Plant Relocation	**Packer or Lugeon Test Record**	Hole ID BH_TUN_006PM
Project No.	TE8364		Ground Level 6.585 mAOD
Engineer	Mott MacDonald Bentley		Date 30/09/2021
Client	Barhale Limited	BS 5930: 1999: Clause 25.5	Page 2 of 2

Test no.			1
Packer type	Double - using initial groundwater level		
Packer pressure		bar	16
Diameter of hole in test area		mm	146
Weather	Overcast, rain		
Type of rock	Clay		

Depth below ground level to

Top of test section	m	14.40
Bottom of test section	m	16.00
Centre of test section	m	15.20
Bottom of hole at time of test	m	18.00
Bottom of casing	m	11.50
Initial ground water level	m	8.54
Assumed standing water level	m	8.54
Length of test section	m	1.60
Gauge height above ground level	m	0.00

Period	Flow l/min	Gauge Pressure bar	Head of water m	Friction head loss m	Total head m	Incremental Lugeon Value	Incremental permeability m/s
1st	0.00	2.52	25.20	0.00	33.74	0.0	0.0E+00
2nd	0.00	2.72	27.20	0.00	35.74	0.0	0.0E+00
3rd	0.00	2.92	29.20	0.00	37.74	0.0	0.0E+00
4th	0.00	2.72	27.20	0.00	35.74	0.0	0.0E+00
5th	0.00	2.52	25.20	0.00	33.74	0.0	0.0E+00



Determined from graph:

Slope of graph 0.000

L, from (100/l)(q/h) (where l is the length of the test section in metres) = 0.0 Lugeons

k, assuming 1 Lugeon unit is equal to a permeability of 10^{-7}m/s = 0.0E+00 m/s

Crew/Operator			SOIL ENGINEERING
MM			
Form No. SE-PGR-F-010	Revision No. 2.04	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Cambridge Waste Water Treatment Plant Relocation Project

GROUND INVESTIGATION

Results of pressuremeter tests carried out by Cambridge Insitu Ltd

---

Client reference	**TE8364**
Contractor	**Soil Engineering**
Cambridge Insitu reference:	**CIR1506/21**
Report date:	**November 2021**
Version:	**1.0**

VOLUME 1 of 2

Text report with a summary of the results

CAMBRIDGE INSITU LTD
Little Eversden
Cambridge
ENGLAND
CB23 1HE

Tel: +44 1223 262361
Fax: +44 1223 263947
Email: cam@cambridge-insitu.com
HTTP: www.cambridge-insitu.com

TASKS	RESPONSIBLE PERSON	AFFILIATION
Initial calibration (Shula SBP)	**Ewan Stockwell**	**Cambridge Insitu Ltd**
Initial calibration (Wally HPD)	**Ewan Stockwell**	**Cambridge Insitu Ltd**
Initial calibration (Dougal)	**Ewan Stockwell**	**Cambridge Insitu Ltd**
Field work	**Ewan Stockwell/ Simon Baxter**	**Cambridge Insitu Ltd**
Preliminary analysis	**Yasmin Byrne / Ewan Stockwell**	**Cambridge Insitu Ltd**
Final analysis	**Yasmin Byrne / Robert Whittle**	**Cambridge Insitu Ltd**
Reporter	**Yasmin Byrne**	**Cambridge Insitu Ltd**
Reviewer	**Robert Whittle**	**Cambridge Insitu Ltd**

Preface - Equations for Modulus

Shear modulus G, where τ is shear stress and γ is shear strain: $G = \tau/\gamma$ [P.1]

G in terms of cavity strain ε_c and cavity pressure p_c: $2G = \delta P_c / \delta\varepsilon_c$ [P.2]
This is valid for a linear elastic response and a small strain alteration

Linear elastic Young's modulus E in terms of G, where v is Poisson's ratio: $E = 2(1+v)G$ [P.3]

Non-linear secant shear modulus G_s: $G_s = \alpha\gamma^{\beta-1}$ [P.4]
where α is the shear stress constant and β is the exponent of linearity obtained from fitting the reloading response in shear stress/shear strain space with a power function. γ is plane shear strain.

Non-linear secant Young's modulus E'_s using invariant shear strain γ_α: $E'_s = 2\alpha[1+v][\sqrt{3}\gamma_\alpha]^{\beta-1}$ [P.5]
Multiplying by √3 converts γ_α to γ assuming no volumetric strains are involved.

Non-linear tangential shear modulus G_t: $G_t = \alpha\beta\gamma^{\beta-1}$ [P.6]

Plane shear strain at failure, undrained case, c_u is undrained shear strength: $\gamma_f = [c_u/\alpha]^{1/\beta}$ [P.7]

Secant shear modulus at failure, in terms of stress: $G_s = \alpha[c_u/\alpha]^{(\beta-1)/\beta}$ [P.8]

For secant shear modulus at mobilised stress levels less than failure, introduce n where $0 < n \le 1$: $G_n = \alpha[nc_u/\alpha]^{(\beta-1)/\beta}$ [P.9]

For the special case of G_{50} at half of the ultimate shear strength: $G_{50} = \alpha[c_u/2\alpha]^{(\beta-1)/\beta}$ [P.10]

Note: substitute τ_f for c_u in the case of drained tests in P.7 to P.10

Volume 2 - Data for tests in all boreholes and all Calibrations

Cambridge Waste Water Treatment Plant Relocation Project

1 Introduction

Cambridge Insitu Ltd (CI) was contracted by Soil Engineering to supply pressuremeter testing services for the Cambridge Waste Water Treatment Plant Relocation Project between Fen Ditton and Horningsea in Cambridgeshire. The testing formed part of the ground investigation for the proposed relocation of infrastructure to a greenfield site. The ultimate Client is Barhale Limited. Testing was specified and instructed by Mott MacDonald.

Pressuremeters are used to obtain representative engineering parameters for stiffness, strength and the initial state of stress. Given these parameters it is then possible to calculate the yield stress and strain, and limit pressure.

The material was predominantly structureless Chalk overlying Gault Clay. Tests were carried out at ten borehole locations, with between two and five tests in each. 17 tests were attempted in Gault Clay, and 14 tests in Chalk. Of these, 25 gave sufficient data for analysis. The levels were between 6.69mAOD and -21.82mAOD (between 2.20mBGL and 32.10mBGL). The fieldwork took place between the 5th August and 14th October 2021 on an intermittent basis as locations and test levels became available.

Two different types of pressuremeter were deployed. A self-boring pressuremeter (SBP) was used for softer ground, and a High Pressure Dilatometer (HPD) in pre-bored pockets where stiffer or heterogenous ground conditions applied. The pressuremeter work was conducted with the assistance of a rotary drilling facility provided by Soil Engineering.

Six unsuccessful test attempts occurred. These were predominantly in the Gault Clay and involved self boring. BH_STW_006 Test 2 was an unsuccessful attempt to self bore the chalk. BH_TUN_018PM Test 3 was an unsuccessful attempt at a pocket for a pre-bored test in Gault Clay.

This report is concerned solely with the presentation of the pressuremeter results. Any previous revisions and preliminary results are now superseded by the data in this report.

1.1 Instrumentation

The two types of pressuremeter deployed on this contract have certain features in common. The central part of each probe is covered by an elastic membrane. Once at the required depth, pressure is applied down an umbilical hose/cable to the inner surface of the membrane. This pressure causes the membrane to load the borehole wall and carry out a cavity expansion test. Measurements of displacement and pressure on the inner surface of the membrane are made directly in the probes. The resolution is high enough to provide data for shear modulus and its variation with shear strain in the range 10^{-4} to 10^{-2}. The instruments contain all the necessary signal conditioning electronics, so the final output of the probes is digital data in RS232 format for direct connection to the USB port of a personal computer.

The major difference between the devices is the method of introducing them into the ground and the alteration this causes to the insitu stress state.

1.1.1 Self Boring Pressuremeter (SBP)

The self-boring pressuremeter is first bored into the ground in a controlled manner that results in only minor alteration of the insitu stress condition of the soil mass. Clays and sands are most suited to this method of pressuremeter testing, as they can be difficult to sample without major disruption to their natural stress state.

Six equally spaced displacement transducers track the radial movement of the inside of the membrane while an internal pressure transducer measures the applied pressure. The SBP is also equipped with two opposite facing pore water pressure measuring transducers positioned at the midpoint of the membrane. These allow the pore water pressure regime to be monitored throughout the drilling and testing phases.

Standard self-boring means that along its entire length the probe is a consistent diameter to within a few microns. The stress in the ground is carried by the body of the probe at all times, an arrangement that is only practicable in weak soils. The SBP used on this contract was setup for ‘weak rock’ work. This means that the cutting arrangement made a hole about 1mm greater in diameter than the expanding section. Only the first 0.25m of the probe carries the full stress in the ground. This change means that the probe can self-bore into stiff clays and weak rocks but at the cost of a small amount of stress relief, small enough to remain within the recoverable range of the material.

The radial expansion capability of the probe is about 15%. This is more than sufficient to carry out a test provided that the boring has been carried out correctly. The pressure capability is 100 bars, enough for all soils and some soft rocks. The system outputs a line of data every 5 or 6 seconds, depending on the number of displacement followers, and the SBP probes deployed are known as’ Dougal’ and ‘Shula’.

1.1.2 High Pressure Dilatometer (HPD)

The 95mm diameter Cambridge High Pressure Dilatometer was developed to carry out a pressuremeter test in soft to weak rock. In use the instrument is lowered into a nominal 101mm pocket, usually made by a rotary coring rig using a T6H/T101 barrel. Once in position, oil or gas pressure is applied down an umbilical and inflates a membrane covering the central third of the probe, so loading the borehole wall. Movements of the cavity wall and the necessary pressure are measured in a similar way to the SBP.

Although intended for soft to weak rocks, the displacement range and resolution of the equipment is such that it can make suitable tests in much weaker material, such as stiff clay.

The pressure capability is 200 bars in normal use, 300 bars under special circumstances. The displacement capability is the equivalent of 50% shear strain. Maximum pressure and maximum displacement do not occur in the same test.

A single HPD was used on this contract, known as ‘Wally’. This version of the HPD outputs a line of data every 10 seconds.

1.2 Analysis

The pressuremeter loading curve can be solved directly using mathematical expressions for the expansion of a cylindrical cavity. The solution conventionally is quoted in terms of strength and stiffness parameters for the material, typically shear modulus, shear strength or friction angle as appropriate, and the insitu lateral stress. The success of this method is dependent on the validity of the assumptions that have to be made about the nature of the ground and the geometry of the cavity expansion configuration.

Appendix D is a detailed guide to the analyses that have been applied and uses some examples to show how choices are made and the implications.

1.2.1 Assumptions

- Assumptions about the material response assume that at the test level the material is homogeneous with isotropic properties behaving as a continuum. If the material is a soil it is assumed that it is fully saturated.

- An assumption about the instrument is that the length to diameter ratio of the expanding section is large enough for end effects to be negligible allowing the test to be modelled as a plane strain expansion.
- The pressuremeter test gives data for the total radial stress and radial displacements of the cavity wall. The displacements are a direct function of the hoop strain. In order to solve the boundary problem represented by a cavity expansion it is necessary also to know the radial strain and circumferential stress. If it assumed the test is undrained (as it might be for low permeability materials) then the loading takes place at constant volume. This means that radial and shear strains are derived easily from circumferential strain. If the expansion is drained then a more complex solution is required; shear and volumetric strains are derived using assumptions about the dilatant behaviour of the material.
- In addition it is assumed that the cavity expands as a circle and hence the results have been obtained by analysing the curve derived from the average of all displacement followers as this gives the best representation of a circular expansion. Unless the probe is an exact fit to the cavity the output from individual arms is almost meaningless, because the centre of the probe is the reference for all measured displacements and is free to translate in relation to the cavity.

1.2.2 Shear stiffness

Plausible and consistent data for shear modulus have been obtained from the unload/reload cycles and several cycles were incorporated into each test. The simplest approach is to assume linear elasticity so that the slope of a chord through the cycle gives the shear modulus.

In principle the slope of the initial loading is also a source of modulus data but in a pre-bored test this is not sensible choice. Values for modulus from this part of the test are designated G_i . The ratio G_{ur}/G_i is an approximate indication of the degree of disturbance caused by the pocket formation and subsequent unloading of the cavity wall. For a pushed test the significance of the initial slope is uncertain and G_i should not be used.

At the time of measurement all modulus parameters are shear modulus G. They can be converted to Young's modulus E - if the material is isotropic then the relationship $E = 2G(1+\nu)$ can be used where ν is Poisson's ratio. We have applied 0.3 as this is a common choice. However the appropriate choice will depend on the particular application and the values for E may need re-calculation – the shear modulus parameters are independent and will not change.

In all soils the unload/reload response is hysteretic due to the strain dependency of stiffness. We have applied the procedure suggested by Bolton & Whittle (1999) to derive the stiffness/strain degradation properties in the shear strain range 10^{-4} to 10^{-2}. If the material is cohesive and with low permeability then the test is conducted at a rate that does not permit excess pore water pressure to drain. Consequently, after failure, the mean effective stress is constant and all unload/reload cycles give a similar response. This is the case for the tests in Gault Clay.

The tests in chalk are drained, so there is also a stress dependency to consider. We have looked at applying an adaptation of the Bellotti et al (1989) procedure to adjust the drained stiffness/strain trends to a reference stress. It happens that for the tests in the structureless chalk most of the cycles are carried out when the material is deforming at close to constant volume conditions. This means that the cycles within a single chalk test are not greatly different, one from the other. The major difference is between the first cycle and subsequent cycles, where the first is more affected by the consequences of pocket formation. Stress adjustment, therefore, has not been carried out.

Parameters from all the unload/reload cycles are given in Table 3.3. Those adjudged to be representative for the individual tests are given in Table 3.4. They are not the conservative choice.

1.2.3 Pore water pressure and vertical stress

The ambient pore water pressure has been determined based on ground water monitoring information provided by Soil Engineering for each borehole. Refer to Table 3.1 for test specific values.

The total vertical stress is calculated from an assumed bulk unit weight, 20kN/m^3.

1.2.4 Strength

UNDRAINED:

All of the tests in Gault Clay has been assumed to follow an undrained loading path.

Provided that the material has not been pushed, the strength and limit pressure can be obtained from the expansion phase of the test using the simple elastic/perfectly plastic solution of Gibson & Anderson (1961). Jefferies (1988) applies this model to the case of cavity contraction, giving an alternative method of discovering the shear strength. The result of the analysis process is a set of parameters that ought to be capable of producing the measured field data. The final act of the analysis procedure is to demonstrate this is the case. Whittle, 1999, is a curve fitting method for undrained pressuremeter tests in a non-linear elastic/perfectly plastic soil. The length of the strain scale is adjusted until the two estimates of strength obtained from the loading and contraction agree, and the measured results for stiffness are used without alteration. This leaves only one free variable, the cavity reference pressure, and that is set for best fit. This value is also assumed to be the best estimate of the insitu lateral stress σ_{ho}.

Values for shear strength are further supported by applying the 1972 Palmer numerical analysis to the contraction data.

DRAINED:

All the tests in chalk have been judged to be following a drained loading path. The primary indication is the increase in stiffness with stress level for successive unload/reload cycles. This indicates increasing mean effective stress and therefore analysis by methods that identify the angles of internal friction ϕ and dilation ψ.

Two procedures can be applied. Hughes et al (1977) is applicable to expansion data and can identify the peak angle of friction and dilation. Withers et al (1989) is applied to contraction data. Both analyses assume cohesion-less material, an assumption that is examined in the curve fitting part of the analysis.

To fully apply these solutions it is necessary to know the residual friction angle when the material is deforming under constant volume conditions. We have assumed that as the material is unloaded the mobilised friction angle will tend to this state, giving a residual angle of between 27° and 32°.

As with the undrained analysis the derived parameters can be modelled using a modified $c' - \phi$ solution (Carter et al, 1986). There are two unknowns, drained cohesion c' and p_o, that must be adjusted for best fit. The drained model is less constrained than the undrained version and consequently estimates of the insitu lateral stress are more uncertain. Based on information provided by Soil Engineering a Poisson's ratio of 0.25 has been applied to the model.

1.2.5 Cavity reference pressure

We have given estimates for the cavity reference pressure p_o. We have assumed that the values for p_o are representative of the total insitu lateral stress σ_{ho} .

For an initial estimate we have attempted iteration from the yield stress using the procedure of Marsland & Randolph (1977). These estimates are likely to over-estimate σ_{ho} and modelling the tests has been utilised to optimise the results.

If the test has been self-bored it is sometimes possible to recognise the initial stress from inspection of the early loading response ('lift-off') or by inspection of pore pressure data.

1.3 Report Layout

Although it is necessary to make judgments when analysing data, this remains a factual report. The parameters derived represent what seems a reasonable choice having applied a particular analysis. Other choices are possible, and the intention is that this report provides a full description of the tests and analytical methods employed so that the choices made here can be checked or modified.

This report is in two volumes. Volume 2 contains the test data, both raw and analysed, predominantly in graphical form. Volume 1 summarises the results (see Section 3 for detail) and provides explanatory text. Some plots of parameters against elevation have also been included but the data are not separated by borehole or material. Conveniently, most of the chalk tests are at elevations above 0 and are easily recognised.

The appendices of this volume detail instrumentation, calibration, test procedure and analysis.

1.4 Notation

The data collection system employed on site utilises a limited keyboard that restricts the options for describing a test. In particular it stores tests in the form B**T* where ** must be a number. The 'B', which may be modified, is intended to refer to the borehole and the 'T' refers to the individual test, so a typical test reference is B001T02 – the second test in borehole BH-TUN-001PM.

This limitation does not apply to the analysed data which uses different software. Calibration tests to evaluate membrane stiffness and system compliance are reported in a similar manner but using a test number that cannot be confused with an actual test.

1.5 Units

Pressure is quoted throughout in kPa. Displacements are quoted in millimetres which in turn are eventually converted to percent cavity strain. Depths are given in metres below ground level (mBGL) and elevation is given in metres above ordnance datum (mAOD). The data for ground levels was supplied by Soil Engineering.

2 Details of work carried out

Table 2.1 below details the pressuremeter testing carried in the boreholes. Table 2.2 provides background information about the tests and probe used. Table 2.3 provides borehole information. Notes on the work carried out and tables of information are provided below.

Table 2.1 Sequence of work

Test	Internal ref.	Depth (mBGL)	Date	Max Pressure (kPa)	Material	Remarks
BH_STW_006 Test 1	B006T01	2.70	05/08/2021	1143	Structureless Chalk	
BH_STW_006 Test 2	B006T02	N/A	05/08/2021	N/A	Structureless Chalk	SBPM hit obstruction. Drilling aborted
BH_STW_006 Test 3	B006T03	8.00	05/08/2021	1041	Structureless Chalk	
BH_STW_011A Test 1	B011T01	3.80	31/08/2021	1365	Structureless Chalk	
BH_STW_011A Test 2	B011T02	N/A	01/09/2021	N/A	Gault Clay	SBPM would not advance. Drilling aborted.
BH_STW_011A Test 3	B011T03	13.50	01/09/2021	1660	Gault Clay	
BH_STW_011A Test 4	B011T04	21.70	02/09/2021	1768	Gault Clay	
BH_STW_012a Test 1	B012T01	4.20	10/08/2021	2290	Structureless Chalk	
BH_STW_012a Test 2	B012T02	7.70	10/08/2021	1088	Structureless Chalk	
BH_STW_012a Test 3	B012T03	13.20	11/08/2021	940	Gault Clay	Highly anisotropic expansion, only single loop possible on loading curve
BH_STW_019A Test 1	B019T01	2.90	18/08/2021	1663	Structureless Chalk	
BH_STW_019A Test 2	B019T02	6.50	18/08/2021	1124	Structureless Chalk	Electrical short at 170kPa. This was repaired and the test resumed.
BH_STW_019A Test 3	B019T03	9.40	18/08/2021	1562	Structureless Chalk	
BH_STW_020 Test 1	B020T01	4.50	06/09/2021	702	Structureless Chalk	
BH_STW_020 Test 2	B020T02	8.50	06/09/2021	2506	Chalk	
BH_STW_020 Test 3	B020T03	2.20	07/09/2021	1637	Gault Clay	
BH_STW_021 Test 1	B021T01	5.45	16/08/2021	1110	Structureless Chalk	
BH_STW_021 Test 2	B021T02	9.20	16/08/2021	1452	Structureless Chalk	
BH_STW_021 Test 3	B021T03	12.00	16/08/2021	1511	Chalk	
BH_TUN_001PM Test 1	B001T01	12.50	13/09/2021	1142	Gault Clay	
BH_TUN_001PM Test 2	B001T02	18.50	14/09/2021	1613	Gault Clay	
BH_TUN_006PM Test 1	B6PMT01	12.20	29/09/2021	154	Gault Clay	Pocket oversized
BH_TUN_006PM Test 2	B6PMT02	12.90	29/09/2021	1132	Gault Clay	
BH_TUN_006PM Test 3	B6PMT03	18.50	29/09/2021	1382	Gault Clay	
BH_TUN_011PM Test 1	B11PMT01	6.00	13/10/2021	701	Gault Clay	
BH_TUN_011PM Test 2	B11PMT02	24.95	14/10/2021	1761	Gault Clay	
BH_TUN_018PM Test 1	B018T01	27.00	01/10/2021	1948	Gault Clay	Burst at 2MPa
BH_TUN_018PM Test 2	B018T02	n/a	04/10/2021	n/a	Gault Clay	SBPM refused, test aborted
BH_TUN_018PM Test 3	B018T03	28.70	04/10/2021	481	Gault Clay	Pocket oversized
BH_TUN_018PM Test 4	B018T04	30.40	04/10/2021	2634	Gault Clay	
BH_TUN_018PM Test 5	B018T05	32.10	05/10/2021	2916	Gault Clay	

Notes:

1. **Depth** is given as metres below ground level to the centre of the measuring section. The SBP membrane is 0.46 long, hence the affected zone is ± 0.23m of the quoted test centre. The HPD membrane is 0.60 long, hence the affected zone is ± 0.30m of the quoted test centre.
2. **Max Pressure** is the maximum pressure reached by the end of loading and may be used as a rough indication of how the material strength is changing with depth.

Table 2.2 Probe details and calibrations

Test	**Operator**	**Probe**	Transducer calibration	Membrane stiffness	System compliance
BH_STW_006 Test 1	EJS/SB	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_STW_006 Test 2	EJS/SB	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_STW_006 Test 3	EJS/SB	Wally (HPD)	13/07/2021	E0907T21	E0907T21
BH_STW_011A Test 1	EJS	Wally (HPD)	13/07/2021	E0907T21	E0907T21
BH_STW_011A Test 2	EJS	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_STW_011A Test 3	EJS	Wally (HPD)	13/07/2021	E0907T21	E0907T21
BH_STW_011A Test 4	EJS	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_STW_012a Test 1	EJS	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_STW_012a Test 2	EJS	Wally (HPD)	13/07/2021	E0907T21	E0907T21
BH_STW_012a Test 3	EJS	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_STW_019A Test 1	EJS	Wally (HPD)	13/07/2021	E0907T21	E0907T21
BH_STW_019A Test 2	EJS	Wally (HPD)	13/07/2021	E0907T21	E0907T21
BH_STW_019A Test 3	EJS	Wally (HPD)	13/07/2021	E0907T21	E0907T21
BH_STW_020 Test 1	EJS	Wally (HPD)	13/07/2021	E0907T21	E0907T21
BH_STW_020 Test 2	EJS	Wally (HPD)	13/07/2021	E0907T21	E0907T21
BH_STW_020 Test 3	EJS	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_STW_021 Test 1	EJS	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_STW_021 Test 2	EJS	Wally (HPD)	13/07/2021	E0907T21	E0907T21
BH_STW_021 Test 3	EJS	Wally (HPD)	13/07/2021	E0907T21	E0907T21
BH_TUN_001PM Test 1	EJS	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_TUN_001PM Test 2	EJS	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_TUN_006PM Test 1	EJS	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_TUN_006PM Test 2	EJS	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_TUN_006PM Test 3	EJS	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_TUN_011PM Test 1	EJS	Shula (SBP)	19/07/2021	E0610T22	E0610T21
BH_TUN_011PM Test 2	EJS	Shula (SBP)	19/07/2021	E0610T22	E0610T21
BH_TUN_018PM Test 1	EJS	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_TUN_018PM Test 2	EJS	Dougal (SBP)	13/07/2021	E0309T22	E0309T21
BH_TUN_018PM Test 3	EJS	Wally (HPD)	13/07/2021	E0907T21	E0907T21
BH_TUN_018PM Test 4	EJS	Wally (HPD)	13/07/2021	E0907T21	E0907T21
BH_TUN_018PM Test 5	EJS	Wally (HPD)	13/07/2021	E0907T21	E0907T21

Notes:

1. **Probe – Three probes were on this project, a six arm self bored pressuremeter known as 'Shula', a three arm self bored pressuremeter known as 'Dougal', a High Pressure Dilatometer known as 'Wally'.**
2. **Operator – EJS is Ewan Stockwell and SB is Simon Baxter, both employees of Cambridge Insitu.**
3. **For the probes there is a transducer calibration referenced by date. There are also separate calibrations for the membrane and system compliance.**

Table 2.3 Borehole location information

Borehole	Easting	Northing	Elevation mAOD	Groundwater level: mBGL
BH_STW_006	549502.5	261260.1	9.39	3.75
BH_STW_011A	549493.8	261023.6	10.17	3.75
BH_STW_012A	549712.9	261183.3	8.12	3.75
BH_STW_019A	549790.4	260872.9	9.42	3.75
BH_STW_020	549898.8	260975.8	8.13	3.75
BH_STW_021	549642.7	260664.3	10.98	3.75
BH_TUN_001PM	547214.1	261518.8	7.13	1.25
BH_TUN_006PM	547838.5	261494.8	6.59	4.50
BH_TUN_011PM	548428.8	261304.0	6.57	1.75
BH_TUN_018PM	549441.5	261003.2	10.24	4.00

Notes:

1. The ground level and coordinates of the borehole have been provided by Soil Engineering.
2. The ground water level is based on ground water monitoring information and provided by Soil Engineering.

3 Summary of results

Table 3.1 details the initial stress state for each of the tests. Table 3.2 summaries the key strength parameters for each test. Table 3.3 summaries the linear and non-linear parameters for deriving shear modulus and stiffness for each loop. Table 3.4 contains the selected modulus parameters for each test.

Table 3.1 Initial stress state

Test	Depth (mBGL)	Elevation (mAOD)	u_o (kPa)	p_o (kPa)	σ_{vo} (kPa)	k_0	OCR
BH_STW_006 Test 1	2.70	6.69	0	76	54	1.41	4.9
BH_STW_006 Test 3	8.00	1.39	24	109	160	0.63	1.4
BH_STW_011A Test 1	3.80	6.37	0	94	76	1.24	3.3
BH_STW_011A Test 3	13.50	-3.33	92	325	270	1.31	6.9
BH_STW_011A Test 4	21.70	-11.53	176	462	434	1.11	5.6
BH_STW_012A Test 1	4.20	3.92	4	97	84	1.16	4.0
BH_STW_012A Test 2	7.70	0.42	39	147	154	0.94	2.1
BH_STW_012A Test 3	13.20	-5.08	93	318	264	1.32	4.8
BH_STW_019A Test 1	2.90	6.52	0	91	58	1.57	4.5
BH_STW_019A Test 2	6.50	2.92	27	113	130	0.83	2.5
BH_STW_019A Test 3	9.40	0.02	55	166	188	0.83	2.3
BH_STW_020 Test 1	4.50	3.63	0	98	90	1.09	3.2
BH_STW_020 Test 2	8.50	-0.37	0	194	170	1.14	3.5
BH_STW_020 Test 3	15.70	-7.57	117	355	314	1.21	7.7
BH_STW_021 Test 1	5.45	5.53	17	150	109	1.45	3.3
BH_STW_021 Test 2	9.20	1.78	53	162	184	0.83	2.8
BH_STW_021 Test 3	12.00	-1.02	81	199	240	0.74	2.4
BH_TUN_001PM Test 1	12.50	-5.37	110	368	250	1.84	5.3
BH_TUN_001PM Test 2	18.50	-11.37	169	520	370	1.75	6.1
BH_TUN_006PM Test 2	12.90	-6.32	82	410	258	1.86	3.7
BH_TUN_006PM Test 3	18.50	-11.92	137	453	370	1.36	3.7
BH_TUN_011PM Test 1	6.00	0.57	42	131	120	1.14	7.5
BH_TUN_011PM Test 2	24.95	-18.38	228	629	499	1.48	4.7
BH_TUN_018PM Test 4	30.40	-20.16	259	958	608	2.00	4.7
BH_TUN_018PM Test 5	32.10	-21.86	276	932	642	1.79	5.2

Notes on Table 3.1

1. **Depth** is the distance below ground level to the centre of the pressuremeter membrane.
2. **Elevation** uses the level provided by Soil Engineering.
3. u_o is the estimated ambient pore water pressure, this has been estimated based on groundwater monitoring information provided by Soil Engineering.
4. p_o is cavity reference pressure and is also the best estimate of σ_{ho}, the lateral insitu stress. For the most part it has been obtained from curve fitting.
5. σ_{vo} is our approximate judgment of the overburden stress assuming a constant increase with depth of 20kPa/metre. This is based on an approximation from the unit weight information provided by Soil Engineering.
6. k_0 is the coefficient of earth pressure at rest, being the ratio of the effective lateral stress to the effective vertical stress.
7. OCR is the over consolidation ratio. This has been derived using a relationship suggested by Wroth (1984) for undrained tests and by using the calculated failure pressure for drained tests.

Table 3.2 Parameters associated with strength

Test	Depth (mBGL)	$P_f\,(obs)$ (kPa)	$P_f\,(calc)$ (kPa)	P_{lim} (kPa)	c_u (kPa)	τ_f (kPa)	ϕ_{cv} (°)	ϕ_{pk} (°)	ψ (°)	c' (kPa)
BH_STW_006 Test 1	2.70	152	266	2963		118	30	35.6	6.7	40
BH_STW_006 Test 3	8.00	459	218	1717		69	30	31.4	1.7	5
BH_STW_011A Test 1	3.80	421	253	2528		114	32	35.6	4.3	40
BH_STW_011A Test 3	13.50	765	784	1970	235	239				
BH_STW_011A Test 4	21.70	749	959	2306	294	293				
BH_STW_012A Test 1	4.20	688	324	5251		151	32	38.3	7.7	60
BH_STW_012A Test 2	7.70	610	280	2128		90	27	27.7	0.8	23
BH_STW_012A Test 3	13.20	493	596	1468	173	172				
BH_STW_019A Test 1	2.90	598	259	3213		104	32	34.3	2.7	20
BH_STW_019A Test 2	6.50	411	281	2085		111	28	29.6	1.8	46
BH_STW_019A Test 3	9.40	597	359	2785		118	32	34.8	3.4	14
BH_STW_020 Test 1	4.50	292	287	1031		106	32	32.4	0.5	10
BH_STW_020 Test 2	8.50	797	597	5092		280	32	35.5	4.2	117
BH_STW_020 Test 3	15.70	621	860	2211	287	290				
BH_STW_021 Test 1	5.45	448	322	2236		107	30	30.3	0.4	8
BH_STW_021 Test 2	9.20	571	414	3501		164	28	37.2	10.8	57
BH_STW_021 Test 3	12.00	582	470	2487		142	28	28.2	0.3	28
BH_TUN_001PM Test 1	12.50	471	637	1496	152	154				
BH_TUN_001PM Test 2	18.50	789	891	2139	247	245				
BH_TUN_006PM Test 2	12.90	614	657	1392	141	143				
BH_TUN_006PM Test 3	18.50	627	747	1788	191	191				
BH_TUN_011PM Test 1	6.00	209	320	898	114	112				
BH_TUN_011PM Test 2	24.95	751	1057	2395	266	267				
BH_TUN_018PM Test 4	30.40	1291	1527	3194	343	346				
BH_TUN_018PM Test 5	32.10	1423	1602	3475	396	395				

Notes on Table 3.2

1. $P_f\,(obs)$ is observed total yield stress, derived from inspection of the loading curve.
2. $P_f\,(calc)$ is calculated yield stress, using values for the cavity reference pressure, non-linearity and strength (C_u or τ_f).
3. P_{lim} is the total limit pressure. If the test is undrained it is the intercept of the plot used to derive the undrained shear strength.
4. c_u is undrained shear strength from the slope of a plot of the natural log of the current shear strain versus total pressure (Gibson & Anderson, 1961).
5. τ_f is the shear stress at first yield. For the drained tests, it can be derived by applying a Mohr-Coulomb failure criteria using the given data for p'_o, c' and ϕ_{pk}. However, for these data the calculation used is $(P_f - P_o) \times \beta$ where P_f is the calculated failure stress, P_o is the best estimate of the insitu stress (Table 3.1) and β is the material non-linearity that was applied when P_f was derived. The same calculation should give the undrained strength for the undrained case so it has been applied to all the tests for comparison. For tests in Gault Clay it does, within a very small margin.
6. ϕ_{cv} is the residual friction angle when the material is deforming at constant volume.
7. ϕ_{pk} and ψ are internal angle of friction and dilation. They are derived in the first instance by applying Hughes et al, 1977 and optimised by curve fitting with an adapted version of Cater et al, 1986.
8. c' is drained cohesion. It is not measured but is a 'found' value required for the best fit curve comparison result. It should be used with appropriate caution.

Table 3.3 Linear and non-linear parameters for deriving shear modulus

Test:	Depth	Loop No.	G_{ur}	E	Constant α	Exponent β	$G_{s0.01\%}$	$G_{s0.1\%}$	$G_{s1\%}$	$E_{s0.01\%}$	$E_{s0.1\%}$	$E_{s1\%}$
	mBGL		MPa	MPa	MPa		MPa	MPa	MPa	MPa	MPa	MPa
BH STW												
006 Test 1	2.70	1	84	219	5.946	0.630	180	77	33	381	163	69
		2	90	234	6.402	0.623	206	87	36	436	183	77
		3	80	208	5.011	0.590	219	85	33	454	177	69
006 Test 3	8.00	1	67	173	11.993	0.780	91	55	33	210	126	76
		2	84	219	6.584	0.659	152	69	32	328	150	68
		3	89	232	6.608	0.635	191	82	35	405	175	76
		4	68	178	4.512	0.593	192	75	29	398	156	61
011A Test 1	3.80	1	53	139	8.983	0.758	83	48	27	190	109	62
		2	72	188	6.965	0.679	134	64	31	292	139	67
		3	83	216	11.224	0.714	156	81	42	347	180	93
		4	81	210	5.588	0.602	218	87	35	456	183	73
011A Test 3	13.50	1	58	152	9.726	0.761	88	51	29	200	116	67
		2	70	181	3.630	0.582	171	65	25	353	135	51
		3	63	165	3.438	0.558	202	73	26	411	149	54
		4	56	146	2.774	0.520	231	76	25	461	153	51
		5	47	122	3.185	0.556	190	68	25	387	139	50
011A Test 4	21.70	1	58	152	6.754	0.643	181	80	35	387	170	75
		2	51	131	6.101	0.624	195	82	34	412	173	73
		3	54	140	4.484	0.588	199	77	30	413	160	62
012A Test 1	4.20	1	142	369	14.026	0.676	277	132	62	603	286	136
		2	132	343	14.587	0.667	313	146	68	678	315	146
		3	139	360	8.303	0.583	387	148	57	799	306	117
		4	138	359	10.061	0.612	359	147	60	753	308	126
012A Test 2	7.70	1	59	154	22.372	0.870	74	55	41	179	133	99
		2	127	329	12.341	0.696	203	101	50	446	222	110
		3	130	337	12.192	0.679	234	112	53	511	244	117
		4	53	139	4.327	0.612	154	63	26	324	133	54
012A Test 3	13.20	1	38	98	3.770	0.629	115	49	21	244	104	44
		2	34	87	3.446	0.618	116	48	20	245	102	42
019A Test 1	2.90	1	82	214	10.666	0.733	125	67	36	280	151	82
		2	146	379	10.706	0.662	241	111	51	520	239	110
		3	172	447	9.431	0.619	315	131	55	665	276	115
		4	145	376	6.017	0.556	359	129	46	732	263	95
019A Test 2	6.50	1	63	163	8.079	0.725	102	54	29	227	121	64
		2	81	210	6.691	0.660	153	70	32	331	151	69
		3	106	276	14.739	0.721	193	101	53	429	226	119
		4	111	288	9.148	0.660	210	96	44	452	207	94
		5	59	153	3.003	0.522	245	82	27	490	163	54
019A Test 3	9.40	1	82	214	11.724	0.737	132	72	39	297	162	89
		2	91	237	10.836	0.699	173	87	43	382	191	96
		3	113	295	6.942	0.610	252	103	42	529	215	88
		4	100	261	8.694	0.636	248	107	46	529	229	99
020 Test 1	4.50	1	19	50	1.790	0.649	45	20	9	97	43	19
		2	25	65	1.610	0.594	68	27	10	141	55	22
		3	26	68	1.508	0.559	88	32	11	179	65	23
		4	25	64	2.090	0.591	90	35	14	188	73	29
020 Test 2	8.50	1	50	129	10.301	0.780	78	47	28	180	108	65
		2	82	214	11.272	0.732	133	72	39	299	161	87
		3	149	386	13.628	0.681	257	123	59	561	269	129
		4	188	488	21.494	0.694	360	178	88	791	391	193
		5	188	490	15.956	0.643	427	188	83	914	402	176
020 Test 3	15.70	1	60	156	7.889	0.664	174	80	37	377	174	80
		2	52	134	5.888	0.625	186	79	33	394	166	70
		3	57	147	3.878	0.574	196	74	28	404	151	57
021 Test 1	5.45	1	47	123	4.605	0.639	128	56	24	273	119	52
		2	48	126	4.516	0.621	148	62	26	313	131	55

Test:	Depth	Loop No.	G_{ur}	E	Constant α	Exponent β	$G_{s0.01\%}$	$G_{s0.1\%}$	$G_{s1\%}$	$E_{s0.01\%}$	$E_{s0.1\%}$	$E_{s1\%}$
		3	41	106	2.749	0.567	148	55	20	304	112	41
021 Test 2	9.20	1	59	154	10.577	0.757	99	57	32	226	129	74
		2	97	252	13.214	0.724	168	89	47	375	199	105
		3	123	320	11.253	0.652	278	125	56	596	267	120
		4	116	301	7.231	0.581	343	131	50	708	270	103
021 Test 3	12.00	1	95	248	4.830	0.605	184	74	30	384	155	62
		2	114	296	3.454	0.530	262	89	30	526	178	60
		3	121	316	3.743	0.523	303	101	34	606	202	67
BH_TUN_												
001PM Test 1	12.50	4	96	250	3.555	0.525	282	95	32	566	189	63
		1	43	111	3.848	0.608	142	58	23	298	121	49
		2	43	112	3.112	0.568	166	62	23	341	126	47
001PM Test 2	18.50	3	46	118	3.029	0.571	158	59	22	324	120	45
		1	58	150	7.073	0.660	162	74	34	350	160	73
		2	47	122	4.180	0.579	202	77	29	417	158	60
006PM Test 2	12.90	3	50	129	4.790	0.612	171	70	29	359	147	60
		1	28	72	2.845	0.590	124	48	19	258	100	39
		2	26	67	2.745	0.580	131	50	19	271	103	39
006PM Test 3	18.50	3	29	76	3.334	0.617	113	47	19	239	99	41
		1	55	143	6.611	0.656	157	71	32	338	153	69
		2	48	125	6.425	0.648	164	73	32	352	157	70
		3	52	134	4.690	0.610	170	69	28	357	146	59
011PM Test 1	6.00	1	27	70	2.351	0.614	82	34	14	173	71	29
		2	25	65	2.170	0.599	87	35	14	182	72	29
		3	26	67	2.000	0.592	86	33	13	178	70	27
011PM Test 2	24.95	1	82	212	7.228	0.637	205	89	38	436	189	82
		2	63	163	9.071	0.671	188	88	41	408	191	90
		3	65	170	5.970	0.625	189	80	34	399	168	71
018PM Test 4	30.40	1	67	174	5.345	0.611	192	79	32	404	165	67
		2	56	145	5.786	0.616	199	82	34	419	173	71
		3	51	131	5.614	0.608	208	84	34	435	176	72
		4	57	148	6.548	0.615	227	94	39	478	197	81
018PM Test 5	32.10	1	105	272	7.989	0.647	206	92	41	442	196	87
		2	66	171	8.147	0.651	203	91	41	435	195	87
		3	57	148	7.523	0.635	217	94	40	462	199	86
		4	61	158	7.039	0.608	260	106	43	546	221	90
		5	66	170	6.154	0.589	271	105	41	562	218	85

Notes on Table 3.3

1. $\mathbf{G_{ur}}$ is modulus obtained by taking the slope of the chord bisecting a cycle of unloading and reloading. This can only be shear modulus if the material response is linear elastic.
2. E is the Youngs modulus calculated from the linear shear modulus (G_{ur}) assuming a Poisson's ratio ν of 0.3:- $E=2G(1+\nu)$
3. Due to the non-linear characteristics of the soil, secant shear modulus is given by a power law of the form $G_s = \alpha\gamma^{\beta-1}$ where α and β are discovered from a plot of reloading data on log scales. If the response is linear elastic then $\beta = 1$ and α would be identical to G_{ur}, quoted in the first column.
4. Secant shear modulus parameters are given at three plane shear strain levels, γ of $10^{-4}/10^{-3}/10^{-2}$, but any value of shear strain can be used in the range 10^{-4} to 10^{-2}. All these modulus values are G_{hh}. 10^{-2} is approximately the shear strain at which the over-consolidated clay will yield, but it is too low for sand, where the yield strain is more likely to be 3×10^{-4}.
5. For comparison purposes, values for secant Young's modulus E_s at three axial strain values are given. These are derived from the following relationship: $E_s = 2\alpha(1+v)\left(\gamma_a\sqrt{3}\right)^{\beta-1}$

where v is Poisson's ratio and here is an arbitrary 0.3. The $\sqrt{3}$ term converts axial or invariant shear strain to plane shear strain, so that α and β can be used.

Table 3.4 Selected modulus parameters

Test	β	α MPa	$G_{s0.01\%}$ MPa	$G_{s0.1\%}$ MPa	$G_{s1\%}$ MPa	$E_{s0.01\%}$ MPa	$E_{s0.1\%}$ MPa	$E_{s1\%}$ MPa	G_y MPa	G_{50} MPa
BH_STW_006 Test 1	0.623	6.402	206	87	36	436	183	77	44	109
BH_STW_006 Test 3	0.635	6.608	191	82	35	405	175	76	44	135
BH_STW_011A Test 1	0.714	11.224	156	81	42	347	180	93	38	93
BH_STW_011A Test 3	0.520	3.150	262	87	29	523	173	57	34	65
BH_STW_011A Test 4	0.588	4.496	200	77	30	414	161	62	31	50
BH_STW_012A Test 1	0.667	14.587	313	146	68	678	315	146	97	202
BH_STW_012A Test 2	0.679	12.192	234	112	53	511	244	117	71	172
BH_STW_012A Test 3	0.618	3.979	134	56	23	283	117	49	28	43
BH_STW_019A Test 1	0.619	9.431	315	131	55	665	276	115	97	232
BH_STW_019A Test 2	0.660	6.691	153	70	32	331	151	69	38	79
BH_STW_019A Test 3	0.610	6.942	252	103	42	529	215	88	47	147
BH_STW_020 Test 1	0.559	1.508	88	32	11	179	65	23	5	21
BH_STW_020 Test 2	0.694	21.494	360	178	88	791	391	193	58	198
BH_STW_020 Test 3	0.574	4.220	213	80	30	439	165	62	31	52
BH_STW_021 Test 1	0.621	4.516	148	62	26	313	131	55	51	68
BH_STW_021 Test 2	0.652	11.253	278	125	56	596	267	120	29	155
BH_STW_021 Test 3	0.523	3.743	303	101	34	606	202	67	44	139
BH_TUN_001PM Test 1	0.571	3.726	194	72	27	398	148	55	41	69
BH_TUN_001PM Test 2	0.660	7.055	162	74	34	349	159	73	40	57
BH_TUN_006PM Test 2	0.580	2.813	135	51	19	278	106	40	24	40
BH_TUN_006PM Test 3	0.648	6.588	169	75	33	361	161	71	45	66
BH_TUN_011PM Test 1	0.592	2.378	102	40	16	212	83	32	20	31
BH_TUN_011PM Test 2	0.625	6.119	193	82	34	409	173	73	40	61
BH_TUN_018PM Test 4	0.608	6.476	240	97	39	502	204	83	43	67
BH_TUN_018PM Test 5	0.589	6.443	284	110	43	589	229	89	45	73

Notes on Table 3.4

1. **This table selects representative unload/reload cycle data from each test.**
2. **β and α have the meanings defined in Table 3.3.**
3. **G_s is the secant shear modulus against plane strain and E_s is the secant Young's modulus against invariant strain. These are calculated as defined in Table 3.3. The results are presented at three strain intervals.**
4. **G_y is the shear modulus when the material is on the point of yielding.**
5. **G_{50} is secant shear modulus when 50% of the available shear stress has been mobilised.**

Figure 3.1 Cavity Reference Pressure against Elevation

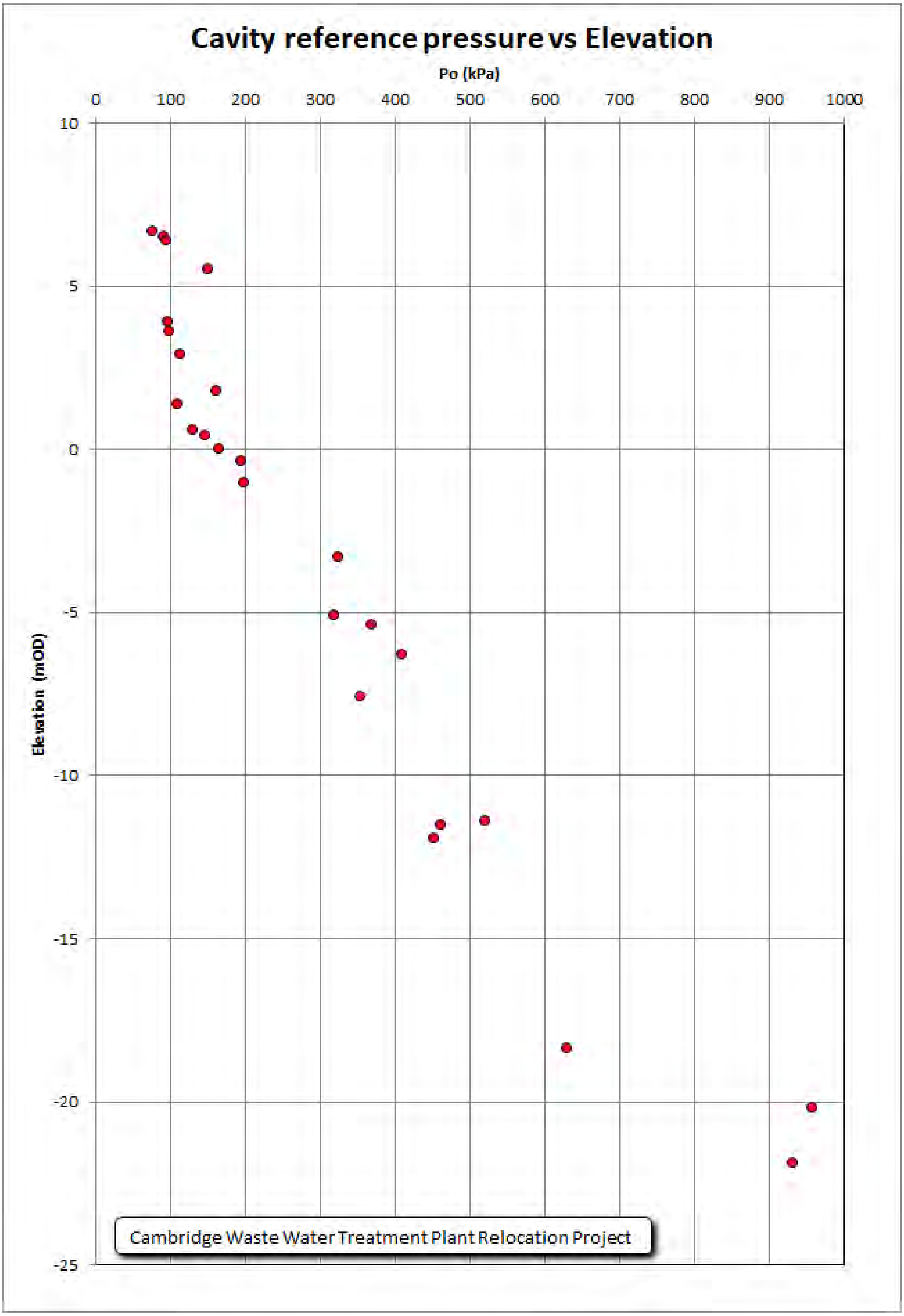


Figure 3.2 Coefficient of earth pressure at rest against Elevation

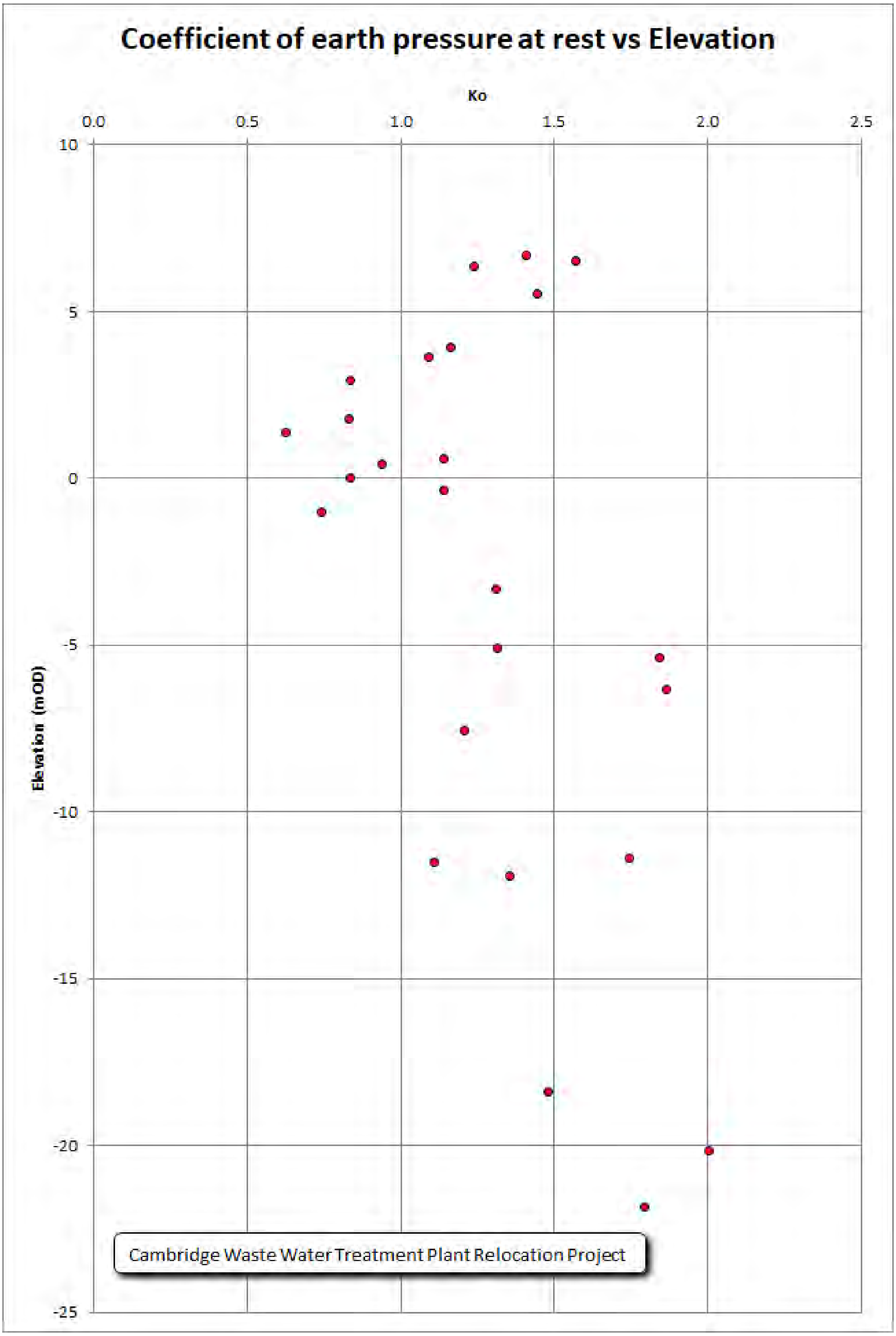


Figure 3.3 Shear stress at first yield against Elevation

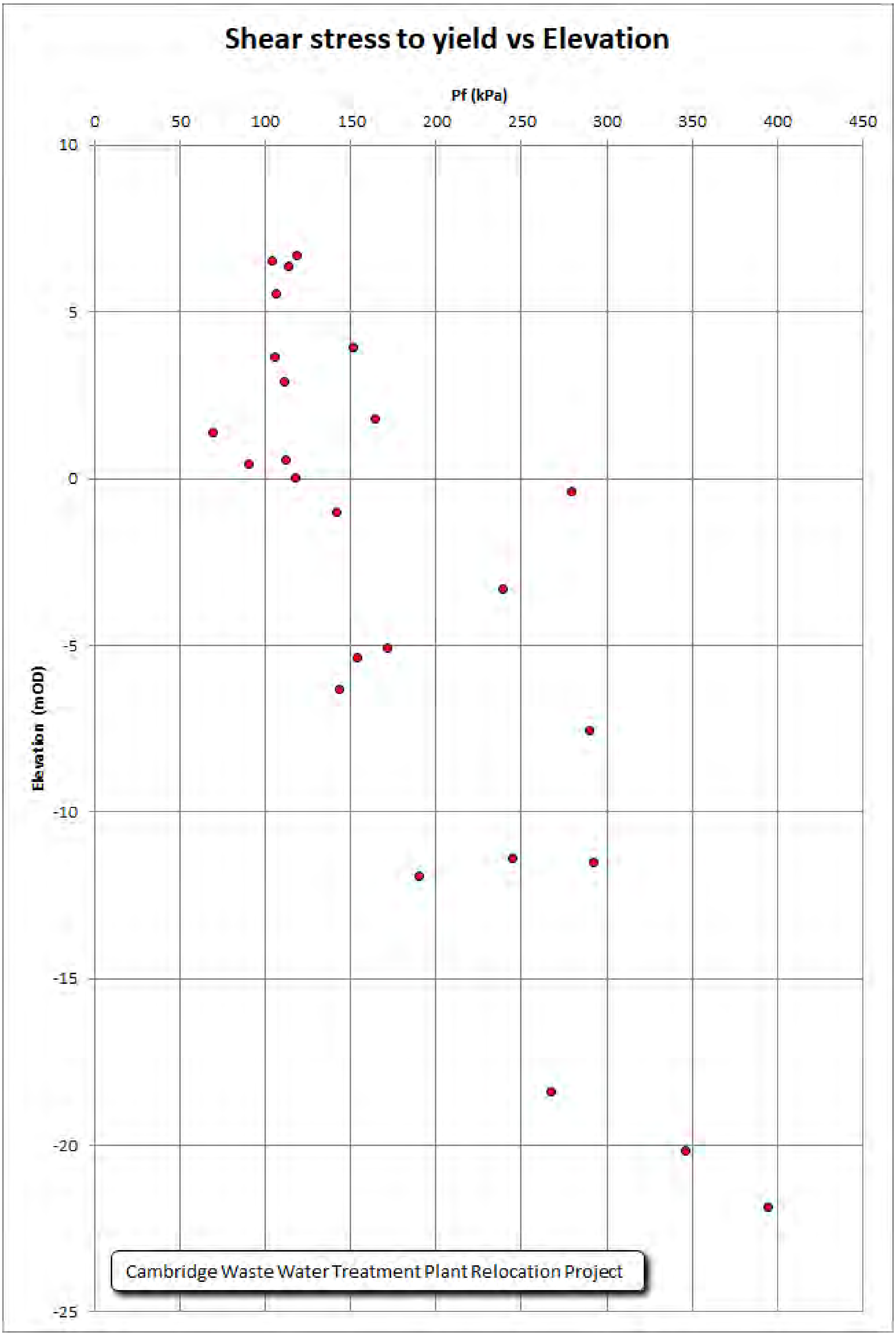
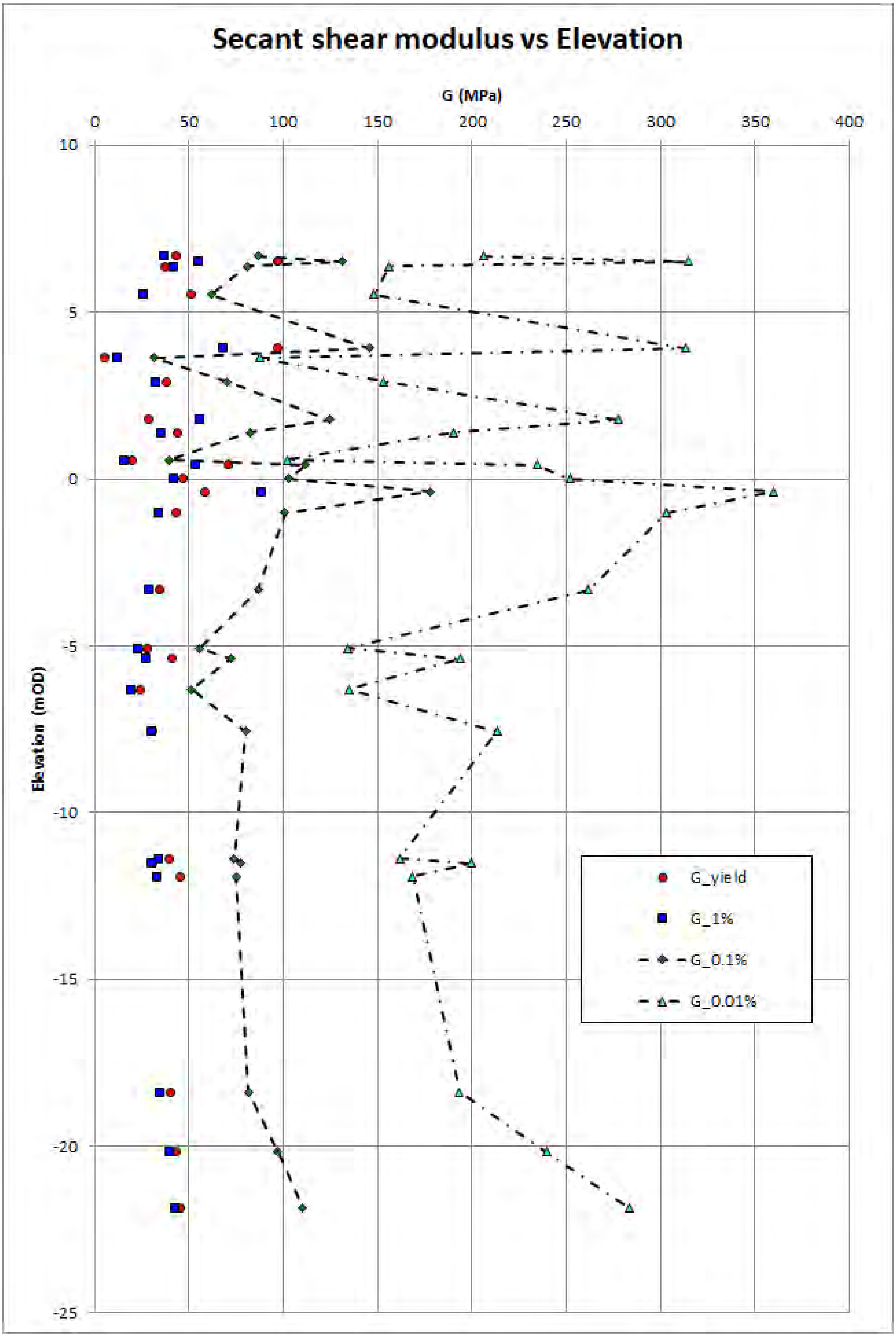


Figure 3.4 Secant shear modulus against Elevation



4 Field Curves

Figure 4.1 All tests on common axes – BH_STW_006

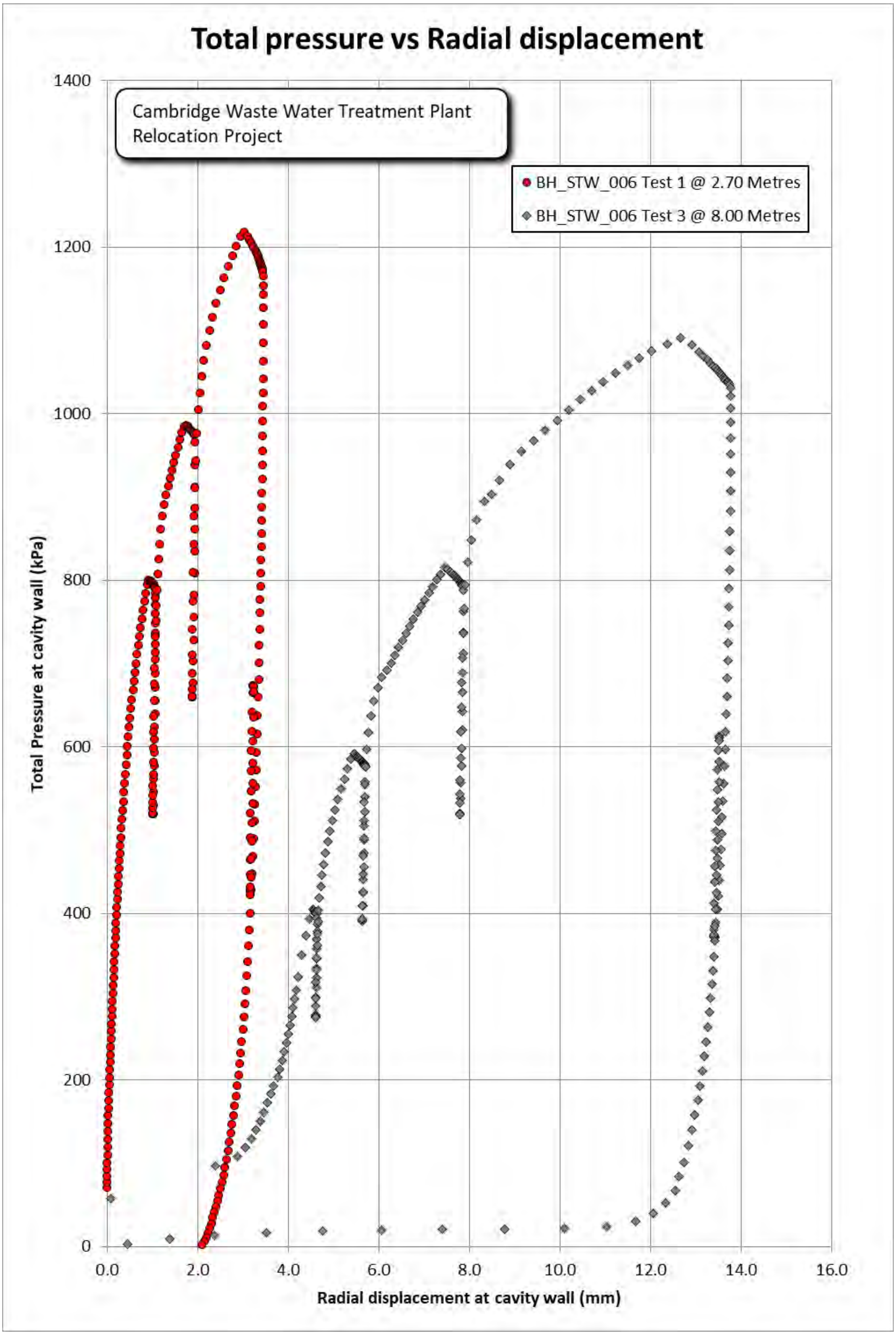


Figure 4.2 All tests on common axes – BH_STW_0011A

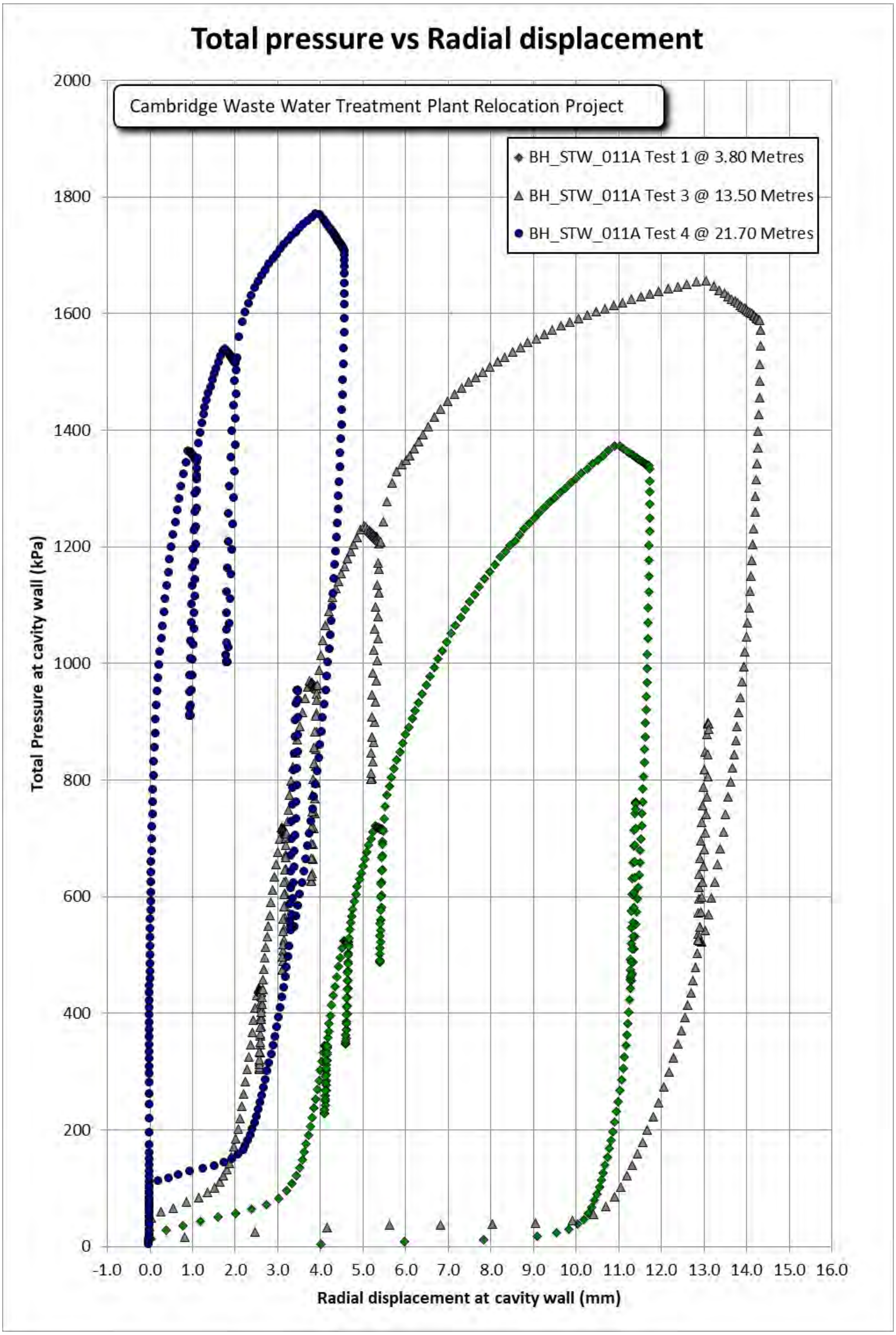


Figure 4.3 All tests on common axes – BH_STW_0012A

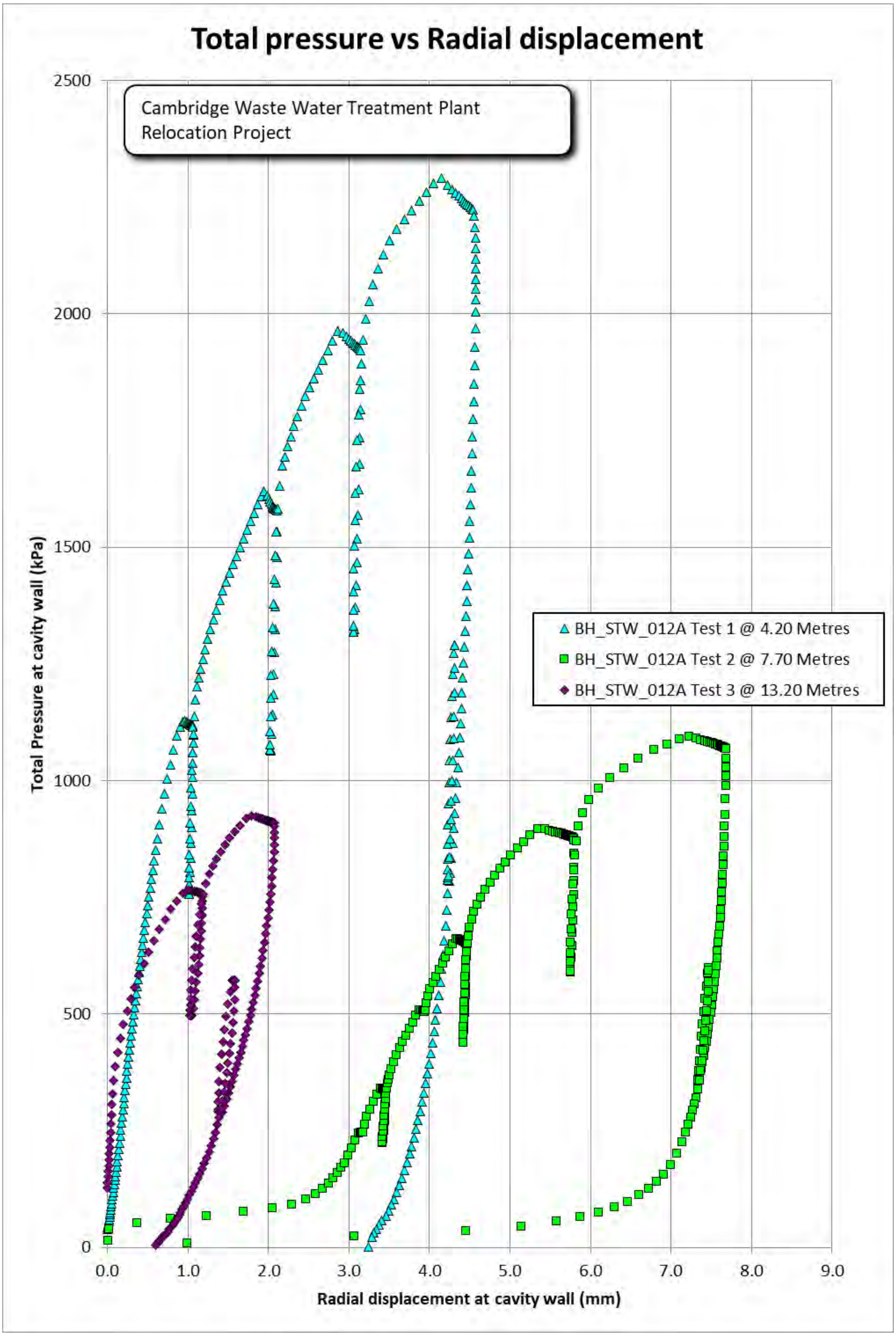


Figure 4.4 All tests on common axes – BH_STW_0019A

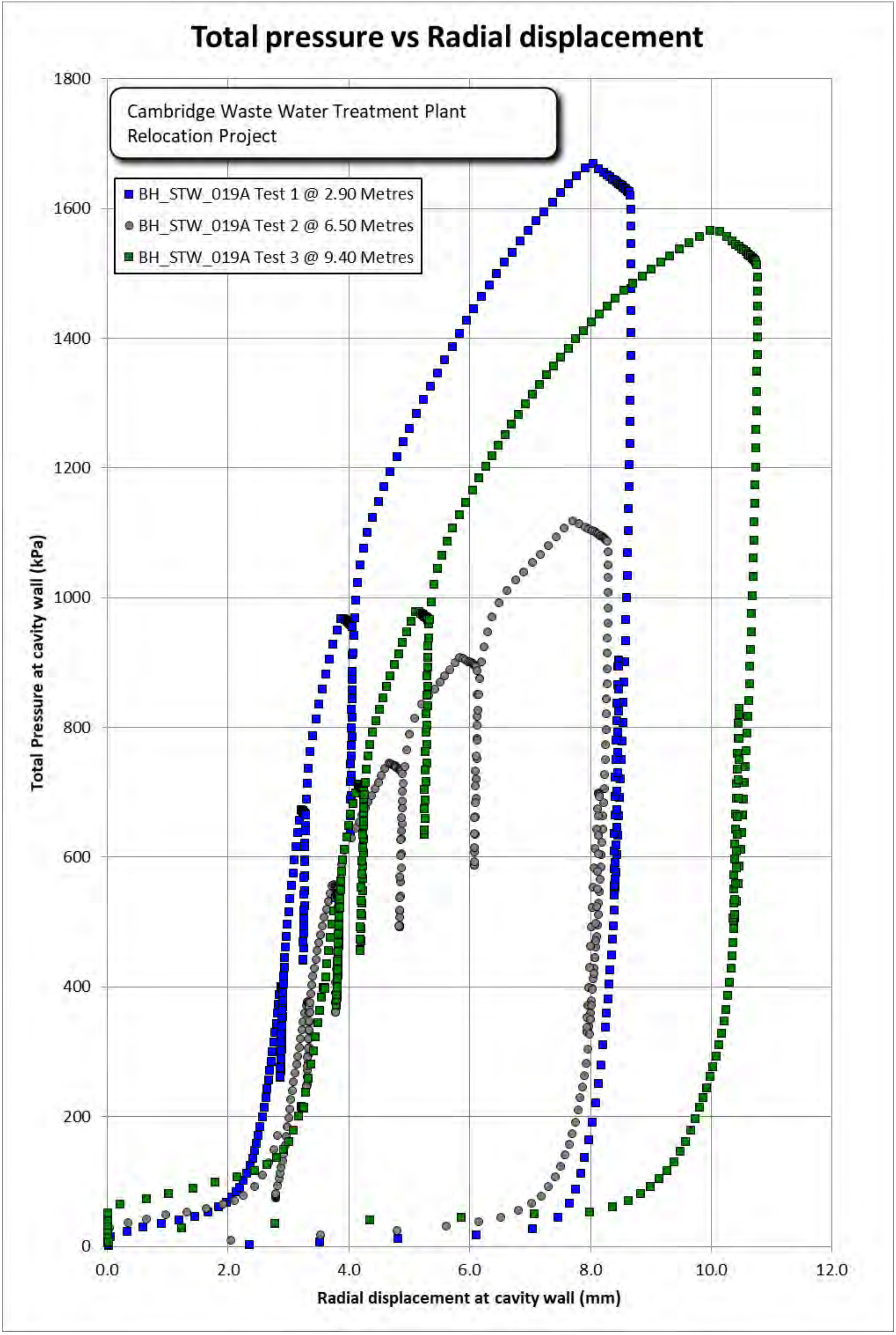


Figure 4.5 All tests on common axes – BH_STW_0020

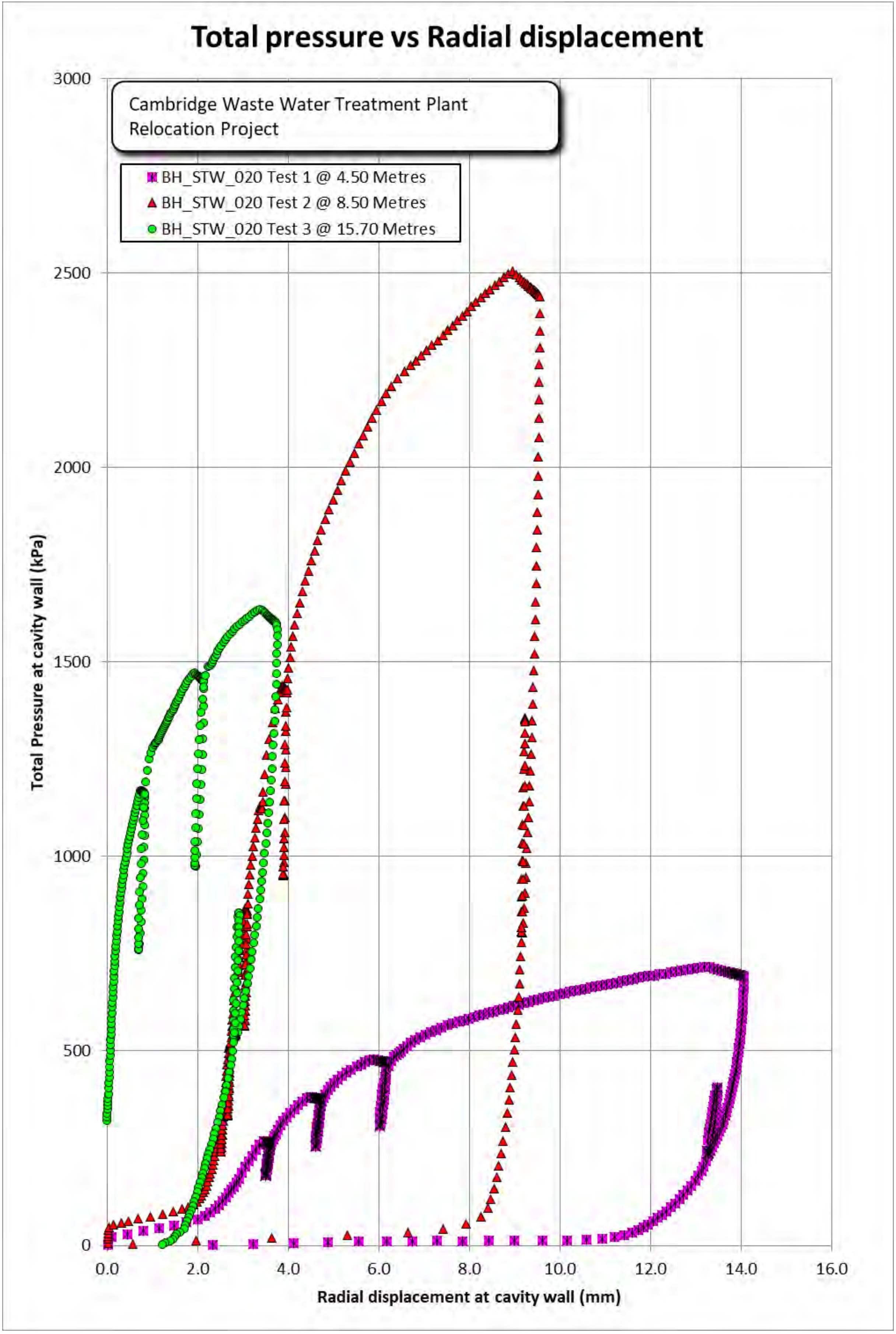


Figure 4.6 All tests on common axes – BH_STW_0020

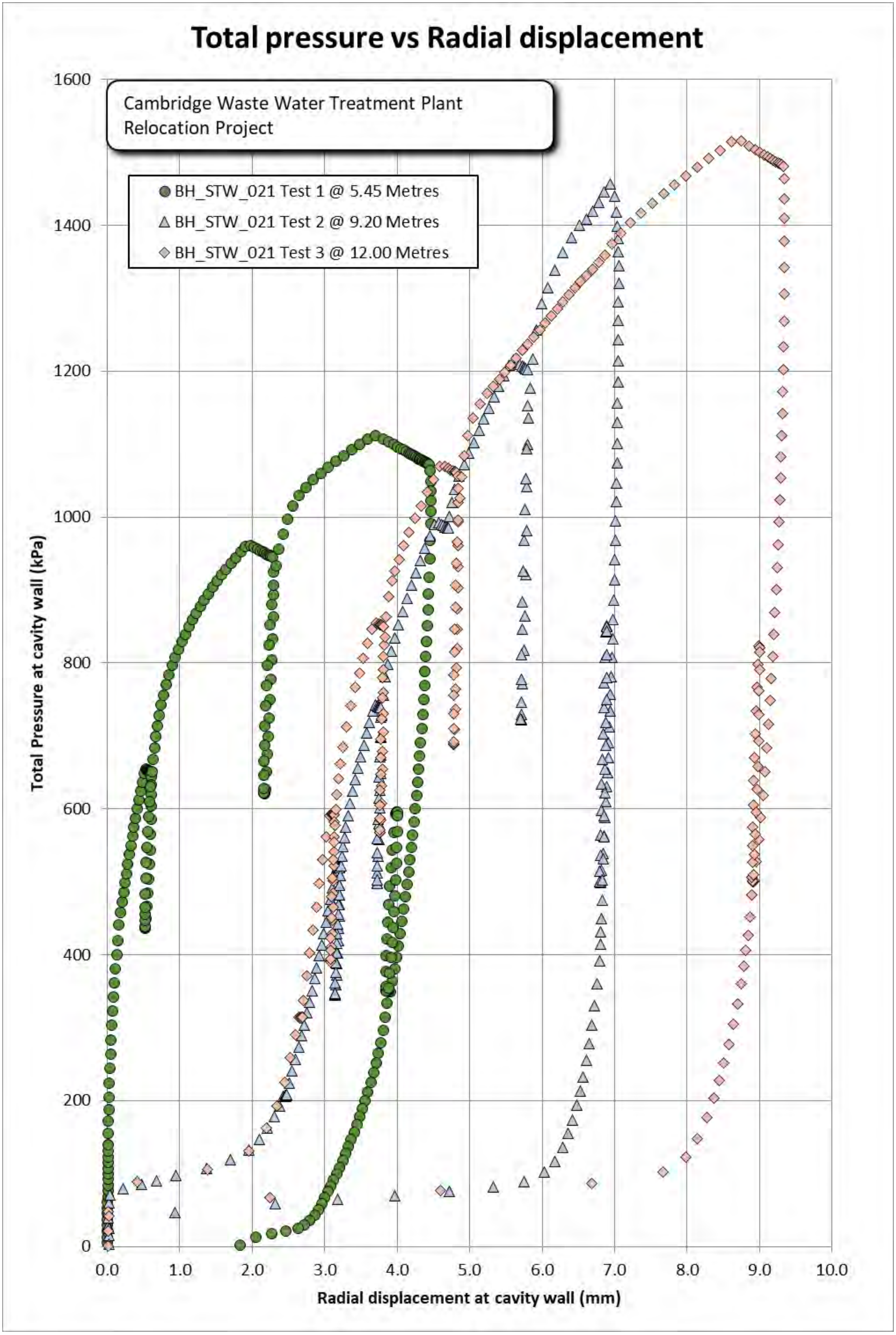


Figure 4.7 All tests on common axes – BH_TUN_001PM

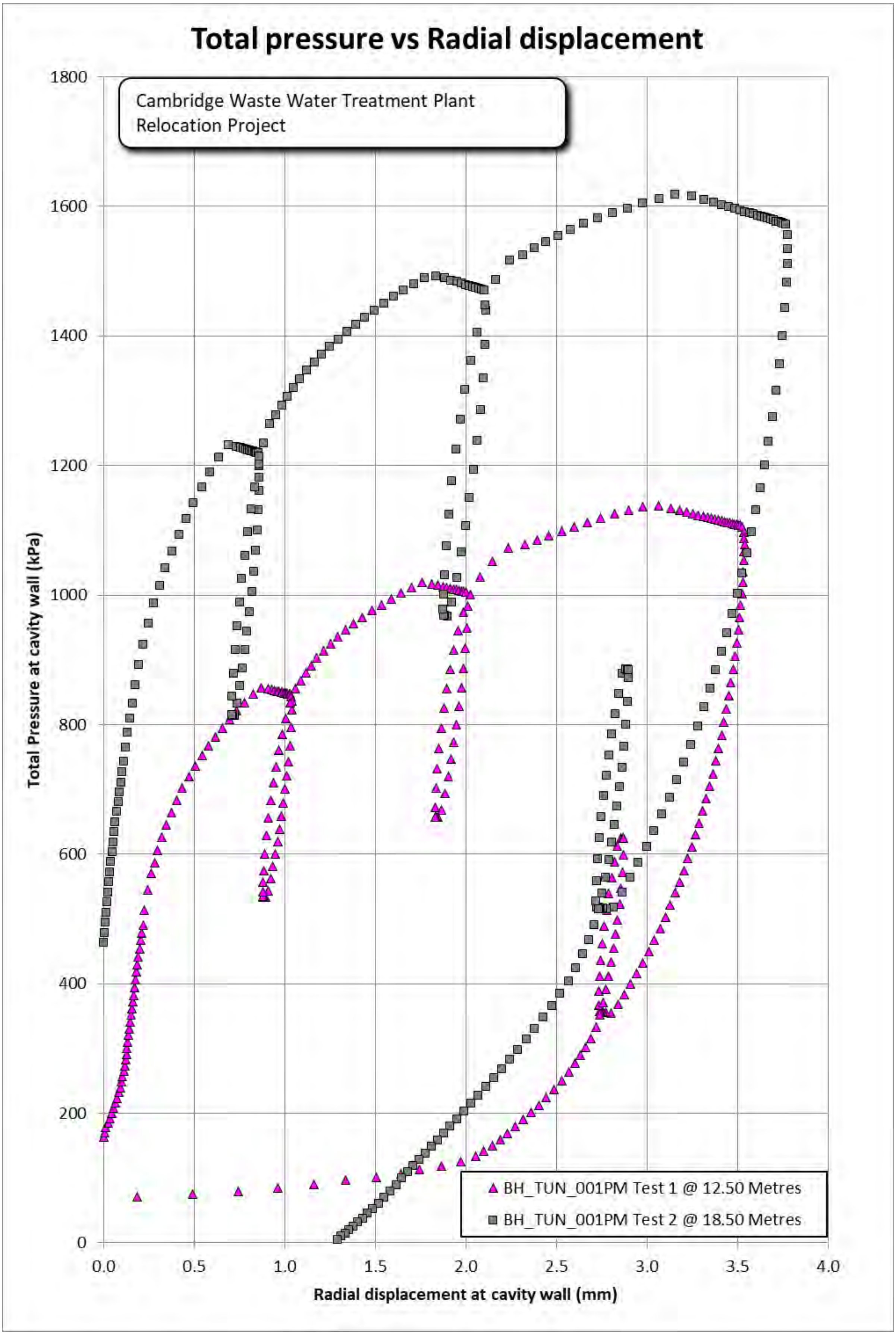


Figure 4.8 All tests on common axes – BH_TUN_006PM

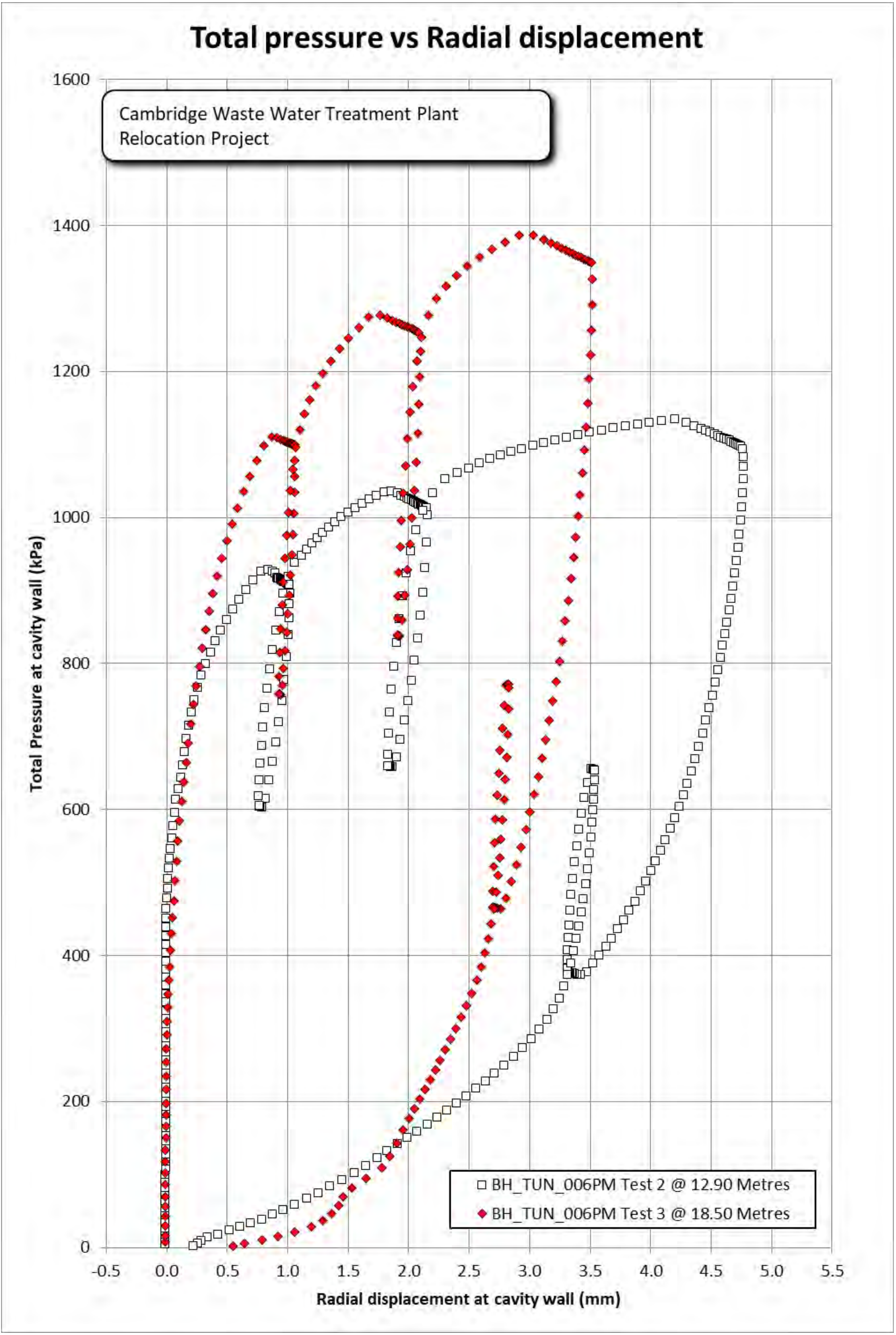


Figure 4.9 All tests on common axes – BH_TUN_011PM

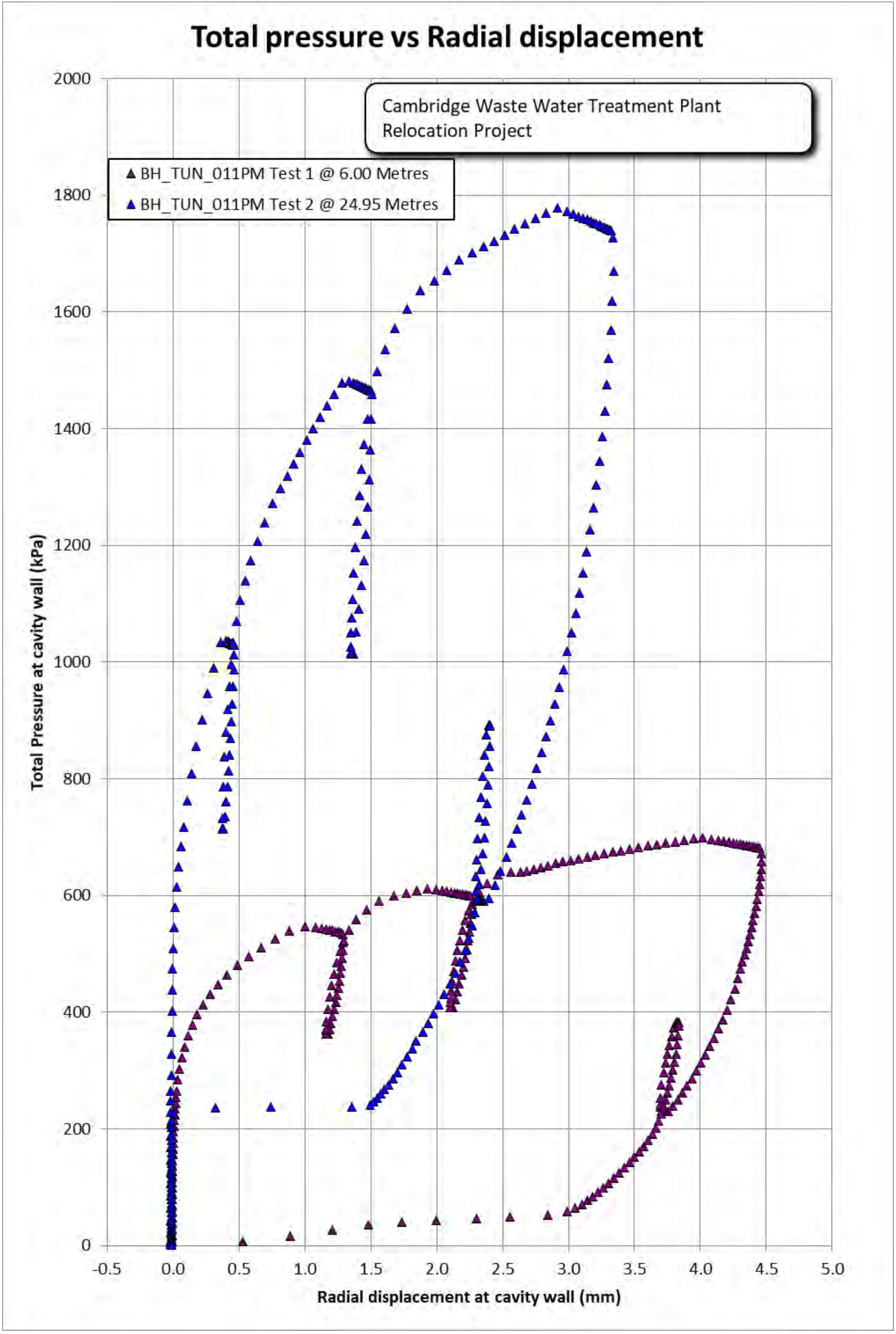
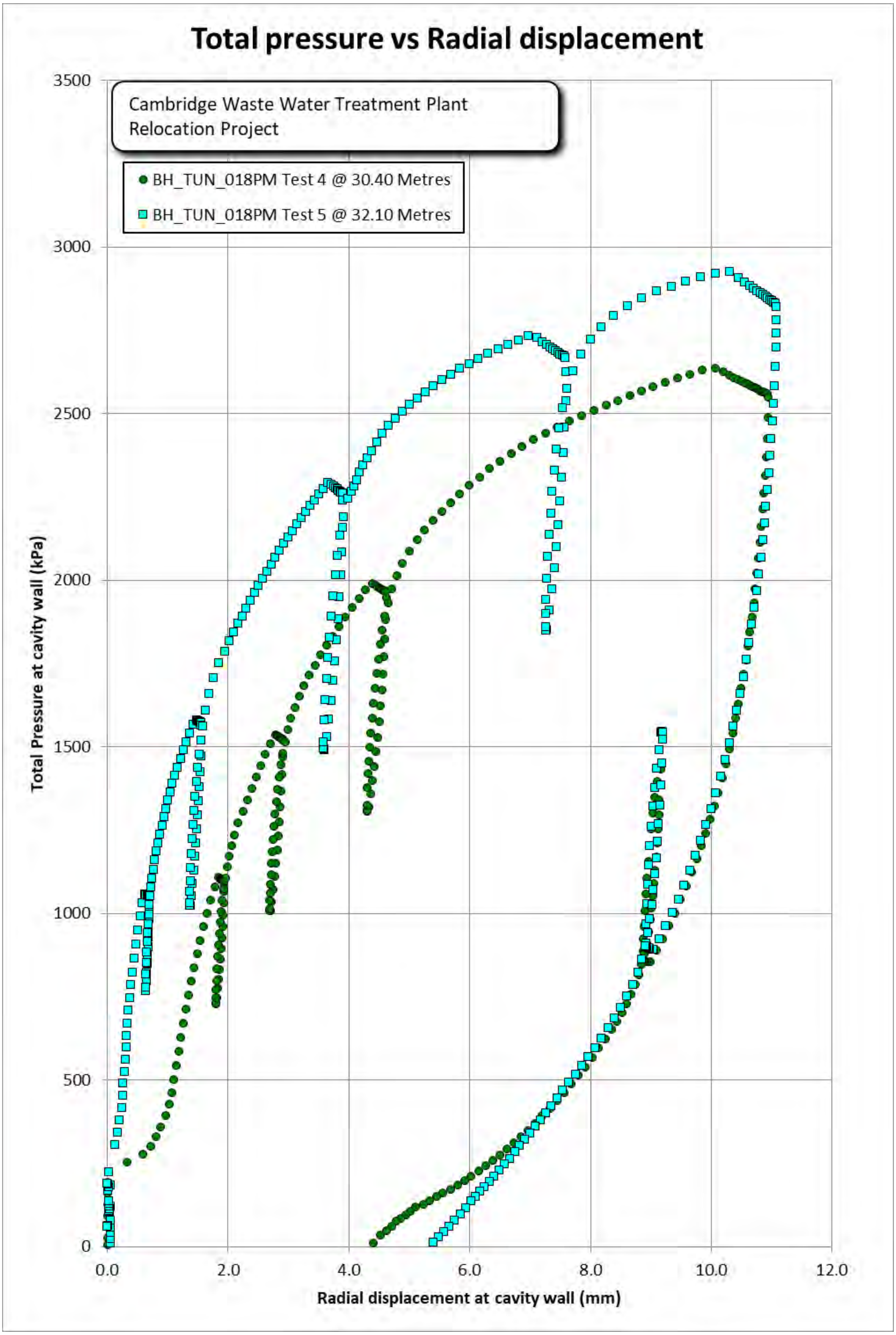


Figure 4.10 All tests on common axes – BH_TUN_011PM



APPENDIX A A DESCRIPTION OF THE EQUIPMENT

1 The High Pressure Dilatometer (HPD)

The 95mm High Pressure Dilatometer (95HPD) is a pre-bored hole pressuremeter for testing a 101mm diameter pocket. When a test is required it is lowered into a pocket in the ground conventionally formed by an H size barrel. On completion of a test it is removed from the borehole which is then extended by conventional drilling techniques.

The instrument is 2 metres long. The central third of the instrument is covered by a 6mm thick reinforced rubber membrane. Pressure is applied to the inside of the instrument and the membrane expands, pressing against the borehole wall. The radial displacement of the inside boundary of the membrane is measured at six points equally distributed around the centre of the expanding section. It is up to 95mm in diameter at the ends of the membrane and 94mm diameter at the centre of the membrane where displacements are sensed.

Figure 1.1 The 95mm High Pressure Dilatometer

This displacement, and the pressure necessary to cause the movement, are continuously monitored by strain gauged transducers contained within the instrument. Also within the instrument is the analogue and digital electronic circuitry necessary to condition the signals from the transducers. Every ten seconds a set of readings from all the measuring circuits are transmitted to the surface as an RS232 data stream which may be connected directly to the serial port of a microcomputer. Plotting these readings of displacement against pressure produces a loading curve for the material being tested. A number of mathematical analyses are available for translating this loading curve to fundamental strength and stiffness parameters for the ground.

Because the instrument has six strain arms there is some redundancy in the measurement of strain, and this enables the user to carry out a successful test even if one of the arms are defective. In order to give a similar level of reliability to the pressure measuring system a second pressure cell is included in the HPD-MPX, and its readings provide a check of the performance of the first transducer.

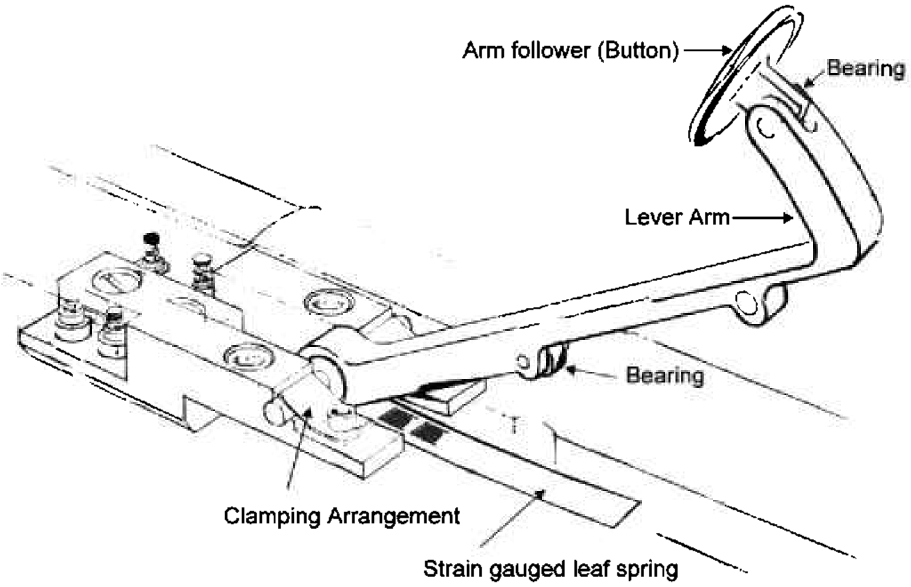


Figure 1.2 Displacement sensor of the 95mm HPD

The HPD can apply up to 30MPa of pressure to the ground, and can expand from an initial diameter of 95mm to nearly 150mm. It will resolve movements of less than 1 micron and pressure changes of less than 1kPa. Hence although it was developed to test weak rock it can make a test at two extremes of ground conditions - stiff clays, which yield at pressures below 1MPa, and weak rock with a shear modulus greater than 4GPa.

Although internally complex by the standards normally applied to instrumentation of this kind, it is reliable and robust, and the routine maintenance is straightforward. Because all the signal conditioning electronics is contained in the probe itself, the instrument is unaffected by external changes such as replacing the cable.

An additional feature of this pressuremeter is an electronic compass module fitted to the foot of the instrument. This gives a continuous reading of the orientation of a fixed reference on the instrument with respect to magnetic North. The compass consists of two magneto-resistive sensors at right angles to each other. The output of the compass therefore is two signals which are the sine and cosine of the angle made with the Earth's magnetic field. The quotient of these gives an unambiguous direction.

Like all expansion pressuremeters in commercial use the HPD has one significant uncertainty- the loading curve which it produces is derived from following the movement of the *inside* boundary of an elastic membrane. This is different from the movements of the *outside* boundary of the membrane, and hence the movements in the material itself. For the majority of the tests for which the HPD is used, this uncertainty is not significant. However, for a small number of tests it is critical; for this reason, the calibration procedure described in Appendix B necessarily is complex in order to reduce the margin of uncertainty and set limits to it.

Figure 1.3 Under the membrane of an HPD 95

2 The Self Boring Pressuremeter (SBP)

It is a probe about 88 millimetres in diameter and 1.2 metres long. Approximately 0.5m can be expanded by dry nitrogen gas and a typical test will expand the instrument by 10%.

The expansion is monitored by three or six followers, depending on the version of the probe used. These are conventionally referred to as 'strain arms' or more usually 'arms'. They are spaced evenly around the middle of the expanding test section. The arms are forced to follow the movements of the membrane by strain gauged leaf springs, and hence radial expansion is converted to an electrical output.

The internal pressure is measured by a strain gauged cell within the instrument. A further two cells are attached to the membrane, 180° apart, and these measure the changes in pore water pressure during the test.

The membrane covering the expanding portion of the instrument is in two parts. The inner layer, which is sealed, is made of nitrile rubber and is about 4mm thick. This inner skin is then covered by an outer layer, which because of its appearance when the instrument is inflated is known as a 'Chinese Lantern' (CHL). The CHL is made up of stainless steel strips. It has two main tasks - to take the frictional forces that occur when the instrument is being bored into the ground, and to provide some protection from inclusions that might otherwise puncture the inner membrane.

Figure 2.1 The Self Boring Pressuremeter without a Chinese lantern

The foot of the instrument is fitted with a sharp edged internally tapered cutting shoe. When boring, the instrument is jacked into the ground, and the material being cut by the shoe is sliced into small pieces by a rotating cutting device. It is a shearing process. The distance between the leading edge of the shoe and the start of the cutter is important and can be optimised for a particular material. If too close to the cutting edge the soil experiences some stress relief before being sheared. If the cutter is too far behind the shoe edge then the instrument begins to resemble a close ended pile. In stiff materials the usual setting is flush with the cutting shoe edge. The cutting device takes many forms. In soft clays it is generally a small drag bit, in more brittle material a rock roller is often used.

The instrument is connected to the jacking system by a drill string. This is in two parts, an outer casing to transmit the jacking force and an inner rod to rotate the cutter device. The casing is smaller than the maximum instrument diameter and the drill string is extended in one metre lengths as necessary to allow continuous boring to take place.

The cut material is flushed back to the surface through the instrument annulus. Normally water is used but air and drilling mud can also be used if appropriate.

The self boring method has been well documented and a complete description of the instrument and its test can be found in the references.

There is an isolated pressure-tight compartment at the lower end of the probe containing analogue and digital circuitry. All transducers in the probe are

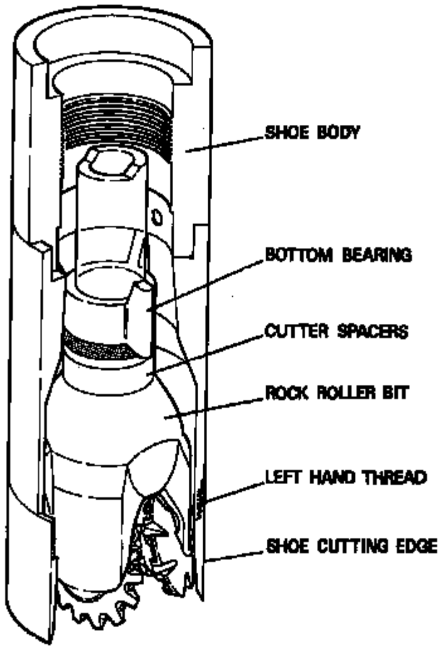


Figure 2.2 The rock roller configuration

read once every five or six seconds, depending on the version, and the result is output as digital numbers in ASCII format via an RS232 compatible serial link. All the signal conditioning is carried out in the probe itself, so the pressuremeter is unaffected by changes to external equipment including the cable.

The SBP can be arranged to cut the same diameter over its entire length – this is only appropriate for the softest ground conditions. In stiffer ground, the cutting head is larger by 1mm than any other part of the probe. This allows the instrument to penetrate ground of the strength of very weak rock.

Figure 2.3 The SBP ready to use

2.1 Boring Equipment

The SBP can be bored into its test positions by a conventional rotary drilling rig. The head rotates and pushes at the same time. To separate these two forces Cambridge Insitu supply an adapter incorporating a thrust bearing that allows a rotary head to drive the two rod SBP system. Water flush (supplemented with drilling muds, if available) is used, applied by whatever water pump is fitted to the drill rig. The reaction for the self boring is the self –weight of the drill rig.

A typical arrangement is shown in Figure 2.4 left. Figure 2.4 right shows a schematic of the adapter.

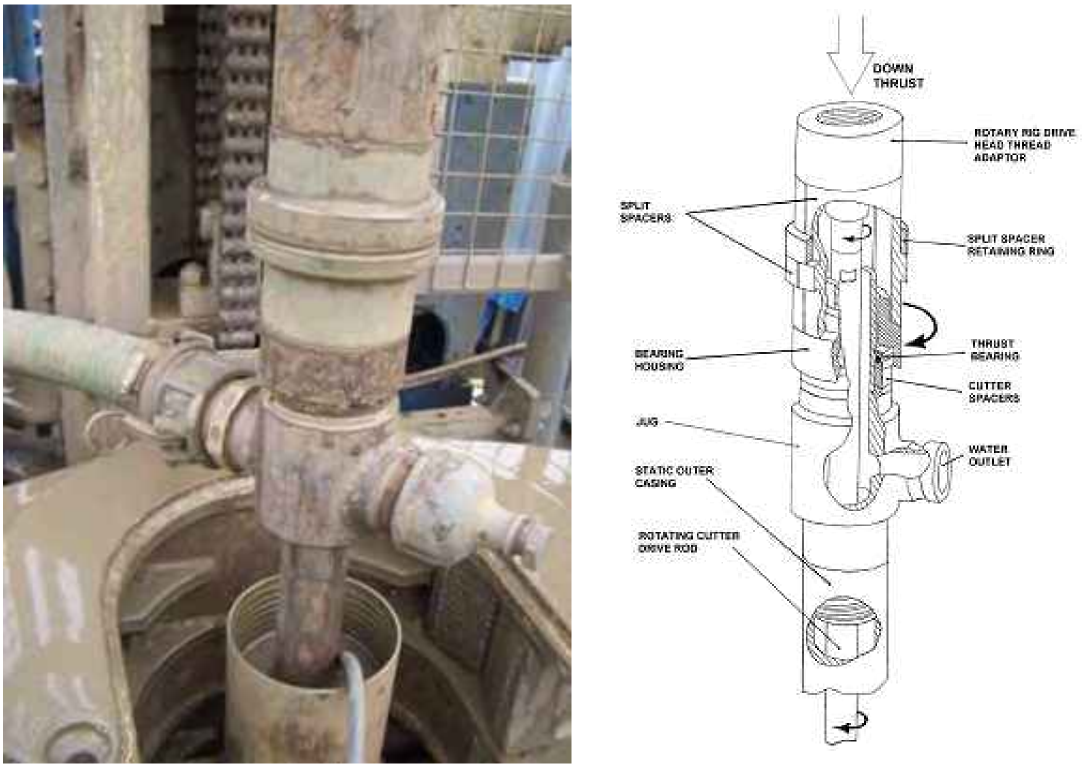


Figure 2.4 left: SBP system with drill rig right: Rotary Rig Adapter

3 The Membrane

The membrane itself is a nitrile rubber sleeve. Because the behaviour of the membrane has an influence on the derived displacements it is kept relatively thin (8mm for the standard probe) so that its contribution is small. By its very nature there is a gap between the instrument and the borehole and steps have to be taken to prevent the membrane extruding axially. This is achieved by stiffening the ends of the membrane with rings of stainless steel fingers known because of their appearance as 'Christmas Trees'.

There is a version of the membrane which carries local reinforcement at the ends consisting of kevlar strands. When the applied pressures are fairly modest (no more than about 50% of the available range) then this membrane can be used without Christmas trees.

The entire length of the of rubber membrane is covered with a sheath of eighteen stainless steel strips which are axially stiff but free to expand radially. This sheath protects the membrane from sharp edges, and is known as a 'Chinese Lantern'. The individual strips do not overlap in the closed position.

4 The Pressurising System

The instrument is inflated by oil or gas. A strong hose connects the instrument to the pressure source, either a manually operated hydraulic pump or a pneumatic control system. The passage down the centre of the hose is large enough to incorporate a steel logging cable with four electrical conductors. Three of these conductors are used; one carries the digital signals output by the instrument, and two carry power to the instrument from a conventional 12 volt vehicle battery. The power consumption of the pressuremeter is small; up to 500 metres of hose and cable could be connected to the instrument with only minor modification.

Figure 4.1 The control system

The advantages of the oil inflation are that it is inherently safe, requires very little equipment and because it is re-cycled the consumable costs are low. However if the instrument is on a long cable it takes time for the oil to return to the surface and in a dry hole it will never return unaided.

When working over water, it is normal to fill the probe itself with oil but surcharge it with air. Should the membrane become punctured the oil will keep the water out of the probe.

5 Electronic Interface Unit (EIU)

All pressuremeter hardware is powered by a single 12 volt vehicle battery. The battery is connected to the EIU, which introduces some protection and distributes the power to a number of outlets, including one for the pressuremeter. The returning signals from the pressuremeter connect to the same socket. The digital signals pass through an opto-isolation circuit and are then made available on two identical sockets for connection to the serial port of a computer. There is also an analogue signal which represents the output of TPC A.

The unit has a panel meter which can be switched either to read the battery volts or to read the analogue signal representing pressure in the probe.

6 Data Logging / Analysis Software

Software developed by Cambridge Insitu is used to log the data during the test, and for analysing the results subsequently.

The logging software stores the incoming data, displays the pressure/expansion curve in real time, and provides a text file output of the test data in engineering units. This file is read directly by the analysis program but can also be read by any of the common spreadsheet programs.

The analysis software provides routines which implement a number of standard analyses. The analyses tend to be graphically driven, meaning that the analyst identifies and marks significant parts of the curve, either for breakpoints or slope. The final screen for the analysis is then output as hardcopy backup for the decisions made.

APPENDIX B CALIBRATING CAMBRIDGE PRESSUREMETERS

1 Introduction

The calibrations are of two kinds. The most straightforward are those related to the performance of the transducers that determine changes in stress and displacement. However, no matter how exact the measurement, what is being determined are the changes caused to the *inner* surface of a sealed membrane. The purpose of the test is to determine the alterations to the cavity wall on the *outer* surface of the membrane. The second aspect to the pressuremeter calibration therefore is calculating the difference between these two surfaces. The difference is due to the strength of the membrane and the finite stiffness of the instrument.

All Cambridge pressuremeters use similar procedures so examples are given from a variety of probes. This description is laid out in the following order:

1. Scale factors
2. The displacement measuring system
3. Pressure measuring transducers
4. Reference (‘zero’) outputs
5. Membrane stiffness
6. Instrument compliance
7. Instrument straightness
8. Membrane thinning
9. Repeatability (or how much effort should be devoted to calibrations)

2 Scale Factors

The transducers in the probes are based on full bridge strain gauge circuits, where one half of the bridge is in compression and the other is seeing tension. The gauges are matched and distributed so that the effects of temperature alteration cancel out. Any such transducer produces an output dependent on the voltage being applied to it, the stress deflecting it and the amplification or buffering between it and the recording system.

The instruments contain electronic devices that provide a regulated voltage to the transducers and amplification of the resulting output signals. Because this electronic conditioning is a fixed part of the system it is not mentioned when presenting calibrations. The electrical output of the transducer, in volts, is quoted only as a function of the deflecting stress. This function is termed 'sensitivity' and gives the scale factor for deriving pressure or displacement from the transducer electrical output.

Although the output of the transducers is described as voltages, the true output of the system is a digital data stream of ASCII encoded numbers representing volts. All variables associated with producing the digital output from the strain gauge signals are a function of the pressuremeter itself, and are independent of external changes (such as alterations to the connecting cable).

When using the sensitivity calibrations to convert readings from volts into engineering units we make two important assumptions about this output; that it is linear, and that the hysteresis is negligible. The calibration procedure is the evidence that these assumptions are reasonable.

3 The Displacement Measuring System

The displacement measuring devices are often referred to as 'the arms'. The arms are calibrated by mounting a micrometer above each in turn and recording the output for a given deflection. When calibrating an instrument, it is necessary to plot these readings for both an increasing and reducing deflection. The difference at a given point between the increasing and reducing path is a measure of the hysteresis. The worst-case figure is noted, and corrective action is taken if the hysteresis is outside an acceptable limit - normally 0.5% of the sensitivity. We use micrometer heads with a non-rotating stem to ensure we are not spoiling the hysteresis measurement.

The slope of the best fit straight line through all the points is used to quote the arm sensitivity - as an output for a given deflection in units of millivolts per millimetre (mV/mm). See Figure 3.1.

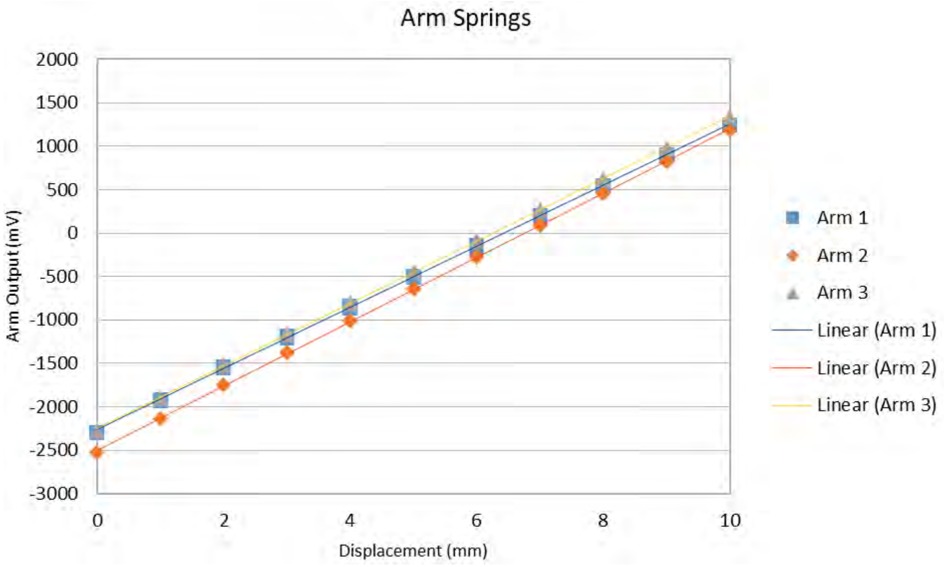


Figure 3.1 Arm Calibration example

4 Pressure Measuring Transducers

For pressure measuring circuits the maximum possible sensitivity is desirable, the only requirement is that the sensitivity be known and be linear and stable.

The sensitivity of *internal* pressure transducers is determined by placing a large metal cylinder over the probe and applying a known pressure to the inside of the instrument. The pressure being applied is measured by a standard test gauge. As with the arms, readings are plotted, the hysteresis noted, and the best fit straight line drawn through the plotted points.

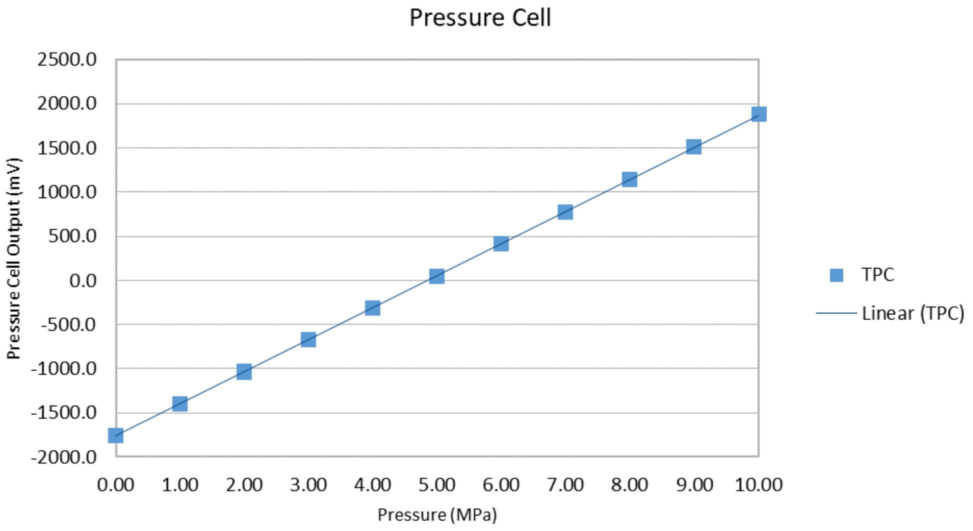


Figure 4.1 Pressure cell calibration example.

Pressure sensitivities are quoted in units of millivolts per MPa. See Figure 4.1.

5 Reference ('zero') outputs

The other parameter that the transducers have is a known output for an 'at rest' position. This is the value of the outputs produced by the circuits with atmospheric pressure both inside and outside the instrument, and any displacement measuring system at the initial radius position. This is called a little misleadingly 'zero'.

The absolute value of this figure is normally unimportant - it is not necessary that the figure be zero volts for zero displacement or stress, just that it be known. For practical purposes, as the analogue to digital converter outputs a number between –3.2767 and +3.2767 volts, the 'at rest' readings for the arms are set to be about -2 volts to allow a large output range with a margin for gradual drift over time.

A similar situation applies to the pressure cell – the absolute value of the 'zero' output is unimportant provided it allows the full pressure of the system to be resolved. Adjustment positions using 1% metal film resistors are provided in the instruments for setting all 'zero' outputs.

It is recommended to take (and make a record of) zero readings both at ground level and also at test depth immediately prior to carrying out a test. A significant change between zero readings must be investigated. 'Significant' would mean a change of 30 millivolts from the last set of zero readings. It is not unusual for shifts of a few millivolts to occur from day to day. It is important that the zero readings be stable when viewed over a period of a few minutes.

Note that when using oil to inflate a probe, ground level readings are the preferred reference because once in the borehole the pressure transducers will read the head of oil. For gas inflation it is probably better to use the zero readings when the probe is in place in the borehole, because it will then be at the temperature most applicable to the test. However, the self boring probe is fitted with pore pressure transducers. These two transducers must use zeroes recorded at ground level if they are to read the full water pressure in the ground.

6 Membrane stiffness

The membrane that is expanded by a pressuremeter has its own initial tension requiring a finite pressure to move it. The readings measured by the stress cells need to be reduced by this pressure in order to determine the net stress being applied to the ground.

The membrane correction is idealised as two components – a fixed pressure (in kPa) to move the membrane from its position at rest on the instrument, and a variable pressure dependent on the radial expansion, in units of kPa/mm.

The technique for obtaining the correction data is to pressurise the instrument in free air, ideally using similar rates of expansion as would be applied during a test.

The slope and the intercept on the pressure axis of the graph produced by this test give the membrane correction information for each arm. See Figure 6.1.

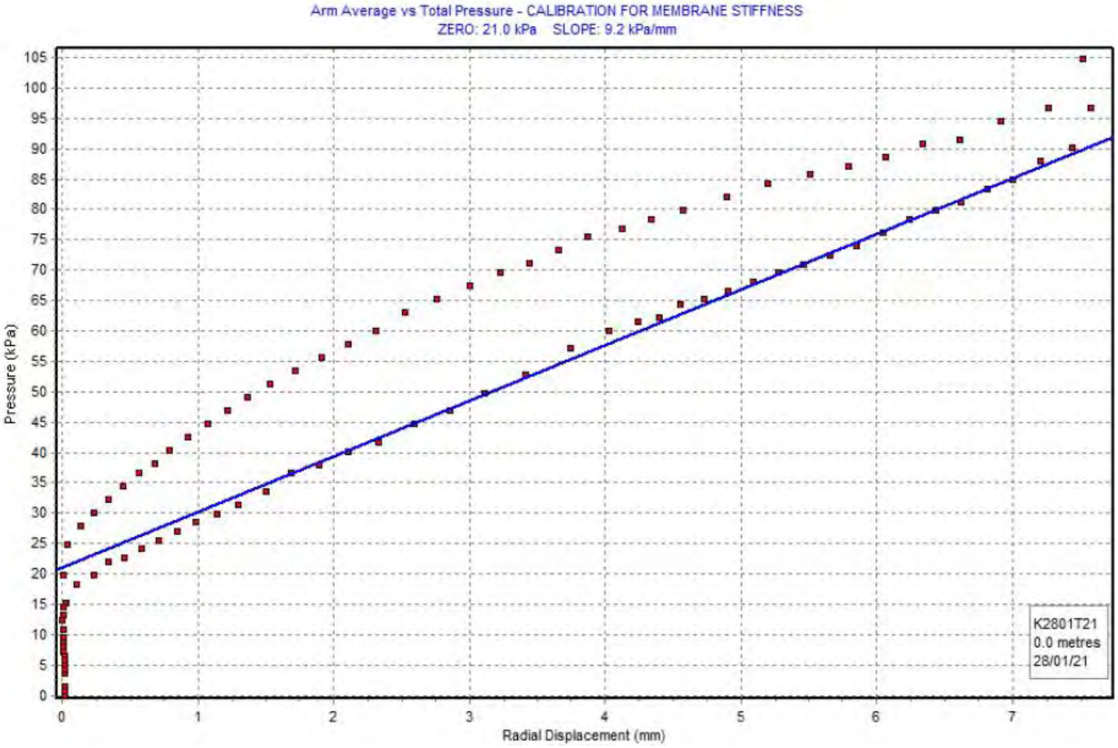


Figure 6.1 An example of an HPD membrane stiffness calibration

Knowing that the membrane does not necessarily possess isotropic properties, it has been customary to derive a different set of figures for each arm position. However an unconfined inflation in air exaggerates any variation in membrane properties; an average correction factor is more appropriate. The argument is that the ground has significant strength and stiffness, so that the membrane is always the weaker component. Hence although in air the weakest part of the membrane will move first when expanding, in the ground this cannot happen. Conversely, when the unconfined membrane is unloaded, the strongest part of the membrane will dominate. The consequence is that in air the membrane response looks like a hysteresis loop. The nearest approximation to the behaviour of the membrane in the ground will be the unloading phase of the test in air.

Typical correction figures are 60kPa and 10kPa/mm. Occasionally we calibrate membranes in a batch to save time when replacing them. The calibration values are written on the membrane.

7 Instrument compliance

The instruments will deform as a consequence of the pressure being internally applied. Put simply, the probes stretch. Because the displacement measuring system uses the body of the instrument as a reference, movements of the body are seen as apparent displacements of the membrane; some ingenuity is needed to isolate the displacement measuring system from this problem. This system compliance has implications for the measurement of shear modulus, and it can become a significant source of error when measuring very high modulus values.

There are a number of effects to consider but they are collectively determined using a single procedure. The correction figure which results is known for historical reasons as 'membrane compression', unfortunately not a good description.

For the Cambridge family of pressuremeters real membrane compression, that is the membrane changing in thickness as a direct result of the pressure differential across it, is almost too small to be measurable. There are a number of other factors to consider of greater magnitude than membrane compression.

Inflating the instrument inside a metal cylinder will provide data on the magnitude of these effects. However a separate source of error, which is a function of the calibration procedure itself, then becomes apparent. The membrane is able to expand axially by a small amount, and as a result experiences a change in thickness which may not occur in the ground. Although steps can be taken to keep this axial movement to a minimum, it cannot be eliminated.

As a consequence of the relatively poor fit of a calibration cylinder, and also the low coefficient of friction between the membrane and the steel by comparison with the membrane and the ground, the instrument will move about in the cylinder - its centre will not be the same as the centre of the cylinder. Only average radial movement can be derived from this calibration process, and it is not sensible to try for separate factors for individual arm.

If metal protective strips are fitted then part of the correction response is due to these strips taking up the form of the cylinder, a process that would only occur in the ground if the material was good rock. This is the explanation for much of the initial curvature that occurs when an assembled probe is inflated inside a metal sleeve - it is a serious error to attempt to derive a correction factor from this part of the loading.

Taking account of all the above, the following method is used. The outer sheath is removed and a thick wall metal tube of known properties is placed over the membrane of the instrument. The instrument is inflated slowly until the membrane contacts the wall of the tube. The test continues, either as a gentle continuous inflation or in discrete steps, holding each step briefly to ensure maximum accuracy. The probe is pressurised up to maximum working pressure. The pressure is then reduced, also in steps of 5 bars. Some users prefer the unloading should be down to 20 bars, then the probe should be reloaded again to maximum pressure and unloaded to zero, in effect doing a large unload/reload cycle. In a good calibration, all loading and unloading slopes will be similar, but it sometimes happens that the probe moves with respect to the cylinder and this will affect the data. In this event doing the second reloading would give the best correction information.

The calibration is obtained by plotting the pressure/displacement data on a large scale, and finding the best fit slope through the points. The slope ought to be the known expansion of the cylinder for the pressure applied. In practice it is always a little more, the difference being the ‘membrane compression’ figure. We quote the figure in terms of ‘mm/GPa’ a typical compression being between 2 & 5mm/GPa, depending on the type of probe. See Figure 7.1.

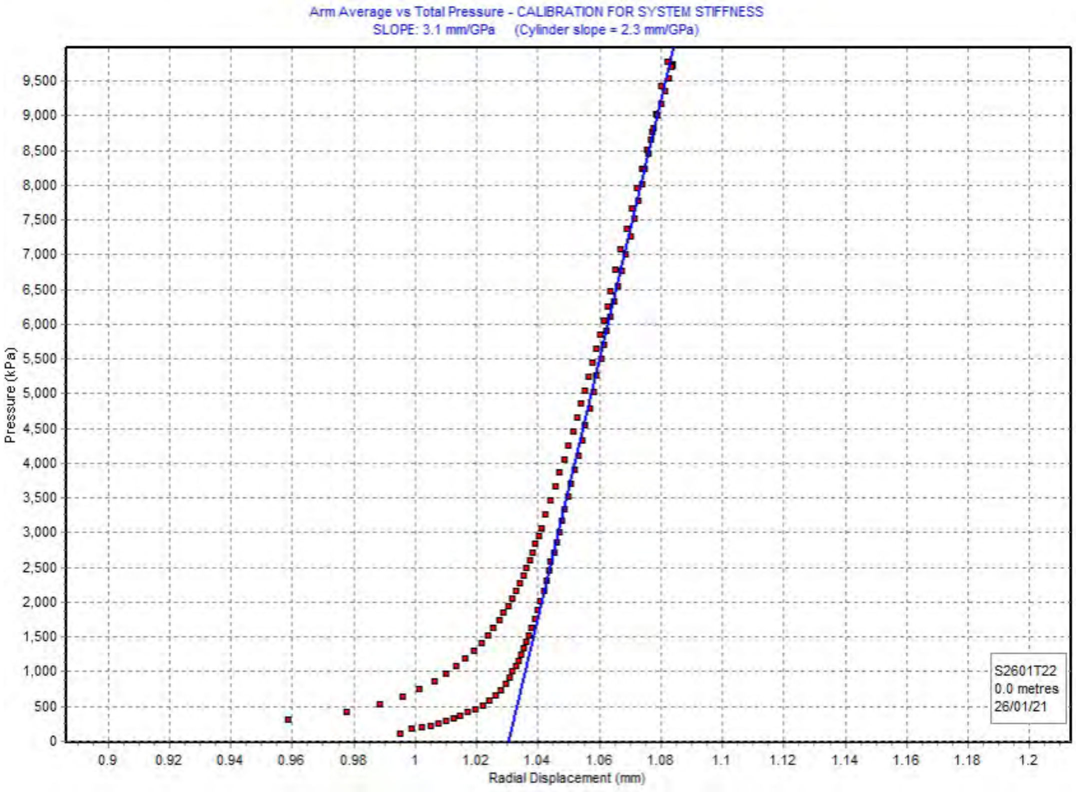


Figure 7.1 An SBP system compliance calibration

Quoting the compression in this manner allows the software to calculate the appropriate error for every step of pressure and to make the necessary adjustment to the measured displacements.

To put the correction in context, a slope of 3mm/GPa is equivalent to a modulus greater than 4GPa.Because the calibration is highly repeatable, within about 5%, the actual uncertainty is considerably higher than 4GPa, so shear modulus of 20GPa or more can be determined within acceptable limits.

8 Instrument straightness

All instruments can become bent during operations due to the large forces that occasionally are applied when the probe is not well supported. Before bringing the instrument on site it is good practice to check that the instrument is straight (within a small tolerance). The method for doing this is to support the instrument at the points where the membrane is clamped, and then to rotate the instrument whilst the run out is observed at a number of points. A record is kept indicating the total runout at these points, and the probe can be straightened if the deformation is significant.

The instrument is never perfect, and it happens that frequently a consistent bias in the displacement system (especially in the vicinity of initial movement of the membrane) can be linked to a lack of straightness.

This is an especially important check for the self boring probe.

9 Membrane thinning

During a test, the pressuremeter membrane changes in thickness as a consequence of being stretched. This change in thickness can be calculated by assuming to a first approximation that the cross-section area of the membrane remains constant. The calculation is incorporated into the program that converts raw data into engineering units.

Note that the term 'membrane' includes the stainless steel protective sheath, and that the measurement made by the arms is the radial distance to the inside of the membrane.

Definition of Terms

a	is the internal radius of the membrane at rest
b	is the external radius of the membrane at rest
c	is the internal radius of the membrane expanded
r	is the external radius of the membrane expanded
t	is the thickness of the stainless steel sheath strips
d	is the measured movement of the strain arm
E	is the actual expansion of the membrane

Calculation

At rest the cross-section area of rubber $= \pi(b-t)^2 - \pi a^2$

The expanded cross-section area of rubber $= \pi(r-t)^2 - \pi c^2$

Because the rubber is incompressible, these must be equal:-

Therefore $(b-t)^2 - a^2 = (r-t)^2 - c^2$

Now:- $c = a + d$

and:- $r = b + E$

hence $(b-t)^2 - a^2 = [(b+E)-t]^2 - (a+d)^2$

$$\therefore [(b-t)+E]^2 = (b-t)^2 - a^2 + (a+d)^2$$

$$(b-t)^2 + d(2a+d)$$

$$(b-t) + E = \sqrt{[(b-t)^2 + d(2a+d)]}$$

$$E = \sqrt{[(b-t)^2 + d(2a+d)]} - (b-t)$$

This is the form in which the calculation is commonly applied to the data, with 2*a*, 2*b* and *t* being known from the manufacturer's data, and *d* being the measurement made by the displacement sensors during the test.

Typical dimensions for three types of probe are:-

	47mm RPM	**88mm SBP**	**95mm HPD**
	(mm)	(mm)	(mm)
2*a*	38.00	79.15	81.00
2*b*	47.00	88.10	95.00
t	0.5	0.5	0.5

To apply the correction at a given expansion the *average* radius of the expanding membrane is calculated. This average is then entered into the equation and the ratio between the corrected average and the raw average is expressed as a scale factor (for example it is about 0.86 for an RPM at all expansions). The scale factor is then applied to the individual arm displacement outputs.

10 Repeatability (or how much effort should be devoted to calibrations)

Although it is important regularly to check the sensitivities of the strain gauge circuits, it is unusual for them to change markedly. Indeed it is common for the hysteresis to improve with use or exercise. 90% of the performance of a strain gauge bridge application can be predicted from its design; the calibration removes the uncertainty due to manufacturing tolerances, and can give early warning of impending problems in a particular circuit.

The expansion test is concerned with making relative measurements, not absolute measurements. The displacement measuring system will resolve movements of less than 0.5 microns over a range of 13 millimetres; the pressure measuring system will resolve changes of 0.1 kPa over a range of 20MPa. This resolution is considerably higher than can be seen with a standard micrometer or test gauge. To put it into context, 0.5 microns is approximately the wavelength of ultraviolet light. Obviously, there is no practical possibility of checking by measurement a movement so small.

Hence the term 'calibrating' is inappropriate. What is done in practice is to check that the various sensors are linear over a number of relatively coarse steps or intervals. We assume that this linear behaviour will be true for very much smaller changes.

We expect successive calibrations on the same sensor to be within 2% and investigate a difference greater than 3%.

We also ignore smaller sources of error in this assumption of linearity, such as temperature change. The full bridge configuration is inherently insensitive to temperature variation, and in addition the strain gauges used are matched to the characteristics of the surface to which they are bonded. When critical measurements are being made during a test, for example when taking a reload loop, it is reasonable to assume the temperature remains constant. The ground is usually at a constant temperature whenever a test is carried out, but sometimes there are problems - the temperature of the gas being supplied to the downhole tool can have an influence especially if the gas bottle reservoir is lying outside in direct sunlight.

Spreadsheet software is used to present the results of the calibrations for sensitivity. One benefit of this is that gradients are calculated by linear regression routines; this ensures different operators given the same set of data will derive identical calibration factors. The calibrations are presented as a tabulation of transducer output against a known reference, with the linearity and hysteresis quoted for each calibration step.

The membrane corrections seldom change greatly and the strength of material tested means that for the most part any errors in the magnitude of the correction are of minor importance. In general, if the material is weak (shear strength less than 100kPa) then membrane strength and stiffness are important. If the material is extremely stiff (shear modulus greater than 1GPa) then correcting for instrument compliance is important. In between these two extremes the influence of the imperfections of the machine on the derived parameters is minor.

APPENDIX C TEST PROCEDURES

1 Description of the Test

The tests the pressuremeters make are loading tests. Pressure is applied to the instrument and readings are taken of this pressure and the resulting displacements of the cavity. Plotting pressure against displacement gives a test curve with a characteristic 'S' shape. The two kinds of test can be made dependent on probe used.

A) The material yields well before the maximum pressure capability of the equipment is reached.

B) Tests where the maximum pressure capability of the probe is the limiting factor and the material does not yield.

This project only saw type A tests.

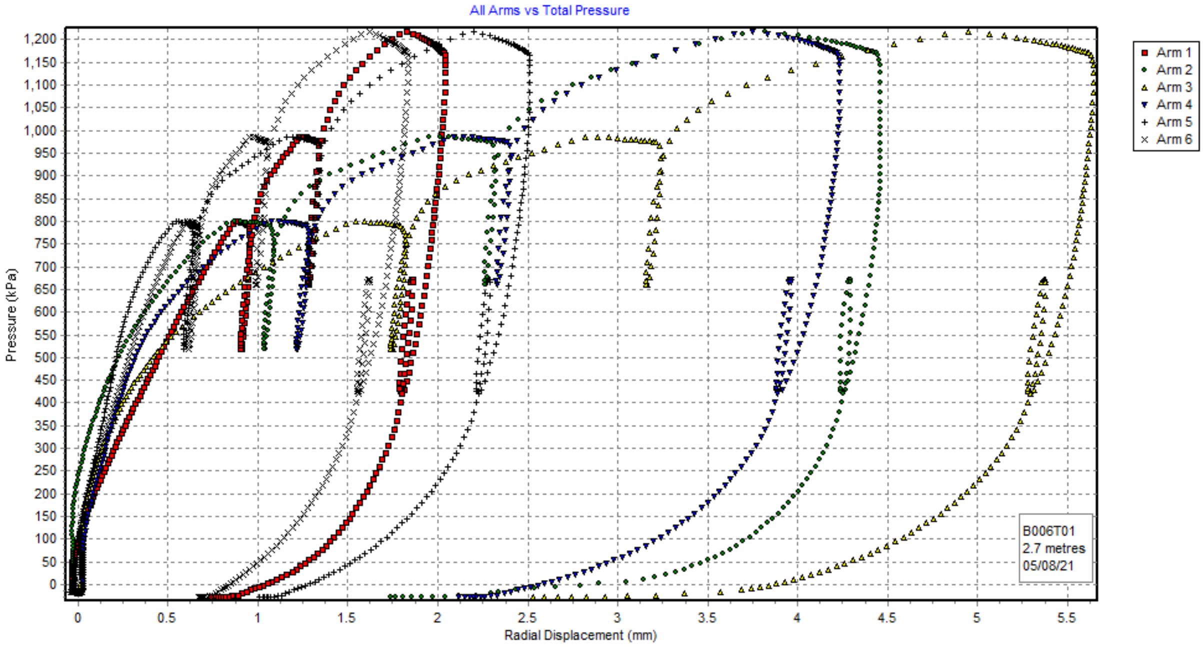


Figure 1.1 Example of test in a material showing significant deformation

There are several ways of using the data contained in the pressure/strain curve but the most common is to use it to derive fundamental parameters about the strength of the material being tested. Therefore, the precise manner in which the test is carried out should be chosen to make it easier to assess these parameters.

The slope of the initial linear part can give a value for the initial shear modulus G_i but because this part of the curve is sensitive to the disturbance produced by the coring the derived value may well not be representative of the true shear modulus of the material.

A better estimate of shear modulus (G)can be made by taking unload/reload loops at intervals along the loading path. To do this a little of the pressure that has been applied is released and then reapplied in a controlled manner, taking readings of the changing strain. This produces a characteristic loop. The slope of the best fit straight line through the long axis of the loop can be used to derive G_{ur}.

The value of G produced in this way is relatively insensitive to the initial drilling disturbance. The shear modulus is probably the single most useful parameter that the test can produce. Because of this significance it is usual to take at least two loops at suitable points on the test curve. Suitable points would be on the linear part of the curve and as soon as there are indications of failure. Loops can also be taken on the unloading curve. Before starting the loop the pressure is held for at least 1 minute to allow residual creep effects to minimise – 3 minutes is about the time taken to carry out a cycle.

Deductions about the material strength or internal friction angle are made from the part of the curve following yield until the end of loading for pre-bored and self bored tests . Note that it is also possible to analysis the final cavity contraction curve for strength and stiffness. In many ways this is preferable, because there is only minor uncertainty concerning the origin of the contraction event.

2 Logging Rate

A line of data representing the output of all transducers was logged every 6 seconds for the SBP and 5 seconds for the RPM.

3 Placing the HPD

The HPD test is carried out in a 101mm pocket that has been formed by coring. Coring is the conventional method because the recovered core can give some information about the pocket before the instrument is placed. Samples of the core are normally of sufficient quality to permit standard laboratory testing, which can be compared with the pressuremeter results.

The pocket itself should be at least 2 metres long. This allows the user some choice about the exact point in the pocket in which to place the HPD. Note the following crucial measurements

- From the foot of the instrument to the centre of the measuring section is 0.9 metres.
- The expanding part of the instrument is about 0.6 metres.
- The instrument is 2 metres long - if the BW extension rod is added to this then the effective length from the foot of the pressuremeter to the start of the rotary drill string is 3 metres. If the pocket is longer than 3 metres then the diameter of the drill rod used to place the pressuremeter must not exceed 75mm; this together with two thicknesses of hose, is the maximum that will fit into a 101mm pocket.

From these dimensions it is apparent that the instrument must be at least 1.3 metres into the pocket, and for safety we use 1.7 metres as a minimum. The very lowest part of the pocket should be avoided as this is often the area most spoiled by the coring, but as the test centre is some distance from the foot of the instrument this is not normally a problem.

Soft patches in the core suggest a point that ought to be in the test section. However soft patches at the ends of the expanding section may result in the membrane bursting before the pocket has been properly loaded.

It is a truism that the quality of the test is dependent on the quality of the initial coring. However many good tests have been made in pockets where no core at all was recovered. Standard coring practice is designed to preserve the core without regard for the borehole wall. This is the opposite of what the priorities need to be for the pressuremeter test.

4 Placing the RPM

The sequence was as follows:

Starting with a working RPM system, calibrated and in all respects ready to go:

The support drill crew formed a pocket at least 0.7metres long by using either a custom made SPT split spoon or button bit provided by Cambridge Insitu Ltd. The drill string is then removed. Using conventional drill rods the RPM was placed at the desired location. The RPM has its own umbilical.

This is a high pressure pneumatic hose threaded with an electrical cable. It was taped at regular intervals to the drill rod.

If the RPM has difficulty finding its way into the pocket the drill head can be used to give a gentle push. Normally the weight of the drill string is sufficient. Once the depth was confirmed a cavity expansion test was carried out. Once the test is completed, the electronics are switched off, electrical cables and pneumatic hoses at the surface were disconnected and the drill string lifted back until the probe was recovered. Finally, following testing the probe is checked, cleaned, and made ready for the next test.

5 Drilling and placing the SBP

The SBP operation takes place under a rotary rig. Before using the SBP the borehole must be cleaned out beyond the end of the rotary casing. The probe is lowered to the bottom of the borehole, in a similar way RPM. However, unlike the RPM the drill string used is special to the SBP and has an inner and an outer rod. The sequence of events was as follows:

1. The rig prepared a hole to a nominated depth approximately 0.5 metres above the intended test point.
2. The instrument was laid horizontally on a holding frame and a single length of casing and inner rod was added to the probe. The pore pressure cells on the probe were de-aired and covered to prevent evaporation. A line of zero readings were then taken from the data logging system. The pore water pressure response during the drilling operation was logged (Figure 5.1).
3. The instrument was lowered down the borehole using the rig winch, with lengths of casing added at intervals of about 3 metres.
4. Approximately 1 metre was self bored, using the column of previously installed water well casing as kentledge. This force is kept to the minimum necessary consistent with good return flow so that the probe enters the ground at a constant force. Typically a metre of self-boring took about 30 minutes. The return from the SBP was observed but discarded.
5. Once at depth a test was carried out, with two or more unload/reload cycles.
6. After the test the probe was extracted, the borehole was cleaned out and advanced by the rig to the next test depth.

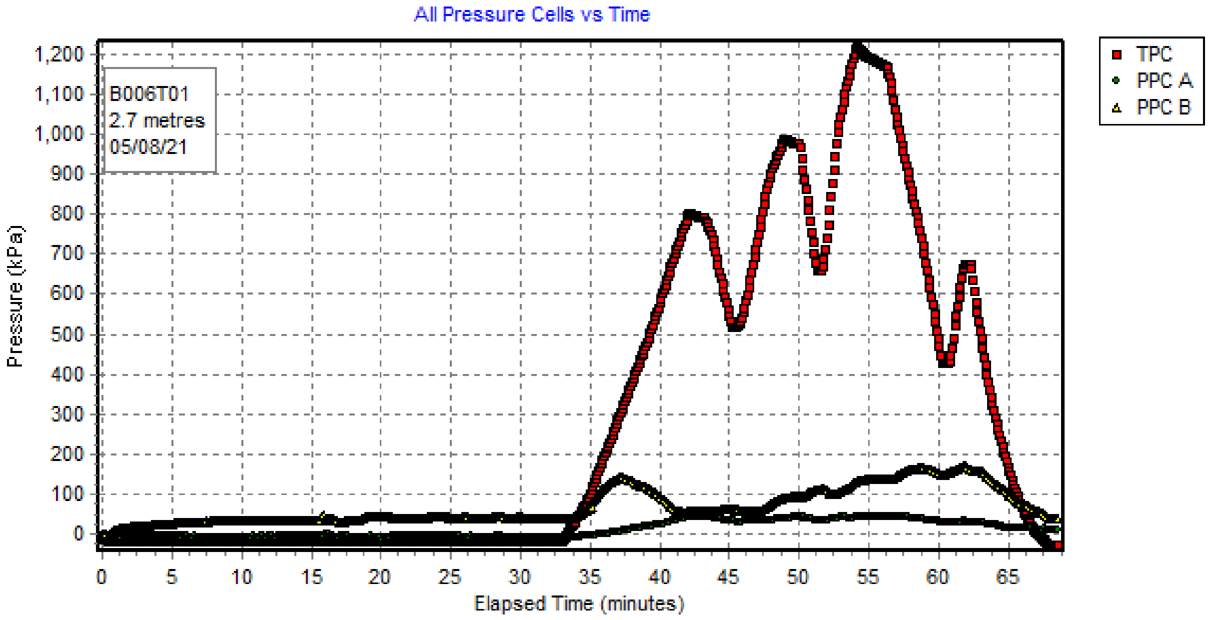


Figure 5.1 Drilling and testing example, SBP pore pressure response

6 Terminating a test

The decision about when to stop a test depends on a number of factors, as follows:

- For any test the operator is trying to record at least two unload/reload cycles and to record a full cavity contraction. This is because in recent times the advantages of analysing the unloading of a cavity have become apparent.
- If possible, the operator wants to see the material yield, and record at least some of the plastic response of the material.
- If the maximum pressure capability of the instrument is reached then this is an obvious termination imperative. However no test on this contract reached the pressure limit of the equipment.
- This decision making process can be informed by indications that the material is showing unusual behaviour such as a structural breakdown.
- If the maximum displacement capability of the instrument is reached then this is an obvious reason to terminate the test. The criteria for termination based on displacement depends on the material and the size of the initial pocket. A tight pocket in any material can be taken further than one in an oversize pocket that yields at stress levels greater than 100 bars.

APPENDIX D INTERPRETING PRESSUREMETER TESTS

This appendix gives details of the methods used to derive the results of pressuremeter tests on this contract. The text is illustrated with examples from the fieldwork.

1 MATERIAL PROPERTIES FROM PRESSUREMETER TESTS IN SOIL.

1.1 Notation

P_o	Initial cavity reference stress (total)
P	Pressure
P_f	Pressure when yield first occurs at the cavity wall (total)
P_{max}	Maximum pressure reached
r	Radius
r_o	Initial radius of cavity
ε_c	Cavity strain
G	Shear Modulus

1.2 Overview

There are two well established approaches to the interpretation of expansion pressuremeter test data. The first, developed by Menard, uses empirical correlations to allow measured co-ordinates of pressure and displacement to be inserted directly into design equations. This approach depends on a standardised test procedure and a large data bank of pressuremeter tests correlated with observations of the response of finished structures.

The second approach, which will be described briefly here and is the usual way of interpreting the pressuremeter test in the UK, relies on solving the boundary problem posed by the pressuremeter test.

The aim of the pressuremeter test is to expand a long cylindrical cavity within an undisturbed mass of soil. Fundamental strength properties of the material can be deduced from measurements made of cavity pressure and displacement.

In practice no instrument can be placed into the ground without affecting the surrounding soil. In the case of a self-bored pressuremeter test the disturbance is generally within the elastic range of the soil and can be allowed for in the analysis procedure. For all other kinds of pressuremeter the disturbance is irrecoverable, and analysis takes place on those parts of the curve following strain reversal.

1.3 The pressuremeter test in soil - initially elastic response/failure in shear.

Consider that the soil is homogeneous and shows simple elastic behaviour before failing in shear. The stress path followed by an element of soil adjacent to the cavity is given in Figure 1.1 and the corresponding pressure /strain curve is shown alongside.

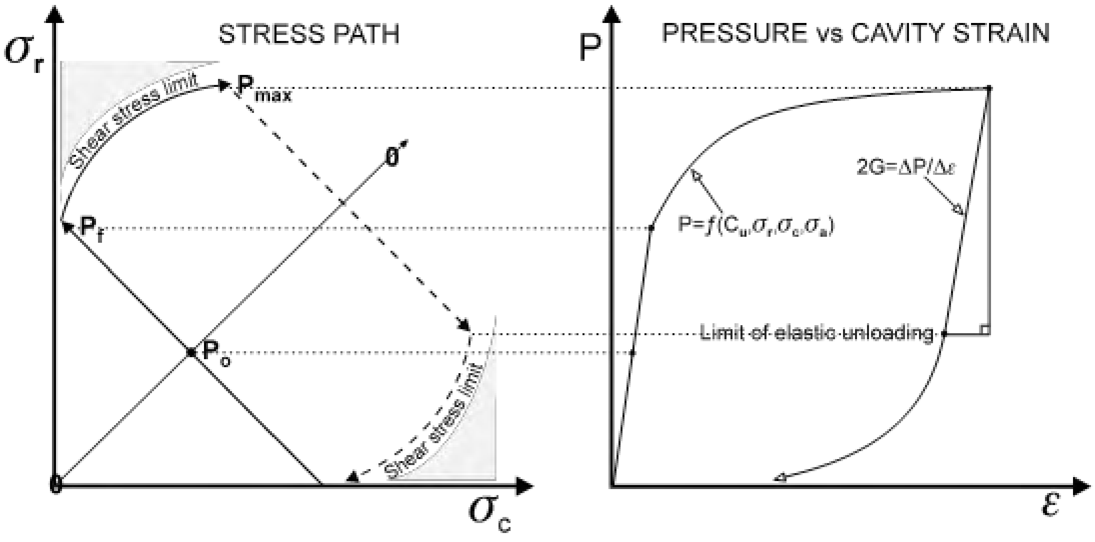


Figure 1.1: Elastic Response followed by failure in shear

The radial stress, ideally at the insitu horizontal stress for a perfect installation, increases atthe same rate as the circumferential stress decreases, regardless of whether the material is deforming under plane strain or plane stress conditions. The line 0 - 0 represents stress equality, so that in the ideal case considered here the point P_o is the insitu lateral stress.

Once the radial stress increases above the insitu stress then the shear stress in the soil at the cavity wall will increase. If the insitu lateral stress is low, then it is possible that the circumferential stress would go into tension. However, in this example the insitu stress is high enough to ensure that the shear stress limit is reached before tensile stresses can be generated.

The pressure necessary to initiate shear failure is denoted P_f in Figure 1.1. After this pressure the strain rate shows a substantial increase, and the form of this part of the pressure/strain curve is a function of the shear strength of the material.

Radial stress and circumferential stress now increase together. If the shear stress limit is constant, and is not influenced by pressure, and if the material deforms at constant volume, then the failure shear strength can be determined by the analytical solution developed by Gibson & Anderson.

Before the shear stress limit is reached the pressuremeter response is elastic, both in loading and unloading. Assuming the soil deforms at a constant modulus and the installation is perfect then the slope of the initial loading path gives the shear modulus of the material, using the classic procedure of Bishop, Hill & Mott (1945). The diagram also indicates that reversing the direction of loading causes an initial elastic response giving an alternative means of deriving the shear modulus. This implies that small cycles of unloading and reloading taken anywhere in a test after reaching the shear stress limit can be used as a source of stiffness information (Hughes 1982).

As Figure 1.1 suggests, the complete unloading of the pressuremeter can also be used to give strength and stiffness parameters comparable with those obtained from the loading path.

From the right-hand side of the stress diagram it is apparent that the pressuremeter provides a limited set of the necessary information for resolving the stresses and strains around the probe. Specifically, it gives the changes in radius of the borehole wall (a particular case of hoop strain) and the corresponding changes in radial stress at the borehole wall. There are no data for hoop stress or radial strain or movements in the vertical direction. Test procedures are chosen to allow the missing data to be inferred – for example an undrained expansion means shearing occurs at constant volume and hence changes of radial strain must be equal and opposite to changes in hoop strain. The unseen vertical axis data are rendered redundant by making pressuremeters long with respect to their diameter, allowing plane strain expansion to be assumed.

1.4 Defining strain

For a pressuremeter measuring the radius of an expanding cavity the conversion from displacement to strain is:

$$\varepsilon_c = \frac{r - r_o}{r_o} \qquad \text{[Equ 1.1]}$$

where r is the current radius of the cavity and r_o is the original radius of the cavity in the insitu state. This is simple strain and when displacements are measured at the borehole wall is termed cavity strain, ε_c.

r_o can be approximated by the at rest radius of the instrument. The preferred approach is to identify when the applied pressure has reached the insitu lateral stress, and interpolate from this the corresponding radius, which then becomes r_o.

Note that although the pressuremeter measures the radius of the cavity wall, ε_c is a specific instance of circumferential or hoop strain. It is usually expressed as a percentage.

Figure 1.1 shows how pressures and strains in the expanding borehole are defined.

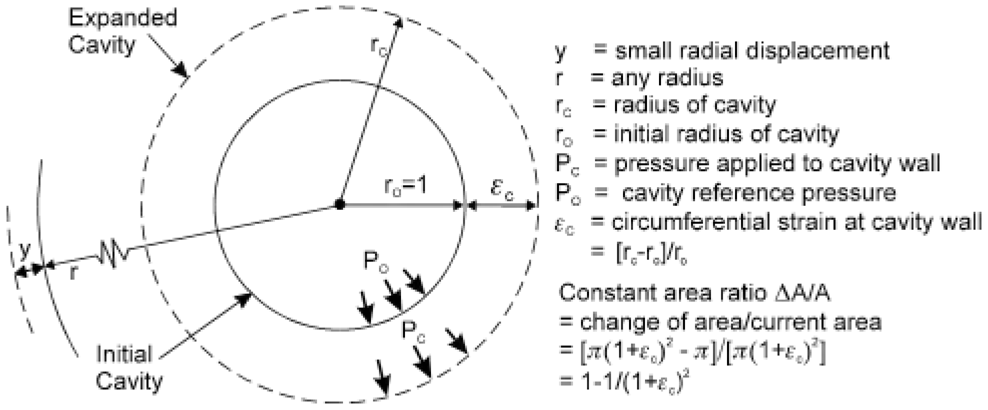


Figure 1.1: Pressures and strains around the expanding cavity

The other strain commonly used is the constant area ratio, which is shear strain. As Figure 1.1 indicates it can be defined in terms of simple strain.

The large expansion pressuremeter test results in the soil experiencing very large strains and the approximations of simple strain conventionally used in pressuremeter testing when converting displacements are inappropriate. True strain or natural strain is the sum of the incremental increase in radius divided by the current radius, which is conveniently defined as:

$$Ln\left(\frac{r}{r_o}\right) \text{ or } Ln(1+\varepsilon_c) \qquad \text{[Equ 1.2]}$$

This makes it possible to use the 'at rest' radius of the probe as an origin for strain, even though the soil particle adjacent to the probe before starting to inflate the membrane has been displaced by at least the instrument radius.

Some calculations are easier with true strain. Consider the equation for determining shear modulus from the slope of rebound cycles - Mair and Wood (1987) write this as:

$$2G = \left[\frac{r}{r_o}\right]\left[\frac{\Delta P}{\Delta \varepsilon}\right] \qquad \text{[Equ 1.3]}$$

It is apparent from [Equ 1.2] that the term $(\frac{r}{r_o})$ is a correction factor made necessary as a consequence of using simple strain - the equation reduces to:

$$2G = \left[\frac{\Delta P}{\Delta \varepsilon}\right] \qquad \text{[Equ 1.4]}$$

if ε is defined in terms of true strain. As $\Delta\varepsilon$ is merely a change in strain, no knowledge of the actual strain origin is required in order to calculate a modulus parameter.

1.5 Average displacements versus the output of the separate axes

There are a number of displacement sensors in the expansion probe but recommended practice is to quote parameters from the average displacement curve. This is for two reasons:

- The reference for the measured displacements is the body of the instrument itself - trying to separate the individual axes means assuming that the body of the instrument remains fixed at all times, which is not realistic.
- All available analyses assume isotropic properties in the surrounding soil, and only the average pressure/strain curve represents this condition.

These remarks assume that the instrument is in full working order throughout the test - failure of a displacement follower means that alternative strategies must be adopted.

The significance of the first point above has been demonstrated by an examination of cycles of unloading taken from separate arms (Whittle 1993) and by work with a six arm version of the Self Boring Pressuremeter (Whittle et al 1995). In the case of the three arm Self Boring Pressuremeter an exception is sometimes made for the initial part of the loading prior to yield. In such circumstances the response of the separate arms may yield clues to the initial stress state in the surrounding soil, allowing an assessment of the degree of insertion disturbance.

1.6 The Analysis program

We use (and supply to others) software for analysing a pressuremeter test. The program is called **WINSITU,** which has been in use for a number of years.

To use the program the user must first read in a text file of test data in engineering units. The program needs to know the type of instrument being used, and the user may choose to enter additional background information about the test.

The next task is to identify for the program the nature of the individual data points. Broadly, the options are these:

- a point can be part of the expansion curve
- or part of a reload loop
- or part of the contraction curve
- or none of the above. This might mean a ‘rogue’ data point, but it is more likely to be true of parts of the loading where the expansion was slowed prior to taking an unload/reload cycle. Data points recorded at this time are neither part of the expansion nor part of a cycle and should be identified as such.

There is a quick on-screen routine for marking the points. Once marked, they appear in different colours. Most of the analyses use a limited set of the available data - for example the Gibson & Anderson analysis for undrained shear strength uses only points on the expansion curve.

The program implements all the standard analyses mainly in a graphical form. As Figure 1.1 implies, there are significant changes of gradient in the pressure/strain curve denoting critical soil parameters. The user of the program is provided with on-screen tools to mark these breakpoints or to obtain the slope of the loading curve. The tools can be visualised as rulers, whose position is stored by the program in the file of test data. The evidence for any derived parameter is a screen dump of the appropriate analysis that shows the position of any rulers set by the user and quotes the parameter obtained. Even when the user declines to make a choice it is good practice to provide the screen dump as evidence of why a choice is difficult.

The results for a test appear as a summary sheet of derived parameters followed by a number of plots showing the application of the various procedures.

Sometimes analyses are required which are not included in the WINSITU program. In such instances commonly available spreadsheet software is used to implement the new analysis. Inevitably in such circumstances there is some risk of human error affecting the conversion of data in engineering units to the form required for analysis. WINSITU has export facilities and wherever possible is used as the data source for the spreadsheet.

2 ANALYSES FOR INSITU LATERAL STRESS

2.1 Notation

P_o	Initial cavity reference stress (total)
P_f	Pressure when yield first occurs at the cavity wall (total)
σ_{ho}	Total insitu lateral stress
σ_{vo}	Total insitu vertical stress
k_o	Ratio of horizontal to vertical effective insitu stress
C_u	Undrained shear strength
τ_f	Shear stress when yield first occurs
G_i	Shear modulus from the initial slope of the loading curve
β	Exponent of non-linearity

2.2 Overview

The expansion pressuremeter test is a sequence of measured co-ordinates of pressure and displacement of the cavity wall (once suitable corrections have been made to compensate for the response of the elastic membrane).

For an SBP it is possible to recognise the insitu lateral stress by inspection, the so-called lift-off method. It is also possible to recognise by inspection the shear stress limit (the point marked P_f in Figure 1.1) as this is indicated by the onset of a markedly non-linear response. An iterative procedure first suggested by Marsland & Randolph (1977) allows the insitu lateral stress to be inferred. The method is not valid for tests in sands and tests in material with non-linear elastic properties. This effectively rules out all soils. Nevertheless, it is usual to run the analysis because it tends to set an upper limit to any estimate of insitu lateral stress. Both these methods are outlined by Mair & Wood (1987).

A more complex approach uses the full set of parameters derived from a pressuremeter test within a model and discovers whether the measured field curve can be recovered. The input data set is then adjusted in a controlled manner until the best match for all parameters is obtained.

The self-boring pressuremeter is fitted with pore pressure transducers, and the trend of excess pore water pressure against total stress can be used to identify yield stress and insitu lateral stress.

All these methods amount to obtaining a value for the cavity reference pressure, P_o. It is not possible to measure the insitu lateral stress σ_{ho} because the act of placing instrumentation always results in some disturbance, even if small. The methods above are indirect indicators for determining σ_{ho}.

It is open to question whether the reference stress is equivalent to the insitu lateral stress, and it is usual to bring a range of evidence to bear in order to decide if a particular value for P_o is also a plausible value for σ_{ho}. External evidence might take the form of using the derived reference stress within a k_o calculation, or checking that the derived vertical/horizontal anisotropy can be supported by the material shear strength:

$$\sigma_{ho} - \sigma_{vo} < 2C_u \quad \text{[Equ 2.1]}$$

In practice there is a wide range of values that would satisfy this condition so only the most extreme estimates for σ_{ho} would be identified by this test.

2.3 Lift-off

This method was developed for the SBP. In principle it is a straightforward procedure. The instrument is assumed to be bored into the ground with insignificant disturbance caused to the surrounding material. If the insitu conditions around the instrument remain unchanged by the insertion process, then the pressure at which the membrane first moves and the cavity begins to expand is P_o. The corresponding cavity diameter will be the same as the at rest diameter of the instrument. Because the initial part of a SBP test is very stiff the choice is made from an enlarged view of the first 0.2mm (0.5% strain) of the expansion. In the example there is slight disturbance, in this case stress relief, and the selected stress is a little higher than the stress at which the membrane first moves.

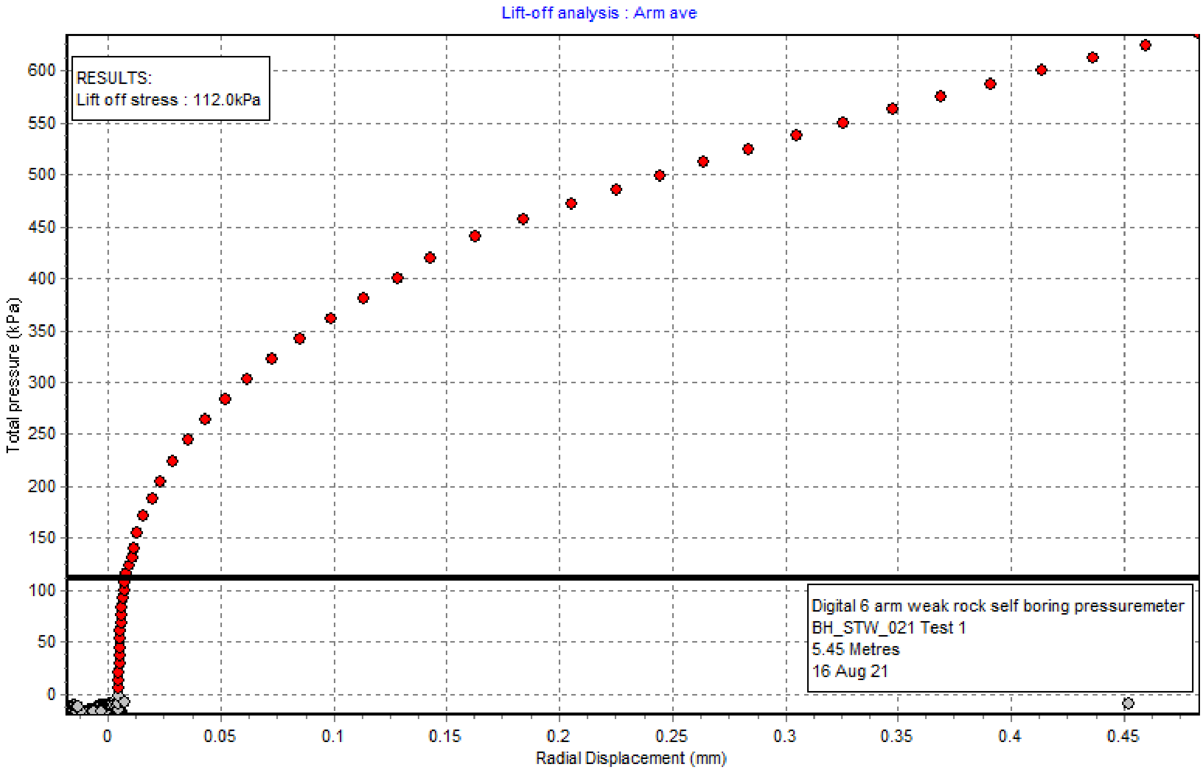


Figure 2.1 An example of lift-off

Difficulties can arise because the instrument has finite stiffness and hence there is instrument compliance to be separated from the expansion of the cavity. In addition, the instrument is being externally loaded by the lateral stress when the test is started. This external stress tends to deflect the arms of the instrument and reveals any imperfections in the seating of the arms. The imperfections, in effect small movements, are revealed when the pressure differential across the membrane is removed, i.e. exactly at the point where the cavity reference pressure is reached. In a simplistic approach these arm 'signatures' could be considered as positive indications of the reference pressure. However, in the ground it is not possible to have displacements without an associated change in stress, which add to or subtract from the reference pressure.

As a result of finite instrument stiffness and small movements from the displacement sensors applying the lift-off analysis means that there can be considerable uncertainty attached to identifying a plausible reference pressure. Conventional practice for coping with this uncertainty is to relax the definition of 'lift-off' to mean something more like 'significant movement'.

Figure 2.2 is a typical illustration of the problems involved with identifying lift-off. Here the individual arms from a SBP test are plotted together, with Figure 2.1 being the average output of these arms. There are a choice of lift-off points corresponding to a rigorous interpretation of what is implied by the term. In general, the strict lift-off stress is that obtained from the first arm to move and sometimes small movements seen in separate arms cancel out in the average view. The difference one side of the probe to the other suggests that the probe may not be installed perfectly vertically, and cancelled movement show the influence of instrument compliance.

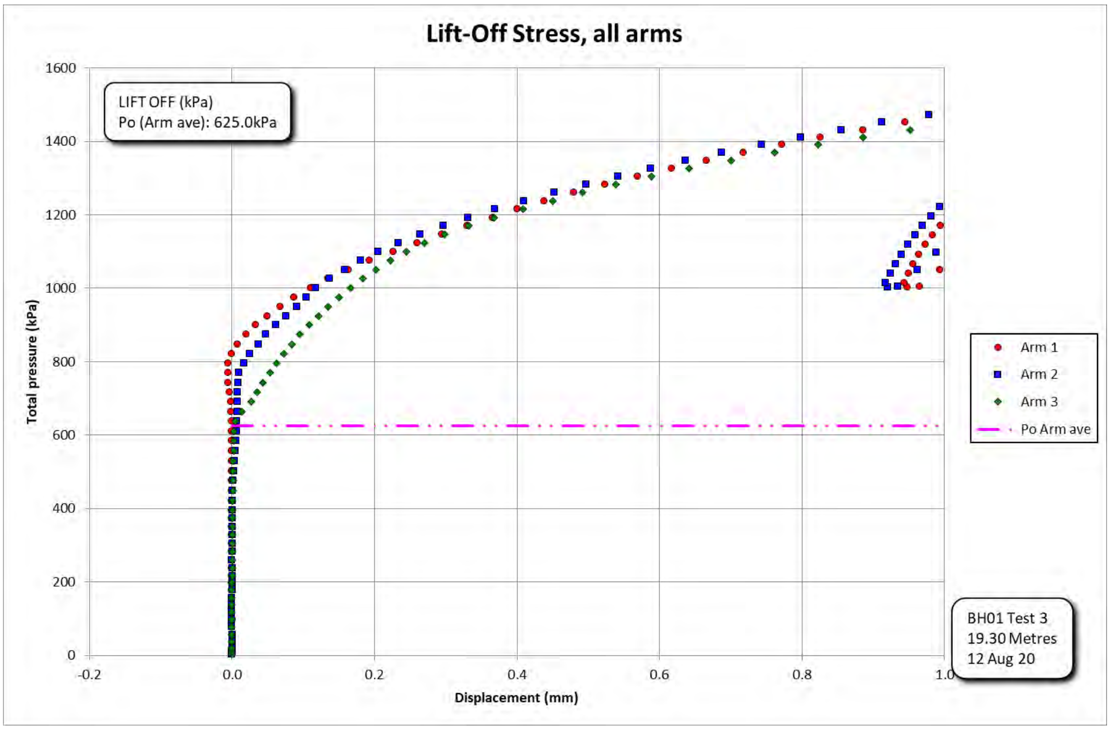


Figure 2.2: Lift-off, all arms shown (not from this contract)

It is important to bear in mind the scale. All the lift-off information is concentrated into the first 100 microns of the expansion or about 0.25% cavity strain. In this test the elastic strain range is at least 1.0% cavity strain. Because the movements are well within the elastic range of the material the analyst is justified in attributing significance to the output of the separate arms. In this event the arithmetic mean of the separate lift-off points is often a more useful parameter than lift-off derived from averaged arm displacement data.

Accepting that some movement takes place prior to ‘lift-off’ implies that assumptions be made about the mode of deformation. In the less rigorous application of 'lift-off' it is important that the analyst identifies the onset of plastic behaviour as a guide to deciding that some conspicuous change of form in the loading curve at a lesser stress is likely to be p_o. Our plots would still refer to such a break point as 'lift-off' but clearly it is something else, p_o by inspection perhaps.

2.4 Marsland & Randolph (1977) Analysis

Marsland & Randolph analysis relies on being able to identify the onset of plastic behaviour, the yield stress P_f. The argument is as follows:

- In the vicinity of the insitu lateral stress the soil response is simple elastic manner and therefore the total pressure/ cavity strain plot will be linear
- Elastic behaviour will cease when the undrained shear strength of the soil is reached in the wall of the cavity, and hence the pressure /strain plot will begin to curve (see Figure 1.1).
- This can be expressed as:

$$P_f = P_o + C_u \quad \text{[Equ 2.2]}$$

- From this it follows that P_o can be deduced by iteration. Initially an estimation is made of a value for P_o and used to define a temporary strain origin a total pressure/ log volumetric strain plot is then generated in order to derive a value for C_u. The sum of these two parameters is compared with the selected value of P_f. The choice of P_o is then suitably adjusted and the process repeated until a match is found. It is a straightforward matter to carry out this procedure on the computer.

The modified method in current use is a response to the difficulty that perfectly plastic deformation is not a realistic enough model for many materials and yield may occur at a different shear stress than the large strain shear strength. Hawkins et al (1990) suggested that the most appropriate choice was that value of shear stress pertaining at the apparent onset of plasticity, so [Equ 2.2] now becomes:

$$P_f = P_o + \tau_f \qquad \text{[Equ 2.3]}$$

τ_f can be obtained from a total pressure/ log volumetric strain plot by selecting the slope at the pressure and strain corresponding to the choice of P_f (in practice, using the Palmer (1972) argument to identify the mobilised shear stress at failure). See inset plot in Figure 2.3.

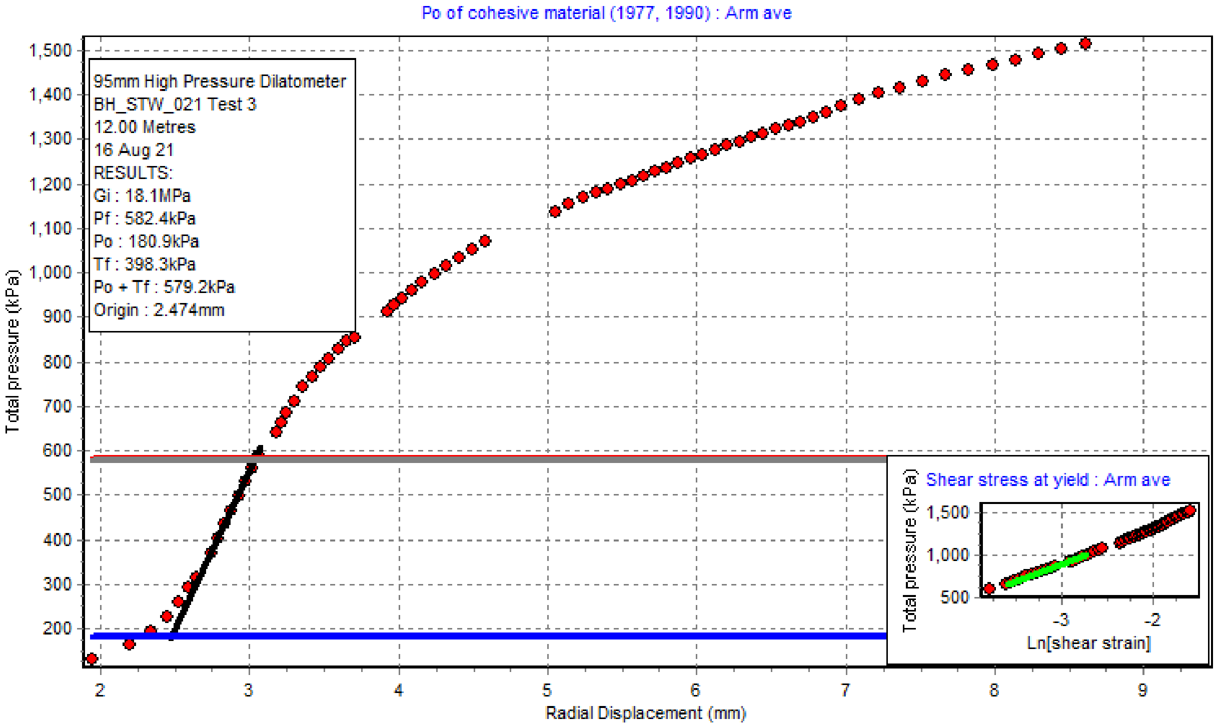


Figure 2.3 An example of the Marsland & Randolph analysis

The analysis is implemented graphically, using a number of rulers to identify significant points on the curve (Figure 2.3).

There are a number of problems:

- There can a choice of slopes for G_i, giving multiple possibilities for P_f. In practice the first slope encountered is usually too stiff to make a credible choice for G_i and is probably an indication of insertion disturbance.
- The assumption of simple elastic response - in practice most soils exhibit marked non-linear elastic characteristics, so that the pressure at which the material appears to go fully plastic is more than one increment of shear strength above P_o - this point is developed later.
- The original analysis was developed as an aid to the interpretation of pre-bored pressuremeter tests in clays where the process of forming the pocket results in the complete

unloading of the cavity prior to the test commencing. It is certain therefore that the soil has seen stress relief. It is arguable whether in these circumstances that the yield point remains unchanged, as more than elastic unloading has taken place. However, the form of such tests does tend to give an unambiguous choice for the onset of plasticity.

- In a self-bored pressuremeter test the situation is not so clear cut. The very factors that make the test desirable also results in more realistic behaviour being seen in the form of the early part of the test, with non-linear elasticity being a feature. Hence a choice of P_f is by no means easy. In general, the better the test the harder such a choice becomes. However, it is probable that in a good test the lift off pressure would be a credible choice so that in the wider context it is not a serious problem.
- A disturbed SBP test does not necessarily imply stress relief. Typically, disturbance arises out of damage to the shoe cutting edge; if the shoe is enlarged then stress relief will result. However, if the shoe is damaged in such a way that it cuts undersize or becomes blocked (even momentarily) then stress increase will take place and plasticity will be masked by a rise in the pore water pressures around the instrument. In this event the analysis can contribute nothing – forcing such data to fit the assumptions of the analysis will over-estimate the insitu lateral stress.

The failure mode represented by [Equ 2.3] is only appropriate for tests in undrained material. However, there is good empirical evidence that no matter the mode of failure, identifying the yield stress and working back to the insitu stress works for all soils, provided one takes the apparent mobilized shear stress at failure, not large strain. For this reason the procedure is often applied with apparent success to tests in frictional material.

2.5 Deriving insitu lateral stress by synthesis

The doubt concerning the appropriateness of using the measured values for cavity reference pressure P_o as best estimates for the insitu lateral stress σ_{ho} mean that other methods for inferring plausible values are required. Jefferies (1988) is a procedure for deriving insitu lateral stress, stiffness and strength from undrained pressuremeter curves by matching the measured data points with an iteratively selected set of numbers. Some rigour is introduced into the procedure by making the single set of parameters match the contraction as well as the expansion phases of the SBPM test.

For the procedure to work the model used to represent the deformation characteristics of the soil has to be realistic. Jefferies (1988) assumes a simple elastic/perfectly plastic shear stress/ shear strain response. Outside of a computer there is no such soil and despite the claims made for it, the procedure fails – in particular it cannot predict the measured field values for stiffness, the one property of the soil pressuremeters can provide without major difficulty.

However the procedure can be used with more realistic soil models, and it is customary now to back-analyse undrained tests using a non-linear elastic/perfectly plastic shear stress/ shear strain solution. This uses measured values of stiffness and shear strength so the only variable to be decided is the insitu lateral stress. Both expansion and contraction phases of the test are fitted as shown in Figure 2.4.

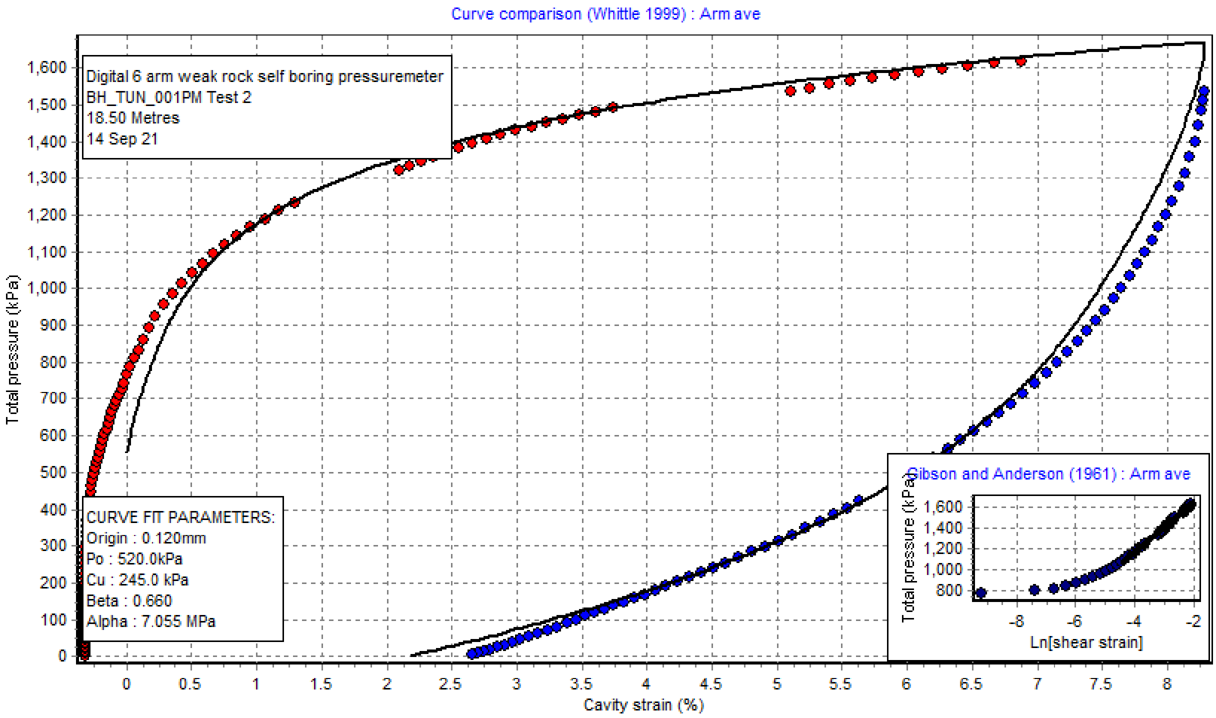


Figure 2.4: Using an undrained non-linear elastic/perfectly plastic solution

For a SBP arranged to drill to size the values for lateral stress derived using this procedures are often lower than those obtained by inspection, and are consistent with a view of the test as slightly under drilled, raising the state of stress around the probe. As in the case of these tests, if the probe is configured to drill fractionally oversize the reverse situation can occur. The procedure can also be applied to pre-bored pressuremeter test data but the fit to the loading will always be questionable.

Note that it is only possible to derive one value for insitu lateral stress using these procedures, as isotropy of soil properties is a fundamental assumption. Because the procedure makes uses of all the evidence it is the preferred method for deriving the insitu lateral stress.

2.6 Deriving parameters from the excess pore pressure trend

Bolton & Whittle (1999) predict the trend of excess pore water build –up from an undrained cavity expansion in a non-linear elastic/perfectly plastic material (Figure 2.5). The significant difference between this trend and that in a simple elastic/perfectly plastic medium is the generation of some excess pore pressure during the elastic phase of the test prior to the material fully yielding. The rate at which the pore pressure rises during the elastic phase is related to the exponent of non-linearity, β, a number less than 1 unless the response is truly linear elastic (the Bolton & Whittle analysis is described more fully later in this Appendix). In both cases, once the material becomes plastic, there is a 1 for 1 correspondence between changes in total stress and changes in pore water pressure.

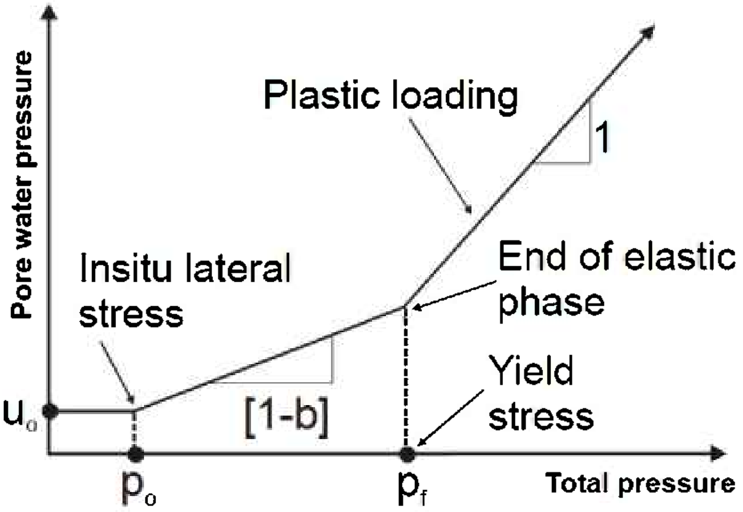


Figure 2.5: The non-linear elastic pore pressure response

In practice very few self boring tests have the necessary minimal disturbance to show the full theoretical curve, and even if they do so then interruptions to the loading to take unload/reload cycles tend to disrupt the plastic response. It is sometimes possible to recognise a partial set of the parameters predicted in Figure 2.5.

Figure 2.6 is a reasonable example. The gradient of the plastic phase is close to the predicted 1 for an undrained expansion and yield and the pseudo-elastic response are clearly delineated. Later in the test when unload/reload cycles are taken the pore water pressure response falls off. This indicates partial drainage, possibly not in the soil mass but locally at the borehole wall where gaps in the protective sheath introduce axial drainage paths.

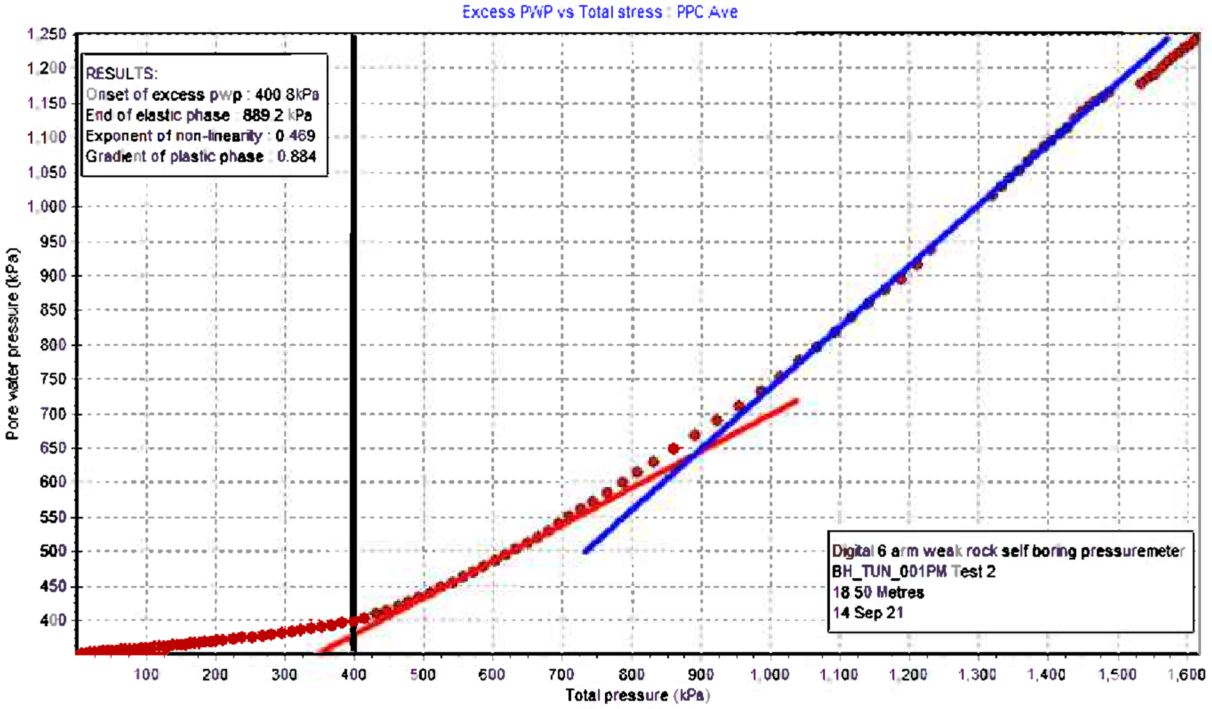


Figure 2.6 An example of pore pressure response

3 SHEAR MODULUS

3.1 Notation

3.2 Notation

α	Shear stress constant when the strain scale is shear strain
β	Exponent of non-linearity
C_u	Undrained shear strength
ε_c	Cavity strain
E_H, E_V	Young's modulus in the horizontal and vertical direction
f	Proportion of strength used
G	Shear modulus
G_s	Secant shear modulus
G_t	Tangential shear modulus
G_{100}	Secant modulus at the maximum elastic shear strain, sometimes termed G_{min} or G_{yield}
G_p	Pressuremeter modulus
G_{HH}, G_{VH}	Shear moduli for transversely isotropic material where the first suffix is direction of loading and the second is the direction of particle movement
k_o	Ratio of horizontal to vertical effective insitu stress
n	Ratio of horizontal to vertical Young's modulus E_H/E_V
η	Radial stress constant when the strain scale is shear strain
P_c	Total pressure measured at the cavity wall
τ, τ_c	Shear stress, suffix c means at the cavity wall
v_{HH}, v_{HV}	Poisson's ratios for transversely isotropic material
γ	Shear strain
γ_c	Shear strain at the borehole wall
γ_f	Shear strain for given strength proportion

3.3 Background

For users of high resolution pressuremeter data the primary purpose of the test is obtaining realistic parameters for the elastic properties of the ground. Up to yield, where yield is defined as the first instance of mobilising the maximum shear stress, the slope of the loading curve can be used as a source of stiffness data. In practice this part of the cavity loading will be affected by disturbance, difficult to quantify, caused by the method used to place the probe in the ground (Figure 3.1, the pseudo-elastic slope).

Once the material is loaded past its yield condition a zone of plastically deformed material starting from the cavity wall begins to extend into the soil mass. One consequence is that the stress history of the insertion process is erased as all elements within the plastic zone are put into a uniform condition. At a radius remote from the cavity wall and the pressuremeter there will be a single boundary where the material is on the point of yielding. If the direction of loading is reversed, the response seen at the pressuremeter will be that of the material beyond the boundary being unloaded elastically and then plastically. If the unloading continues then reverse plastic yield will result.

In Figure 3.1, small cycles of unloading and reloading exploit the response prior to the reverse yield condition to derive the elastic properties of the ground. It is evident that although each cycle is taken at a different cavity radius and stress, the procedure is highly repeatable. This test was pre-bored, so the cavity was completely unloaded prior to the pressuremeter test commencing. The consequences of this are clear when the slope of the initial loading is compared to the unload/reload cycles.

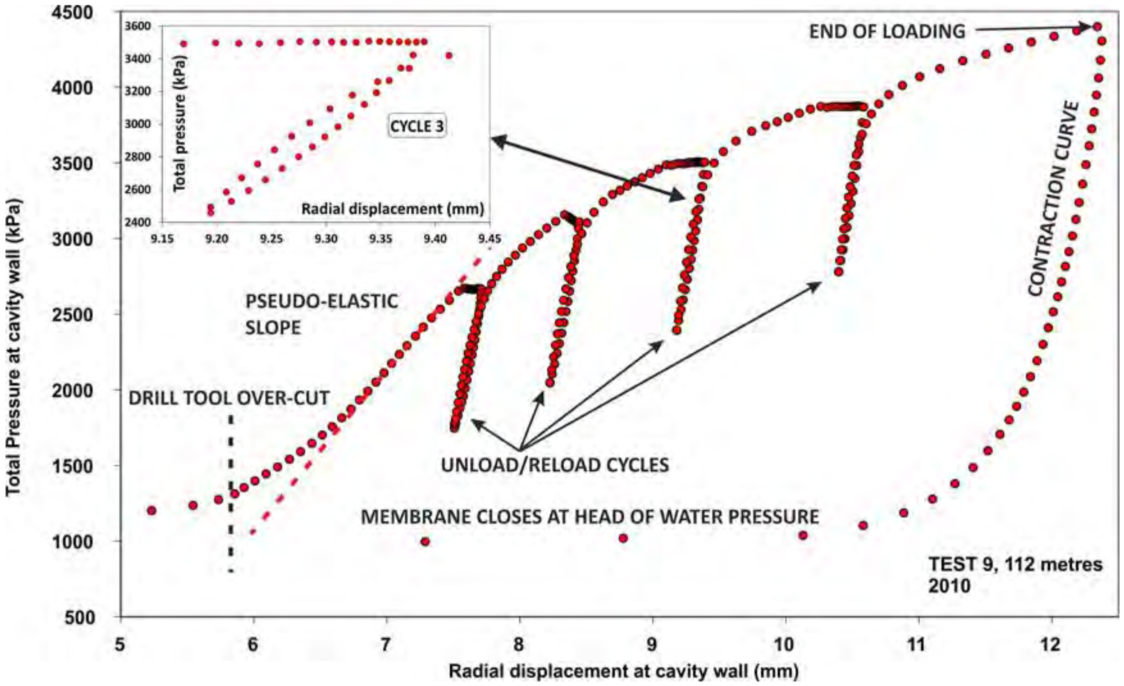


Figure 3.1: Field curve –pre-bored test in silty sand

It would be straightforward to place a line through each of the cycles in Figure 3.1 and use the slope to calculate the shear modulus, G. This is common practice but, unless the material is intact rock, is misleading. The third cycle in Figure 3.1, is shown as an inset, and has a clear hysteretic characteristic. This is due primarily to the influence of strain level on the current modulus. The elastic response of the ground where all deformation is fully recoverable applies to a strain level beyond the reliable resolution of the pressuremeter at shear strains of about 0.002%. The unload/reload cycles are showing the largely recoverable response when the stress alteration is less than that required to make the material yield, shear strains in the range 0.01% to 1%. This is the strain range that is significant for design purposes.

If there are sufficient data in the cycle then it is possible take tangents to the unload or reload path of radial stress against cavity strain and find the current shear stress (Palmer 1972), as in Figure 3.5.It is straightforward to turn these shear stress values into a shear modulus degradation trend. In practice the quantity of data are limited and the alternative is finding a function that describes the unload or reload path. Bolton & Whittle (1999) shows that this non-linear response is adequately represented by a power law. Using the power law parameters to solve the Palmer semi-differential solution gives a continuous stiffness degradation curve (Figure 3.2 and Figure 3.2). The individual points in these figures are the product of taking tangents to the measured data, the lines are the power law trend. Alternatives to the power law method include Jardine (1992) where a 'transformed strain' approach is applied to unload/reload data. The semi-empirical formulations were developed for specific soil types and are not transferable.

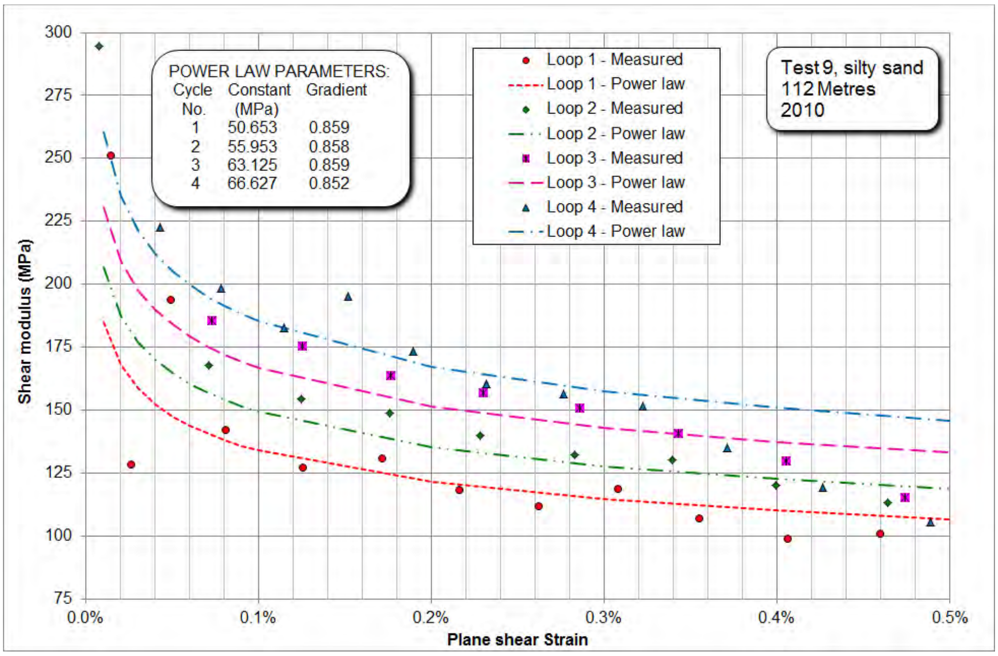


Figure 3.2 Shear modulus degradation curves (drained loading)

If the material has low permeability, giving an undrained loading, then the mean effective stress σ'_{av} following yield is constant, and all cycles will follow a similar path (Figure 3.3).

The material tested in Figure 3.1 is a silty sand and the loading is a drained event. The trend of each cycle (the strain dependency) is almost identical, but successive cycles (Figure 3.2) plot a higher stiffness, because of increasing mean effective stress, σ'_{av}.

A full data reduction will adjust these trends to a reference stress level such as the effective insitu lateral stress, σ'_{ho}. This requires σ'_{av} for each cycle to be calculated. Hence although stiffness is obtainable from all insertion methods, no matter how disturbed, it may still be necessary to determine additional strength related parameters in order fully to reconcile the stiffness data.

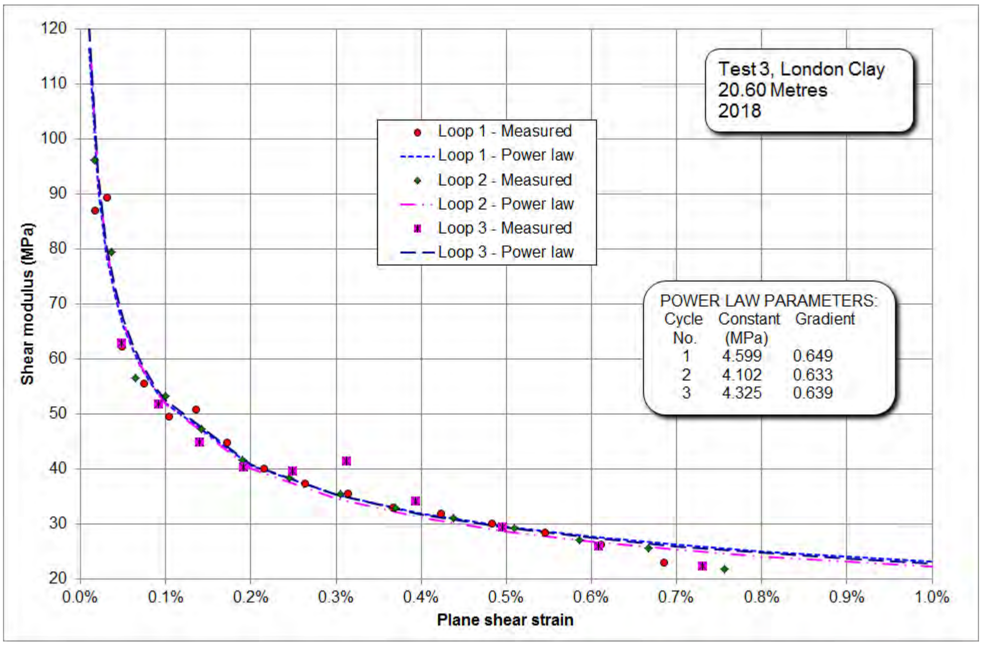


Figure 3.3 Shear modulus degradation curves (undrained loading)

Used vertically, the pressuremeter gives shear modulus parameters of type G_{hh}, where the first suffix shows the direction of loading and the second the direction of particle movement. Many design calculations requiring a value for shear modulus mean in practice the independent shear modulus G_{vh}. It is not possible to discover the ratio connecting G_{hh} and G_{vh} from a conventional pressuremeter test unless it is assumed that the ratio is related to k_o. This is only partly true. Nevertheless, because of the quality and relative speed with which G_{hh} can be determined it may be convenient to measure G_{hh} and assume an appropriate reduction factor. For engineering problems where the direction of loading is lateral, G_{hh} is the most relevant stiffness parameter.

Unloading and reloading are a feature of many laboratory material test procedures and pile loading tests. In the context of a cavity expansion in an infinite medium the first account of the theory behind the procedure is given by Hughes (1982). Cycles are a prominent feature of the Wroth Rankine lecture (Wroth, 1984). Bellotti et al (1989) give an explanation and methodology for manipulating the stress dependency of tests in sand. Muir Wood (1990) and Jardine (1992) explore the potential of the cycles for describing the non-linear strain dependency of the ground. Bolton & Whittle (1999) propose the simple procedure (described below) based on a power function.

Examining the detail within an unload/reload event requires high resolution local displacement measurement. Even in devices that do use local measurement it is necessary to be certain that what is measured is an accurate representation of the movements of the cavity wall, and not the finite stiffness of the probe itself.

The pressuremeter test shears the material. The modulus measured is shear modulus G and is independent of Poisson's ratio ν. G can be used to derive Young's modulus E but ν must be given or estimated. It is also straightforward to derive the bulk modulus M from the shear modulus.

3.4 Describing the unload/reload cycle

Figure 3.4 shows an unload/reload cycle extracted from a field curve such as the example in Figure 3.1. In this case the data are part of a test in stiff clay. In the interval between pausing the loading to take the cycle and the actual reversal of stress there are several data points showing the expansion continuing for no pressure increase. This phase of time dependent deformation is referred to as 'creep'.

Separating the contribution of the multiple processes that contribute to this behaviour is complex. It is unlikely that it will be possible to wait long enough for all creep behaviour to cease. This test in clay is an undrained event. There is a large excess pore pressure in the soil mass at the commencement of the cycle and waiting more than a short time would allow consolidation to take place. However the reducing displacement between readings shows that creep has fallen to a level low enough to permit a cycle to be taken.

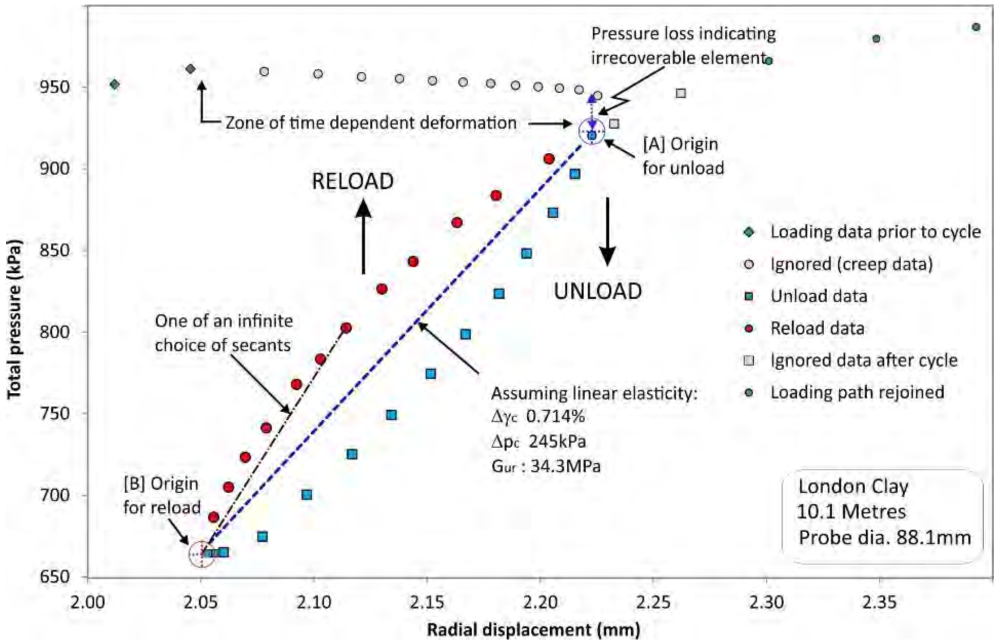


Figure 3.4 Annotated unload/reload cycle

The decrease of pressure continues until sufficient data has been recorded to give a clear indication of the path of the unloading response. The pressure decrease needs to be less than that required to cause reverse plastic failure, which for an undrained test is equivalent to twice the shear strength.

The reloading phase mirrors the unloading with a similar rate of pressure change and eventually crosses the cycle unload path. There are a few points before the main loading path is re-joined because the cycle is not a completely recoverable event.

A chord has been drawn through the start and lowest point of the cycle. The slope of this can be used as a means of calculating shear modulus. If the material response was linear elastic then the result would be the shear modulus. It is apparent that the unloading and reloading data show a non-linear response, and the chord that has been drawn is only the minimum secant. There are an infinite number of steeper secants that could be drawn. The unloading and reloading responses mirror each other, and a rotation of the unloading data would describe the same path as the reloading data. This is made explicit in Figure 3.5.

3.5 Linear elastic interpretation

If the material response is linear elastic then the local gradient prior to yield can be used as a source of modulus data. In Figure 3.1 the part of the curve labelled 'pseudo-elastic' is an example. Because it occurs at the start of the test it is referred to as the initial shear modulus[1], G_i.

Shear modulus is the quotient of the change of shear stress τ and change of shear strain γ:

$$G = \left[\frac{\Delta P}{\Delta \gamma}\right] \qquad \text{[Equ 3.1]}$$

Shear stress and shear strain are not directly measured by the pressuremeter. In Figure 3.4 the axes are radial displacement and radial stress at the cavity wall. If the material is linear elastic then a change of radial stress is equivalent to the change of shear stress (in this example, 244kPa). Displacement needs to be expressed non-dimensionally as strain. The change of current cavity strain

---

[1] [1]Unfortunately, 'initial' is used in two conflicting senses. In the context of non-linear stiffness "initial modulus" generally refers to the maximum or elastic modulus, which in the case of fig 2.1 is certainly not true.

ε_c is the change of displacement divided by the radius of the probe at the mid-point of the cycle, in this example 3.566 x 10^{-3}

Current shear strain at the cavity wall γ_c is twice ε_c, an approximation that is convenient and valid if ε_c is small as detailed in [Equ 1.4].

The calculation for shear modulus G in can be carried out using [Equ 1.4] and gives 34.3MPa. As G has been derived from an unload/reload cycle it normally has the subscript G_{ur}. [Equ 1.4] can be applied anywhere on the loading curve where elastic data can be found. If shear strain is calculated as in the example then it is always current shear strain and [Equ 1.4] remains valid for all expansions. The advantage is that shear modulus can be derived from displacements without the need for prior processing to identify a strain origin for the entire field curve.

In practice the only material routinely showing a linear elastic response up to the point of yield is intact because the material is strong enough to support an open hole without failing in the reverse sense, the slope from the latter part of the field curve gives a result similar to the modulus determined from unload/reload data.

3.6 Non-linear stiffness/strain response

If the material fails in shear then it is likely that for shear strains smaller than the yield value, the stiffness/strain relationship is not linear. The unload/reload cycle can be made to give a comprehensive description of this relationship by looking at smaller steps of pressure/strain other than the points at the extreme ends of the cycle.

Figure 3.5 plots the unloading and reloading data from Figure 3.4 in this way. Each path has its own origin, as indicated Figure 3.4, and the unloading data have been rotated to emphasise that both sets of data are showing the same thing. It follows that it is only necessary to examine one half of the rebound cycle, and the origin for data obtained after the reversal of stress in a loop has the smallest uncertainty because creep is at a minimum (Whittle *et al*, 1992). Figure 3.5 also shows the underlying shear stress response. The test is an undrained event so taking tangents to the radial stress data gives the current shear stress (Palmer 1972, Hughes 1973).

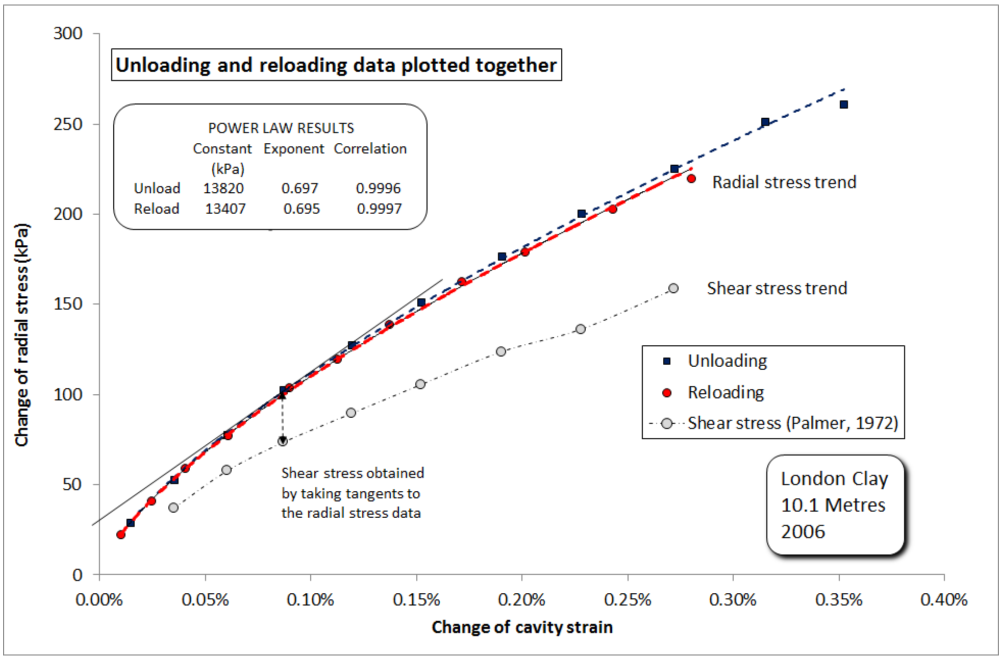


Figure 3.5 The non linear elastic response

The simplest description of the reloading response is a power law. The exponent of the power law defines the non-linearity of the response and is denoted β. It is generally a number between 0.5 and 1 where 1 indicates linear elasticity. In the example β is almost 0.7, appropriate for a silty clay.

The results in Figure 3.5 show the power law trend in radial stress/cavity strain space. Using parameters that the pressuremeter test can determine, this result can be written as:

$$P_c = \eta_h \varepsilon_c^{\beta} \qquad \text{[Equ 3.2]}$$

η_h is the radial stress constant when the strain scale is current cavity strain (circumferential strain at the cavity wall). Because the test is undrained there are no volumetric strains so shear strain is twice the circumferential strain. This approximation is valid for small strains below the yielding value. The result in radial stress/shear strain space is given by:

$$P_c = \eta \gamma^{\beta} \qquad \text{[Equ 3.3]}$$

Where $\eta = \eta_h / 2^{\beta}$.

For an undrained expansion, Palmer (1972) shows that the current shear stress τ_c is given by

$$\tau_c = \frac{dP_c}{d[\ln \gamma_c]} \qquad \text{[Equ 3.4]}$$

Substituting for dP_c using the right hand side of [Equ 3.3] allows the differential equation to be solved giving

$$\tau_c = \eta \beta \gamma^{\beta} \qquad \text{[Equ 3.5]}$$

Bolton & Whittle refer to $\eta\beta$ as the shear stress constant and call it α. Shear modulus G_s is given by;

$$G_s = \tau / \gamma \qquad \text{[Equ 3.6]}$$

so the expression for secant shear modulus is given by

$$G_s = \alpha \gamma_c^{\beta - 1} \qquad \text{[Equ 3.7]}$$

This gives a means of determining the secant shear modulus at any elastic shear strain, although an arbitrary cut-off strain must be assumed below which the modulus will be constant and a maximum – this strain is below the resolution of the SBPM.

Note:

When comparing triaxial results with pressuremeter results, invariant shear strain ε_T *is given by:*

$$\gamma_T = \gamma_c / \sqrt{3} \qquad \text{[Equ 3.8]}$$

Tangential shear modulus G_t is given by

$$G_t = G_s + \varepsilon_c \left(\frac{dG_s}{d\varepsilon_c}\right) \qquad \text{[Equ 3.9]}$$

Hence from the power law:

$$G_t = \alpha \beta \gamma_c^{\beta - 1} \qquad \text{[Equ 3.10]}$$

[Equ 3.7] gives a means of determining the secant shear modulus for shear strains below the yielding value down to 10^{-4}. This is the safe resolution limit of the current generation of pressuremeters and is more than the elastic strain at which the stiffness degradation commences. It is usual to plot the trend between 10^{-4} and 10^{-2} plane shear strain (0.01% to 1%, see Figure 3.2 and Figure 3.3). Ideally the large strain limit should be the yield shear strain of the material. 1% is appropriate for many stiff clays but will be too large for sands and too small for soft clay. Secant shear modulus at yield strain is G_y and is the secant shear stiffness governing the pressuremeter loading curve.

It is not necessary to take cycles of small strain amplitude to obtain small strain stiffness parameters. It is better to make the cycles as large as practicable (subject to the condition that the material is not allowed to fail in extension) to obtain parameters from as wide a strain range as possible.

The Bolton & Whittle analysis was developed for undrained tests. For a test in drained material the solution can be used assuming that whilst the material is deforming elastically there are no volumetric strains. Alternatively, the power approach is merely a curve fitting exercise and the solution in radial stress/cavity strain space [Equ 3.2] can be used to generate a smooth data set. This allows a numerical solution for drained tests to be applied (Manassero, 1989). The results are similar to the undrained parameters with a tendency for β to be slightly higher (more linear). The difficulty is that to apply the drained analysis the ambient water pressure and the constant volume friction angle ϕ'_{cv} must be known or estimated. Figure 3.6 is an example of a test in highly weathered mudstone, with the shear stress/shear strain response obtained by treating a reloading phase as a drained and undrained event. The difference between the two trends will depend on the potential for dilation.

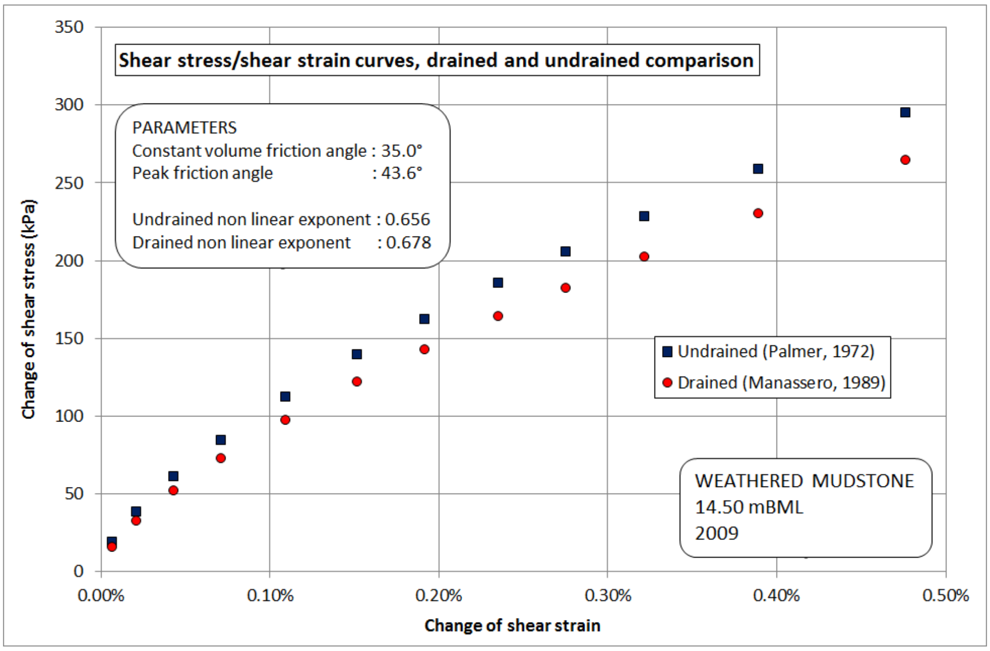


Figure 3.6 Drained & undrained interpretation of the same data

3.7 Stress Level

For modulus parameters derived from undrained expansion tests the mean effective stress remains unchanged throughout the expansion and all stiffness/strain data will plot the same trend. Conversely, failure to plot the same trend implies changes in the mean effective stress. This is true of tests affected by consolidation, but is also true of a heavily disturbed loading where the effects of the pressuremeter installation method have yet to be overcome. For such data it is reasonable to take modulus parameters from as late in the loading as possible. Division of the modulus values by a normalising stress such as the effective insitu lateral stress or yield stress gives a dimensionless parameter for modelling purposes.

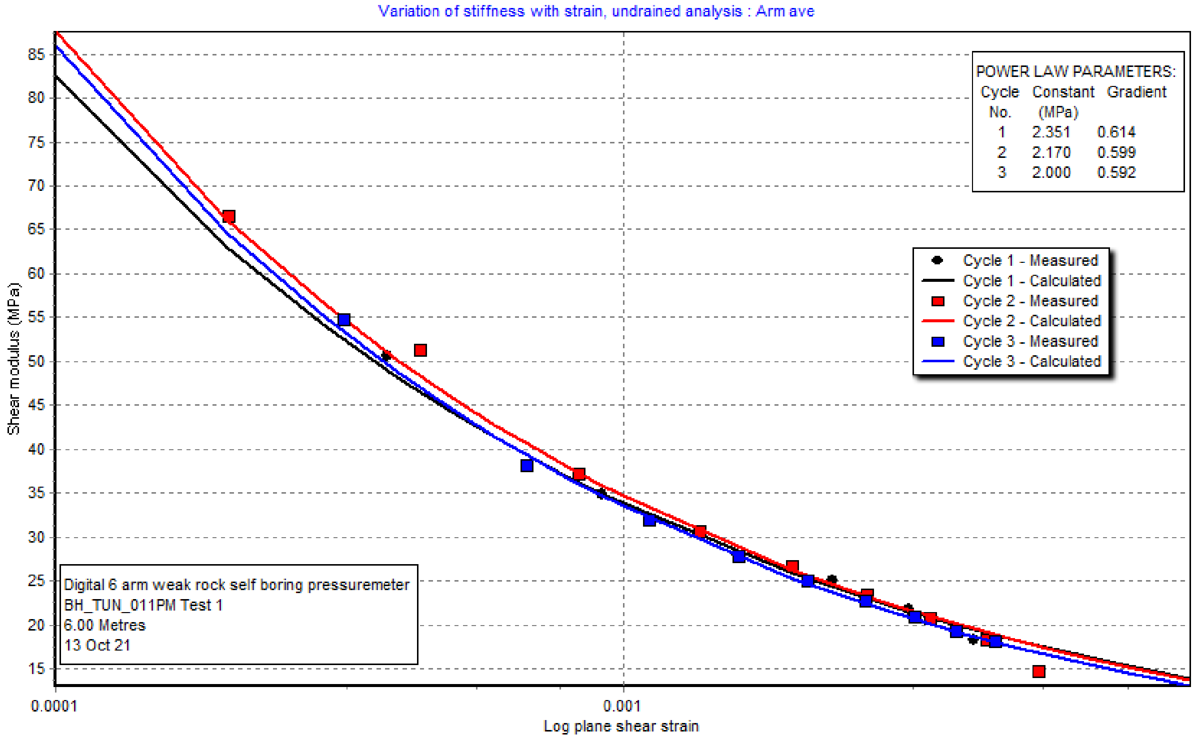


Figure 3.7 Stiffness strain curves (undrained example)

Reducing the unload/reload cycles from *drained* tests is a more complex process and is not described here.

In Figure 3.7 the lines are the result of fitting the reloading response with the power law. The points are obtained by applying the Palmer 1972 solution directly to the measured data and clearly support the idealised trend.

3.8 Shear modulus from other parts of the pressuremeter curve.

The first part of the unloading is an elastic process and can be used as a source of stiffness information. By the time the pressuremeter unloads, creep strains due to consolidation and rate effects will be large, so there will be a tendency for the initial unloading to be too stiff. If some allowance is made for this, then reasonable estimates of the shear modulus will be obtained.

Curve fitting analyses imply a value for the secant shear modulus at yield. Although this is not likely to be the best way of deriving shear modulus data it is important justification for using such analyses that they can predict this independently measurable stiffness.

3.9 Cross hole anisotropy

The pressuremeter test gives values for G_{HH}, the shearing stiffness in the horizontal plane. This is directly applicable to the analysis of radial consolidation or cylindrical cavity expansion due to pile insertion. G_{VH} is applicable all shearing which has an element of deformation in the vertical plane, such as under a footing or round an axially loaded pile.

To convert from G_{HH} to G_{VH} some relationship between the two must be assumed. Wroth et al (1979) suggest that anisotropy arises from two causes:

- Structural anisotropy due to the deposition of soil on well-defined planes
- Stress induced anisotropy, due to the differences in normal stress acting in different directions.

The second cause implies the stiffness in any direction will be a function of the effective insitu stress in that direction, ie a function of k_o.

It can be shown that:

$$G_{HH} = \frac{E_H}{2(1+v_{HH})} \quad \text{[Equ 3.11]}$$

For undrained expansion:

$$v_{HH} = 1 - \frac{n}{2} \quad \text{[Equ 3.12]}$$

Where:

$$n = \frac{E_H}{E_V} = k_o \quad \text{[Equ 3.13]}$$

From this

$$E_H = (4-n)G_{HH} \quad \text{[Equ 3.14]}$$

and

$$E_v = \frac{(4-n)G_{HH}}{n} \quad \text{[Equ 3.15]}$$

This is as far as argument from first principles can go, because of the additional contribution of the manner in which the material is deposited. k_o is likely to lie between 0.5 and 2, so [Equ 3.15] $\frac{E_H}{G_{HH}}$ lies between 2 and 3.5. From [3.16] $\frac{E_v}{G_{HH}}$ lies between 1 and 1.75.

It is likely that G_{VH} will be linked to E_V by Poisson's ratio in a relationship of the form of [Equ 3.15]. Plausible values of $\frac{E_v}{G_{VH}}$ would seem to be 2.4 to 3. Hence in a material with k_o of 2, G_{VH} could be as low as $\frac{G_{HH}}{3}$. Simpson et al (1996) come to the same conclusion but find in practice heavily over-consolidated London clay gives relationships of the order of: $G_{VH} \cong 0.65G_{HH}$. The influence of the strain range is not separately considered in these studies, and it is possible that the G_{100} values would be similar in all planes.

Lee & Rowe (1989) give details of the anisotropy characteristics of many clays varying from lightly over consolidated to heavily over consolidated. The general conclusion is $\frac{E_v}{G_{VH}}$ lies between 4 and 5, rather more than the isotropic relationship of 3. However, their paper was concerned with the impact of anisotropic stiffness properties on surface settlement. Deriving G_{VH} from E_v is therefore unsatisfactory, because although $G_{VH}$is insensitive to the direction of loading, E_v is not.

4 ANALYSES FOR UNDRAINED SHEAR STRENGTH (C_U)

4.1 Notation

δ	Small change
A	Current area of cavity
δA	Change in current area of cavity
α	Shear stress constant when the strain scale is shear strain
β	Exponent of non-linearity
$\mathrm{d}x$	Differential of x (where x is changeable)
ε_a	Axial strain
ε_c	Cavity strain
ε_θ	Circumferential strain
ε_r	Radial strain
ε_{max}	Maximum cavity strain (also termed maximum hoop strain)
G	Shear modulus
I_r	Rigidity index
P	Total pressure
P_c	Total pressure measured at the cavity wall
P_o	Initial cavity reference stress (total)
P_l	Total limit pressure when $\frac{\delta A}{A} = 1$
P_{max}	Maximum pressure reached
σ_r	Radial stress
σ_θ	Circumferential stress (also termed hoop stress)
σ_{ho}	Insitu lateral stress
r	Radius
r_f	Radius of cavity at first yield
r_c	Current radius of cavity
τ	Shear strength
u	Increment of radial displacement at a point in the continuum
γ	Shear strain
$\gamma_c, \gamma_{ce}, \gamma_{cc}$	Shear strain at the borehole wall, 2nd suffix denotes test stage - e for expansion and c for contraction
$\gamma_\gamma, \gamma_{\gamma e}, \gamma_{\gamma c}$	Shear strain at which the material reaches first failure, 2nd suffix denotes test stage - e for expansion and c for contraction

4.2 Overview

Once the strain origin is known, the expansion and contraction phases of the test can be used to determine the material shear strength. Two methods have been applied:

Case A

Assume the shape of the shear strength/ shear strain curve and hence derive a closed form solution for the pressuremeter curve. For the SBPM tests on this contract a non-linear elastic/perfectly plastic soil response has been assumed. This has been solved (Bolton & Whittle 1999) for the case where the non-linear elastic characteristics are given by a power law. Strictly, the form of the elastic phase is of no consequence for the derivation of shear strength once perfect plasticity is assumed, and the classic procedure developed by Gibson & Anderson (1961) could be used. For both solutions the slope of the pressure /strain curve plotted on semilog axes gives the shear strength directly and an estimate of the ultimate limit pressure. However, the terminology of the non-linear elastic solution is different from the linear elastic model and this avoids some conceptual problems.

Case B

Make no assumptions about the shape of the shear stress/ shear strain curve but differentiate the measured pressuremeter curve directly to give the shear stress response. Palmer (1972) gives the differential equation used to describe the complete shear stress/ shear strain response of a material deforming under undrained conditions. The equation can be solved graphically or numerically by taking the current tangent of the total pressure/cavity strain plot, but the success of the method depends on the smoothness of the measured data.

4.3 Bolton & Whittle (1999)

Figure 4.1 gives the shear stress/ shear strain response of a non-linear elastic/perfectly plastic soil. Both expansion and contraction are included. Because this solution is not widely known it is given in greater depth here than is strictly necessary.

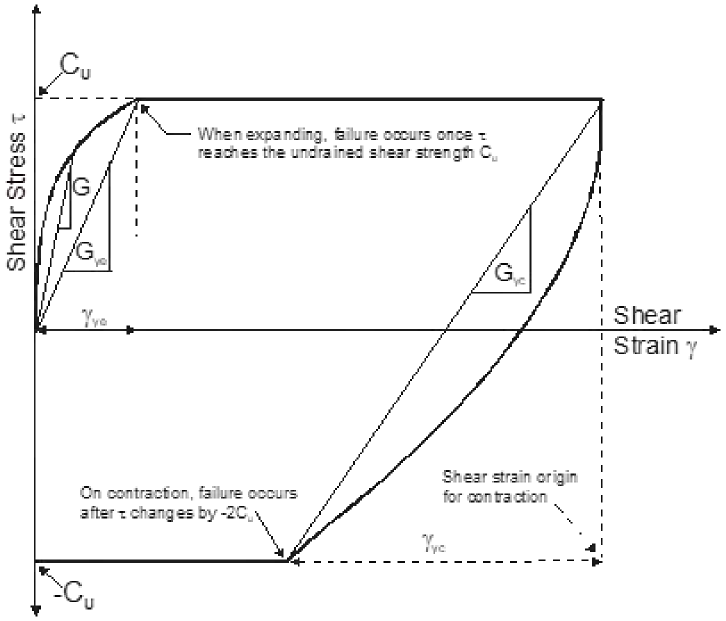


Figure 4.1: Non-linear elastic/ perfectly plastic shear stress/ strain curve

It is assumed that the non-linear elastic response of soils can be fitted with a power law of the form:

$$\tau = \alpha\gamma^{\beta}$$

[Equ 4.1]

This assumption is justified by inspecting unload/reload cycles.

Around the pressuremeter, assume that the soil is deformed under conditions of axial symmetry and the expansion is undrained. The following relationships apply:

$$\text{Axial strain} = \varepsilon_a = 0$$

[Equ 4.2]

$$\text{Circumferential strain} = \varepsilon_\theta = -\frac{u}{r}$$

[Equ 4.3]

Assuming that expansion is undrained the radial strain is:

[Equ 4.4]

$$\varepsilon_r = -\varepsilon_\theta = \frac{u}{r}$$

[Equ 4.5]

$$\text{Shear strain} = \gamma = \varepsilon_\theta + \varepsilon_r = \frac{2u}{r} = \delta A/A$$

[Equ 4.6]

The equation of radial equilibrium applies throughout the expansion:

$$r = \frac{\mathrm{d}\sigma_r}{\mathrm{d}r} + (\sigma_r - \sigma_\theta)$$ [Equ 4.7]

Using τ to represent the maximum shear stress, this becomes

$$r\frac{\mathrm{d}\sigma_r}{\mathrm{d}r} + 2\tau = 0$$ [Equ 4.8]

Using the constitutive relationship [Equ 4.1] and writing the current area in terms of radius:

$$\frac{\mathrm{d}\sigma_r}{\mathrm{d}r} + \frac{2\alpha}{r}\left(\frac{\delta A}{\pi r^2}\right)^{\beta} = 0$$ [Equ 4.9]

[Equ 4.9] can be re arranged to:

$$\frac{\mathrm{d}\sigma_r}{\mathrm{d}r} + 2\alpha\left(\frac{\delta A}{\pi}\right)^{\beta} r^{-(2\beta+1)} = 0$$ [Equ 4.10]

From by integrating between the reference state, and the pressure and radius at the cavity wall:

$$\int_{P_o}^{P} \sigma_r = -2\alpha\left(\frac{\delta A}{\pi}\right)^{\beta}\int_{\infty}^{r_c} r^{-(2\beta+1)}\mathrm{d}r$$ [Equ 4.11]

Resulting in:

$$P - P_o = 2\alpha\left(\frac{\delta A}{\pi}\right)^{\beta}\left(\frac{1}{r^2}\right)^{\beta}\left(\frac{1}{2\beta}\right) = \frac{\alpha}{\beta}\left(\frac{\delta A}{A}\right)^{\beta}$$ [Equ 4.12]

The right-hand side of this result is the shear stress mobilised at the cavity wall and can be written as $\frac{\tau_c}{\beta}$. Note that if $\beta = 1$, the condition for linear elastic response, the right-hand side of [Equ 4.12] reverts to the following familiar expression where α is shear moulus G:

$$\alpha\left[\frac{\delta A}{A}\right]$$ [Equ 4.13]

The end of the elastic phase is reached when $\tau_c = C_u$ for the expansion, hence

$$P - P_o = \frac{C_u}{\beta}$$ [Equ 4.14]

Thereafter, there is a plastic zone confined by the limiting elastic radial stress of $\frac{C_u}{\beta}$. Equation [4.8] still applies, so

$$r\frac{\mathrm{d}\sigma_r}{\mathrm{d}r} + 2C_u = 0$$ [Equ 4.15]

This gives

$$\mathrm{d}\sigma_r = -2C_u\frac{\mathrm{d}r}{r}$$ [Equ 4.16]

Integrating between the radii of the cavity wall and of the elastic-plastic transition:

$$\int_{P_c}^{Po+\frac{C_u}{\beta}} \mathrm{d}\sigma_r = -2C_u\int_{r_c}^{r_f}\frac{\mathrm{d}r}{r}$$ [Equ 4.17]

Hence:

$$P_c = P_o + C_u\left[\frac{1}{\beta} + ln\left(\frac{r_f^2}{r_c^2}\right)\right]$$ [Equ 4.18]

If a soil being sheared at constant specific volume (Gibson & Anderson 1961), ie:

$$\frac{r_f^2}{r_c^2} = \frac{\gamma_{ye}}{\gamma_{ce}}$$ [Equ 4.19]

Then ratio of the shear strain required to initiate plasticity during expansion γ_{ye} to the shear strain at the cavity wall during expansion γ_{ce}. This leads to:

$$P_c = P_o + C_u\left[\frac{1}{\beta} - \ln(\gamma_{\gamma e}) + \ln(\gamma_{ce})\right] \qquad \text{[Equ 4.20]}$$

This result resembles the simple elastic/perfectly plastic solution proposed by Gibson & Anderson. For the special case of a simple elastic response when $\beta = 1$ the two solutions are identical. Indefinite expansion of the borehole and limit pressure is predicted by:

$$P_l = P_o + C_u\left[\frac{1}{\beta} - \ln(\gamma_{\gamma e})\right] \qquad \text{[Equ 4.21]}$$

and substituting this into [Equ 4.20] gives:

$$P_c = P_l + C_u \ln(\gamma_{ce}) \qquad \text{[Equ 4.22]}$$

showing the undrained shear strength and limit pressure can be obtained from the gradient and intercept of a plot of total pressure at the cavity wall versus the natural log of the current cavity shear strain (Figure 4.2). Note that equation [Equ 4.20] makes no explicit reference to shear modulus.

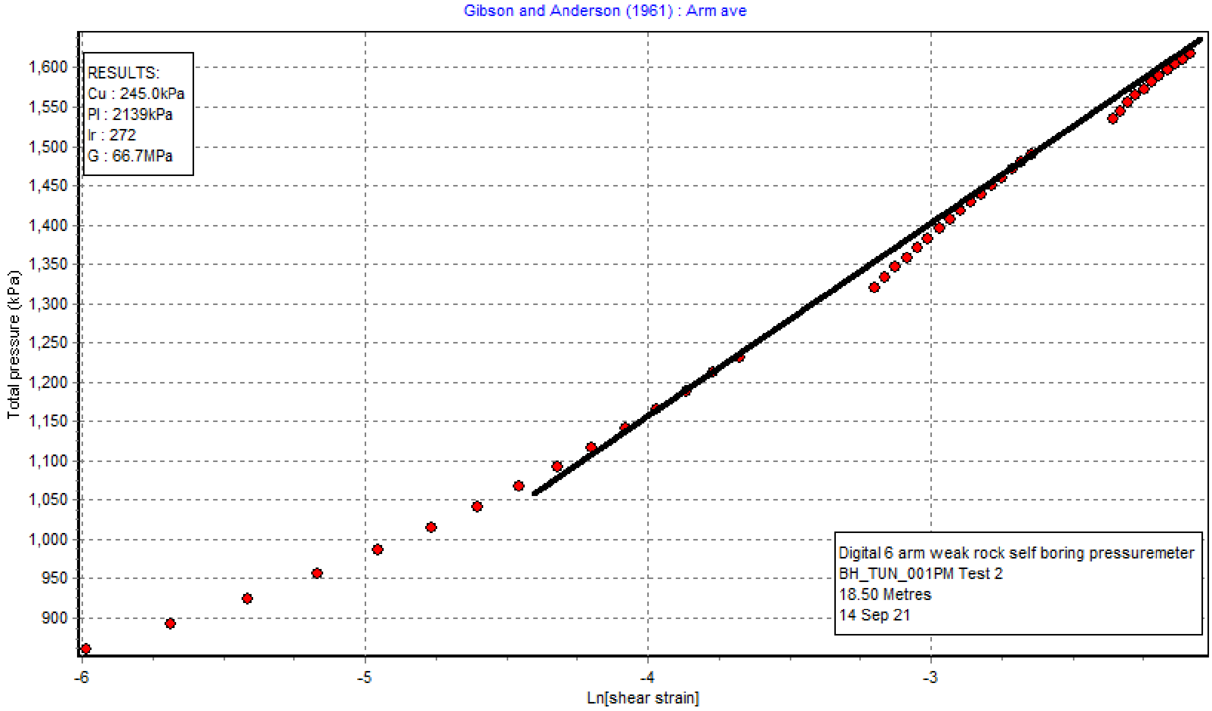


Figure 4.2 Deriving undrained shear strength from expansion data

4.4 Analysing pressuremeter undrained contraction data

The expansion phase ends at some value of pressure and cavity strain at the borehole wall P_{max} and $\varepsilon_{c_{max}}$. This is the origin for the contraction event. During contraction, the end of the elastic phase is reached when $\tau_c = -2C_u$, hence:

$$P_{max} - P = \frac{2C_u}{\beta} \qquad \text{[Equ 4.23]}$$

Jefferies (1988) gives the simple elastic solution for the relationship between pressures and strains at the cavity wall once reverse plastic failure is initiated:

$$P = P_{max} - \frac{2C_u}{1 + \ln(\gamma_{cc}) - \ln(2\gamma_{\gamma e})} \qquad \text{[Equ 4.24]}$$

This is not quite as his solution is written - γ_{cc} is the shear strain at the cavity wall during contraction [Equ 4.25] and $\gamma_{\gamma e}$ is the shear strain required to initiate yielding when expanding the cavity. From [Equ 4.20] it follows the non-linear elastic version of [Equ 4.24] is given by:

$$P = P_{max} - 2C_U \left[\frac{1}{\beta} + \ln(\gamma_{cc}) - \ln\left(\frac{2\gamma_{\gamma e}}{\beta}\right)\right] \qquad \text{[Equ 4.25]}$$

Shear strain γ_{cc} is obtained from conventional cavity strain ε_c by:

$$\gamma_{cc} = \frac{1 + \varepsilon_{max}}{1 + \varepsilon_c} - \frac{1 + \varepsilon_c}{1 + \varepsilon_{max}} \qquad \text{[Equ 4.26]}$$

An inspection of [Equ 4.26] indicates that a plot of the natural log of the contraction shear strain against total pressure at the cavity wall gives a curve whose ultimate gradient is $-2C_u$.

Figure 4.3 gives an example for the contraction phase. As before, if $\beta = 1$, the condition for simple elastic response, all non-linear elastic equations given above revert to published solutions for simple elastic/perfectly plastic material.

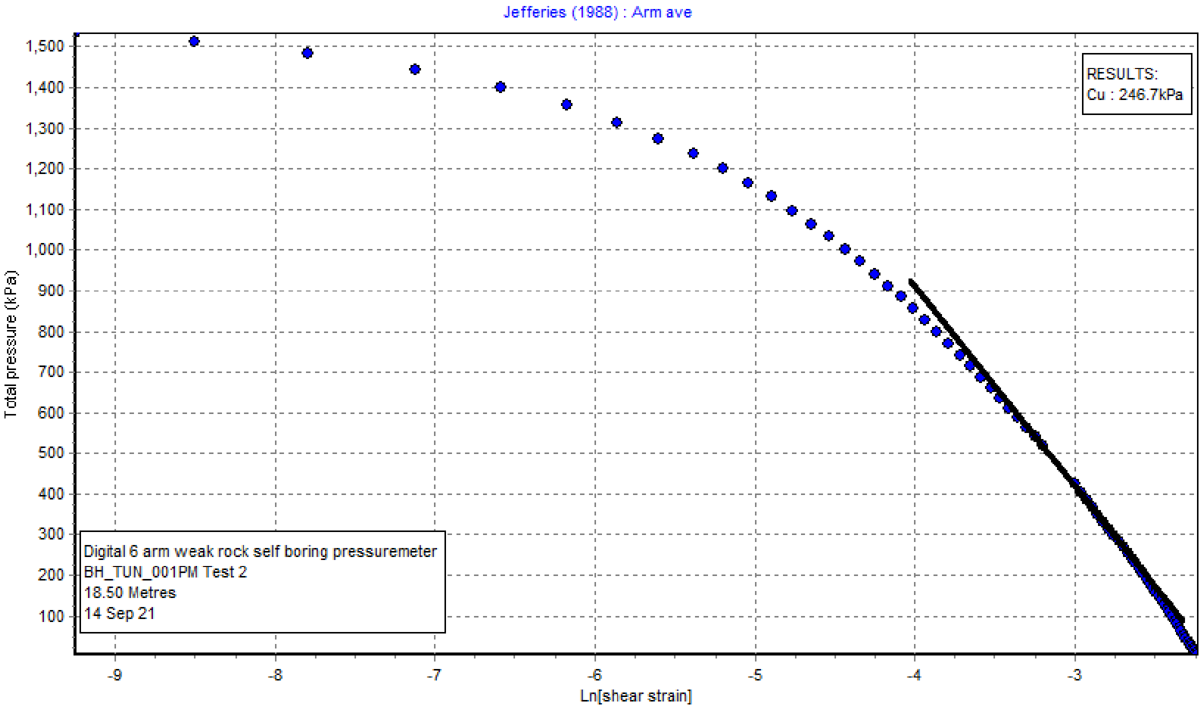


Figure 4.3: Using the contraction curve to derive undrained shear strength

Sometimes there is uncertainty in deciding the ultimate slope in both the expansion and contraction examples. For the expansion there can be indications of shear strength changing after the point in loading where unload/reload loops have been taken. It is assumed here that the taking of the cycles has allowed partial drainage, invalidating the primary assumption underpinning the analysis. For the contraction there is a difficulty in that the slope sometimes increases sharply towards the end -the start of this seems to coincide with the point where the major and minor stresses reverse.

One good reason for using contraction data to discover the shear strength is the certainty of knowing the origin for the contraction event. Altering the length of the strain scale for the expansion event has a noticeable impact on the derived shear strength. All things being equal, a comparison between loading and unloading values may indicate insertion disturbance but also a means for correcting for it.

4.5 Subtangent Analysis (1972)

Palmer (1972) is an analysis which derives the shear stress/shear strain curve directly from the local slope of the measured pressure/cavity strain expansion data. The attraction of the analysis is no assumptions are required concerning the shape of the shear stress/shear strain response. The derivation of shear strain from cavity strain requires no volumetric strains are developed, which means the analysis is usually applicable to undrained expansion tests only.

Provided the material response is elastic, no volumetric strains are generated and thus the result is useful for describing the stiffness/strain response seen in unload/reload cycles, regardless of the permeability of the material.

In terms of cavity strain the shear stress τ is approximately:

$$\tau = \varepsilon_c \frac{dP_c}{d\varepsilon_c} \qquad \text{[Equ 4.27]}$$

Indicating the mobilised shear stress is the product of the current slope and cavity strain and explains why the analysis is sometimes called the Subtangent method. [Equ 4.27] is an approximation. The exact expression is:

$$\tau = \frac{dP}{d\ln(\gamma)} \qquad \text{[Equ 4.28]}$$

When examining pushed RPM tests the analysis can be used on the final contraction.

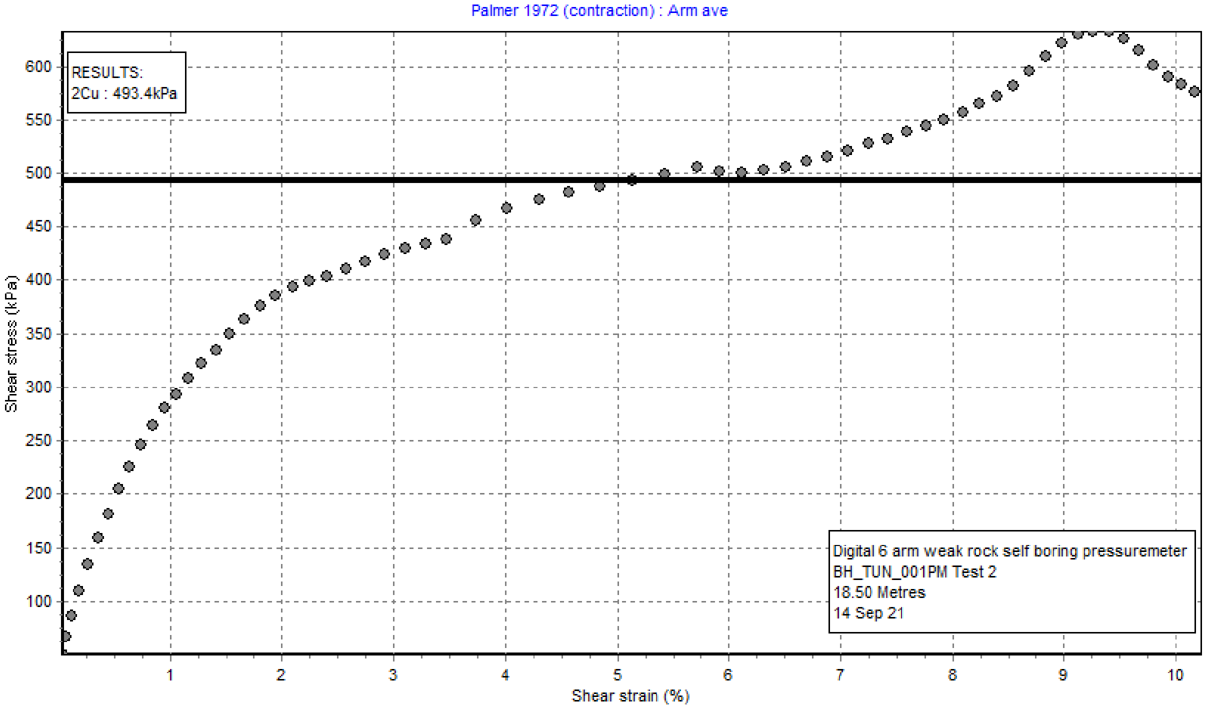


Figure 4.4: Palmer (1972) analysis applied to contraction data

5 ANALYSES FOR STRENGTH, DRAINED LOADINGS

5.1 Notation

α	$1/M$
$A^{\#}$	Constant
A	$A = \frac{T}{(1+\alpha)}$

β	$1/N$
B	$B = \frac{-Z}{(1-\beta)}$
c	Cohesion
C	$C = 1 - A - B$
d	The stress exponent, describing the variation of stiffness with stress level
ε_c	Cavity strain also termed circumferential strain
ε_{max}	Maximum cavity strain at the end of loading
ε_{yc}	Cavity strain at the onset of reverse plasticity
ε_R	Radial strain
ε_v	Volumetric strain
ε_θ	Circumferential strain at the elastic/plastic boundary
h	The exponent of a non-linear elastic power law
G	Shear modulus
G_s	Secant shear modulus
J	A scale factor to adjust for stiffness at differing stress levels
k_a^{cv}	$k_a^{cv} = \frac{1}{k_p^{cv}}$
k_p^{cv}	Constant volume stress ratio coefficient
$M \text{ or } n$	$n = M = \frac{1-sin\psi}{1+sin\psi}$ M and n are used interchangeably. Withers, Howie, Hughes and Robertson typically uses n and Carter et al typically use M
N	$N = \frac{1-sin\phi'}{1+sin\phi'}$
P_o	Effective cavity reference pressure
P_l	Effective limit pressure for an infinite cavity expansion
P'_{max}	Maximum effective pressure reached during expansion
P, P'	Pressure at cavity wall, suffix ' denotes effective
q_{xx}	The co-efficient of a non-linear elastic power law. The first suffix is r or s denoting radial stress or shear stress intercept. The second suffix is c or s and defines the strain scale, circumferential or shear.
q_{ref}	Radial stress elastic constant at insitu or reference stress
r	Radius
r_o	Initial radius of cavity
r_a	Current radius of cavity
R	Radius of the elastic/plastic boundary
S	$S = \frac{(1 + sin\psi)sin'\phi}{1 + sin\phi'}$
σ_{AV}	Mean effective stress
σ_c	Circumferential stress
σ_r	Radial stress
σ_R	Radial stress at the cavity wall at first yield
σ_{RU}	Radial stress at the cavity wall at yield in cavity contraction
σ'_{ho}	Effective insitu horizontal stress
T	$T = 2 + Z$
u	Increment of radial displacement at a point in the continuum
u_o	Initial pore water pressure in the ground
ϕ'	Peak angle of internal friction
ϕ_{cv}	Critical state angle of internal friction
ψ	Dilation angle
τ	Shear stress

v	Poisson's ratios
w	The intercept of a plot of stiffness against stress level
χ	$\chi = \frac{(1-v) - v(M+N) + (1-v)MN}{MN}$
γ	Shear strain
$\boldsymbol{Y}$	$\boldsymbol{Y} = \frac{1+\alpha}{1-\beta} = \frac{NM+N}{NM-M}$
Z	$Z = \frac{2\chi}{(\alpha+\beta)}$

5.2 Overview

For drained expansion tests in purely frictional material the strength is described in terms of the peak angle of internal friction and dilation. The method used is that due to Hughes et al (1977). The form of the shear stress/ shear strain curve is simple elastic/perfectly plastic and dilation and friction are related by Rowe's dilatancy law. Although the soil response during elastic deformation is more realistically described as non-linear elastic, this has no effect on the plastic part of the curve from where strength is derived.

The technique is to plot effective pressure against cavity strain on log scales and to discover by inspection the maximum slope of the resulting curve. It is usual to only quote a single value for friction and dilation. The same assumptions have been applied by Withers et al (1989) to produce a solution for cavity contraction.

Manassero (1989) is a numerical solution that applies Rowe's dilatancy law as a flow rule. Elastic strains in the plastic area are ignored for simplicity.

For tests in c′ – phi material a method based on the solution of Carter et al (1986) is used. In such material the value for friction angle can often be identified from the Hughes analysis.

5.3 Hughes et al (1977)

In addition to the usual conditions governing the expansion of a cylindrical cavity in plane strain this analysis assumes the following:

- A simple elastic/perfectly plastic model
- The expansion is fully drained, i.e. no excess pore water pressures are allowed to develop
- Following yield the sand deforms at a constant angle of internal friction
- Volumetric and shear strains are connected by Rowe's dilatancy law (1962)

Rowe's dilatancy law can be written:

$$\frac{1+sin\phi'}{1-sin\phi'} = \left(\frac{1+sin\phi_{cv}}{1-sin\phi_{cv}}\right)\left(\frac{1+sin\psi}{1-sin\psi}\right) \quad \text{[Equ 1.1]}$$

At failure the effective pressure at the cavity wall p′ is given by:

$$P' = \sigma'_{ho}(1+sin\phi') \quad \text{[Equ 5.1]}$$

Following failure:

$$\ln(P') = S\ln[\frac{\varepsilon_c}{1+\varepsilon_c} + \frac{c}{2}] + A^{\#} \quad \text{[Equ 5.2]}$$

where S is

$$S = \frac{(1+sin\psi)sin'\phi}{1+sin\phi'} \quad \text{[Equ 5.3]}$$

[Equ 5.2] indicates that s is approximately the gradient of effective pressure plotted against cavity strain on log scales. Once obtained, both $sin\phi'$d $sin\psi$ can be derived.

By incorporating Rowe's stress dilatancy theorem (1962) and by knowing or estimating constant volume friction angle, the gradient can be turned into values for the peak angles of internal friction and dilation:

$$sin\phi' = \frac{S}{1 + (S - 1)sin\phi_{cv}} \qquad \text{[Equ 5.4]}$$

$$sin\psi = S + (S - 1)sin\phi_{cv} \qquad \text{[Equ 5.5]}$$

The factor $\frac{c}{2}$, representing elastic strain in the plastic region, is usually ignored - it has been shown to introduce an error of about 0.03% in the strain scale for a typical dense sand.

An example of the Hughes analysis is shown in Figure 5.1. Both the ambient pore water pressure U_o and ϕ_{cv} are required to implement the analysis. Because the expansion is drained the membrane normally collapses at the head of water pressure, and an estimate of U_o can often be made from this behaviour. ϕ_{cv} must either be given or estimated. The analysis is sensitive to the choice of strain origin.

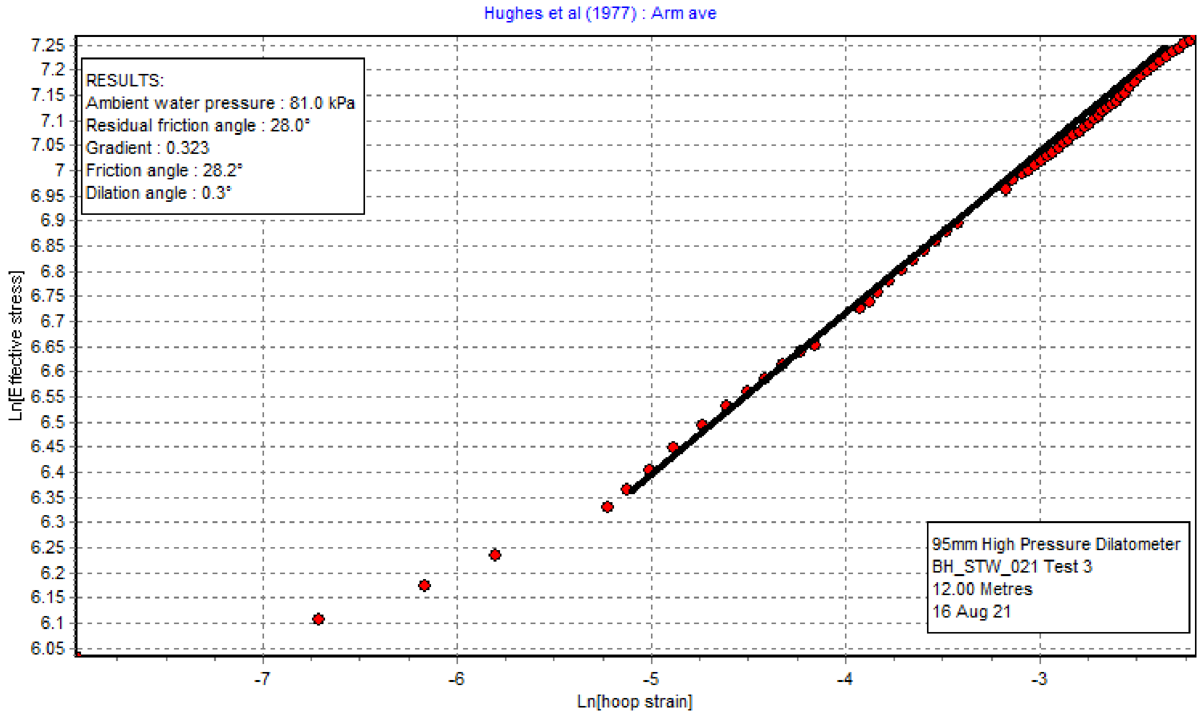


Figure 5.1 Example of Hughes et al (1977) solution

If the test shown in Figure 5.1 was taken to a high enough cavity strain then the final part of the loading would show strain softening indicating that the peak friction angle is passed and the current internal angle is reducing towards a residual value. Curvature at relatively low strain (as in the example) indicates the presence of some cohesion, in which case the ultimate slope of the trend gives the best estimate of the friction angle.

5.4 Withers, Howie, Hughes and Robertson (1989)

Withers, Howie, Hughes and Robertson (1989) is an analysis for the unloading of a cone pressuremeter in sand.

The solution is a development of the Hughes et al (1977) analysis for a cavity expansion in sand. During expansion, given a low disturbance insertion, effective radial stress is related to circumferential strain by the following:

$$P' = \sigma'_{ho}\left[\frac{2}{1+N}\right]\left[\left(\frac{G}{\sigma'_{ho}}\right)(1+N)\left(\frac{1+N}{1-N}\right)\varepsilon_c + \left(\frac{1-n}{2}\right)\right]^{\left[\frac{1-N}{1+n}\right]} \quad \text{[Equ 5.6]}$$

This solution cannot be sensibly applied to CPM expansion data. The final unloading, however, is in principle valid. It starts with an elastic phase which ends when the effective radial stress is

$$P'_{max} = NP' \quad \text{[Equ 5.7]}$$

The cavity strain at the onset of reverse plasticity will be

$$\varepsilon_{yc} = \varepsilon_{max} - \left[\frac{(1-N)P'_{max}}{2G}\right] \quad \text{[Equ 5.8]}$$

The solution for the plastic contraction is

$$P' = NP'_{max}\left[\frac{2G(\varepsilon_{max}-\varepsilon_{yc})(1+nN)}{nP'_{max}(1-N)(1+N)} - \left(\frac{1-n}{n(1+N)}\right)\right]^{\frac{nN^2-n}{nN^2+N}} \quad \text{[Equ 5.9]}$$

If $\log \frac{P'}{P'_{max}}$ is plotted against $\log\left[(\varepsilon_{max}-\varepsilon_{yc})/(1+\varepsilon_{max})\right]$

$$s = \frac{nN^2 - n}{nN^2 + N} \quad \text{[Equ 5.10]}$$

In principle these equations can be used to draw the entire test curve. In practice this is generally unsuccessful, because the simple assumptions cannot capture the complex response of most sands.

Quite frequently, there is no long straight portion in this plot. It can be imagined that after reaching failure in contraction at the peak angle of internal friction the sand quickly falls into an ultra loose condition. The analysis can depend, therefore, on identifying the point of maximum curvature in log log space and is not very convincing.

However when the analysis does work it can be useful in assessing the origin for strain on the *loading*. Because the contraction starts from a defined origin there is no uncertainty in the strain scale. Adjusting the loading scale to give similar answers using the Hughes et al analysis indirectly corrects for insertion disturbance.

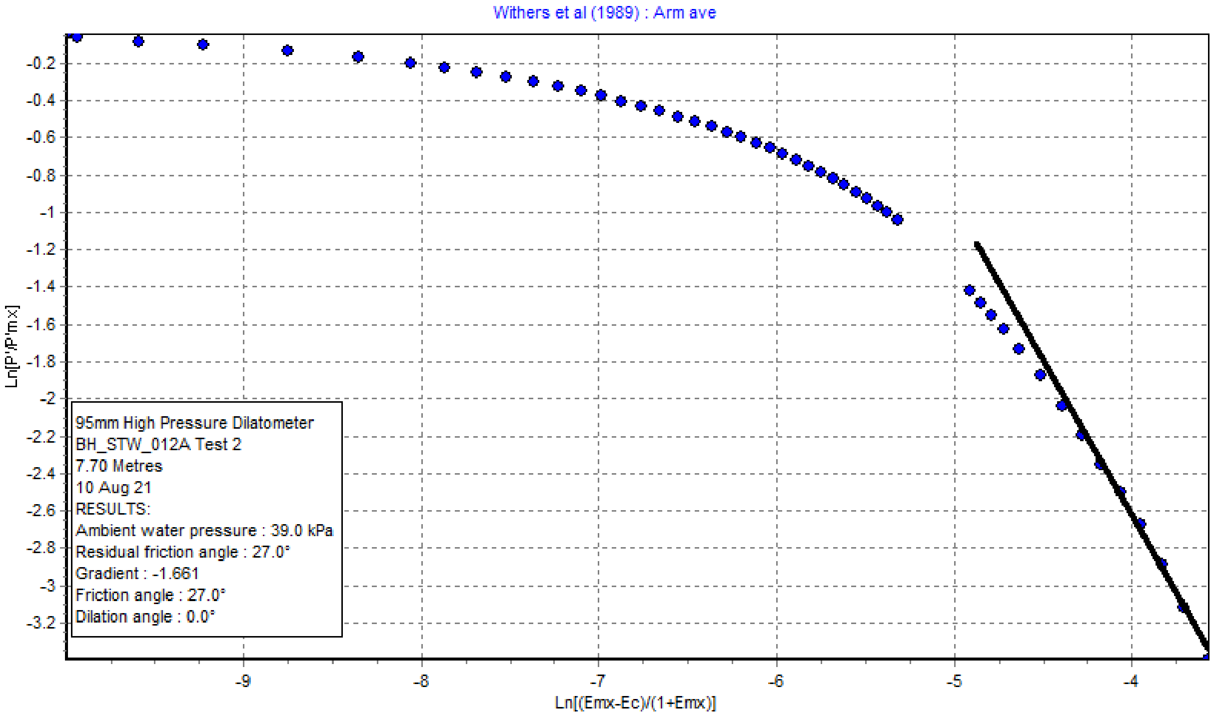


Figure 4.2 **Example of Withers et al (1989) solution**

5.5 Carter et al (1986, adapted 2010)

Carter et al (1986) is a closed form analytical solution for cavity expansion tests in ideal cohesive frictional material. There is an explicit small strain expression of the solution which makes a convenient basis for a curve comparison routine. What is presented here is a modified version of the solution incorporating non-linearity in the elastic phase of the test. A power law is used to describe the non-linear response and the parameters for the power law are obtained from rebound cycles carried out during the test. Unload/reload cycles offer the means of obtaining the elastic properties of the ground independently of disturbance caused by the process of placing the instrumentation - it is a necessary aspect of the methodology presented here that the analysis be constrained by the measured values of soil stiffness.

The process starts with the parameter set already obtained from the conventional analyses for cavity reference pressure, stiffness and internal angle of friction. Using the measured pressures but calculating the cavity strains according to the input parameter set, a theoretical curve is generated. This is overlaid on the measured field data. If the mis-match is significant, then certain parameters can be adjusted to improve the match. The fixed parameters are the stiffness data. The curve comparison procedure covers elastic loading, plastic loading and elastic contraction – the plastic contraction part of the test is ignored for the present. For simplicity, all stresses in the following description are effective. As does Carter *et al* the method is developed first in terms of a purely frictional material and is then modified for cohesion. The solution is presented in terms appropriate for cylindrical cavity expansion, the spherical case has been ignored.

There are two main reasons for using this procedure. With the analyses available at the present time it is difficult to separate out the contribution of cohesion and friction in a dilating material. This can be done reasonably easily with the curve comparison approach. The other reason is that the influence of cavity reference pressure on the overall curve is very obvious. Tests in material of this type are often pre-bored and there is very little that can be done to assess the cavity reference pressure when the initial part of the loading curve is dominated by disturbance effects. With this procedure implausible values are identified very easily.

5.5.1 Carter, Booker and Yeung (1986)

Assuming small deformations (where 10% cavity strain is considered small), Carter *et al* offer the following general solution for a cylindrical cavity expansion:

$$\frac{u}{r} = \varepsilon_\theta \left[A \left(\frac{R}{r} \right)^{1+\alpha} + B \left(\frac{R}{r} \right)^{1-\beta} + C \right] \qquad \text{[Equ 5.11]}$$

In terms of parameters that the pressuremeter can measure directly, circumferential strain ε_c and radial stress P at the cavity wall, this solution can be written as:

$$\varepsilon_c = \varepsilon_\theta \left[A \left(\frac{P'}{\sigma_R} \right)^{\boldsymbol{Y}} + B \left(\frac{P'}{\sigma_R} \right) + C \right] \qquad \text{[Equ 5.12]}$$

Carter et al point out the similarity between this solution and that offered by Hughes et al (1977). Using the current notation the solution of Hughes et al can be written:

$$\varepsilon_c = \varepsilon_\theta \left(\frac{P'}{\sigma_R} \right)^{\boldsymbol{Y}} \qquad \text{[Equ 5.13]}$$

The omission of the linear and constant terms in [Equ 5.13] comes about because the earlier solution ignores elastic strain in the plastic region. The attraction of the earlier solution is that plotting cavity strain against radial stress on log scales gives the gradient γ which can used to discover the approximate values of friction angle ϕ and dilation angle ψ, so it is helpful to carry out the Hughes *et al* analysis as a means of providing input parameters for the Carter *et al* solution. The Hughes log-log plot also indicates the influence of cohesion, because the data will plot a strain-softening curve rather than a straight line.

5.5.2 Elastic Strain and non-linear stiffness

In the simple elastic model the cavity strains before yield are given by:

$$\text{Where } P_o < P' < \sigma_R \text{ then } \varepsilon_c = \frac{P - P_o}{2G} \qquad \text{[Equ 5.14]}$$

Then at first yield when $P' = \sigma_R = P_o(1 + \sin\phi)$:

$$\varepsilon_c = \frac{P_o \sin\phi}{2G} \qquad \text{[Equ 5.15]}$$

The non-linear elastic versions of [Equ 5.14] and [Equ 5.15] are:

$$\text{Where } P_o < P' < \sigma_R \text{ then } \varepsilon_c = \left[\frac{P' - P_o}{q_{ref}} \right]^{\frac{1}{h}} \qquad \text{[Equ 5.16]}$$

Then at first yield when $P' = \sigma_R$

$$\varepsilon_c = \left[\left(\frac{P_o}{q_{ref}} \right) \left(\frac{N - 1}{N(2h - 1) + 1} \right) \right]^{\frac{1}{h}} \qquad \text{[Equ 5.17]}$$

The derivation of the non-linear elastic equations is given later. At the end of loading the cavity has a maximum pressure P'_{max} and expansion ε_{max} and the first part of the final unloading is elastic with a non-linear characteristic prior to yield in extension. The elastic circumferential strain is given by:

$$\text{Where } P'_{max} > P' > \sigma_{RU} \text{ then } \varepsilon_c = \varepsilon_{max} - \left[\frac{P'_{max} - P'}{Jq_{ref}} \right]^{1/h} \qquad \text{[Equ 5.18]}$$

Then at first yield when $P'_{max} > P'$ and $P' = \sigma_{RU}$

$$\varepsilon_c = \varepsilon_{max} - \left[\left(\frac{P'_{max}}{Jq_{ref}}\right)\left(\frac{N^2-1}{N(2h-1)+N^2}\right)\right]^{1/h} \qquad \text{[Equ 5.19]}$$

The explanation of the terms Q_{ref} and h and J is now presented, based on the methodology of Bolton and Whittle (1999). This solution uses a power law to describe the development of shear stress with strain for strains below the elastic/plastic threshold:

$$\tau = q_{ss}\gamma^h \qquad \text{[Equ 5.20]}$$

The co-efficient and exponent of the power law in [Equ 5.20] can be derived from plotting reloading data from unload/reload cycles. The origins for the data are the loop turnaround points. However, for the purposes of curve fitting, the trend of radial stress versus cavity strain is required. This is not shear modulus, where the data would be shear stress plotted against shear strain. Figure 5.2 is an example (not from a test on this contract).

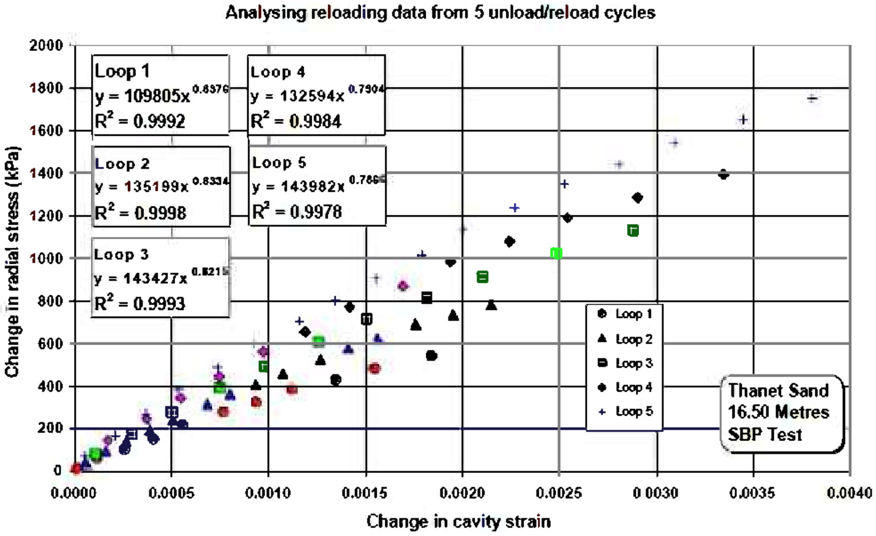


Figure 5.2 Plotting stiffness curves (not from this contract)

It is easy to manipulate the trends in Figure 5.2 to give shear modulus. Assuming no volumetric strains are being developed whilst the material is deforming elastically, shear strain can be derived by multiplying the cavity strain values by two. Furthermore Bolton & Whittle show that the shear stress coefficient is related to the radial stress coefficient as follows:

$$q_{ss} = hq_{rs} \qquad \text{[Equ 5.21]}$$

and secant shear modulus G_s is

$$G = q_{ss}\gamma^{h-1} \qquad \text{[Equ 5.22]}$$

5.5.3 Manipulating stiffness data for changes in mean effective stress

The stiffness data represented by q_{ref} and h give the stress/strain response of the elastic part of the curve. It is necessary to know the cavity strain at yield when this relationship will cease, given by [Equ 5.17]. Thereafter a single value of shear modulus, at yielding strain, is used implicitly by [Equ 5.12].

When the final unloading commences the shear modulus applicable to this part of the test will also depend on q_{ref} and h with q_{ref} multiplied by a scale factor decided by the increase in the mean effective stress. All that is then required is to know when the elastic unloading stops, and this is given by [Equ 5.19].

The yielding value of shear modulus for [Equ 5.12] is likely to be lower than that from simply taking the slope of the first loop in the test but probably higher than the initial slope of the virgin loading curve, which will be influenced by disturbance.

Bellotti et al (1989) give a procedure for converting modulus at intermediate stress levels to a reference level, the insitu mean effective stress p_o. It is based on the relationship proposed by Janbu (1963) and in terms of the nomenclature used here can be written:

$$q_{ref} = q_{rc}\left(\frac{P_o}{\sigma_{AV}}\right)^d \qquad \text{[Equ 5.23]}$$

Given a value of radial stress at the cavity wall P, the mean effective stress can be calculated as follows:

For unload/reload where $P' > \sigma_R$ then $\sigma_{AV} = (\frac{P - c\cos\phi}{1+\sin\phi})$ [Equ 5.24]

For unload/reload where $P' < \sigma_{RU}$ then $\sigma_{AV} = (\frac{P + c\cos\phi}{1-\sin\phi})$ [Equ 5.25]

These two equations also incorporate the contribution of cohesion, c.

The modulus exponent d is obtained by plotting the mean effective stress against modulus and finding the best fit power law. The best correlation is obtained using q and h together as both are needed to fully describe the shape of the elastic response. Once a value for q_{ref} is obtained it is possible to predict the appropriate 'q' value for any other part of the curve, such as the final unloading, by calculating the mean effective stress for that point and multiplying by the ratio of that stress to the initial stress state. This is the scale factor J in [Equ 5.18] and [Equ 5.19].

5.5.4 Influence of Cohesion

It is straightforward to introduce the influence of cohesion using Caquot's principle. All stresses are raised by $c\cot\phi$,so that [Equ 5.12] now becomes:

$$\varepsilon_c = \varepsilon_\theta[A\left(\frac{P' + c\cot\phi}{\sigma_r + c\cot\phi}\right)^{\boldsymbol{Y}} + B\frac{P' + c\cot\phi}{\sigma_r + c\cot\phi} + C] \qquad \text{[Equ 5.26]}$$

If there is no cohesion then the additional terms are zero and the equations revert to the frictional only form.

5.5.5 Deriving the limit pressure

Despite being a small strain solution it is possible to use the Carter et al solution in its adapted form to discover the limit pressure of an infinitely large expansion. At the limit state the ratio R/r_a of the elastic-plastic boundary to the current cavity size reaches a constant condition, which can be written:

$$\frac{1}{\varepsilon_\theta} = \left[T\left(\frac{R}{r_a}\right)^{1+\alpha} - Z\left(\frac{R}{r_a}\right)^{1-\beta}\right] \qquad \text{[Equ 5.27]}$$

or re-arranged to give:

$$\frac{1}{\varepsilon_\theta} = \left[T\left(\frac{P_l}{\sigma_R}\right)^{\boldsymbol{Y}} - Z\left(\frac{P_l}{\sigma_r}\right)\right] \qquad \text{[Equ 5.28]}$$

where P_l is limit pressure. To apply these results, [Equ 5.18] is used to discover the elastic yield strain ε_R . Now estimate the ratio P_l/σ_R and use [Equ 5.28] within an iterative procedure to modify the guess until the known value of ε_R is obtained. Once the ratio has been identified, multiply it by the yield stress σ_R to obtain the limit pressure. This is effective limit pressure and we add to it the ambient pore water pressure to give the total limit pressure.

5.5.6 Deriving the elastic equations

Assuming the non-linear elastic response of the soil prior to yield can be described by a power law of the form $\tau = q_{ss}\gamma^h$ (after Bolton & Whittle 1999) and assuming that whilst the soil is deforming elastically there are no volumetric strains then it follows that the principal stresses at first yield can be written as:

$$\sigma_r = P_o + \frac{\tau}{h} \qquad \text{[Equ 5.29]}$$

$$\sigma_c = \sigma_r - 2\tau \qquad \text{[Equ 5.30]}$$

Where τ represents the mobilised shear stress at failure. For a perfectly plastic frictional material development of the plastic zone occurs at a constant stress ratio, with the radial stress the major principal stress so at yield

$$\frac{\sigma_r}{\sigma_c} = N = \frac{(1 + sin\phi)}{(1 - sin\phi)} \qquad \text{[Equ 5.31]}$$

Substituting [Equ 5.29] into [Equ 5.30] and the result into [Equ 5.31] leads to:

$$Np_o + \frac{N}{h}\tau - 2N\tau = P_o + \frac{\tau}{h} \qquad \text{[Equ 5.32]}$$

And this can be re-arranged to find τ/h:

$$\frac{\tau}{h} = P_o\left(\frac{(N-1)}{N(2h-1)+1}\right) \qquad \text{[Equ 5.33]}$$

So substituting into [Equ 5.29] gives:

$$\sigma_R = P_o\left(1 + \frac{(N-1)}{N(2h-1)+1}\right) \qquad \text{[Equ 5.34]}$$

Alternatively, using the friction angle ϕ:

$$\sigma_R = P_o\left(1 + \frac{sin\phi}{h(1+sin\phi) - sin\phi}\right) \qquad \text{[Equ 5.35]}$$

The final unloading starts with the radial stress at a maximum P'_{max}. 'Non-linear' yield in extension first occurs at the borehole wall when the radial stress is:

$$\sigma_r = P'_{max} - \frac{2\tau}{h} \qquad \text{[Equ 5.36]}$$

The circumferential stress at yield will be $\sigma_r + 2\tau$ hence:

$$\sigma_c = P'_{max} - \frac{2\tau}{h} + 2\tau \qquad \text{[Equ 5.37]}$$

The mobilised shear stress τ is discovered in a similar way to the elastic loading equations noting that yield in contraction occurs with the circumferential stress being the major principal stress. Radial stress $(2\tau/h)$ for the elastic part of the final unloading is:

$$\frac{2\tau}{h} = \left(\frac{P'_{max}(N-1)}{N-1+h}\right) \qquad \text{[Equ 5.38]}$$

The equivalent to [Equ 5.34] for the final unloading is:

$$\sigma_{RU} = P'_{max}\left[1 - \frac{(N-1)}{(N-1+h)}\right] \qquad \text{[Equ 5.39]}$$

Alternatively, using the friction angle ϕ:

$$\sigma_R = P'_{max}\left(1 - \frac{2sin\phi}{h(1 - sin\phi) + 2sin\phi}\right) \qquad \text{[Equ 5.40]}$$

If $h = 1$, the value for linear elasticity, [Equ 5.34] and [Equ 5.39] revert to the standard equations for yield in a frictional material. Typical values for h in sand like material would be 0.6 – 0.8.

For a c' – phi material the failure does not occur at a constant stress ratio but can be made to seem so if all stresses are raised by $c\ cot\phi$. Thus, [Equ 5.31] becomes:

$$\frac{\sigma_r + ccot\phi}{\sigma_c + ccot\phi} = N \qquad \text{[Equ 5.41]}$$

So failure on first loading occurs when:

$$\sigma_R = \sigma_{ho} + \left[\frac{(\sigma_{ho} + ccot\phi)(N - 1)}{N(2h - 1) + 1}\right] \qquad \text{[Equ 5.42]}$$

Or:

$$\sigma_R = \sigma_{ho} + \left[\frac{(\sigma_{ho} + ccot\phi)sin\phi}{h(1 + sin\phi) - sin\phi}\right] \qquad \text{[Equ 5.43]}$$

If there is no cohesion then [Equ 5.35] and [Equ 5.43] are the same. If the material is linear elastic, $h = 1$ and [Equ 5.42] reverts to the familiar Mohr-Coulomb expression for first yield. Similarly, the expression for first yield in unloading in a c'-phi material is obtained by taking equation [Equ 5.36] and [Equ 5.37] and using the argument that the failure stress ratio is given by:

$$\frac{\sigma_c + ccot\phi}{\sigma_r + ccot\phi} = N \qquad \text{[Equ 5.44]}$$

This leads to the following expression for the yielding stress in unloading:

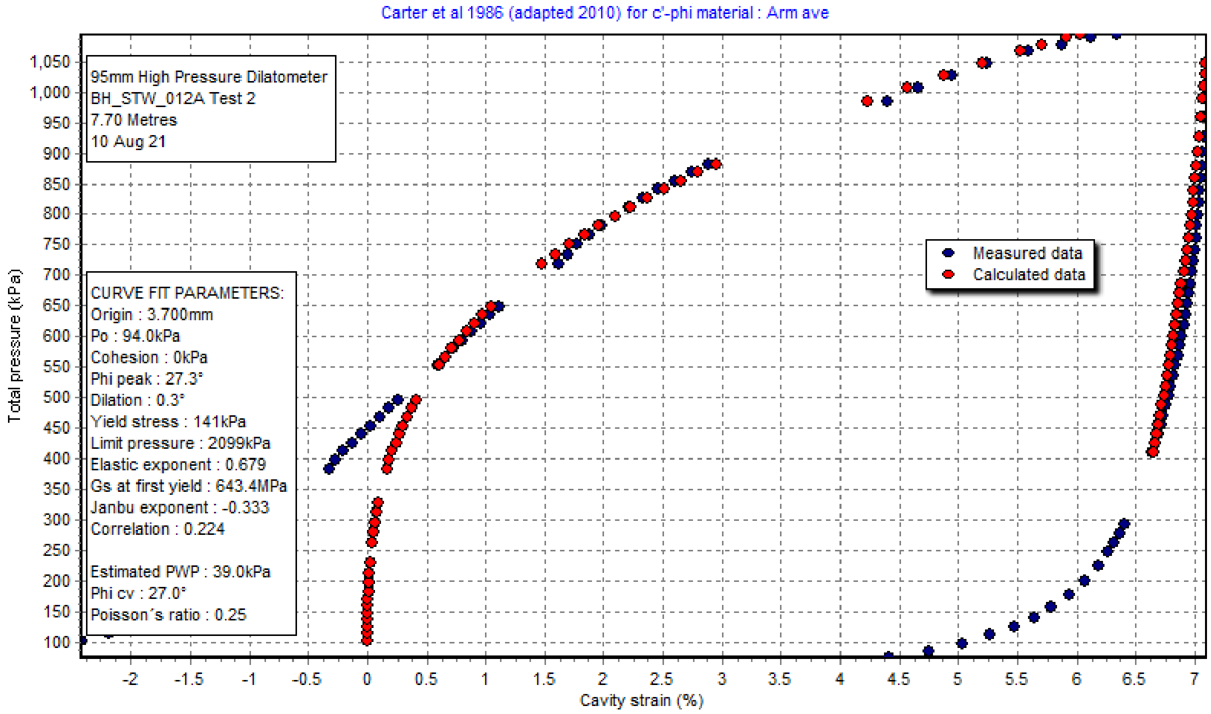
$$\sigma_{RU} = P'_{max} - \left(\frac{(P'_{max} + ccot\phi)(\mathrm{N} - 1)}{(N - 1 + h)}\right) \qquad \text{[Equ 5.45]}$$

Or:

$$\sigma_{RU} = P'_{max} - \left(\frac{(P'_{max} + ccot\phi)2sin\phi}{h(1 - sin\phi) + 2sin\phi}\right) \qquad \text{[Equ 5.46]}$$

5.5.7 Example

A typical result of the curve fitting method applied to a test is given in Figure 5.3. This particular test shows some cohesion. The elastic range on the final unloading is predicted reasonably well, although this is not always the case. The list of parameters in the top left hand corner includes the Janbu exponent of how stiffness varies with stress level at yield strain.



95mm High Pressure Dilatometer
BH_STW_012A Test 2
7.70 Metres
10 Aug 21

CURVE FIT PARAMETERS:
Origin : 3.700mm
Po : 94.0kPa
Cohesion : 0kPa
Phi peak : 27.3°
Dilation : 0.3°
Yield stress : 141kPa
Limit pressure : 2099kPa
Elastic exponent : 0.679
Gs at first yield : 643.4MPa
Janbu exponent : -0.333
Correlation : 0.224

Estimated PWP : 39.0kPa
Phi cv : 27.0°
Poisson's ratio : 0.25

Figure 5.3 Drained test, curve fitting example, some cohesion

6 DERIVING OVER CONSOLIDATION RATIO FROM PRESSUREMETER DATA

6.1 Notation

Λ	Plastic volumetric strain ratio and for most clays is ≈ 0.8
β	Exponent of non-linearity
C_u	Undrained shear strength
I_p	Plasticity index
m	Exponent
M	The frictional coefficient equal to $6\sin\phi\,(3-\sin\phi)$ and is ≈ 1 for typical values of ϕ.
nc	Normally consolidated
P'_y	Maximum past effective stress
P'_f	Effective yield stress
P'_a	Effective overburden stress
R_p	Over consolidation ratio
r	Spacing ratio between equivalent points on the isotropic consolidation line and critical state line and is ≈ 2
σ'_{vo}	Effective insitu vertical stress (overburden stress)

6.2 Overview

Soil is over consolidated when its current state of stress is less than the maximum stress it experienced in the past. There are a number of ratios that could be called the over consolidation ratio (OCR) but the particular one described here is R_p where:

$$R_p = \frac{P'_Y}{P'_A}$$ [Equ 6.1]

R_p is the ratio of maximum past effective stress to the current effective stress. For our purposes P'_A is the effective overburden stress and is usually easy to estimate to a suitable accuracy.

6.3 Wroth 1984

Wroth (1984) gives a correlation, using critical state soil mechanics nomenclature, between the undrained shear strength ratio and OCR:

$$\frac{C_u}{\sigma_{vo}} = \frac{M}{2}\left(\frac{R_p}{r}\right)^{\Lambda}$$ [Equ 6.2]

The labelling here is slightly different from the published form, and in particular Wroth takes care to specify that the undrained shear strength and friction angle are triaxial test parameters, not those from plane strain shearing. Nevertheless, in view of the other uncertainties these are minor objections and combining these assumptions leads to the following:

$$R_p = 2\left(\frac{2C_u}{\sigma_{vo}}\right)^{\frac{1}{\Lambda}}$$ [Equ 6.3]

Ladd et al (1977) quote a similar expression using classical soil mechanics terminology, and this can be re-arranged to give the following:

$$R_p = \left[\frac{C_u}{\sigma_{vo}(0.11 + 0.0037 I_p)}\right]^{\frac{1}{m}}$$ [Equ 6.4]

where I_p is plasticity index. Ladd et al (1977) note that the exponent m reduces slightly with increasing OCR and has the range 0.85 to 0.75. Wroth ('84) states that $m = \Lambda$.

Equation 7.4 is related to an earlier empirical formulation offered by Skempton (1957) for natural deposits of clay normally consolidated:

$$\frac{C_u}{\sigma_{vo}} = 0.11 + 0.0037 I_p \qquad \text{[Equ 6.5]}$$

Wroth ('84) also offers the following:

$$R_p^{\Lambda} = \frac{\frac{C_u}{\sigma_{vo}}}{(C_u/\sigma_{vo})_{nc}} \qquad \text{[Equ 6.6]}$$

This normalises the undrained strength ratio and is independent of the frictional coefficient M and the spacing ratio r.

Based on [Equ 6.3] when values for OCR are required it would be reasonable to use the following:

$$R_p = 2(2C_u/\sigma'_{vo})^{5/4} \qquad \text{[Equ 6.7]}$$

APPENDIX E SAMPLE CALCULATION OF A LINE OF DATA

What is described in some detail in this appendix is the steps necessary to convert the raw data output from a High Pressure Dilatometer into engineering units.

In order to convert pressuremeter signals into calibrated data the following steps are taken:

- Zeroing and scaling
- Compression correction
- Membrane correction
- Displacement and average total pressure
- Calculation of pressure outside membrane

Calibrations and raw data

The calibrations for this particular test are presented as follows: -

INSTRUMENT CALIBRATIONS:

	TRANSDUCER CORRECTION				MEMBRANE CORRECTION				COMPRESSION	
	ZERO		SLOPE		ZERO		SLOPE			
ARM 1	-1590.6	mV	113.7	mV/mm	60	kPa	14.4	kPa/mm	7	mm/GPa
ARM 2	-1385.5	mV	112.5	mV/mm	60	kPa	14.4	kPa/mm	-24.2	mm/GPa
ARM 3	-1861.3	mV	120.1	mV/mm	60	kPa	14.4	kPa/mm	11.6	mm/GPa
ARM 4	-1326.7	mV	112.5	mV/mm	60	kPa	14.4	kPa/mm	5.1	mm/GPa
ARM 5	-1880.6	mV	105.8	mV/mm	60	kPa	14.4	kPa/mm	7.4	mm/GPa
ARM 6	-2343.8	mV	109.5	mV/mm	60	kPa	14.4	kPa/mm	5.6	mm/GPa
TPC A	-61.9	mV	68.5	mV/MPa						
TPC B	49.2	mV	77.9	mV/MPa						

The line of raw data reads from left to right as follows. The units are volts: -

LINE	TPC A	ARM 1	ARM 2	ARM 3	ARM 4	ARM 5	ARM 6	TPC B	SIN	COS
204	0.5531	-1.3697	-1.1102	-1.3910	-0.8961	-1.4996	-2.0560	0.7717	-1.0710	-0.5917

Zeroing and scaling

The raw data is in units of volts and needs to be corrected for zero offsets and scaled using the sensitivities quoted in the calibration data.

The first operation is to deduct the zero offsets. These are the figures found in the first column of the calibration information but quoted here in volts. The columns for Sin and Cos disappear at this stage, as they are not transferred to the calibrated data file:

	TPC A	ARM 1	ARM 2	ARM 3	ARM 4	ARM 5	ARM 6	TPC B	
Output	0.5531	-1.3697	-1.1102	-1.3910	-0.8961	-1.4996	-2.0560	0.7717	
Zero	-0.0619	-1.5906	-1.3855	-1.8613	-1.3267	-1.8806	-2.3438	0.0492	
Result	0.6150	0.2209	0.2753	0.4703	0.4306	0.3810	0.2878	0.7225	[1]

This result [1] can now be scaled. The information for this is found in the second column of calibration data and is expressed as millivolts per millimetre to calculate displacement, and as millivolts per megaPascal to calculate pressure. As before, the results of the calculations are quoted in volts:

	TPC A	ARM 1	ARM 2	ARM 3	ARM 4	ARM 5	ARM 6	TPC B	
From [1]	0.6150	0.2209	0.2753	0.4703	0.4306	0.3810	0.2878	0.7225	
Slope	0.0685	0.1137	0.1125	0.1201	0.1125	0.1058	0.1095	0.0779	
Result	8.9781	1.9428	2.4471	3.9159	3.8276	3.6011	2.6283	9.2747	[2]
Resulting units	(MPa)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(MPa)	

At this point in the procedure, a choice has to be made about which total pressure cell or combination of cells to use in producing the calibrated data. The difference between the cells is because cell A is read at the beginning of a data scan and cell B at the end. The time taken to make the scan allows some pressure change to occur in the probe. In this example the average of cells A and B are used: $(8.9782 + 9.2747)/2 = 9.1264 MPa$.

Compression Correction

The data is now in engineering units which reflect what is taking place inside the membrane. The remaining corrections are introduced to give a better representation of what is taking place at the point where the membrane bears on the borehole wall.

The displacement data is adjusted for the instrument displacements due to the pressure being applied to it. This is expressed as a linear movement in millimetres per GigaPascal of pressure being applied, and is found in the 5th column of the calibration details:

	ARM 1	ARM 2	ARM 3	ARM 4	ARM 5	ARM 6	
Correction Factor (mm/GPa)	7.0	-24.2	11.6	5.1	7.4	5.6	column 5
Internal Pressure (MPa)	9.1264	9.1264	9.1264	9.1264	9.1264	9.1264	
Adjustment: (correction factor *[2])/1000	0.0639	-0.2209	0.1059	0.0465	0.0675	0.0511	[3]
Internal Displacement (mm)	1.9428	2.4471	3.9159	3.8276	3.6011	2.6283	[2]
Corrected Displacement (mm)	1.8789	2.6680	3.8100	3.7810	3.5336	2.5772	[4]

Membrane Correction

The displacement data calculated so far is the movement measured by the arms to the inside of the membrane. The figures quoted in the calibrated data listings are the movement of the outside of the protective sheath. This is derived from the internal movement by assuming that the cross-section area of the membrane is a constant. A full explanation of this and the derivation of the equation used is discussed in the appendix on calibration technique.

The equation is $$E = t - b + \sqrt{[(b - t)^2 + d(2a + d)]} \qquad [a]$$

Where:

a	is the internal radius of the membrane at rest
b	is the external radius of the membrane at rest
r	is the external radius of the membrane expanded
t	is the thickness of the stainless steel sheath strips
d	is the measured movement of the strain arm
E	is the actual expansion of the membrane

For the pressuremeter used to produce this example:-

$2b$ = 94.0 mm
$2a$ = 81.0 mm
t = 0.5334 mm

Because the membrane can be assumed to have the same thickness at all points on the cross-section the technique employed is to calculate a scale factor from the average displacement.

	ARM 1 mm	ARM 2 mm	ARM 3 mm	ARM 4 mm	ARM 5 mm	ARM 6 mm	
Corrected Displacements	1.8789	2.6680	3.8100	3.7810	3.5336	2.5772	[4]
Average Displacement	3.0415	3.0415	3.0415	3.0415	3.0415	3.0415	[5]
Result of equation [a] using D = [5]	2.6735	2.6735	2.6735	2.6735	2.6735	2.6735	[6]
Scale Factor [6]/[5]	0.8790	0.8790	0.8790	0.8790	0.8790	0.8790	[7]
Apply [7] to [4]	1.6517	2.3452	3.3491	3.3236	3.1061	2.2654	[8]

Displacement and average total pressure

The result, using displacements from [8] and the average total pressure quoted in kPa:

LINE	ARM 1 mm	ARM 2 mm	ARM 3 mm	ARM 4 mm	ARM 5 mm	ARM 6 mm	TPC kPa	
204	1.6517	2.3452	3.3492	3.3236	3.1062	2.2655	9126.4	[9]

In practice the errors introduced by rounding-off calculations may result in small differences in the final figure. This is the line of data seen in the calibrated data file that is passed from the logging program to the analysis program.

Calculation of pressure outside membrane

However, the conversion to data ready for analysis is not yet complete. The column for pressure is the pressure *inside* the membrane. What is required is the pressure on the *outside* of the membrane where it bears against the borehole wall. Before using the calibrated data file, therefore, the analysis program corrects the pressure data for the influence of the membrane, using the data in the calibrations for membrane correction. It is separately calculated for each arm position, although in practice an average correction value tends to be used. The correction figure is the sum of the zero figure (column 3 in the calibrations) plus the increased stiffness with strain (column 4 in calibrations):-

	ARM 1	ARM 2	ARM 3	ARM 4	ARM 5	ARM 6	
From Result [8] (mm)	1.6517	2.3452	3.3491	3.3236	3.1061	2.2654	
Average Displacement (mm)	2.6735	2.6735	2.6735	2.6735	2.6735	2.6735	[10]
Membrane correction slope (kPa/mm)	14.4	14.4	14.4	14.4	14.4	14.4	[11]
Result [10]*[11] (kPa)	38.5	38.5	38.5	38.5	38.5	38.5	[12]
Membrane correction zero (kPa)	60.0	60.0	60.0	60.0	60.0	60.0	
Add zeroes to result [12]	98.5	98.5	98.5	98.5	98.5	98.5	[13]

This is the total membrane correction at each arm position and is now deducted from the total pressure cell readings. In this example because an average membrane correction has been used, the calculation is 9126.4kPa – 98.5kPa giving 9027.9kPa.

When the calibrated data is taken from the Analysis program the format differs from the PRN file produced by the logging program (see D, above). The analysis output gives the average radial displacement of opposing pairs of arms, together with a column of corrected pressure readings for each arm pair, and the uncorrected pressure:

LINE	Arms(1+4)/2 mm	Arms (2+5)/2 mm	Arms (3+6)/2 mm	TPC 1 KPa	TPC 2 KPa	TPC 3 KPa	TPC KPa
204	2.4876	2.7257	2.8073	9027.9	9027.9	9027.9	9126.4

APPENDIX F REFERENCES

BELLOTTI, R., GHIONNA, V., JAMIOLKOWSKI, M., ROBERTSON, P. and PETERSON, R. (1989).
"Interpretation of moduli from self-boring pressuremeter tests in sand". *Géotechnique* Vol.XXXIX, no.2, pp.269-292.

BOLTON M.D. (1986)
“The strength and dilatency of sands.” *Géotechnique* Vol. **36**, No.1, pp 65-78.

BOLTON M.D. and WHITTLE R.W. (1999)
“A non-linear elastic/perfectly plastic analysis for plane strain undrained expansion tests.” *Géotechnique* Vol. **49**, No.1, pp 133-141.

CARTER, .I. P., BOOKER, J. R. & YEUNG, S. K. (1986).
“Cavity expansion in cohesive frictional soils”. *Géotechnique* **36**, No. 3,.pp 349-358

CLARKE, B.G., CARTER, J.P. and WROTH, C.P. (1979).
"In Situ Determination of Consolidation Characteristics of Saturated Clays". *Design Parameters in Geotechnical Engineering*, VII ECSMFE, Brighton, Vol. 2, pp 207- 211

ERVIN, M.C., BURMAN, B.C. and HUGHES, J.M.O.(1980).
"The use of a high capacity pressuremeter for design of foundations in medium strength rock". Int. Conf. on Structural Foundations on Rock, Sydney.

FAHEY, M. and JEWELL, R.J. (1990)
Effect of Pressuremeter Compliance on Measurement of Shear Modulus. Paper submitted to The Third International Symposium on Pressuremeters, Oxford University 2 - 6 April 1990

GHIONNA, V., JAMIOLKOWSKI, M., LANCELLOTTA, R. & MANASSERO, M (1989).
Limit Pressure of Pressuremeter Tests. Proc. of 12th ICSMFE, Rio De Janeiro.

GIBSON, R.E. and ANDERSON, W.F. (1961)
In situ measurement of soil properties with the pressuremeter, Civil Engineering and Public Works Review, Vol. 56, No. 658 May pp 615-618 .

HAWKINS, P.G., MAIR, R.J., MATHIESON, W.G. and MUIR WOOD, D. (1990)
Pressuremeter measurement of total horizontal stress in stiff clay, Proc. ISP.3 Oxford.

HOULSBY, G., CLARKE, B. and WROTH, C.P. (1986).
"Analysis of the unloading of a pressuremeter in sand". Proc. of the 2nd International Symposium on The Pressuremeter and its Marine Applications pp 245-262.

HUGHES, J.M.O. (1973).
An instrument for in situ measurement in soft clays, PhD Thesis, University of Cambridge

HUGHES,J.M.O., ERVIN, M.C. (1980)
Development of a High Pressure Pressuremeter for determining the engineering properties of soft to medium strength rocks.Proc. 3rd Aus.-NZ Conf. Geomechanics, Brisbane, pp.292-296.

HUGHES, J.M.O., WROTH, C.P. and WINDLE, D. (1977)
Pressuremeter tests in sands, *Géotechnique* **4**, pp 455-477

JARDINE, R.J. (1991)
Discussing ‘Strain-dependent moduli and pressuremeter tests’ .
Géotechnique **41***,* No. 4.,pp 621-624

JARDINE, R.J. (1992)
Nonlinear stiffness parameters from undrained pressuremeter tests.
Can. Geotech. **29**, pp 436-447

JANBU, N. (1979).

Soil compressibility as measured in the oedometer. International Journal of Rock Mechanics and Mining Sciences & Geomechanics Abstracts, 16(2), 28

JEFFERIES, M.G. (1988)
Determination of horizontal geostatic stress in clay with self-bored pressuremeter.
Can. Geotech. **25** (3), pp 559-573

LADANYI, B. (1972)
An engineering theory of creep of frozen soils. *Can. Geotech*. **9**: pp 63-80.

LADANYI, B. & JOHNSTON, G.H. (1973).
Evaluation of in situ creep properties of frozen soils with the pressuremeter. *Proc. 2ndInt. Conf on Permafrost,* Yakutsk: pp 310-318.

MARSLAND, A. and RANDOLPH, M.F. (l977).
Comparison of the Results from Pressuremeter Tests and Large Insitu Plate Tests in London Clay. *Géotechnique* **27** No. 2 pp 2l7-243.

MAIR, R.J. and WOOD, D.M(1987)
Pressuremeter Testing. Methods and Interpretation. Construction Industry Research and Information Association Project 335. Publ. Butterworths, London. ISBN 0-408-02434-8

MANASSERO, M. (1989)
Stress-Strain Relationships from Drained Self Boring Pressuremeter Tests in Sand. *Géotechnique* **39**, No.2.

MAYNE, P.W., and KULHAWY, F.H., (1982)
K_o-OCR Relationships in Soil, Journal of the Geotechnical Engineering Division, ASCE, Vol 108, No. GT6, June, pp. 851-872.

MUIR WOOD, D. (1990)
Strain dependent soil moduli and pressuremeter tests. *Géotechnique*, **40**, pp 509-512.

NEWMAN, R.L., CHAPMAN, T.J.P. and SIMPSON, B. (1991)
"Evaluation of pile behaviour from pressuremeter tests". *Proc. Xth European Conference on Soil Mechanics and Foundation Engineering, Florence*, May 1991

OZTOPRAK, S. & BOLTON, M. D. (2013)
Stiffness of sands through a laboratory test database. *Géotechnique* **63**, No. 1, pp 54–70

PALMER, A.C. (1972)
Undrained plane-strain expansion of a cylindrical cavity in clay: a simple interpretation of the pressuremeter test, *Géotechnique* **22** No. 3 pp 45l-457.

RANDOLPH, M.F. and WROTH, C.P. (1978)
"An analytical solution for the consolidation around a driven pile". *Int. J. Numer. Anal. Methods in Geomech.* **3**, pp 217-229

ROBERTSON, P.K. and HUGHES, J.M.O. (1985)
"Determination of Properties of Sand from Self-Boring Pressuremeter Tests ". The Pressuremeter and Its Marine Applications, Second International Symposium.

ROWE, P.W. (1962)
"The Stress Dilatancy Relation for Static Equilibrium of an Assembly of Particles in Contact". Proceedings of the Royal Society. Vol. 269, Series A, pp 500-527.

SAGASETA, C. and HOULSBY, G.T (1988)
Elastic-plastic incompressible flow around an infinite cone. Penetration Testing 1988, ISOPT-1, De Ruiter (ed.), Balkema Rotterdam, pp 933-938.

SKEMPTON, A.W. (1957)
Discussion: Further data on the c/p ratio in normally consolidated clays. *Proc Inst. Civ. Eng.,* **7**, pp 305 - 307

WHITTLE, R.W. and DALTON, J.C.P. (1990)
Discussing 'Experience with the self boring rock pressuremeter'. *Ground Engineering*, Jan/Feb, pp 30-32.

WHITTLE R.W (1993)
Discussing 'The assessment of in situ stress and stiffness at seven overconsolidated clay and weak rock sites'. *Ground Engineering*, Sept 1993, pp 19-20.

WHITTLE R.W (1999)
Using non-linear elasticity to obtain the engineering properties of clay.
Ground Engineering, May, vol. 32, no.5, pp 30-34.

WHITTLE R.W and LIU LIAN (2013)
A method for describing the stress and strain dependency of stiffness in sand. Proc. ISP6, Paris, 2013

WITHERS, N.J., HOWIE, J., HUGHES, J.M.O. and ROBERTSON, P.K. (1989)
Performance and Analysis of Cone Pressuremeter Tests in Sands. Géotechnique 39, No. 3, pp 433-454.

WROTH, C.P. (1984)
"The Interpretation of In Situ Soil Tests". Twenty Fourth Rankine Lecture, *Géotechnique* **34**, No. 4, pp 449-489

Cambridge Waste Water Treatment Plant Relocation Project

GROUND INVESTIGATION

Results of pressuremeter tests carried out by Cambridge Insitu Ltd

Client reference	**TE8364**
Contractor	**Soil Engineering**
Cambridge Insitu reference:	**CIR1506/21**
Report date:	**November 2021**
Version:	**1.0**

VOLUME 2 of 2

Data for tests in all boreholes and all calibrations

CAMBRIDGE INSITU LTD
Little Eversden
Cambridge
ENGLAND
CB23 1HE

Tel: +44 1223 262361
Email: cam@cambridge-insitu.com
HTTP: www.cambridge-insitu.com

Volume 2 Details of work carried out

Table 1.1 below details the pressuremeter testing carried out in the boreholes. Table 1.2 provides background information about the tests and probe used. Table 1.3 provides borehole information Notes on the work carried out and tables of information are provided below:

Table 1.1 Tests included

Test	Internal ref.	Depth (mBGL)	Date	Max Pressure (kPa)	Material	Remarks
BH_STW_006 Test 1	B006T01	2.70	05/08/2021	1143	Structureless Chalk	
BH_STW_006 Test 2	B006T02	N/A	05/08/2021	N/A	Structureless Chalk	SBPM hit obstruction. Drilling aborted
BH_STW_006 Test 3	B006T03	8.00	05/08/2021	1041	Structureless Chalk	
BH_STW_011A Test 1	B011T01	3.80	31/08/2021	1365	Structureless Chalk	
BH_STW_011A Test 2	B011T02	N/A	01/09/2021	N/A	Gault Clay	SBPM would not advance. Drilling aborted.
BH_STW_011A Test 3	B011T03	13.50	01/09/2021	1660	Gault Clay	
BH_STW_011A Test 4	B011T04	21.70	02/09/2021	1768	Gault Clay	
BH_STW_012a Test 1	B012T01	4.20	10/08/2021	2290	Structureless Chalk	
BH_STW_012a Test 2	B012T02	7.70	10/08/2021	1088	Structureless Chalk	
BH_STW_012a Test 3	B012T03	13.20	11/08/2021	940	Gault Clay	Highly anisotropic expansion, only single loop possible on loading curve
BH STW 019A Test 1	B019T01	2.90	18/08/2021	1663	Structureless Chalk	
BH_STW_019A Test 2	B019T02	6.50	18/08/2021	1124	Structureless Chalk	Electrical short at 170kPa. This was repaired and the test resumed.
BH_STW_019A Test 3	B019T03	9.40	18/08/2021	1562	Structureless Chalk	
BH_STW_020 Test 1	B020T01	4.50	06/09/2021	702	Structureless Chalk	
BH_STW_020 Test 2	B020T02	8.50	06/09/2021	2506	Chalk	
BH_STW_020 Test 3	B020T03	2.20	07/09/2021	1637	Gault Clay	
BH_STW_021 Test 1	B021T01	5.45	16/08/2021	1110	Structureless Chalk	
BH_STW_021 Test 2	B021T02	9.20	16/08/2021	1452	Structureless Chalk	
BH_STW_021 Test 3	B021T03	12.00	16/08/2021	1511	Chalk	
BH_TUN_001PM Test 1	B001T01	12.50	13/09/2021	1142	Gault Clay	
BH_TUN_001PM Test 2	B001T02	18.50	14/09/2021	1613	Gault Clay	
BH_TUN_006PM Test 1	B6PMT01	12.20	29/09/2021	154	Gault Clay	Pocket oversized
BH_TUN_006PM Test 2	B6PMT02	12.90	29/09/2021	1132	Gault Clay	
BH_TUN_006PM Test 3	B6PMT03	18.50	29/09/2021	1382	Gault Clay	
BH_TUN_011PM Test 1	B11PMT01	6.00	13/10/2021	701	Gault Clay	
BH_TUN_011PM Test 2	B11PMT02	24.95	14/10/2021	1761	Gault Clay	
BH_TUN_018PM Test 1	B018T01	27.00	01/10/2021	1948	Gault Clay	Burst at 2MPa
BH_TUN_018PM Test 2	B018T02	n/a	04/10/2021	n/a	Gault Clay	SBPM refused, test aborted
BH_TUN_018PM Test 3	B018T03	28.70	04/10/2021	481	Gault Clay	Pocket oversized
BH_TUN_018PM Test 4	B018T04	30.40	04/10/2021	2634	Gault Clay	
BH_TUN_018PM Test 5	B018T05	32.10	05/10/2021	2916	Gault Clay	

Notes:

1. **Depth** is given as metres below ground level to the centre of the measuring section. The SBP membrane is 0.46 long, hence the affected zone is ± 0.23m of the quoted test centre. The HPD membrane is 0.60 long, hence the affected zone is ± 0.30m of the quoted test centre.
2. **Max Pressure** is the maximum pressure reached by the end of loading and may be used as a rough indication of how the material strength is changing with depth.

Table 1.2 Probe details and calibrations

Test	Operator	Probe	Transducer calibration	Membrane stiffness	System compliance
BH_STW_006 Test 1	EJS/SB	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_STW_006 Test 2	EJS/SB	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_STW_006 Test 3	EJS/SB	Wally (HPD)	13/07/2021	E0907T21	E0907T21
BH_STW_011A Test 1	EJS	Wally (HPD)	13/07/2021	E0907T21	E0907T21
BH_STW_011A Test 2	EJS	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_STW_011A Test 3	EJS	Wally (HPD)	13/07/2021	E0907T21	E0907T21
BH_STW_011A Test 4	EJS	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_STW_012a Test 1	EJS	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_STW_012a Test 2	EJS	Wally (HPD)	13/07/2021	E0907T21	E0907T21
BH_STW_012a Test 3	EJS	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_STW_019A Test 1	EJS	Wally (HPD)	13/07/2021	E0907T21	E0907T21
BH_STW_019A Test 2	EJS	Wally (HPD)	13/07/2021	E0907T21	E0907T21
BH_STW_019A Test 3	EJS	Wally (HPD)	13/07/2021	E0907T21	E0907T21
BH_STW_020 Test 1	EJS	Wally (HPD)	13/07/2021	E0907T21	E0907T21
BH_STW_020 Test 2	EJS	Wally (HPD)	13/07/2021	E0907T21	E0907T21
BH_STW_020 Test 3	EJS	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_STW_021 Test 1	EJS	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_STW_021 Test 2	EJS	Wally (HPD)	13/07/2021	E0907T21	E0907T21
BH_STW_021 Test 3	EJS	Wally (HPD)	13/07/2021	E0907T21	E0907T21
BH_TUN_001PM Test 1	EJS	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_TUN_001PM Test 2	EJS	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_TUN_006PM Test 1	EJS	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_TUN_006PM Test 2	EJS	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_TUN_006PM Test 3	EJS	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_TUN_011PM Test 1	EJS	Shula (SBP)	19/07/2021	E0610T22	E0610T21
BH_TUN_011PM Test 2	EJS	Shula (SBP)	19/07/2021	E0610T22	E0610T21
BH_TUN_018PM Test 1	EJS	Shula (SBP)	19/07/2021	E1907T22	E1907T21
BH_TUN_018PM Test 2	EJS	Dougal (SBP)	13/07/2021	E0309T22	E0309T21
BH_TUN_018PM Test 3	EJS	Wally (HPD)	13/07/2021	E0907T21	E0907T21
BH_TUN_018PM Test 4	EJS	Wally (HPD)	13/07/2021	E0907T21	E0907T21
BH_TUN_018PM Test 5	EJS	Wally (HPD)	13/07/2021	E0907T21	E0907T21

Notes:

1. **Probe – Three probes were on this project, a six arm self bored pressuremeter known as 'Shula', a three arm self bored pressuremeter known as 'Dougal', a High Pressure Dilatometer known as 'Wally'.**
2. **Operator – EJS is Ewan Stockwell and SB is Simon Baxter, both employees of Cambridge Insitu.**
3. **For the probes there is a transducer calibration referenced by date. There are also separate calibrations for the membrane and system compliance.**

Table 1.3 Borehole location information

Borehole	Easting	Northing	Elevation mAOD	Groundwater level: mBGL
BH_STW_006	549502.5	261260.1	9.39	3.75
BH_STW_011A	549493.8	261023.6	10.17	3.75
BH_STW_012A	549712.9	261183.3	8.12	3.75
BH_STW_019A	549790.4	260872.9	9.42	3.75
BH_STW_020	549898.8	260975.8	8.13	3.75
BH_STW_021	549642.7	260664.3	10.98	3.75
BH_TUN_001PM	547214.1	261518.8	7.13	1.25
BH_TUN_006PM	547838.5	261494.8	6.59	4.50
BH_TUN_011PM	548428.8	261304.0	6.57	1.75
BH_TUN_018PM	549441.5	261003.2	10.24	4.00

Notes:

1. The ground level and coordinates of the borehole have been provided by Soil Engineering.
2. The ground water level is based on ground water monitoring information and provided by Soil Engineering.

The remainder of this volume is laid out as follows:

- There is a plot of all the field curves on the same axes.
- Thereafter the individual results and plots showing the derivation of the results are given. For each test the pages are in approximately the following order:

Plots from the analysis program WINSITU:

1. A Results Summary Sheet
2. A plot of total pressure against cavity strain, using the output from the average of all displacement followers.
3. A plot of total pressure against the initial part of the expansion, showing the pressure at which, the cavity begins to expand and identifying any 'witness' to the cavity reference pressure Po. Self bored tests only.
4. A plot of excess pore water pressure against total pressure. If the data allow, the total pressure at which excess pore water pressure changes its gradient is identified, hence giving an estimate of the cavity reference pressure Po. Self bored tests only.
5. A plot of Total pressure/Radial displacement showing the slope identified as the initial shear modulus, the apparent yield stress and the cavity reference pressure inferred from this yield stress (Marsland & Randolph 1977, Hawkins 1990).
6. For tests in granular soil, a log-log plot of current cavity strain against effective radial stress, using loading data, quoting the gradient (Hughes et al, 1977). This can be used to derive a peak friction angle and dilation angle if the constant volume friction angle is known (or estimated).
7. For tests in granular soil, a log-log plot of current cavity strain against effective radial stress, using contraction data if available, quoting the gradient (Withers et al, 1989). This can be used to derive a peak friction.
8. For tests in cohesive soil, a semi-log plot of total pressure against current shear strain at the cavity wall, quoting the slope and intercept. These give the undrained shear strength (Cu) and limit pressure (Plim), respectively (Gibson & Anderson 1961, Bolton & Whittle 1999).
9. For tests in cohesive soil, a semi-log plot of total pressure against current shear strain at the cavity wall using contraction data, quoting the slope and the derived undrained shear strength (Cu) (Jefferies, 1988).
10. For tests in cohesive soil, a plot of shear stress against current shear strain at the cavity wall using contraction data (Palmer, 1972).
11. Plots on axes of Radial displacement/Total Pressure showing enlarged views of unload/reload cycles and quoting shear modulus G.
12. Plots on axes of Ln[shear strain]/Ln[radial stress] showing loop reloading paths and quoting the gradient and intercept for each loop.
13. A plot on axes of secant shear modulus/Log[Shear strain] showing the decay of stiffness against strain curves derived from fitting a power law function to reloading data, all cycles. Individual data points obtained from applying Palmer (1972) directly to reloading data are also shown.
14. For undrained tests showing plastic development, a plot on axes of Average Cavity Strain/Total pressure giving the results of curve fitting the field curve with the best set of parameters using a non-linear elastic/perfectly plastic solution (Whittle, 1999).
15. For tests in granular soil, a plot on axes of Average Cavity Strain/Total pressure giving the results of curve fitting the field curve with the best set of parameters using a non-linear elastic/perfectly plastic solution (Carter et al 1986, modified).

Plots taken from the data collection software package WINLOG:

1. On axes of Radial Displacement/Total Pressure showing average displacement.
2. On axes of Radial Displacement/Total Pressure showing all displacement sensors.
3. On axes of Radial Displacement/Total Pressure showing opposing arm pairs.
4. On axes of Radial Displacement/Total Pressure showing the mean trend of even numbered and odd numbered arms.
5. A plot of all the pressure cells against time. Self bored tests only.

Because the information presented here comes from a variety of sources it is not possible to number the pages in a coherent manner, although within a test some pages may be numbered.

Winsitu colour coding

Plots from the analysis program WINSITU use a colour coding scheme to distinguish between different kinds of data. The options are these:

Data description	Colour
On the loading path	red
On the unloading path	blue
To be ignored	grey
Loop unloading	yellow
Loop reloading	magenta

When a particular plot displays one colour only then this is arbitrary and the colour has no significance. When more than one colour is shown then the meaning is indicated above.

Figure 1 All tests on common axes – BH_STW_006

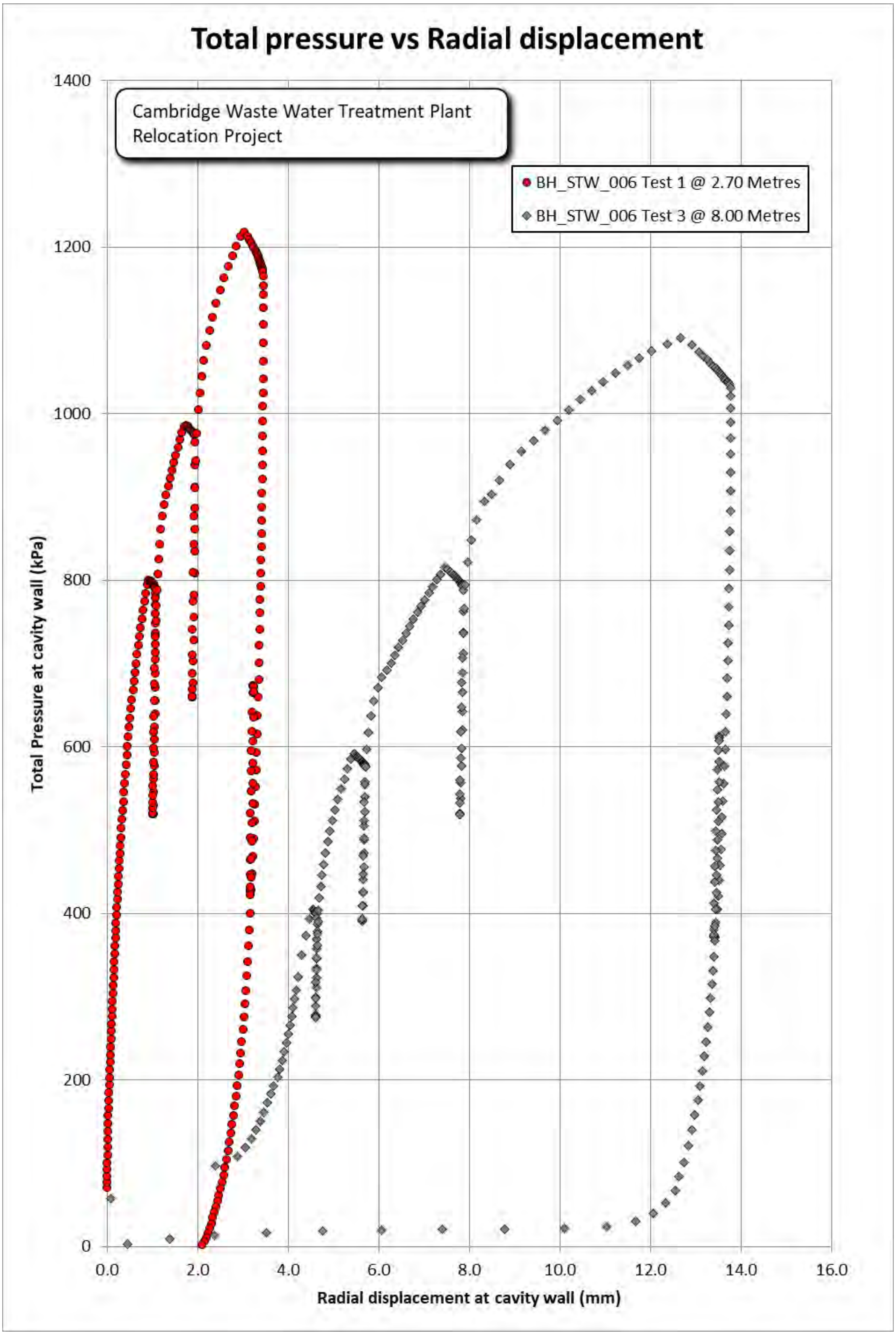


Figure 2 **All tests on common axes – BH_STW_0011A**

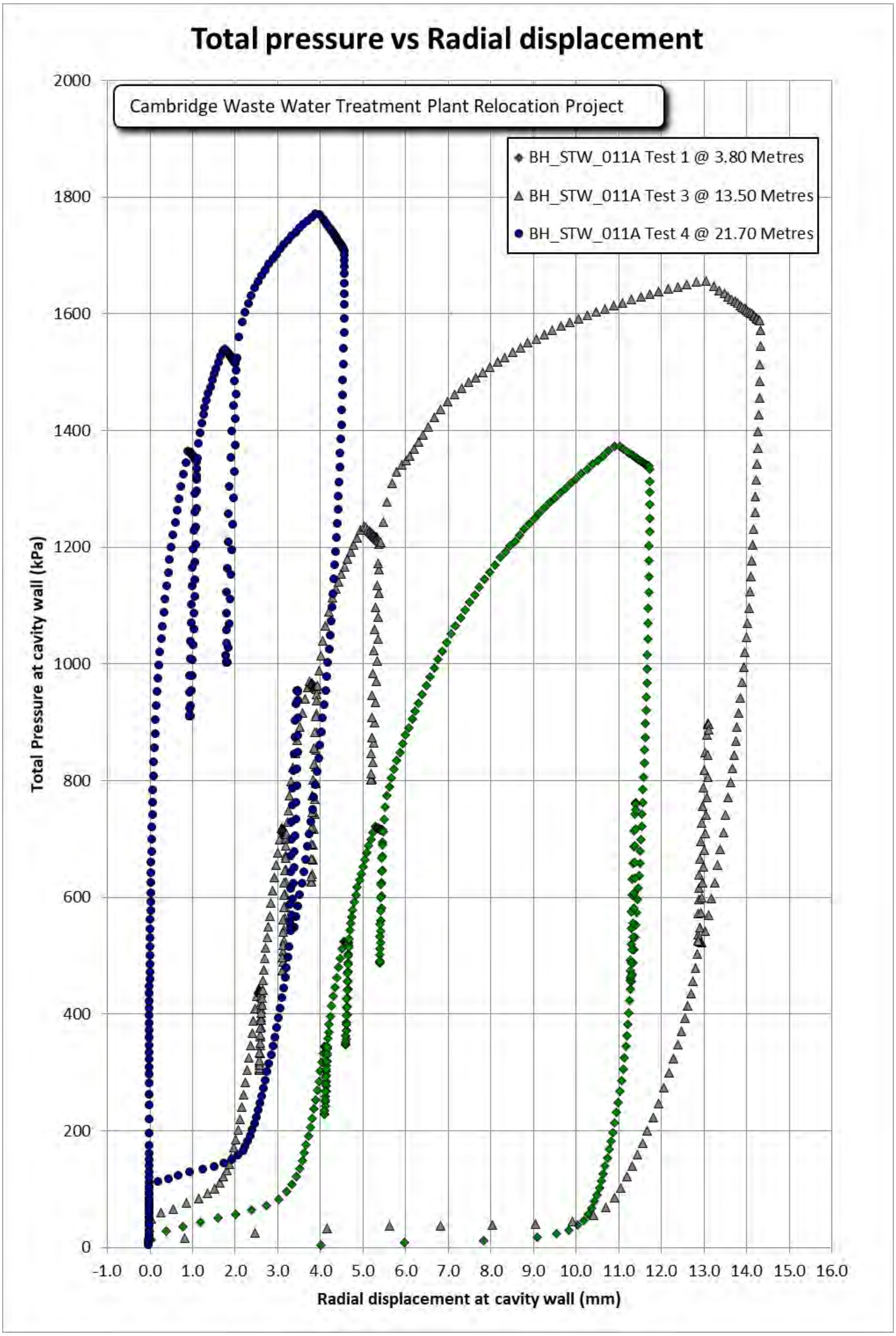


Figure 3 All tests on common axes – BH_STW_0012A

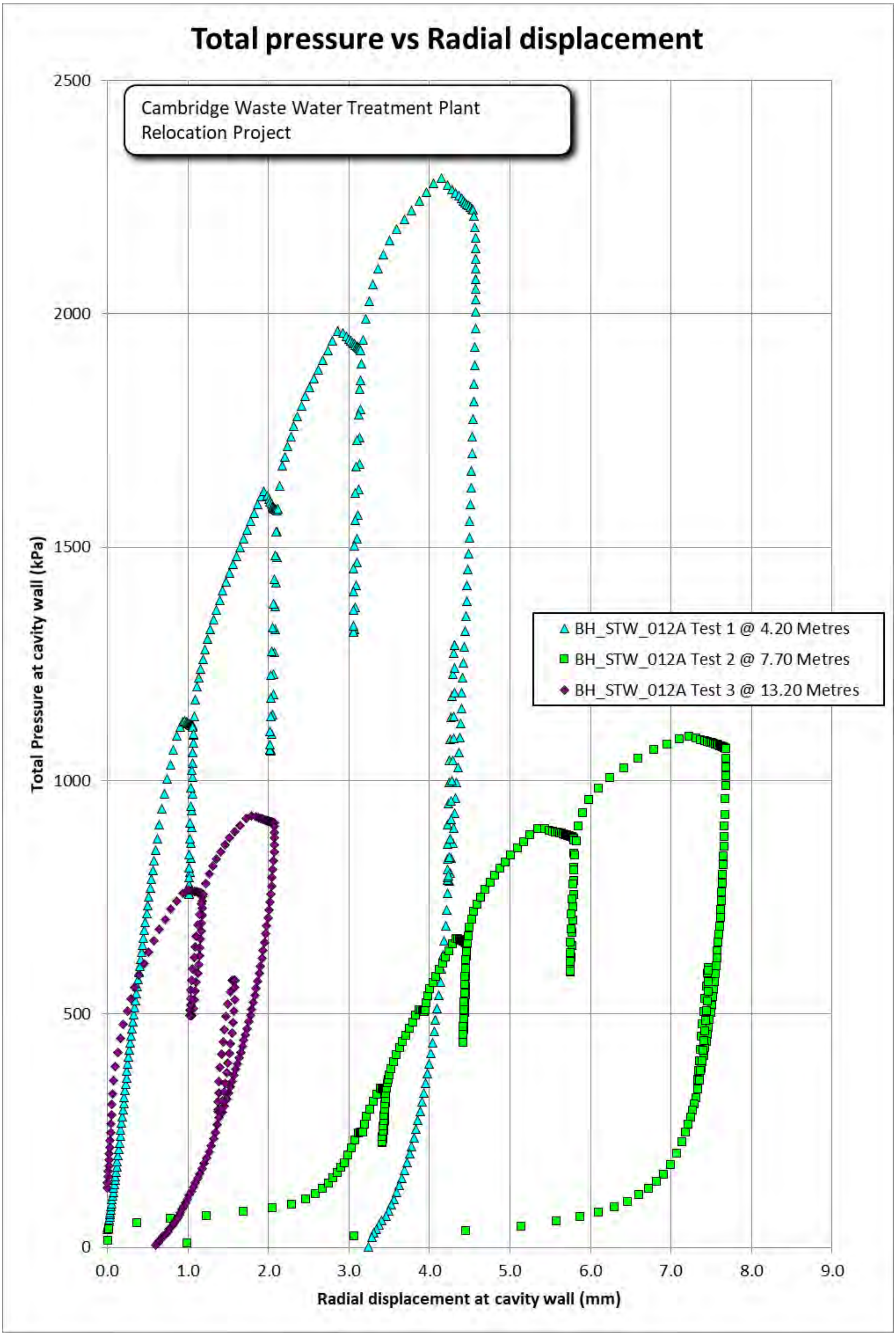


Figure 4 All tests on common axes – BH_STW_0019A

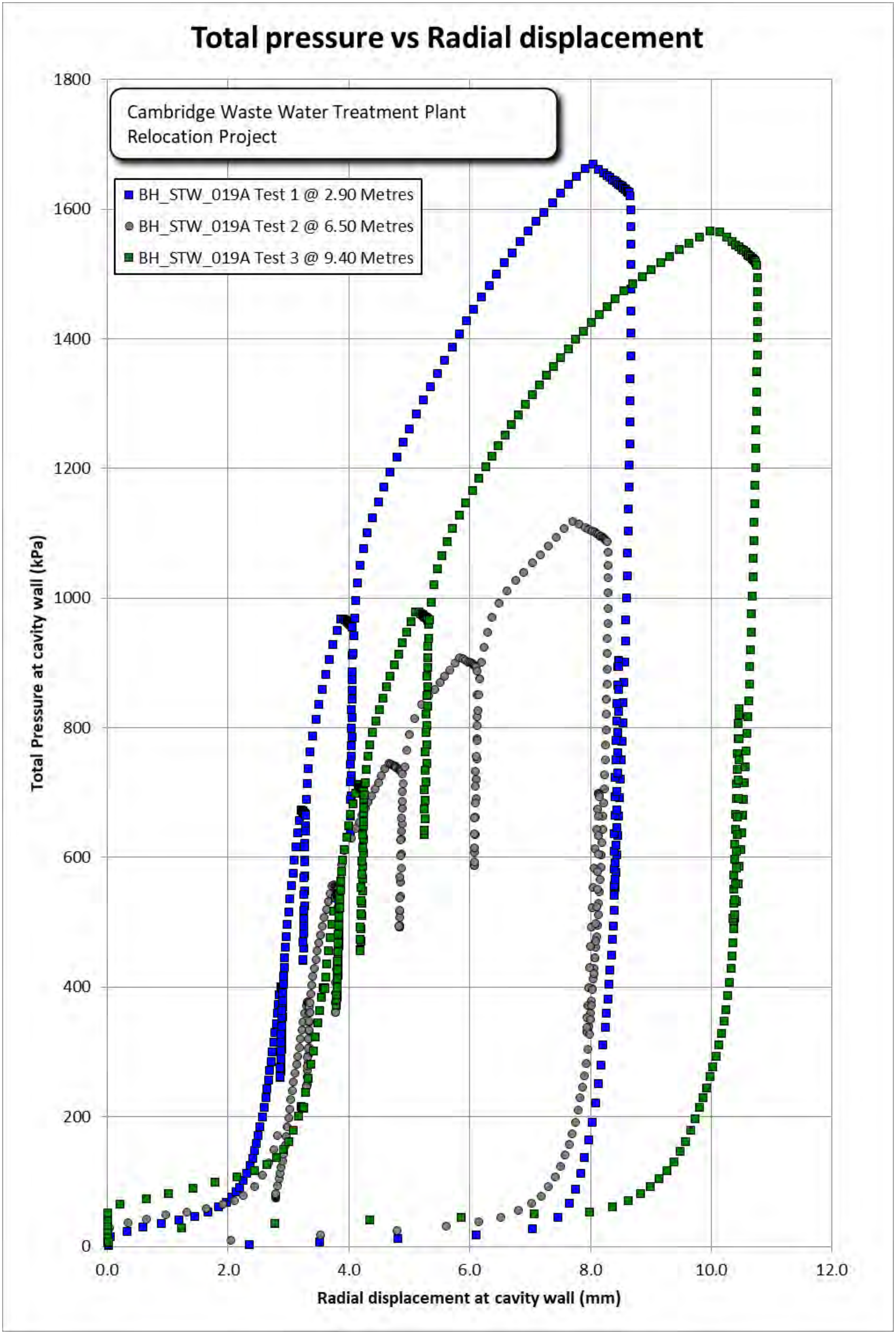


Figure 5 **All tests on common axes – BH_STW_0020**

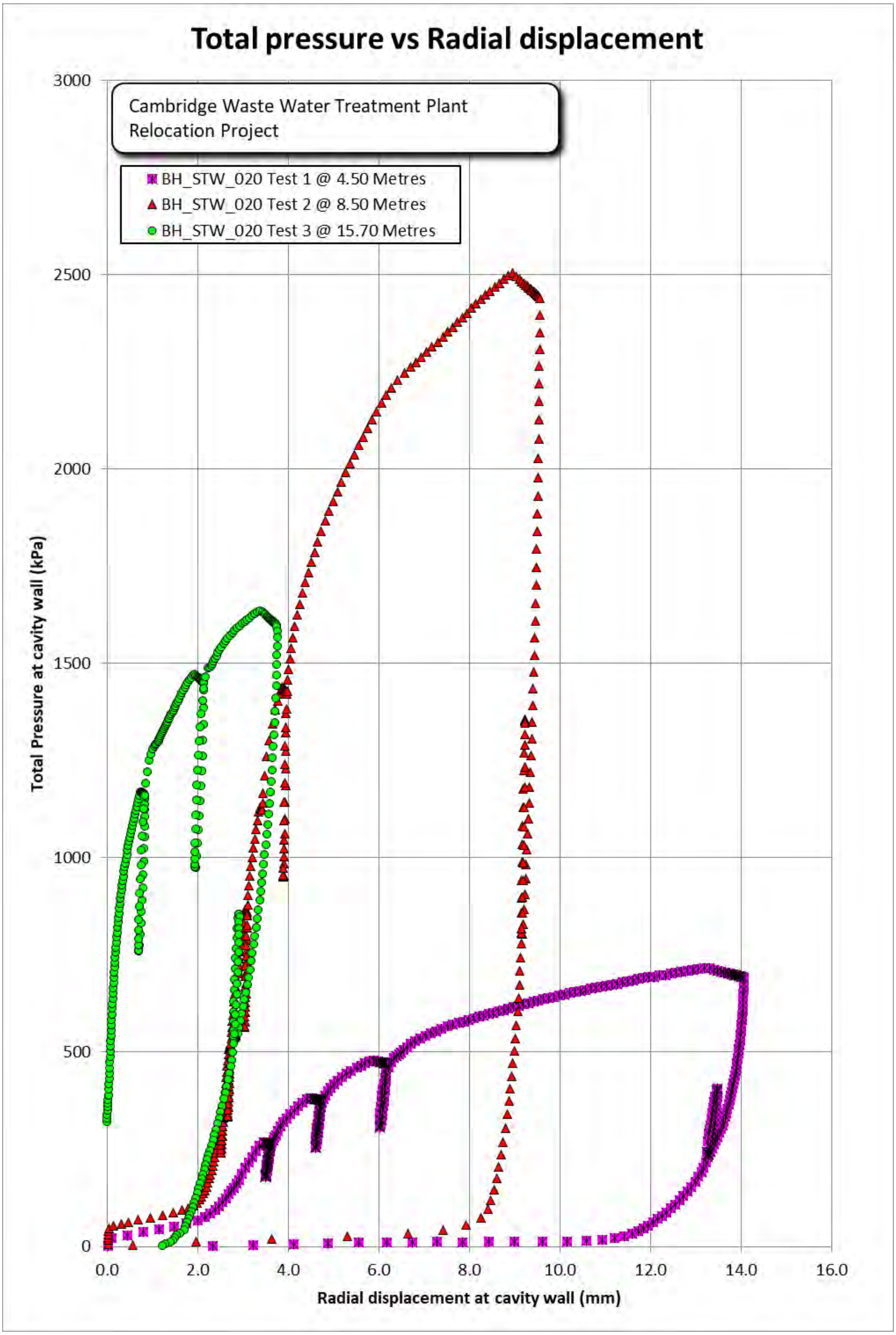


Figure 6 All tests on common axes – BH_STW_0020

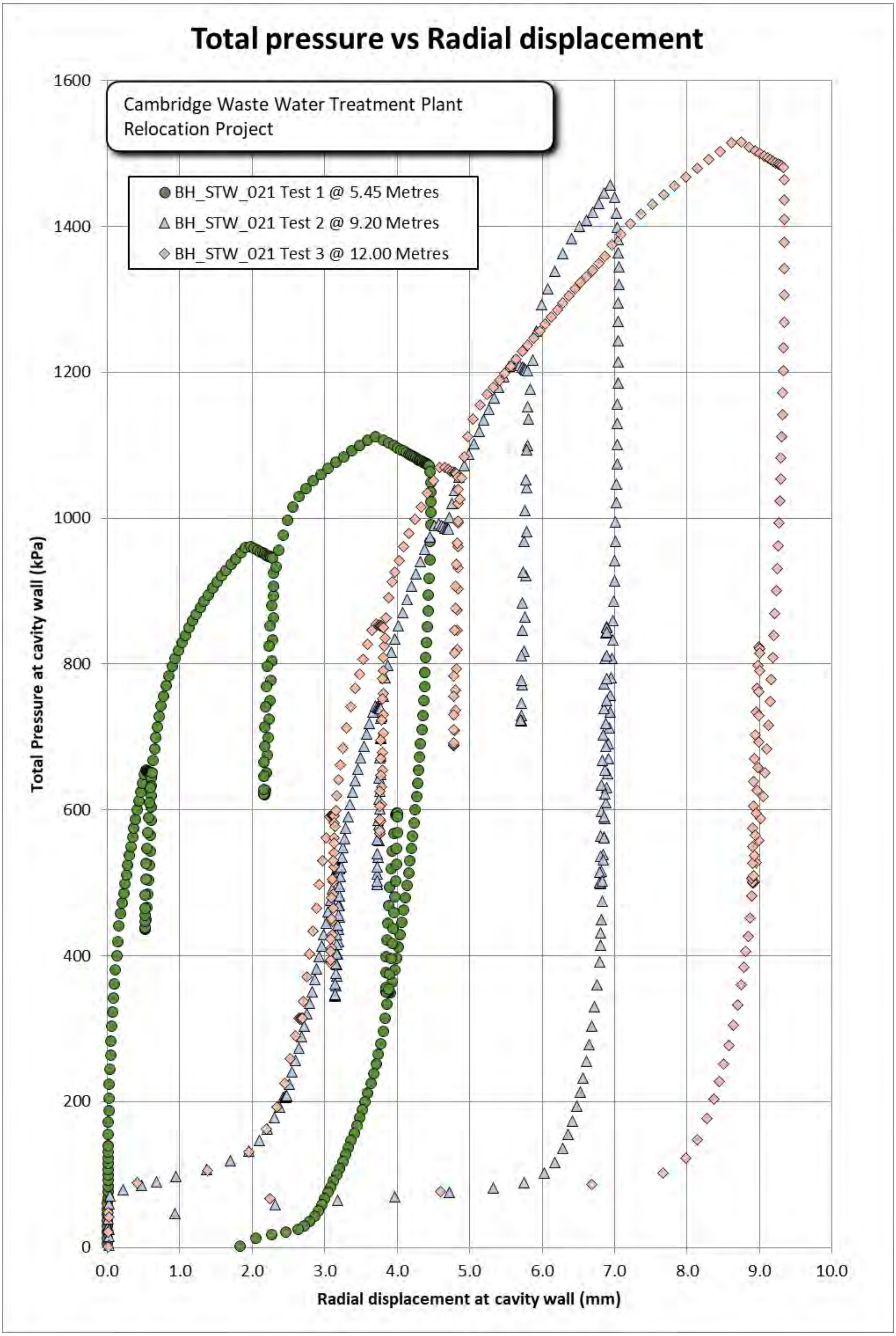


Figure 7 All tests on common axes – BH_TUN_001PM

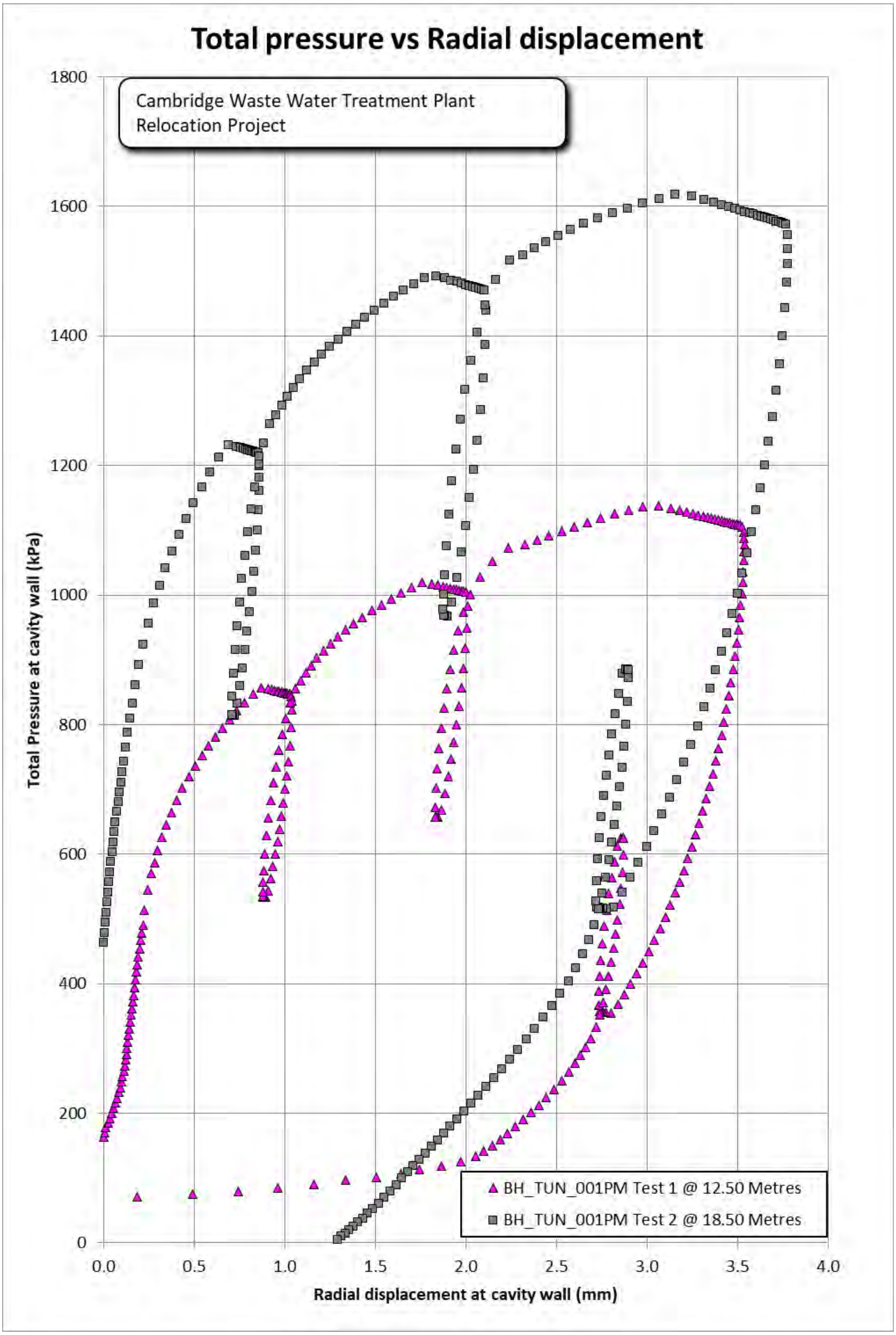


Figure 8 All tests on common axes – BH_TUN_006PM

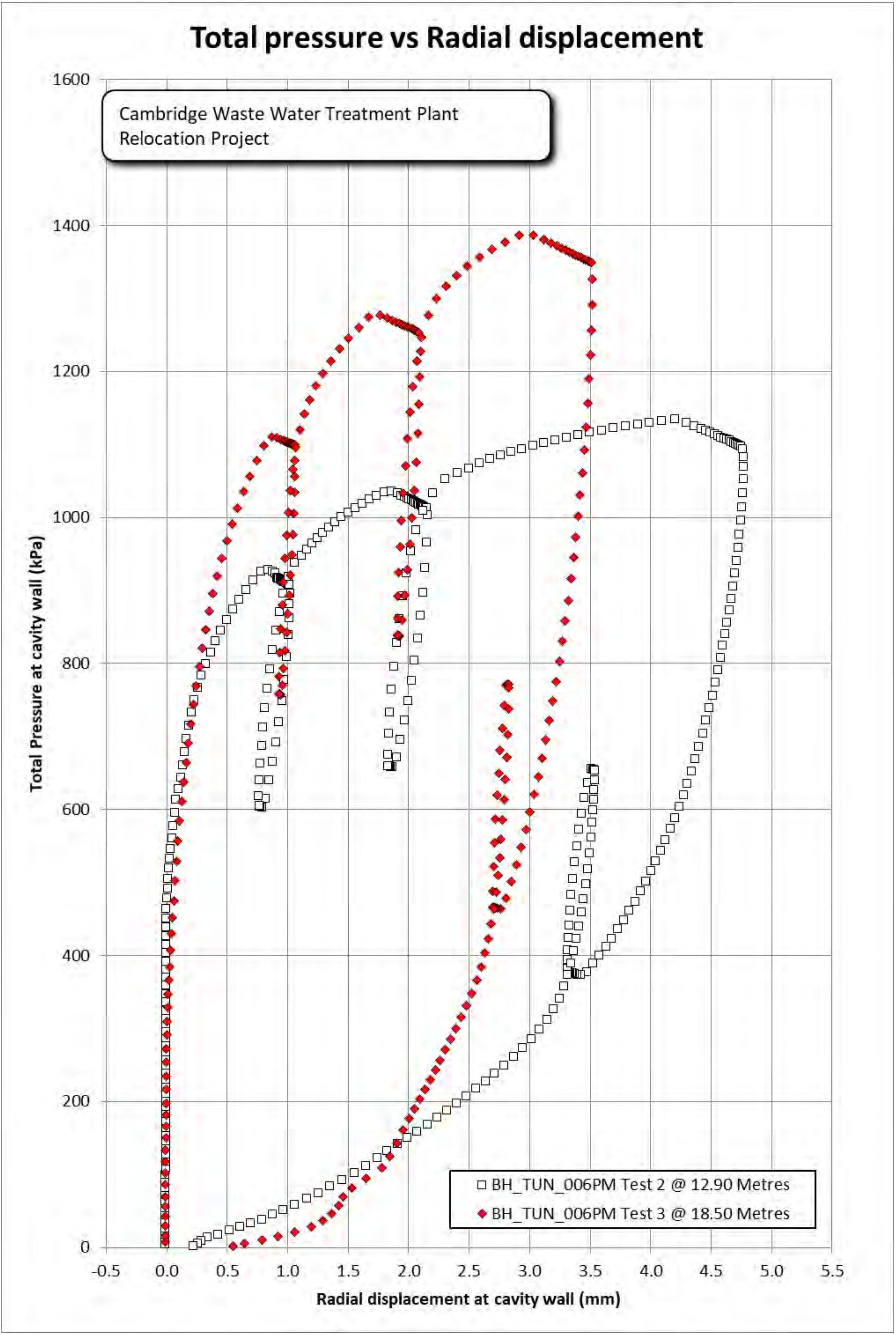


Figure 9 All tests on common axes – BH_TUN_011PM

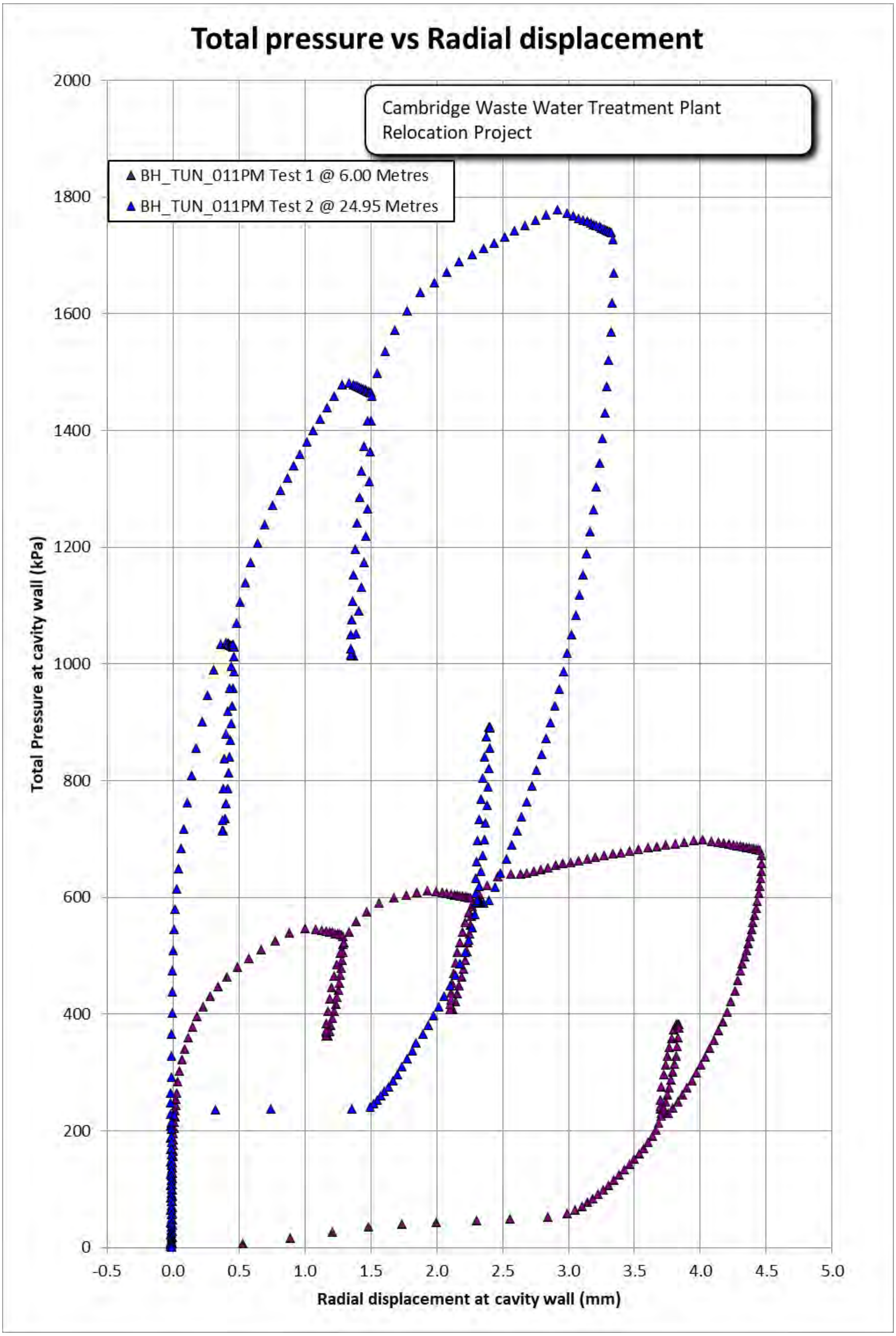
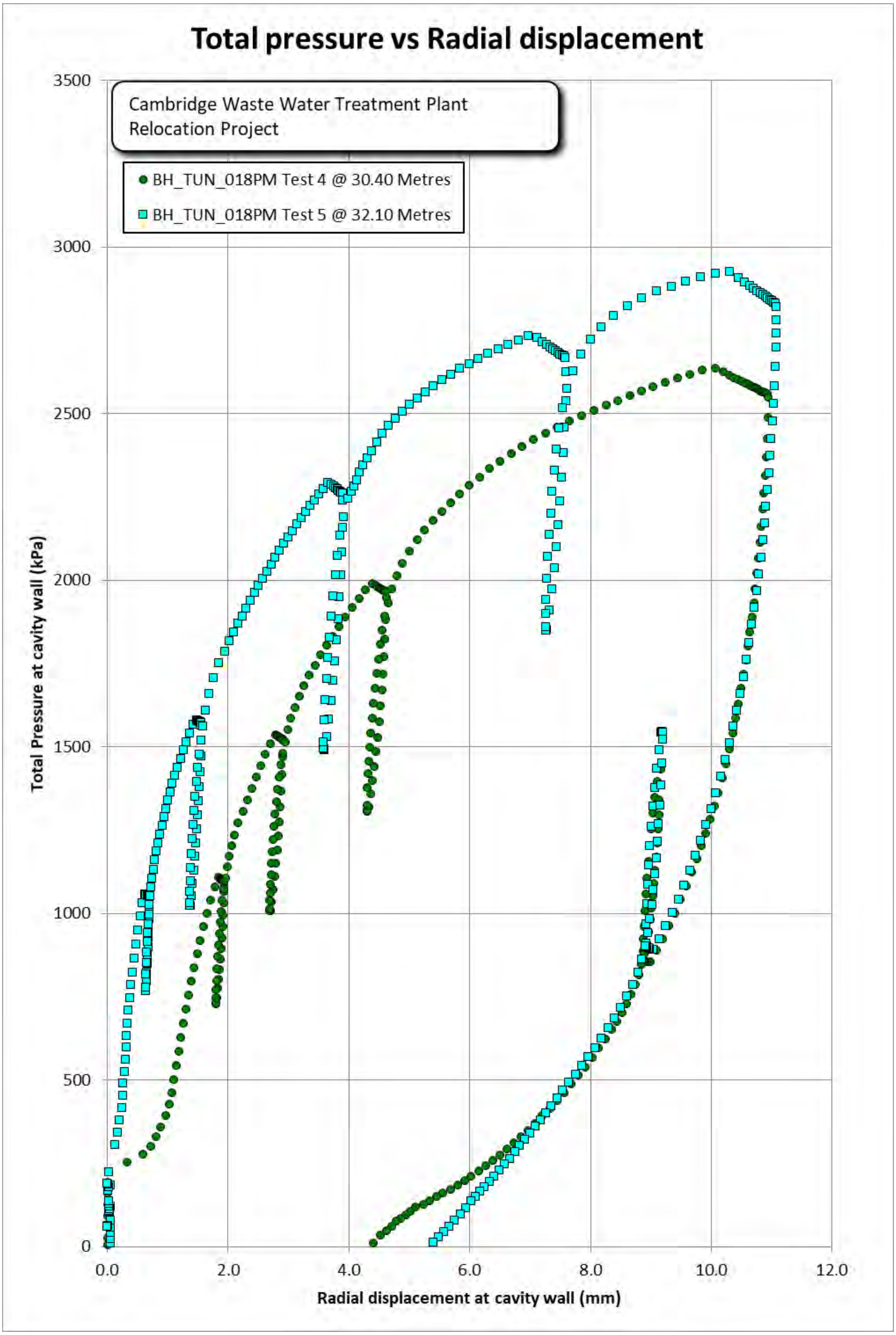


Figure 10 **All tests on common axes – BH_TUN_011PM**



TEST DATA FOR INDIVIDUAL TESTS

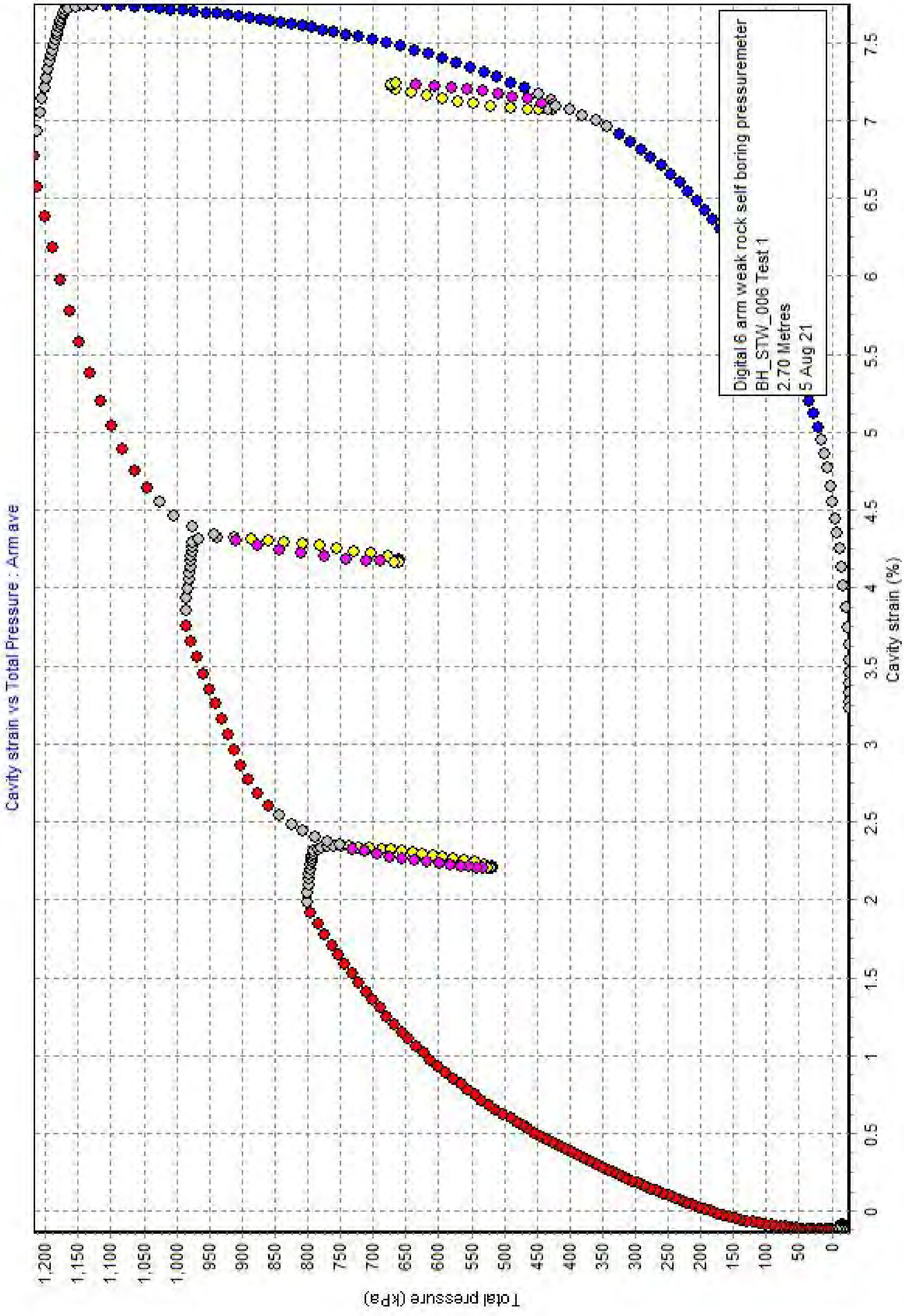
(TAKEN FROM WINSITU and WINLOG FILES)

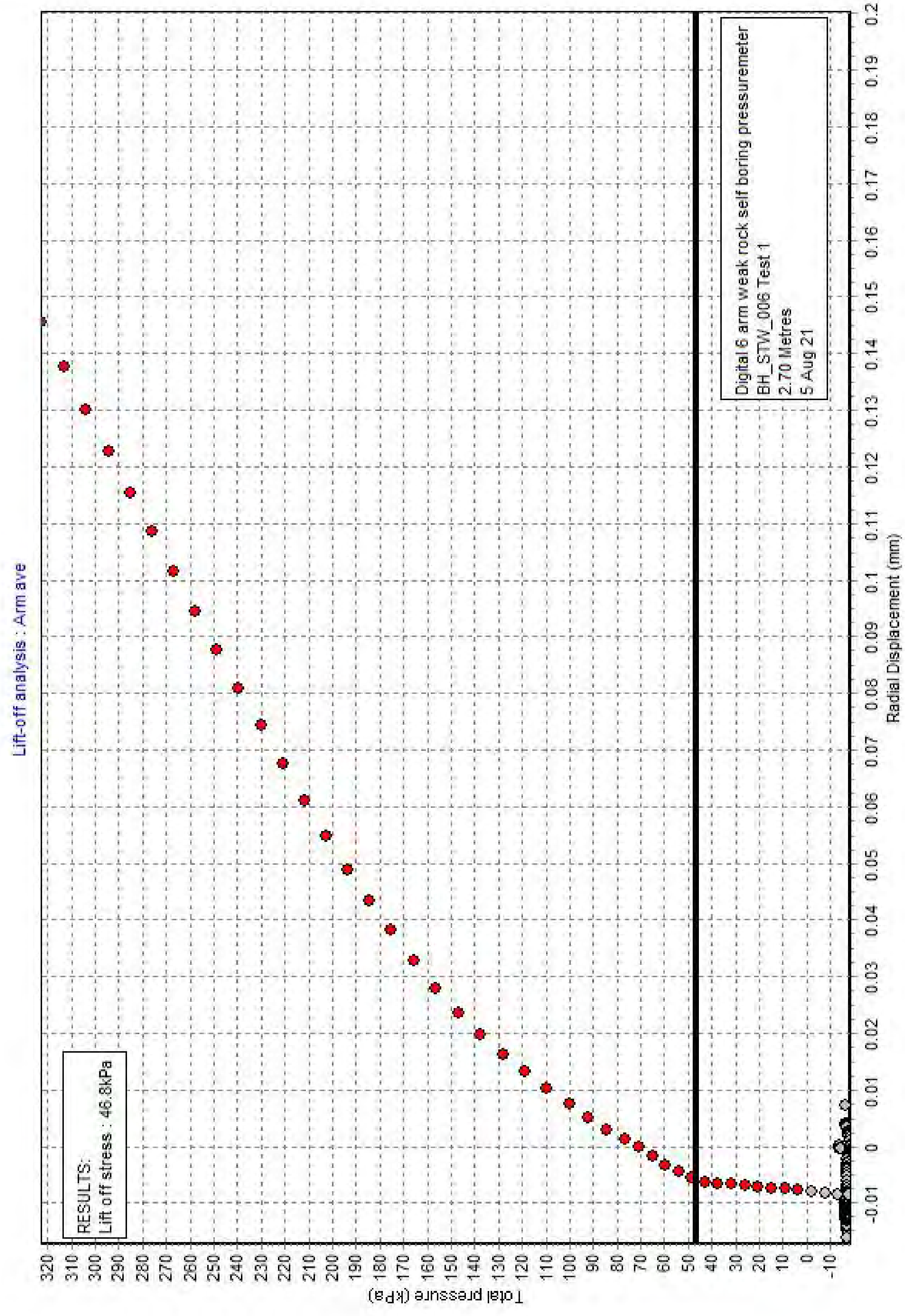
Test	**Internal Ref.**	**Depth (mBGL)**	**Date**
BH_STW_006 Test 1	B006T01	2.70	05/08/2021
BH_STW_006 Test 2	B006T02	N/A	05/08/2021
BH_STW_006 Test 3	B006T03	8.00	05/08/2021
BH_STW_011A Test 1	B011T01	3.80	31/08/2021
BH_STW_011A Test 2	B011T02	N/A	01/09/2021
BH_STW_011A Test 3	B011T03	13.50	01/09/2021
BH_STW_011A Test 4	B011T04	21.70	02/09/2021
BH_STW_012A Test 1	B012T01	4.20	10/08/2021
BH_STW_012A Test 2	B012T02	7.70	10/08/2021
BH_STW_012A Test 3	B012T03	13.20	11/08/2021
BH_STW_019A Test 1	B019T01	2.90	18/08/2021
BH_STW_019A Test 2	B019T02	6.50	18/08/2021
BH_STW_019A Test 3	B019T03	9.40	18/08/2021
BH_STW_020 Test 1	B020T01	4.50	06/09/2021
BH_STW_020 Test 2	B020T02	8.50	06/09/2021
BH_STW_020 Test 3	B020T03	15.70	07/09/2021
BH_STW_021 Test 1	B021T01	5.45	16/08/2021
BH_STW_021 Test 2	B021T02	9.20	16/08/2021
BH_STW_021 Test 3	B021T03	12.00	16/08/2021
BH_TUN_001PM Test 1	B001T01	12.50	13/09/2021
BH_TUN_001PM Test 2	B001T02	18.50	14/09/2021
BH_TUN_006PM Test 1	B6PMT01	12.20	29/09/2021
BH_TUN_006PM Test 2	B6PMT02	12.90	29/09/2021
BH_TUN_006PM Test 3	B6PMT03	18.50	29/09/2021
BH_TUN_011PM Test 1	B11PMT01	6.00	13/10/2021
BH_TUN_011PM Test 2	B11PMT02	24.95	14/10/2021
BH_TUN_018PM Test 1	B018T01	27.00	01/10/2021
BH_TUN_018PM Test 2	B018T02	n/a	04/10/2021
BH_TUN_018PM Test 3	B018T03	28.70	04/10/2021
BH_TUN_018PM Test 4	B018T04	30.40	04/10/2021
BH_TUN_018PM Test 5	B018T05	32.10	05/10/2021

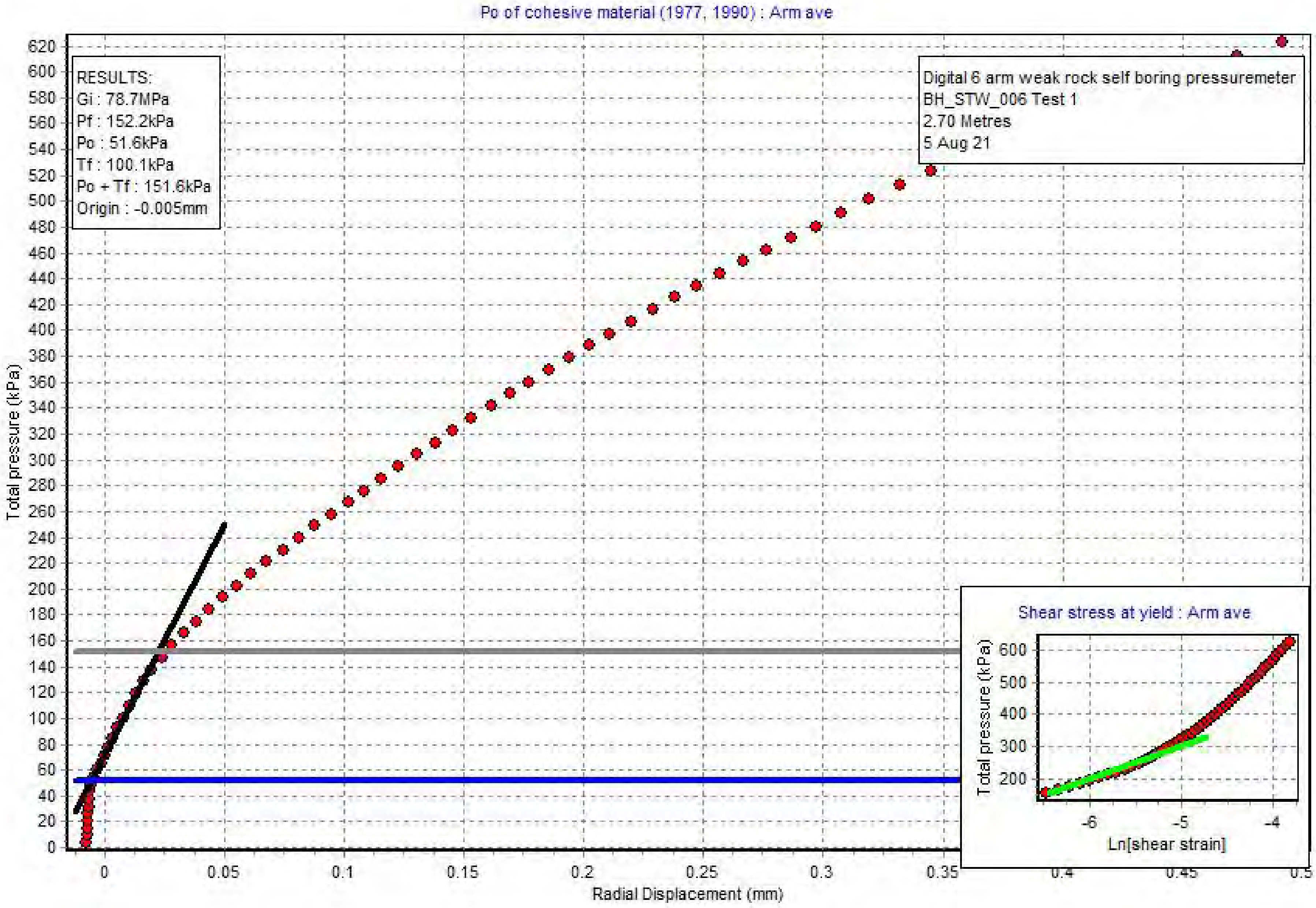
```
BH_STW_006 Test 1 - SUMMARY OF RESULTS
[File made with WinSitu ]

[DETAILS OF TEST]
Project        :   TE8364
Site           :   Cambridge Waste Water Treatment Plant Relocation Project
Borehole       :   BH_STW_006
Test name      :   BH_STW_006 Test 1
Test date      :   5 Aug 21
Test depth     :   2.70 Metres
Water table    :   Nothing entered
Ambient PWP    :   0.0 kPa
Material       :   Structureless chalk
Probe          :   Digital 6 arm weak rock self boring pressuremeter
Diameter       :   88.1 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out
The file includes results from a curve fitting analysis

Analysed by YB/RW on 5 Aug 21

Remarks:  Drained response- based on PPC response

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm)                   :   "Arm ave=0.04"
Po from Marsland & Randolph (kPa)    :   "Arm ave=51.6"
Po from Lift off (kPa)               :   "Arm ave=46.8"
Best estimate of Po (kPa)            :   "Arm ave=76.0"

[UNDRAINED STRENGTH PARAMETERS]
Undrained yield stress (kPa)         :   "Arm ave=152.2"

[DRAINED ANALYSIS OF SANDS]
[Hughes et al 1977]
Constant volume friction angle (°)  :   30.0
Angle of internal friction (°)      :   "Arm ave=35.6"
Dilation angle (°)                  :   "Arm ave=6.7"
Gradient of log-log plot             :   "Arm ave=0.411"

[Withers et al 1989]
Angle of internal friction (°)      :   "Arm ave=35.7"
Dilation angle (°)                  :   "Arm ave=6.7"
Gradient of log-log plot             :   "Arm ave=-2.310"

[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=78.7"
Axis       Loop   Value    Mean Strain  Mean Pc  dE      dPc
           No     (MPa)    (%)          (kPa)    (%)     (kPa)
Arm ave    1      84.4     2.280        628      0.260   220
Arm ave    2      89.9     4.250        788      0.285   257
Arm ave    3      80.1     7.159        552      0.304   244

[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]
Axis       Loop   Intercept  Alpha      Gradient
           No     (MPa)      (MPa)
Arm ave    1      9.441      5.946      0.630
Arm ave    2      10.283     6.402      0.623
Arm ave    3      8.497      5.011      0.590


[PARAMETERS USED FOR DRAINED CURVE MODELLING]
{Axis is  Arm ave}
Strain Origin (mm)                   :   0.04
Po (kPa)                             :   76
Cohesion (kPa)                       :   40
Angle of peak friction (deg)         :   35.6
Angle of peak dilation (deg)         :   6.7
Total yield stress (kPa)             :   266
Total limit stress (kPa)             :   2963
```

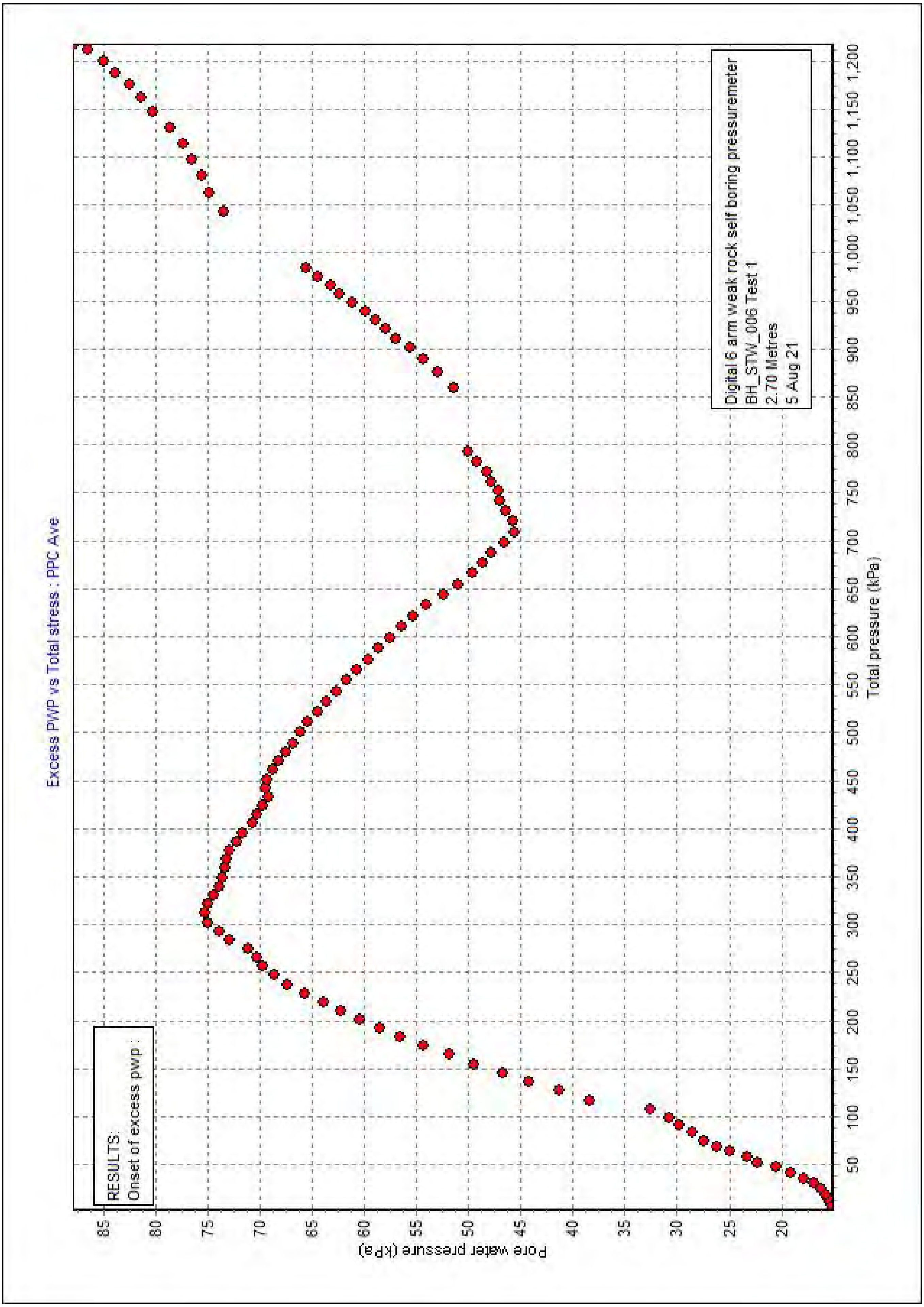
BH_STW_006 Test 1 - SUMMARY OF RESULTS

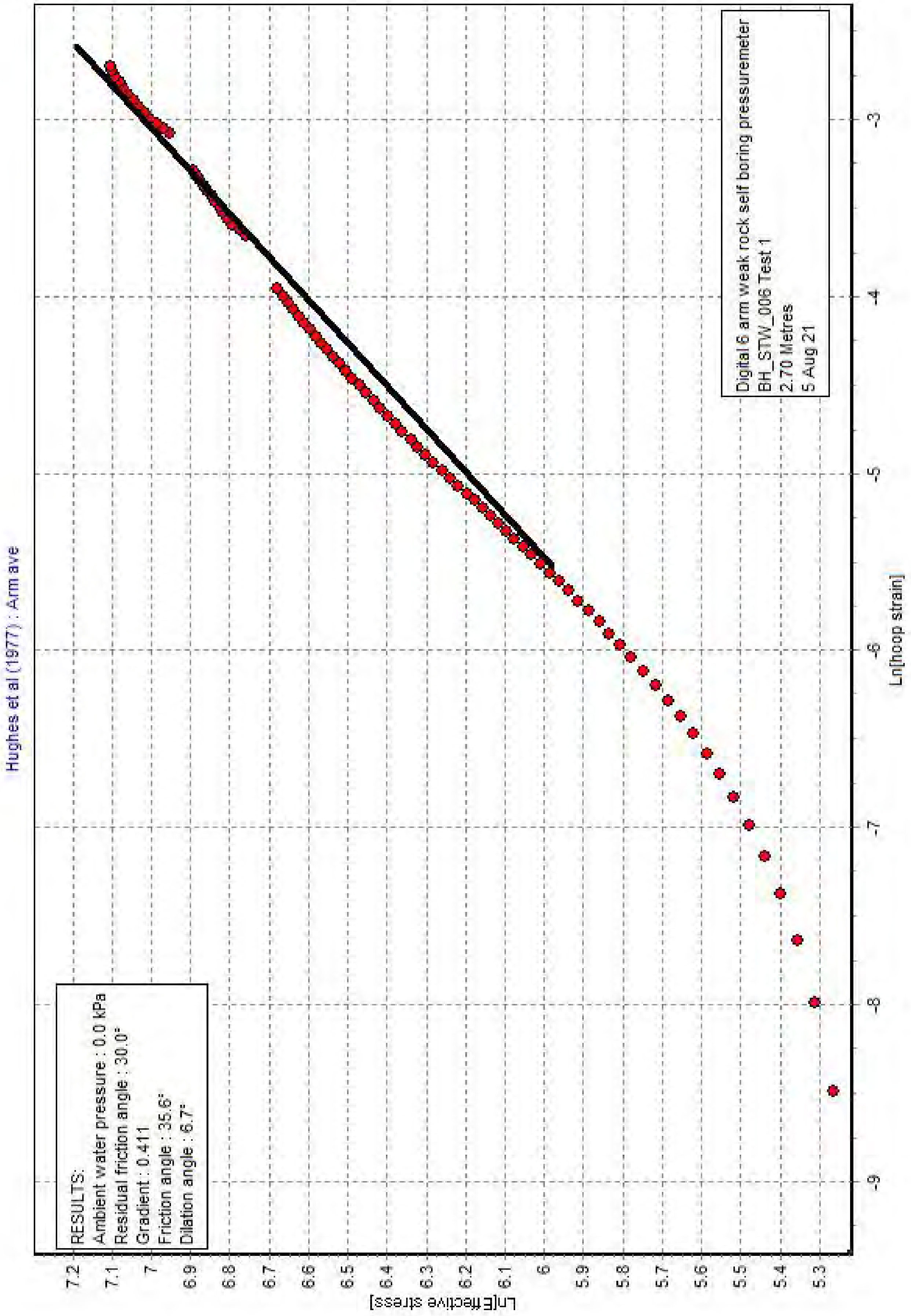
```
G at first yield (MPa)             :   43.5
Non-linear exponent                :   0.623
Janbu exponent                     :   0.150
Correlation                        :   0.317

Ambient pore water pressure (kPa)  :   0
Residual friction angle (deg)      :   30.0
Poisson's ratio                    :   0.25
```

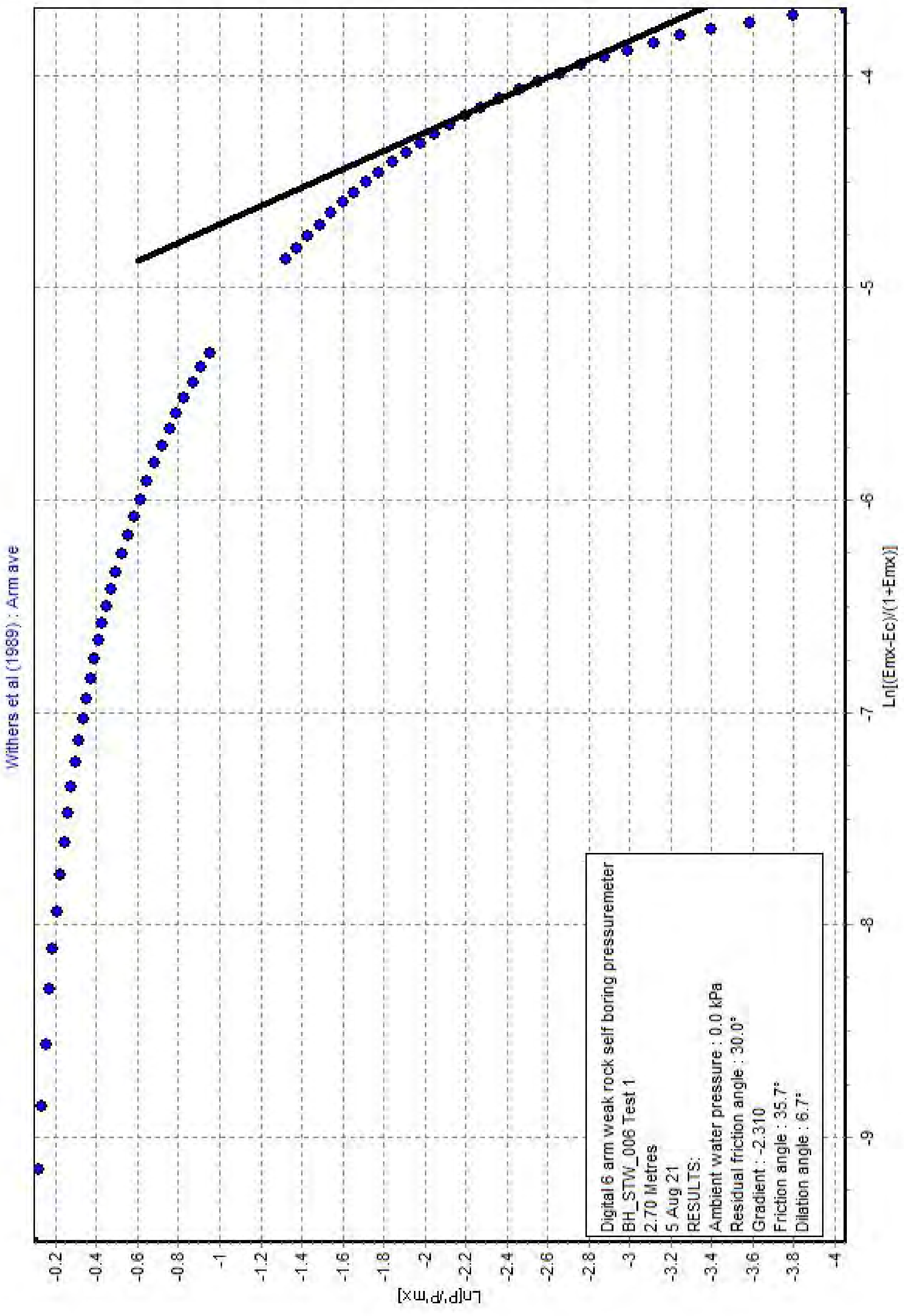

Cavity strain vs Total Pressure : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_006 Test 1
2.70 Metres
5 Aug 21
Total pressure (kPa)
Cavity strain (%)
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5


Lift-off analysis : Arm ave
RESULTS:
Lift off stress : 46.8kPa
Digital 6 arm weak rock self boring pressuremeter
BH_STW_006 Test 1
2.70 Metres
5 Aug 21
Total pressure (kPa)
320
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
Radial Displacement (mm)
-0.01
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
0.11
0.12
0.13
0.14
0.15
0.16
0.17
0.18
0.19
0.2

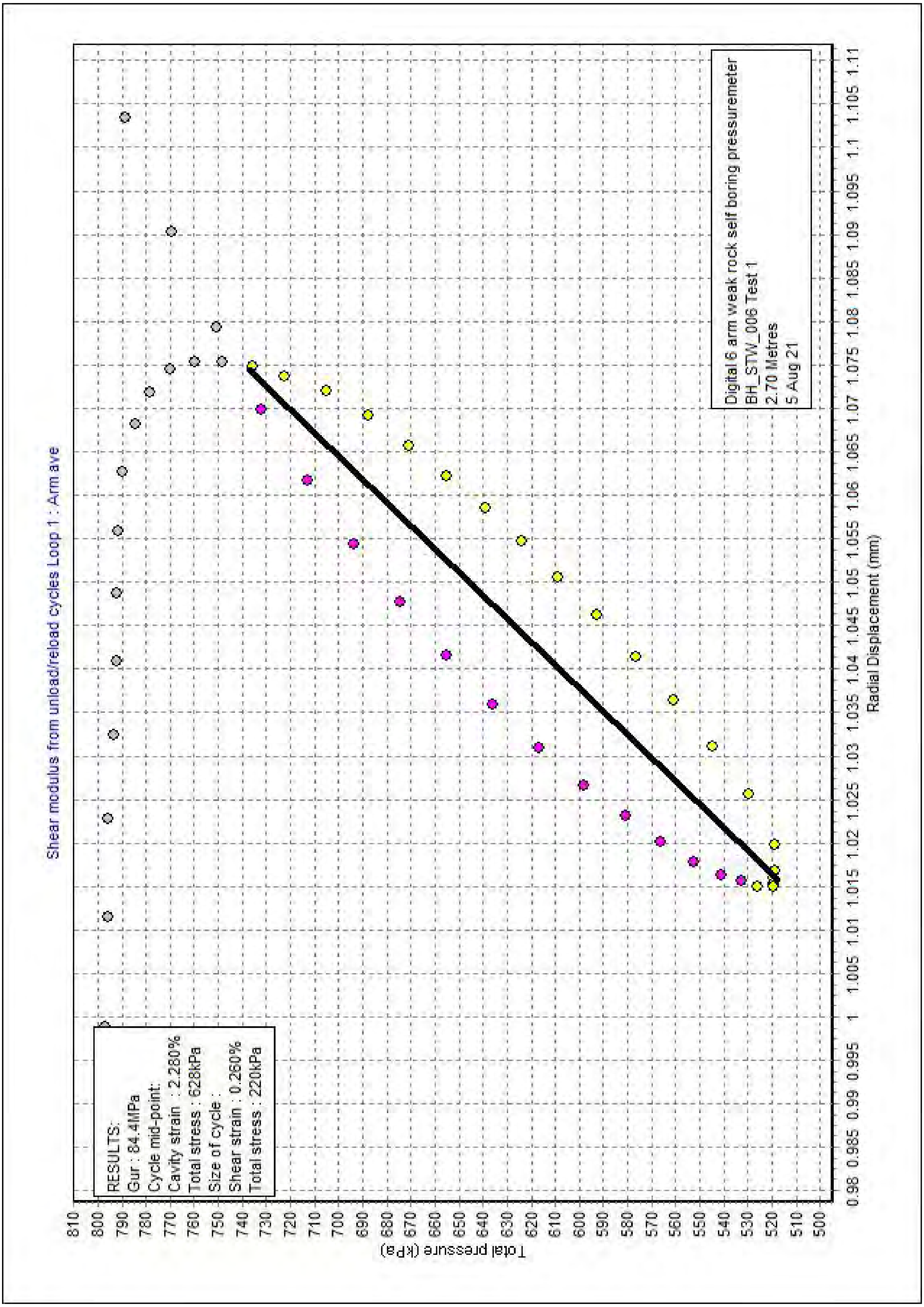

Po of cohesive material (1977, 1990) : Arm ave
RESULTS:
Gi : 78.7MPa
Pf : 152.2kPa
Po : 51.6kPa
Tf : 100.1kPa
Po + Tf : 151.6kPa
Origin : -0.005mm
Digital 6 arm weak rock self boring pressuremeter
BH_STW_006 Test 1
2.70 Metres
5 Aug 21
Total pressure (kPa)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600
620
Radial Displacement (mm)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
Shear stress at yield : Arm ave
Total pressure (kPa)
200
300
400
500
600
Ln[shear strain]
-6
-5
-4


Excess PWP vs Total stress : PPC Ave
RESULTS:
Onset of excess pwp :
Digital 6 arm weak rock self boring pressuremeter
BH_STW_006 Test 1
2.70 Metres
5 Aug 21
Pore water pressure (kPa)
20
25
30
35
40
45
50
55
60
65
70
75
80
85
Total pressure (kPa)
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1,000
1,050
1,100
1,150
1,200

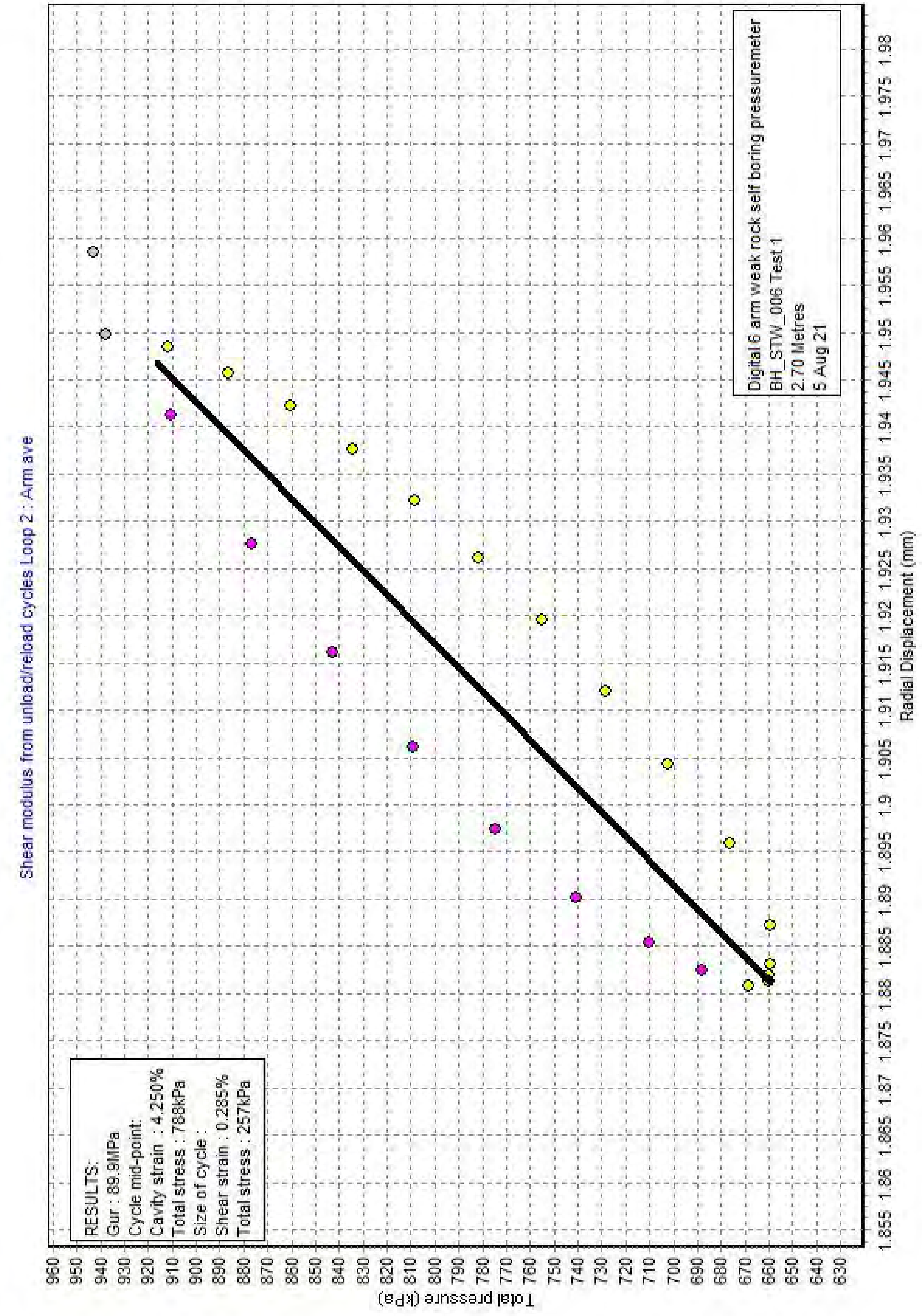

Hughes et al (1977) : Arm ave
RESULTS:
Ambient water pressure : 0.0 kPa
Residual friction angle : 30.0°
Gradient : 0.411
Friction angle : 35.6°
Dilation angle : 6.7°
Digital 6 arm weak rock self boring pressuremeter
BH_STW_006 Test 1
2.70 Metres
5 Aug 21
Ln[Effective stress]
7.2
7.1
7
6.9
6.8
6.7
6.6
6.5
6.4
6.3
6.2
6.1
6
5.9
5.8
5.7
5.6
5.5
5.4
5.3
Ln[hoop strain]
-9
-8
-7
-6
-5
-4
-3

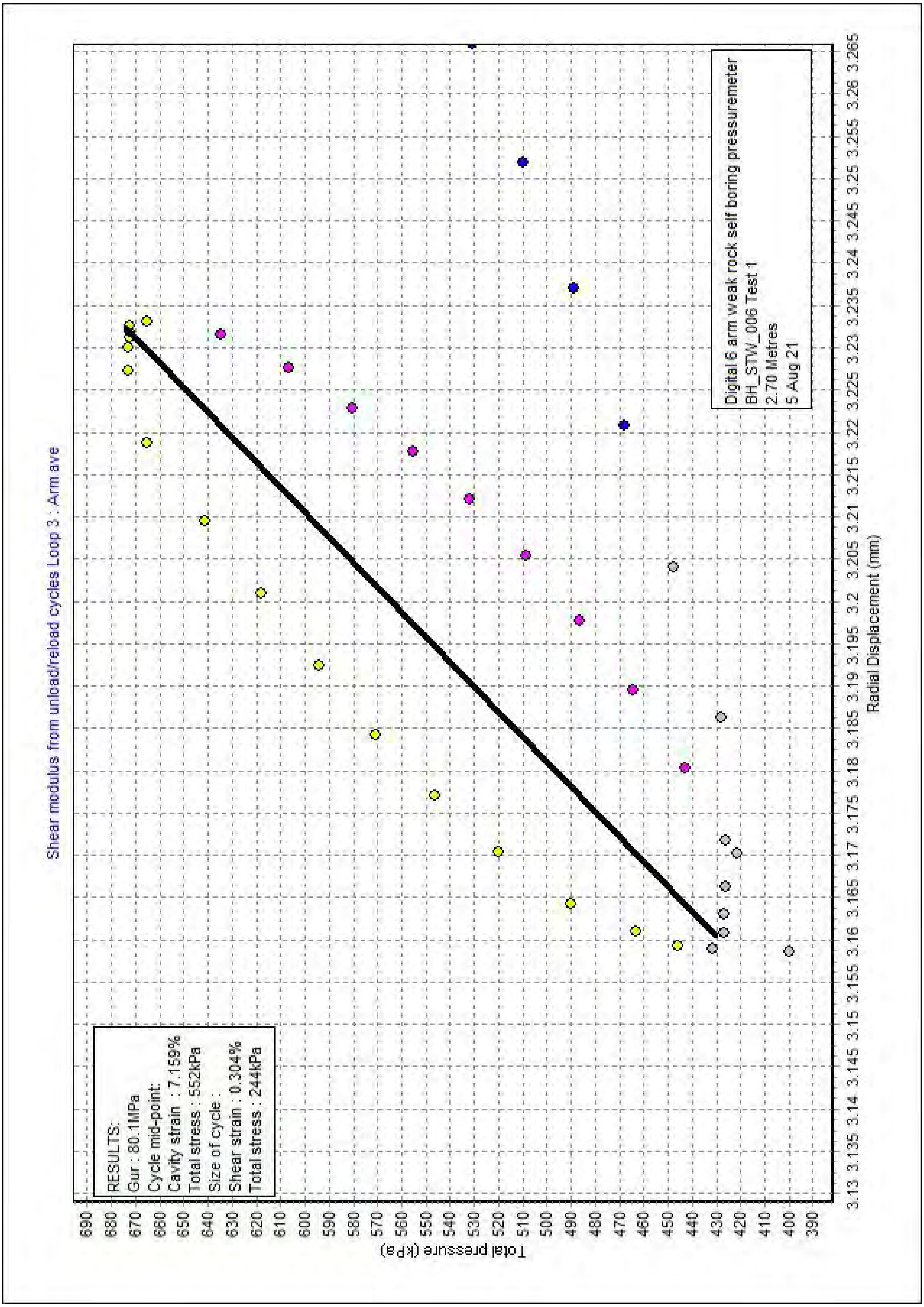


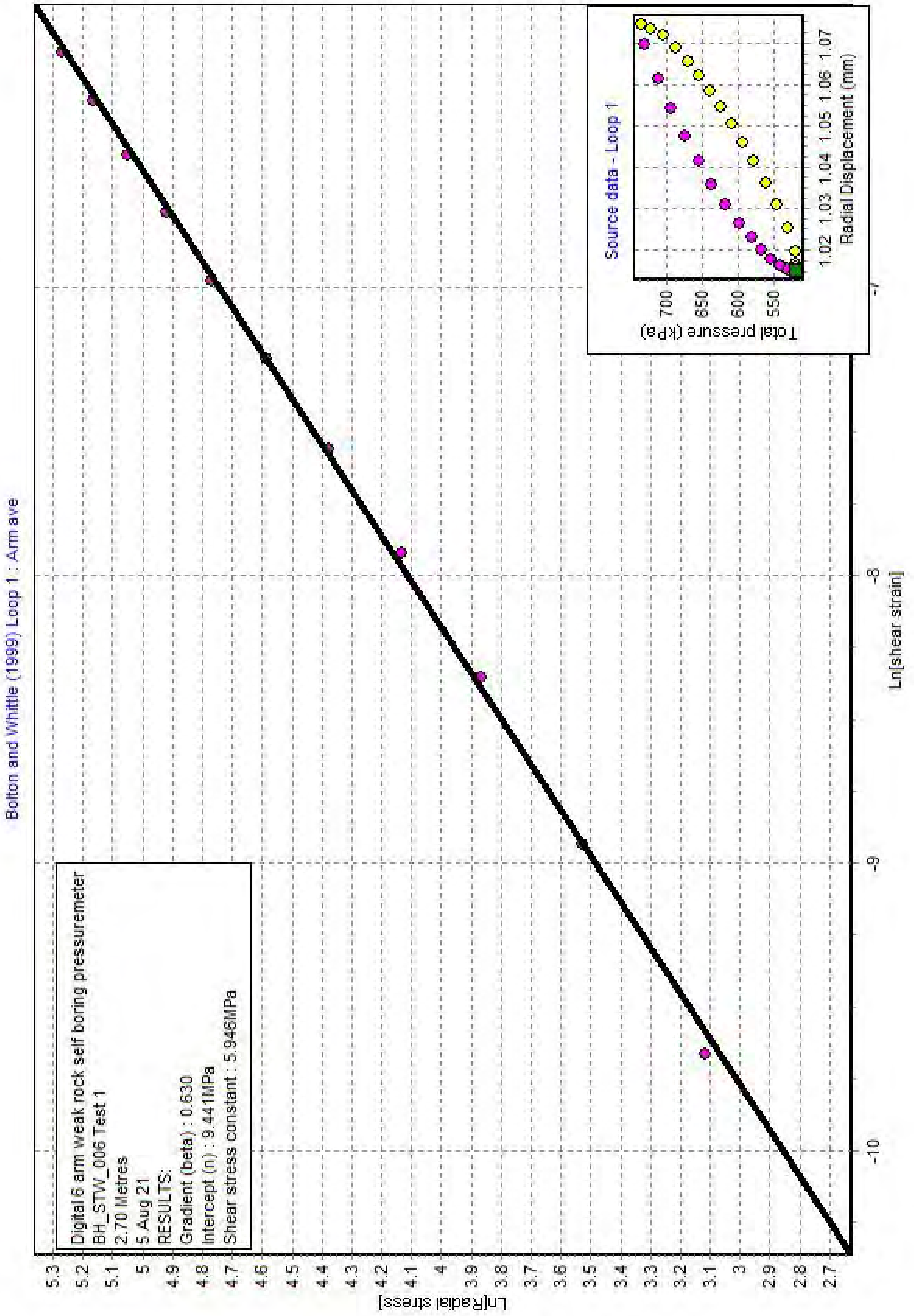
Digital 6 arm weak rock self boring pressuremeter
BH_STW_006 Test 1
2.70 Metres
5 Aug 21
RESULTS:
Ambient water pressure : 0.0 kPa
Residual friction angle : 30.0°
Gradient : -2.310
Friction angle : 35.7°
Dilation angle : 6.7°

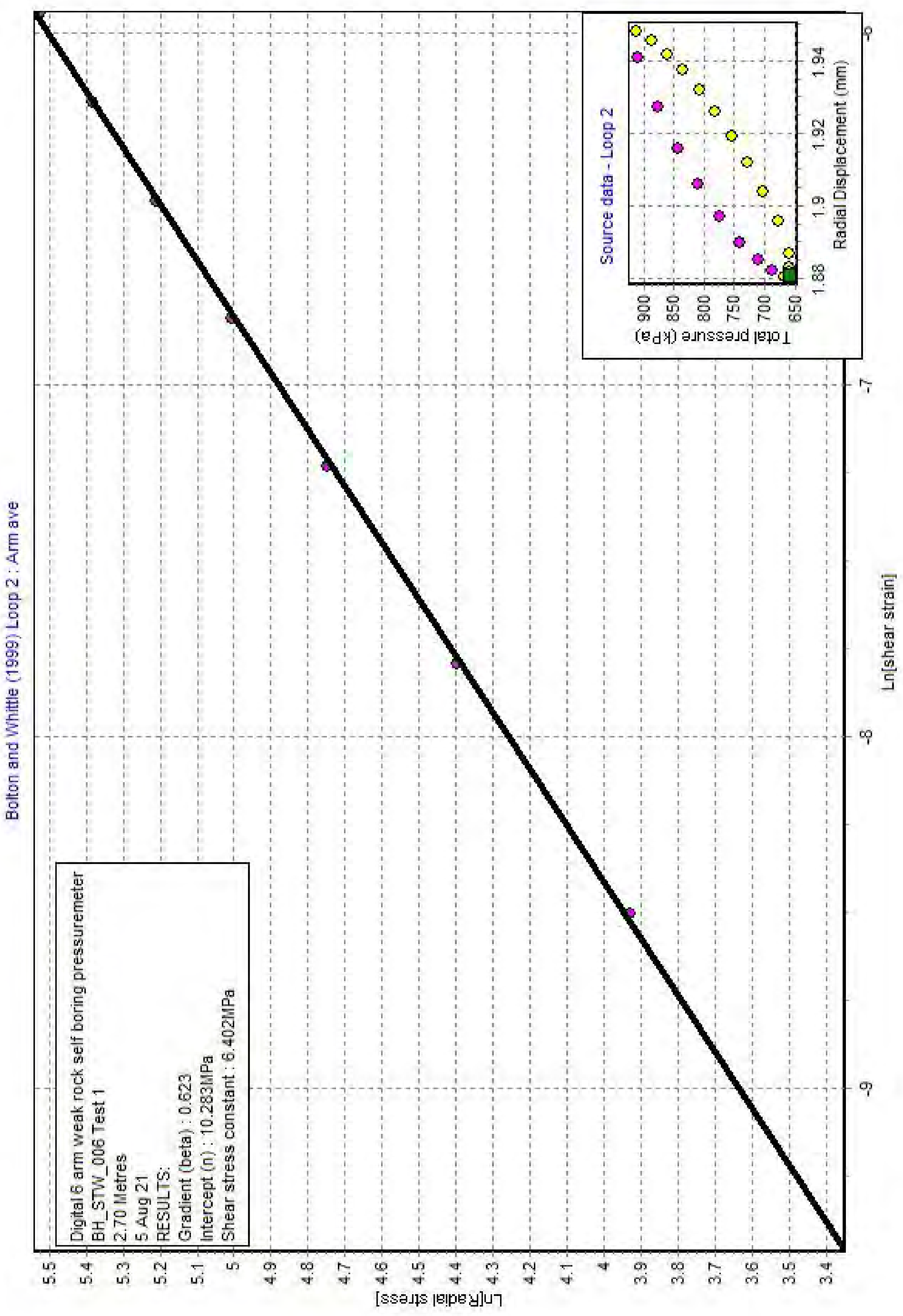


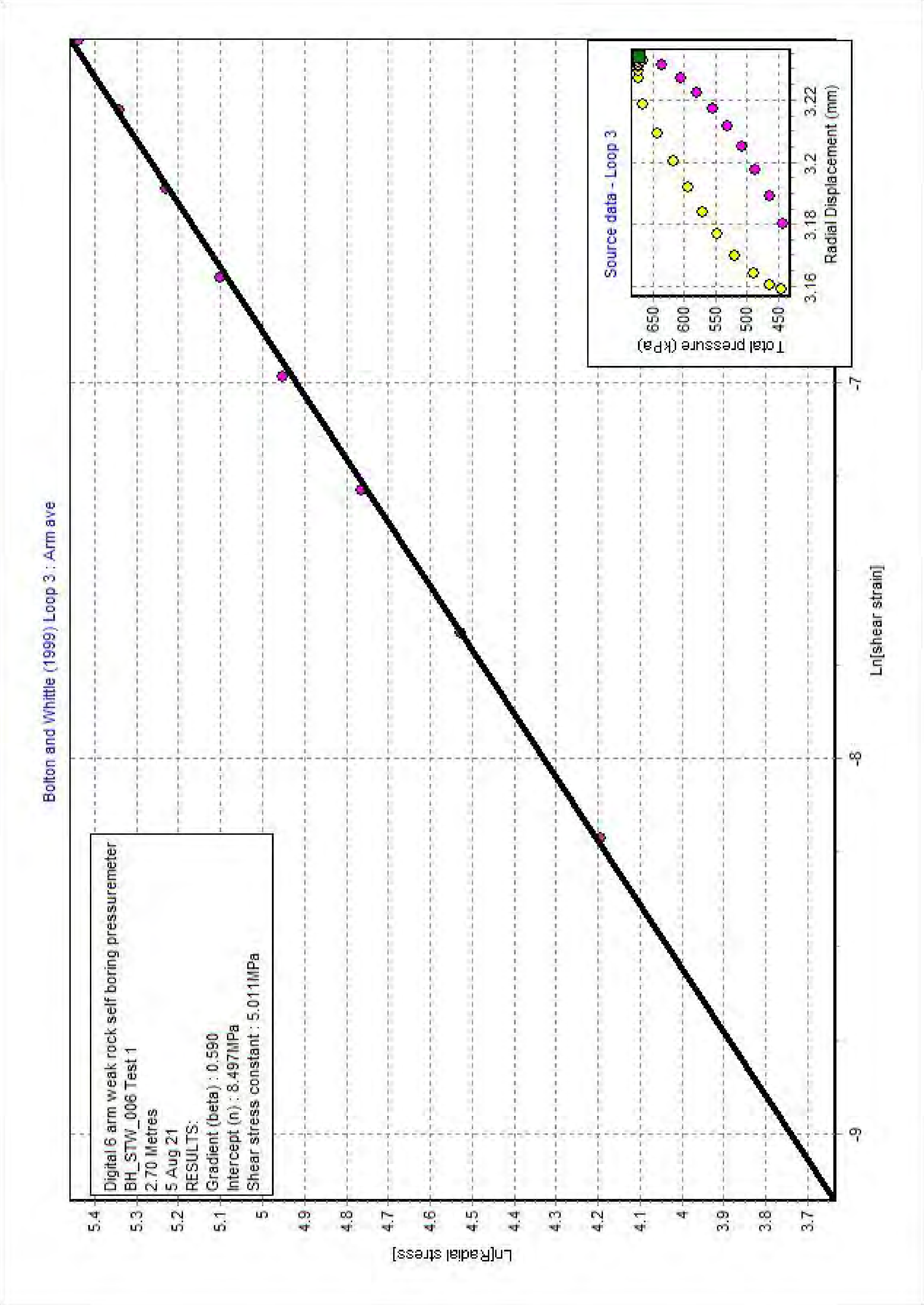
RESULTS:
Gur : 84.4MPa
Cycle mid-point:
Cavity strain : 2.280%
Total stress : 628kPa
Size of cycle :
Shear strain : 0.260%
Total stress : 220kPa


Shear modulus from unload/reload cycles Loop 2 : Arm ave
RESULTS:
Gur : 89.9MPa
Cycle mid-point:
Cavity strain : 4.250%
Total stress : 788kPa
Size of cycle :
Shear strain : 0.285%
Total stress : 257kPa
Digital 6 arm weak rock self boring pressuremeter
BH_STW_006 Test 1
2.70 Metres
5 Aug 21
Total pressure (kPa)
960 950 940 930 920 910 900 890 880 870 860 850 840 830 820 810 800 790 780 770 760 750 740 730 720 710 700 690 680 670 660 650 640 630
Radial Displacement (mm)
1.855 1.86 1.865 1.87 1.875 1.88 1.885 1.89 1.895 1.9 1.905 1.91 1.915 1.92 1.925 1.93 1.935 1.94 1.945 1.95 1.955 1.96 1.965 1.97 1.975 1.98

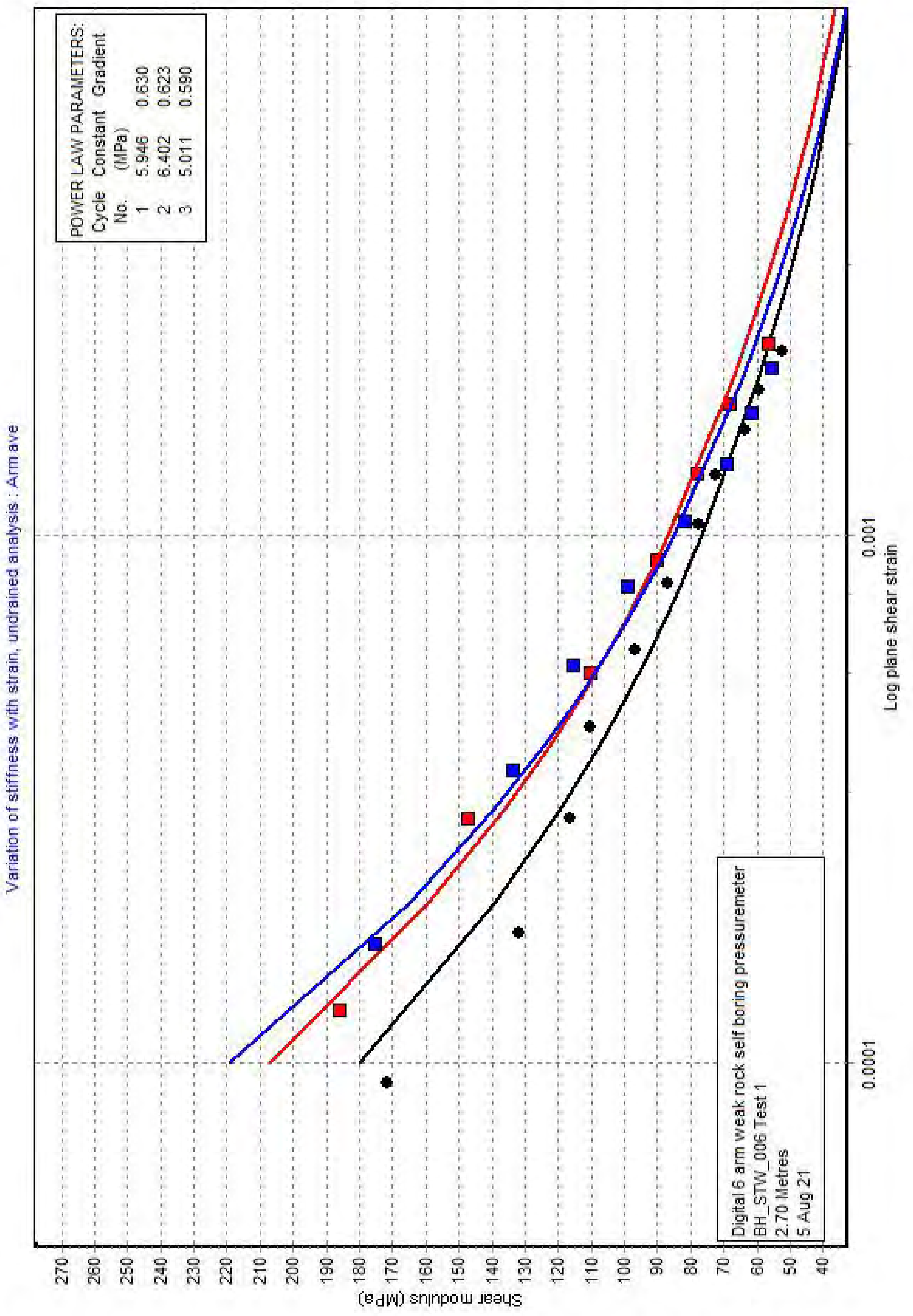

Shear modulus from unload/reload cycles Loop 3 : Arm ave
Total pressure (kPa)
690
680
670
660
650
640
630
620
610
600
590
580
570
560
550
540
530
520
510
500
490
480
470
460
450
440
430
420
410
400
390
Radial Displacement (mm)
3.13
3.135
3.14
3.145
3.15
3.155
3.16
3.165
3.17
3.175
3.18
3.185
3.19
3.195
3.2
3.205
3.21
3.215
3.22
3.225
3.23
3.235
3.24
3.245
3.25
3.255
3.26
3.265
RESULTS:
Gur : 80.1MPa
Cycle mid-point:
Cavity strain : 7.159%
Total stress : 552kPa
Size of cycle :
Shear strain : 0.304%
Total stress : 244kPa
Digital 6 arm weak rock self boring pressuremeter
BH_STW_006 Test 1
2.70 Metres
5 Aug 21

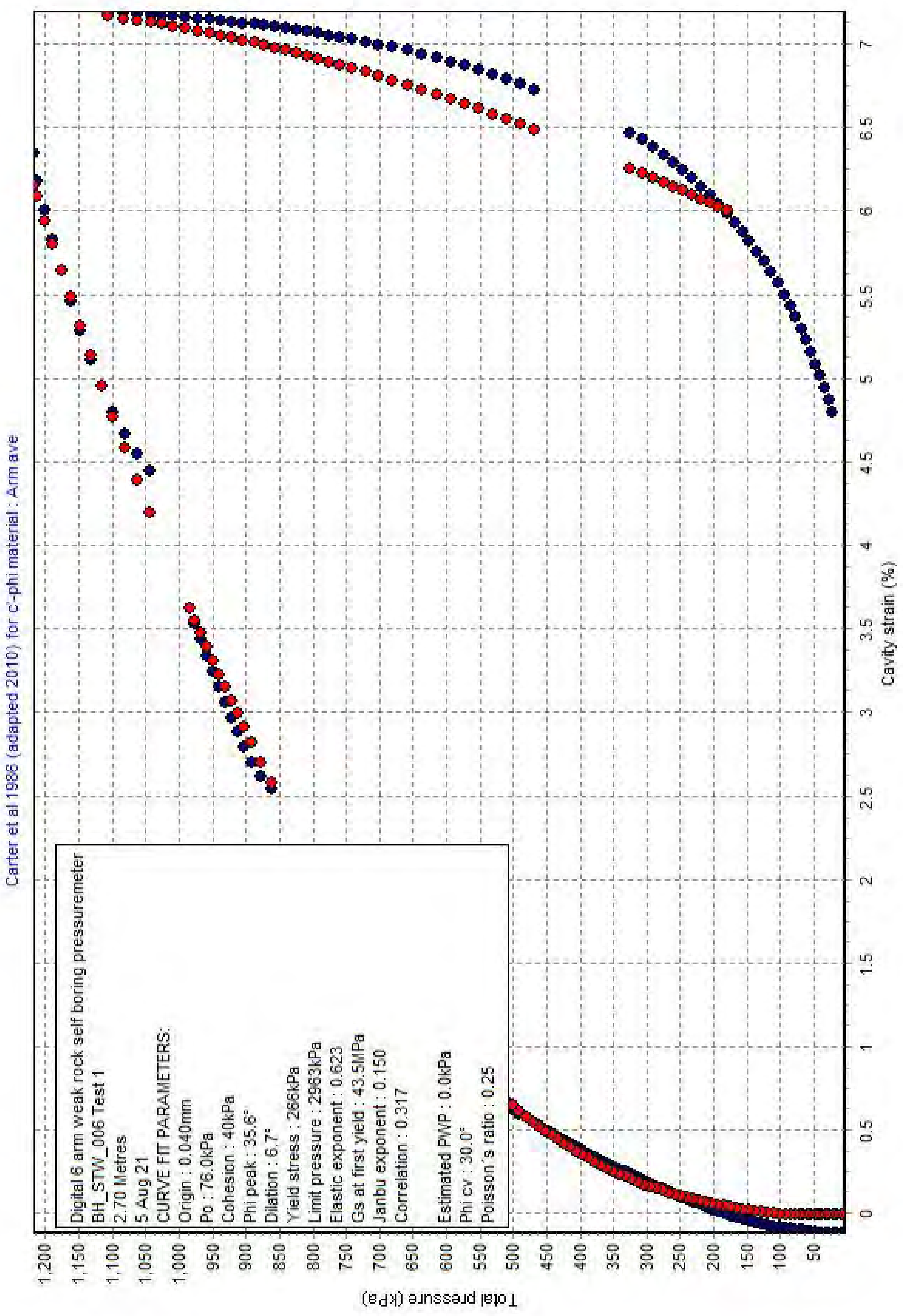

Bolton and Whittle (1999) Loop 1 : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_006 Test 1
2.70 Metres
5 Aug 21
RESULTS:
Gradient (beta) : 0.630
Intercept (n) : 9.441MPa
Shear stress constant : 5.946MPa
Ln[Radial stress]
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
2.7
Ln[shear strain]
-10
-9
-8
-7
Source data - Loop 1
Total pressure (kPa)
700
650
600
550
Radial Displacement (mm)
1.02
1.03
1.04
1.05
1.06
1.07


Bolton and Whittle (1999) Loop 2 : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_006 Test 1
2.70 Metres
5 Aug 21
RESULTS:
Gradient (beta) : 0.623
Intercept (n) : 10.283MPa
Shear stress constant : 6.402MPa
Ln[Radial stress]
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
Ln[shear strain]
-9
-8
-7
-6
Source data - Loop 2
Total pressure (kPa)
900
850
800
750
700
650
Radial Displacement (mm)
1.88
1.9
1.92
1.94



Digital 6 arm weak rock self boring pressuremeter
BH_STW_006 Test 1
2.70 Metres
5 Aug 21
RESULTS:
Gradient (beta) : 0.590
Intercept (n) : 8.497MPa
Shear stress constant : 5.011MPa


Variation of stiffness with strain, undrained analysis : Arm ave
POWER LAW PARAMETERS:
Cycle Constant Gradient
No. (MPa)
1 5.946 0.630
2 6.402 0.623
3 5.011 0.590
Digital 6 arm weak rock self boring pressuremeter
BH_STW_006 Test 1
2.70 Metres
5 Aug 21
Shear modulus (MPa)
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
Log plane shear strain
0.0001
0.001



Digital 6 arm weak rock self boring pressuremeter
BH_STW_006 Test 1
2.70 Metres
5 Aug 21
CURVE FIT PARAMETERS:
Origin : 0.040mm
Po : 76.0kPa
Cohesion : 40kPa
Phi peak : 35.6°
Dilation : 6.7°
Yield stress : 266kPa
Limit pressure : 2963kPa
Elastic exponent : 0.623
Gs at first yield : 43.5MPa
Janbu exponent : 0.150
Correlation : 0.317

Estimated PWP : 0.0kPa
Phi cv : 30.0°
Poisson's ratio : 0.25

B006T01 - TEST & CALIBRATION DETAILS

[PROJECT DETAILS]
Contract name : CWW TPR

[BOREHOLE DETAILS]
Borehole : BH_STW_006

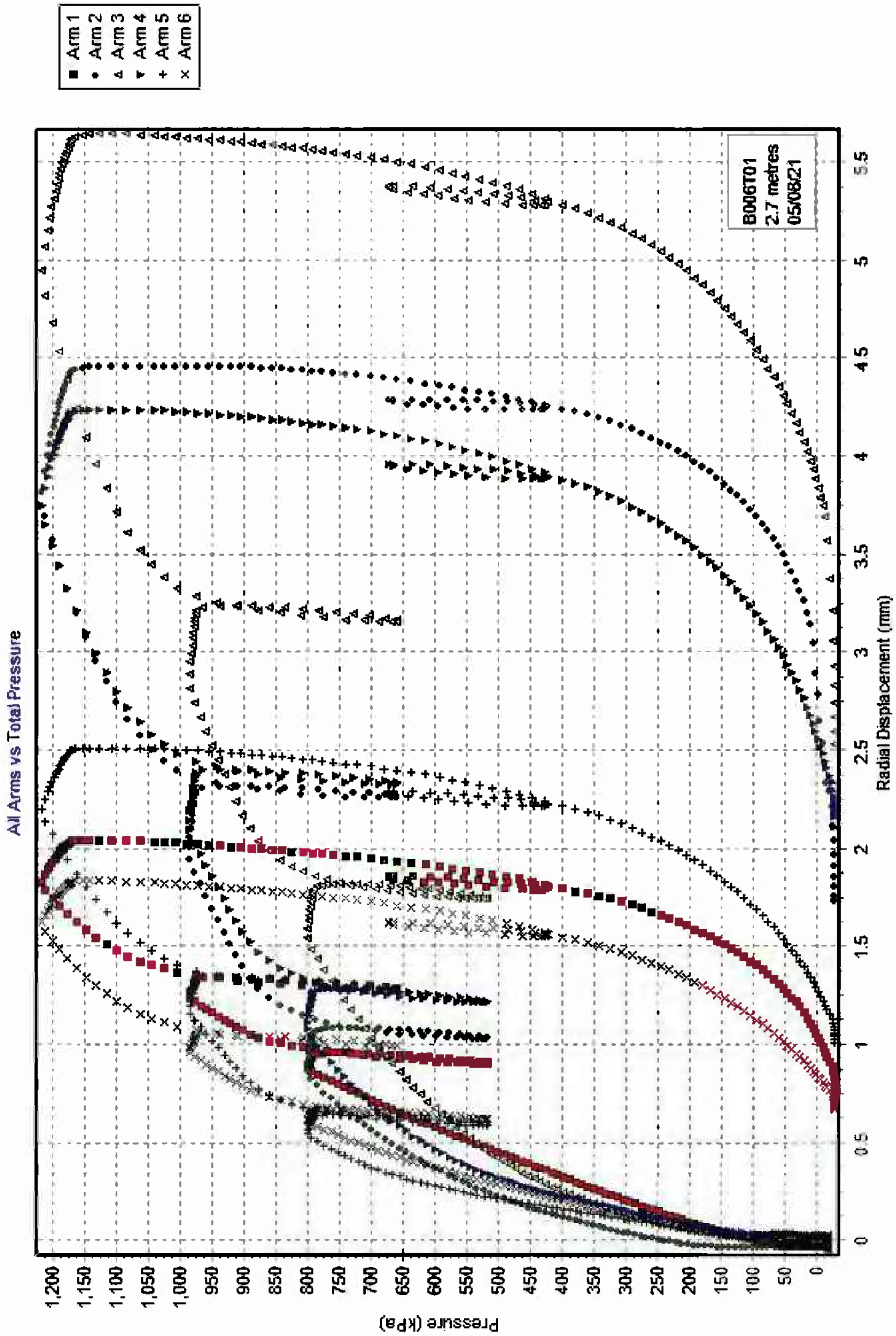
[TEST DETAILS]
Test name : B006T01
Test date : 05/08/21
Depth (M) : 2.70
Material: : Structureless chalk
Heading (deg) : n/a
Data Rate (secs) : 6
Start Line : 1
Stop Line : 686

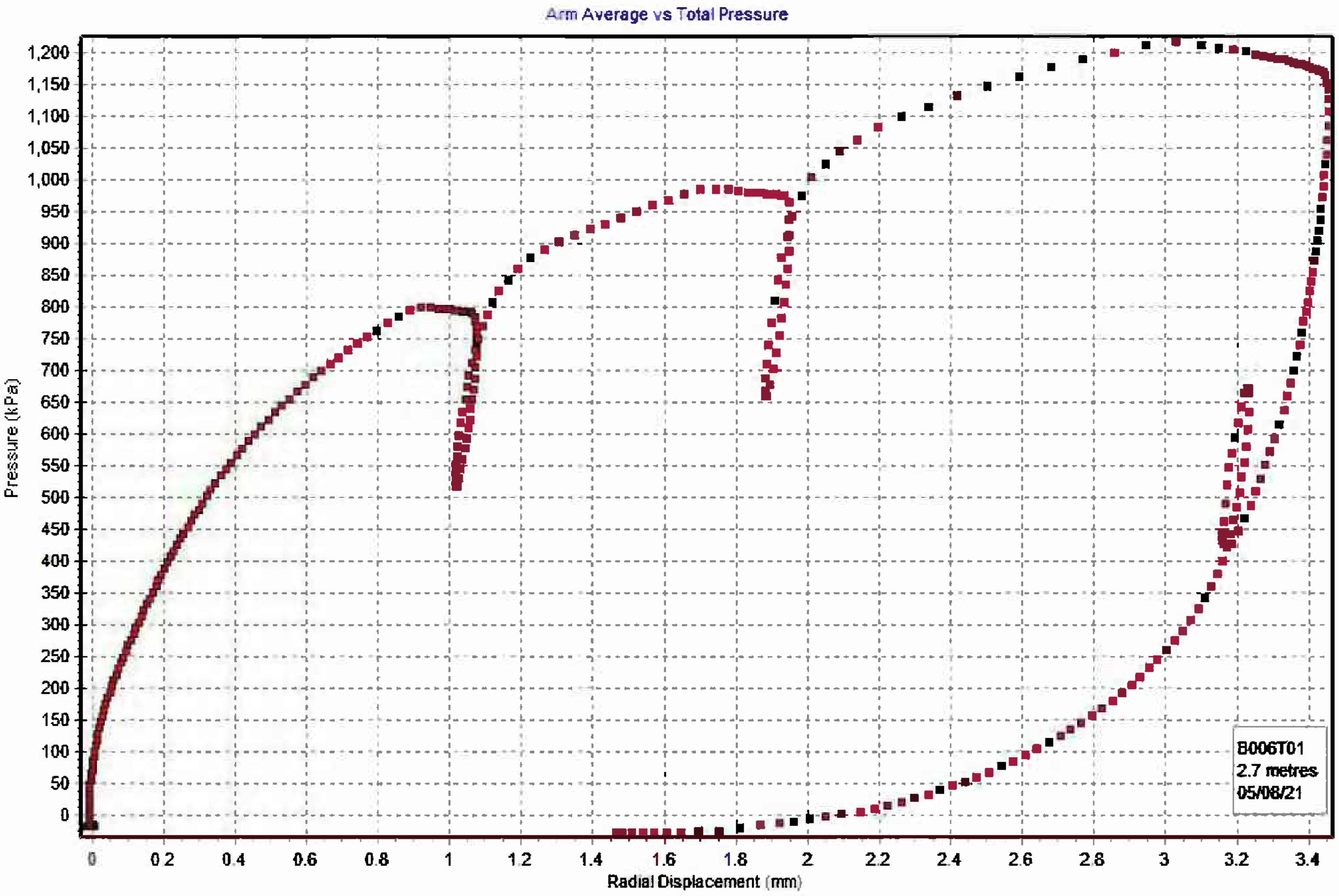
[COMMENTS]
Slow drilling. Highly anisotropic expansion. Early unload as a result

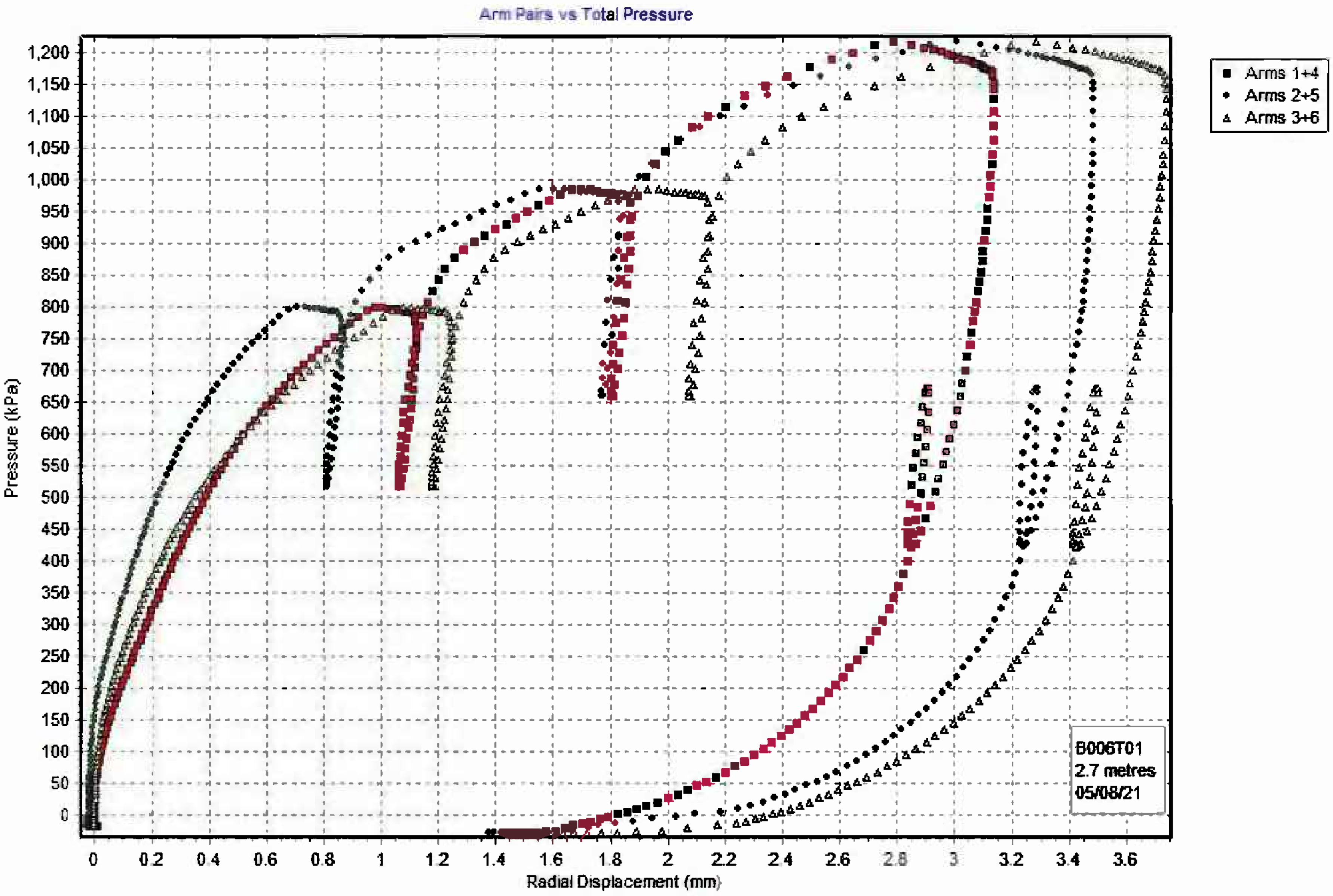
[PROBE DETAILS]
Type : Digital 6 Arm Self Boring Pressuremeter
Diameter over probe : 88.10mm
Diameter under membrane : 79.15mm
CHL strip thickness : 0.5000mm

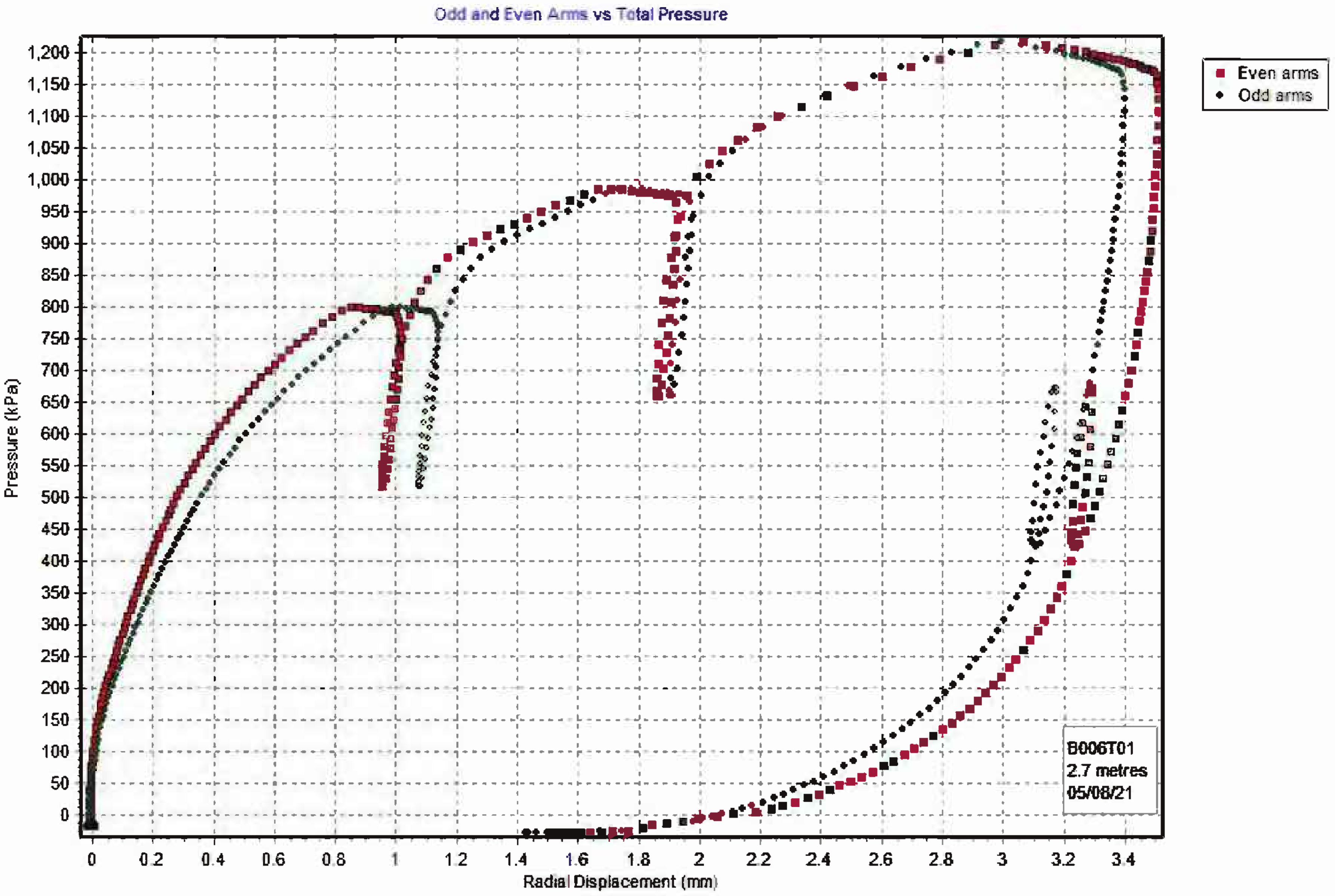
[CALIBRATION FACTORS]

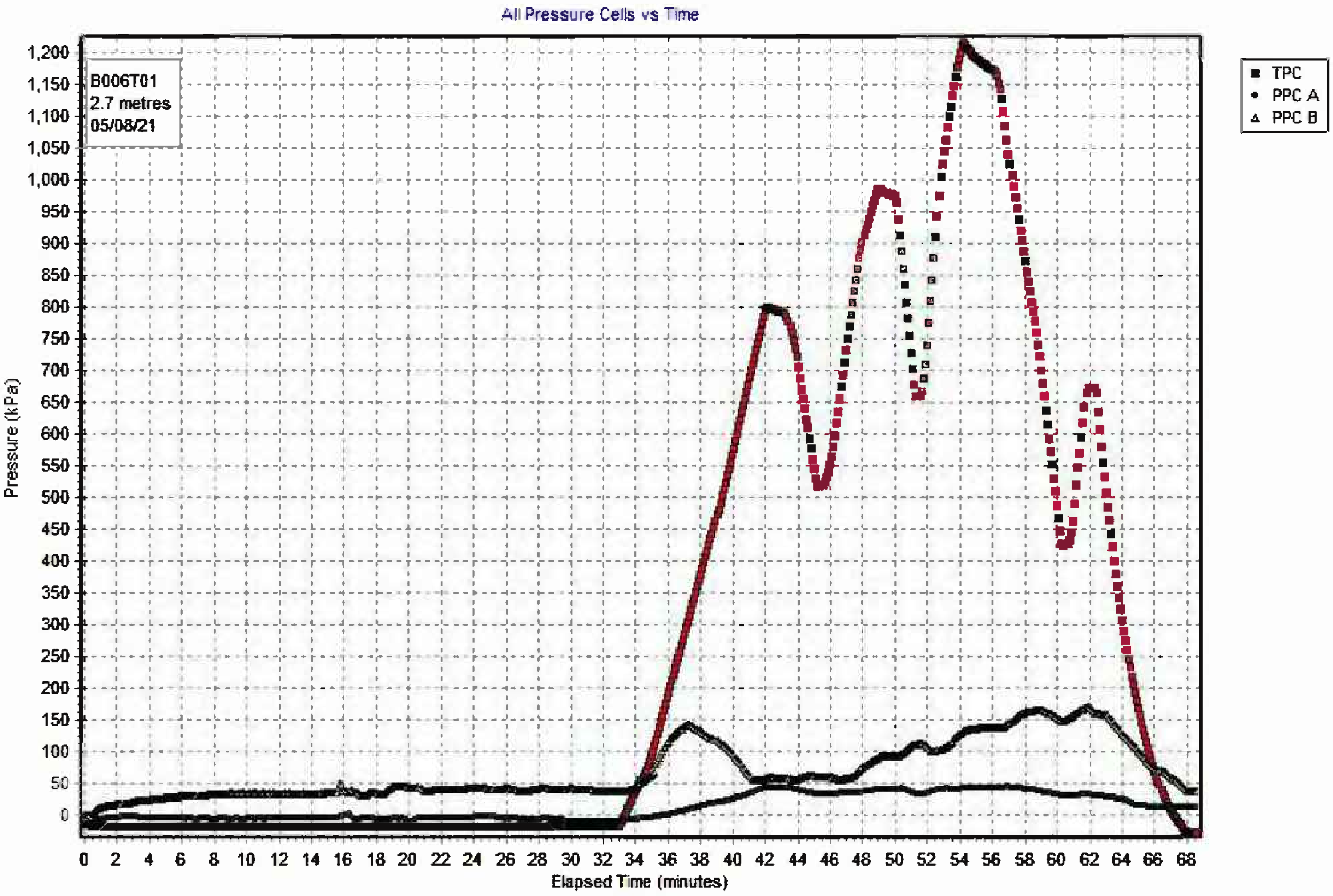
	TRANSDUCERS	MEMBRANE	COMPLIANCE
ARM 1	-81.0 mV and 306.3 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
ARM 2	-929.5 mV and 326.5 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
ARM 3	-330.5 mV and 326.9 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
ARM 4	75.0 mV and 330.0 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
ARM 5	74.0 mV and 330.4 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
ARM 6	-133.2 mV and 329.0 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
PPC A	-2520.1 mV and 402.4 mV/MPa		
PPC B	-2345.1 mV and 388.5 mV/MPa		
TPC	-2381.6 mV and 457.3 mV/MPa		


All Arms vs Total Pressure
■ Arm 1
● Arm 2
△ Arm 3
▼ Arm 4
+ Arm 5
× Arm 6
B006T01
2.7 metres
05/08/21
Pressure (kPa)
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Radial Displacement (mm)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5


Arm Average vs Total Pressure
Pressure (kPa)
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
Radial Displacement (mm)
B006T01
2.7 metres
05/08/21


Arm Pairs vs Total Pressure
Pressure (kPa)
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Radial Displacement (mm)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
3.6
■ Arms 1+4
● Arms 2+5
△ Arms 3+6
B006T01
2.7 metres
05/08/21


Odd and Even Arms vs Total Pressure
Pressure (kPa)
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Radial Displacement (mm)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
Even arms
Odd arms
B006T01
2.7 metres
05/08/21


All Pressure Cells vs Time
B006T01
2.7 metres
05/08/21
■ TPC
● PPC A
△ PPC B
Pressure (kPa)
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68
Elapsed Time (minutes)

B006T02 - TEST & CALIBRATION DETAILS

[PROJECT DETAILS]
Contract name : CWW TPR

[BOREHOLE DETAILS]
Borehole : BH_STW_006

[TEST DETAILS]
Test name : B006T02
Test date : 05/08/21
Depth (M) : 7.60
Material: : Structureless chalk
Heading (deg) : n/a
Data Rate (secs) : 6
Start Line : 1
Stop Line : 252

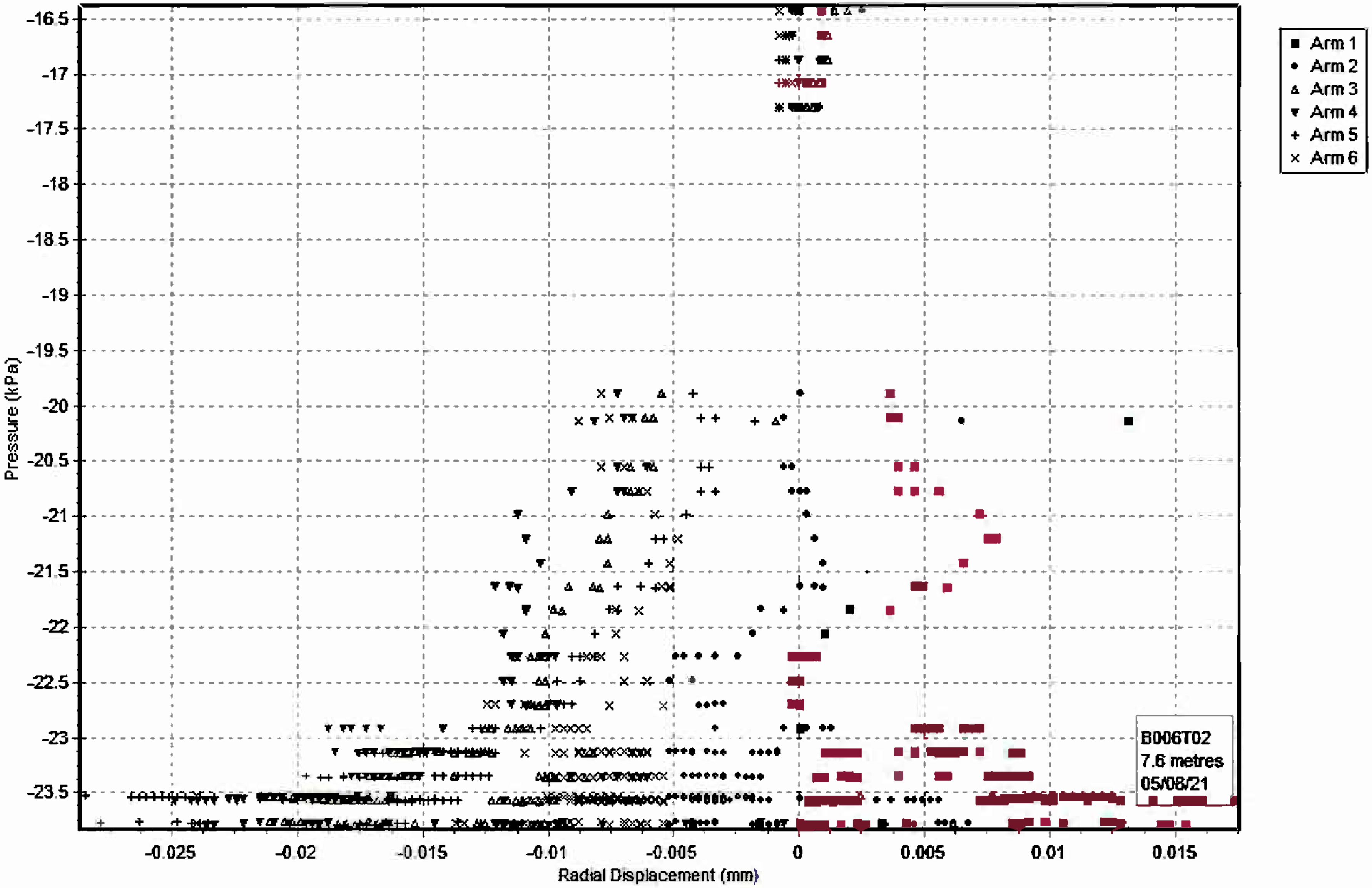
[COMMENTS]
SBPM hit obstruction (likely a clast) during drilling. Test terminated.

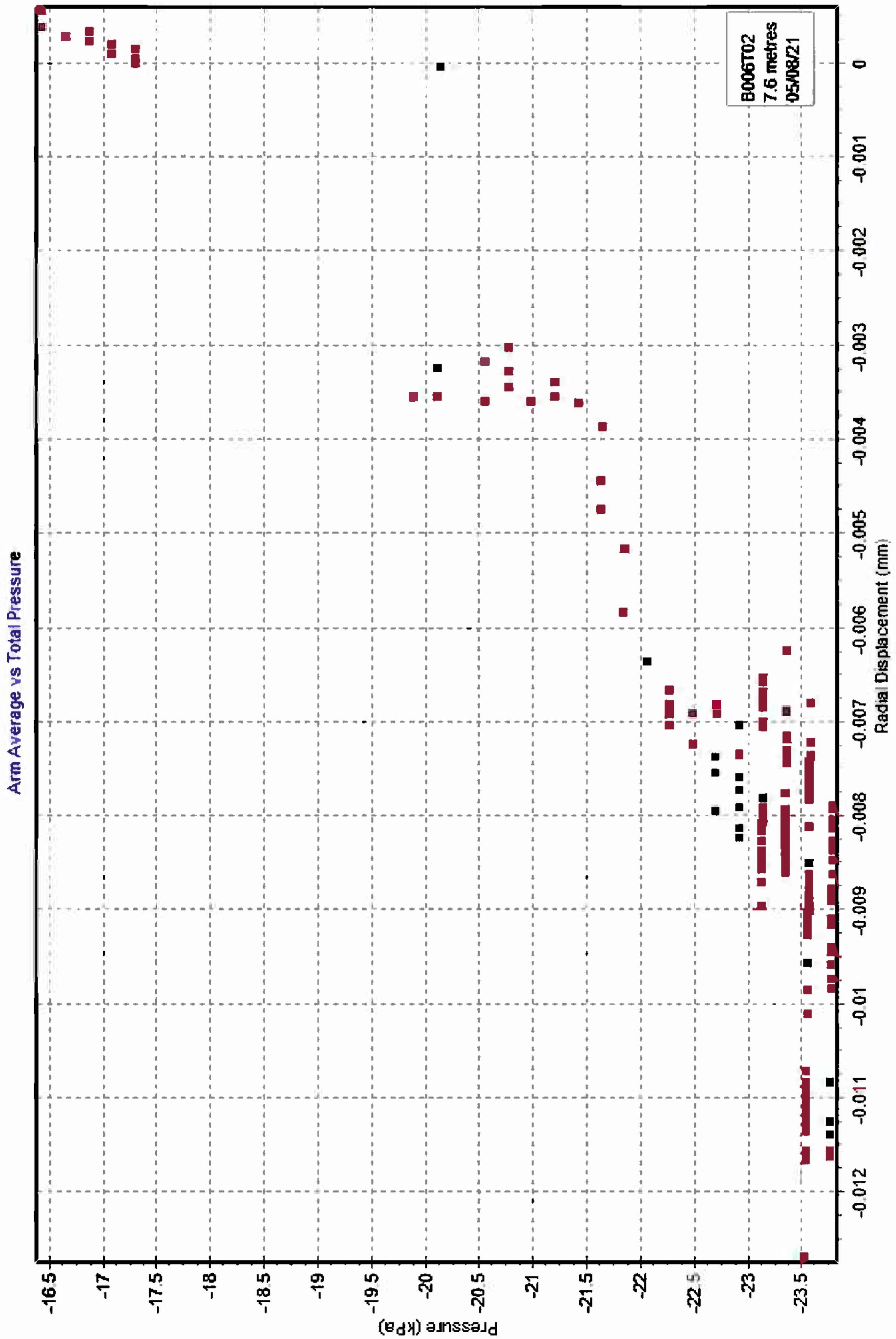
[PROBE DETAILS]
Type : Digital 6 Arm Self Boring Pressuremeter
Diameter over probe : 88.10mm
Diameter under membrane : 79.15mm
CHL strip thickness : 0.5000mm

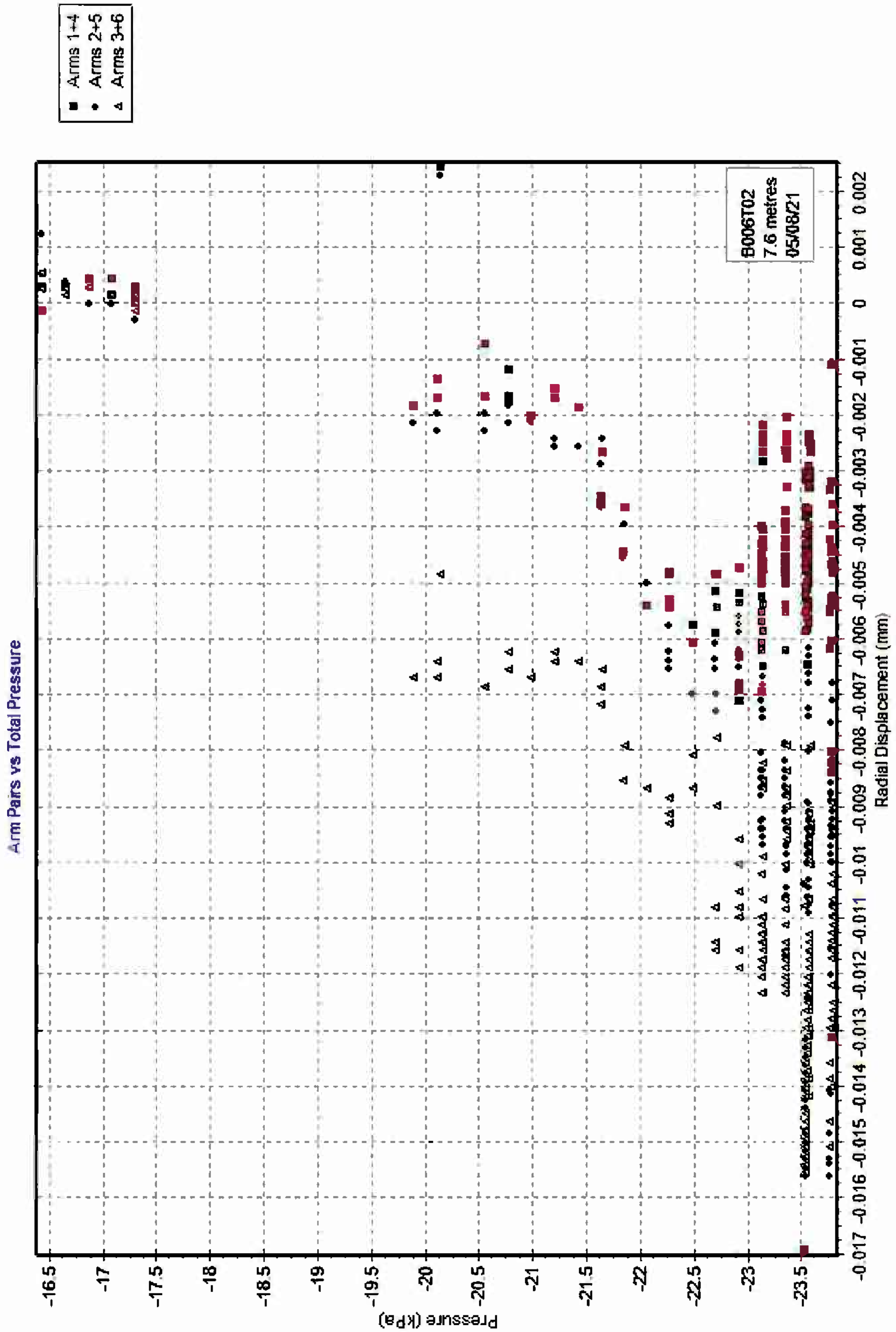
[CALIBRATION FACTORS]

	TRANSDUCERS	MEMBRANE	COMPLIANCE
ARM 1	-82.7 mV and 306.3 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
ARM 2	-932.3 mV and 326.5 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
ARM 3	-332.1 mV and 326.9 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
ARM 4	76.1 mV and 330.0 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
ARM 5	73.8 mV and 330.4 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
ARM 6	-133.3 mV and 329.0 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
PPC A	-2527.1 mV and 402.4 mV/MPa		
PPC B	-2330.2 mV and 388.5 mV/MPa		
TPC	-2380.5 mV and 457.3 mV/MPa		

All Arms vs Total Pressure



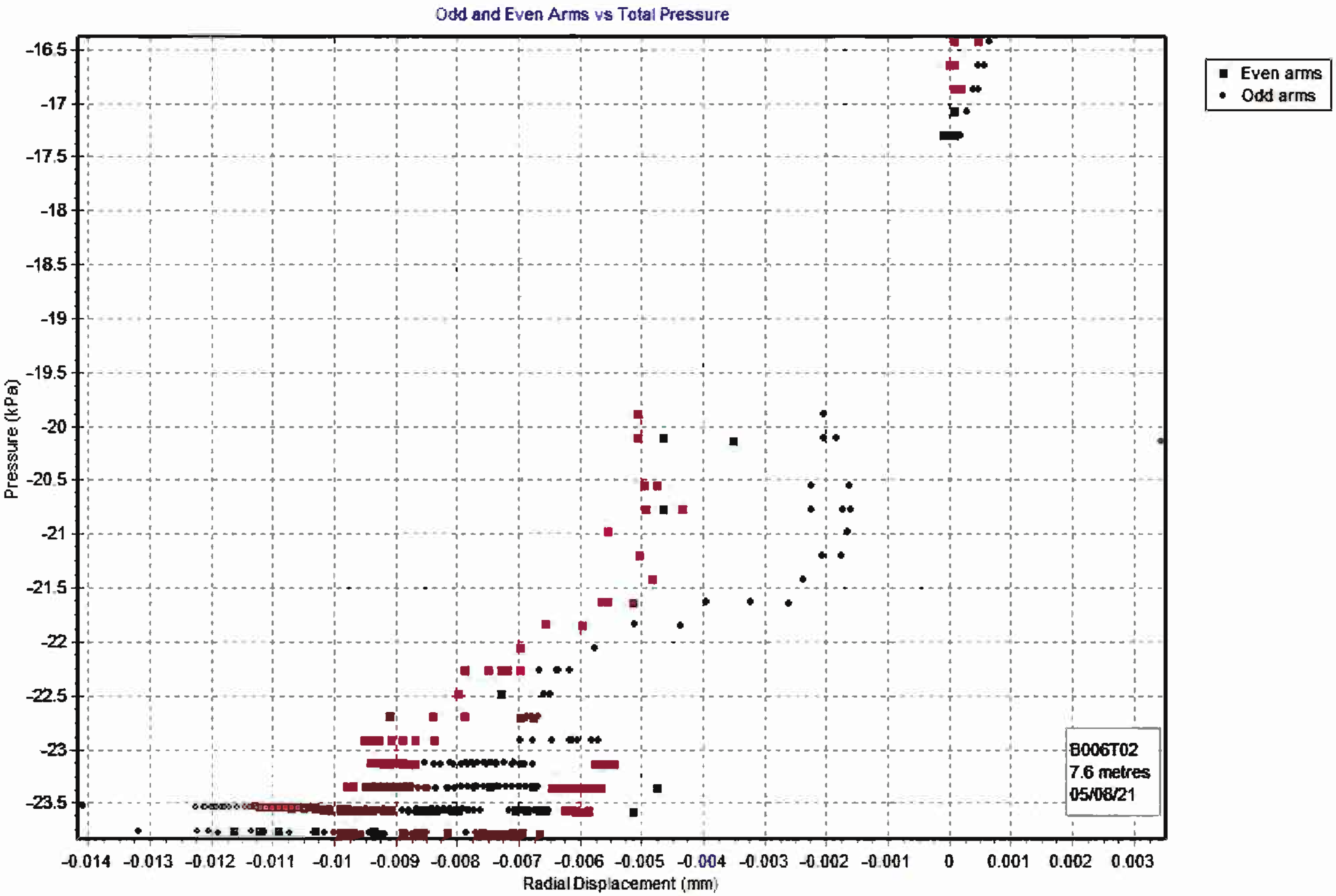

Arm Average vs Total Pressure
B006T02
7.6 metres
05/08/21
Radial Displacement (mm)
0
-0.001
-0.002
-0.003
-0.004
-0.005
-0.006
-0.007
-0.008
-0.009
-0.01
-0.011
-0.012
Pressure (kPa)
-16.5
-17
-17.5
-18
-18.5
-19
-19.5
-20
-20.5
-21
-21.5
-22
-22.5
-23
-23.5

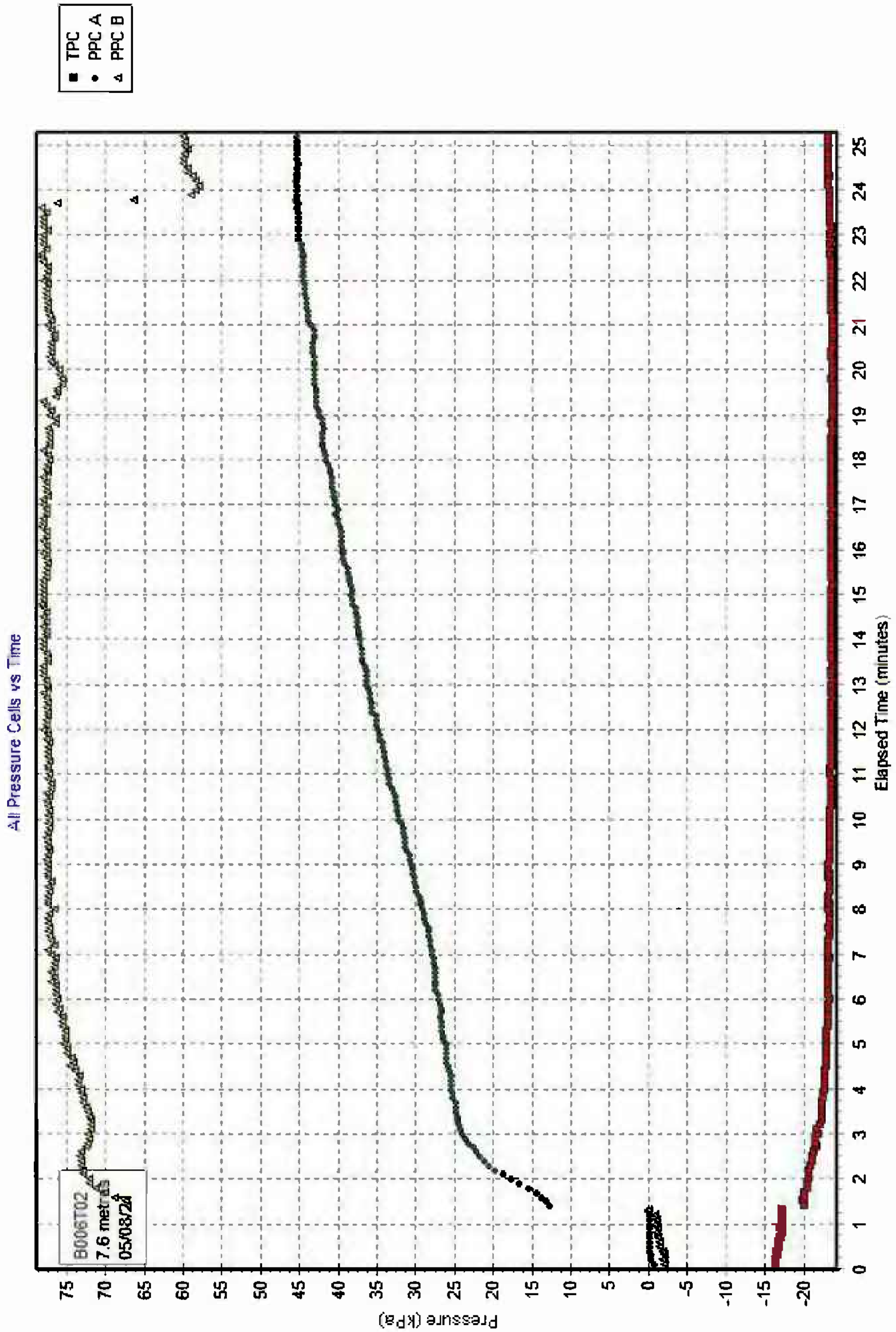

Arm Pairs vs Total Pressure
■ Arms 1+4
● Arms 2+5
△ Arms 3+6
B006T02
7.6 metres
05/08/21
Pressure (kPa)
-16.5
-17
-17.5
-18
-18.5
-19
-19.5
-20
-20.5
-21
-21.5
-22
-22.5
-23
-23.5
Radial Displacement (mm)
-0.017
-0.016
-0.015
-0.014
-0.013
-0.012
-0.011
-0.01
-0.009
-0.008
-0.007
-0.006
-0.005
-0.004
-0.003
-0.002
-0.001
0
0.001
0.002

CIR1506/21

Cambridge WWTPR

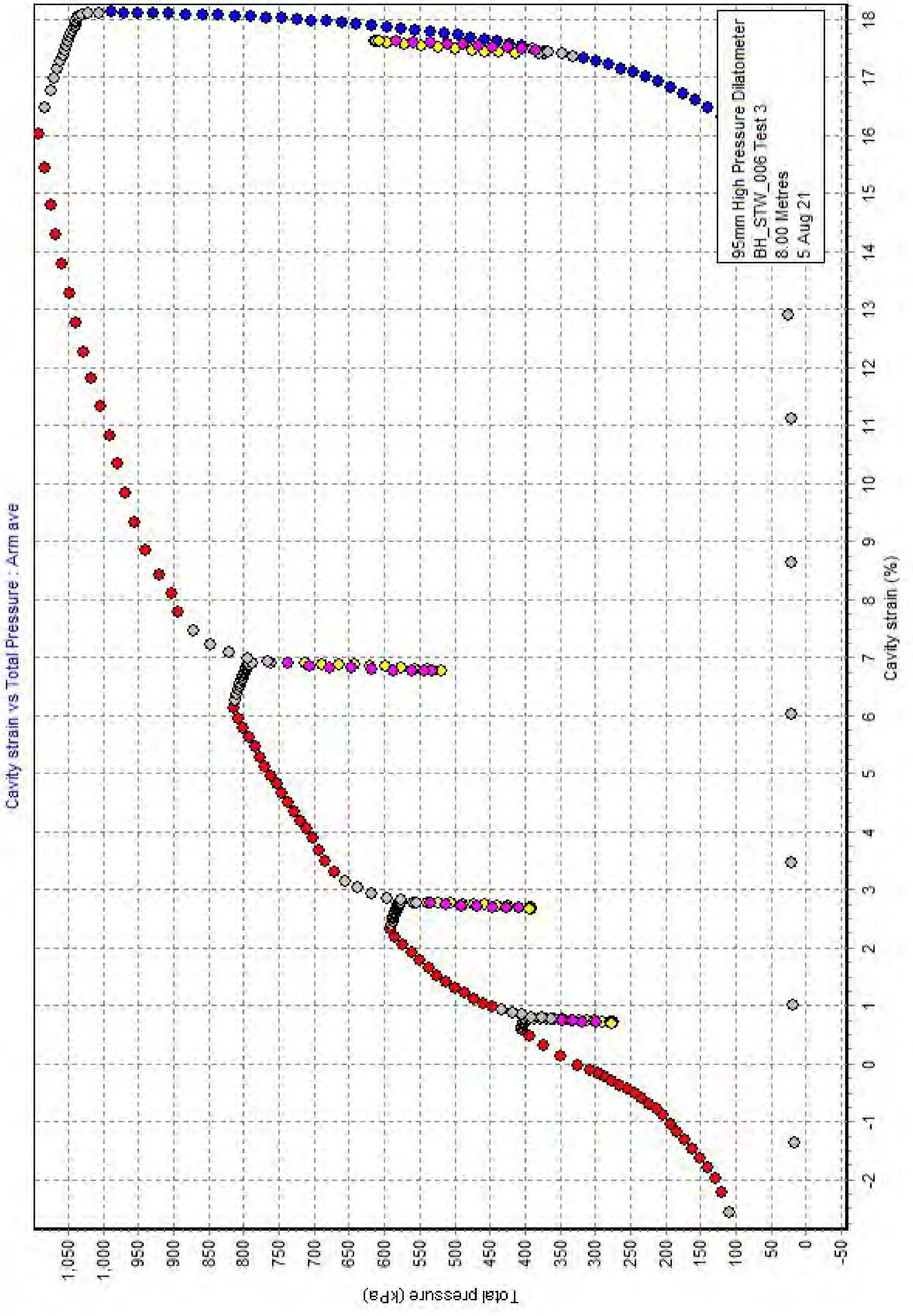
Pressuremeter Testing

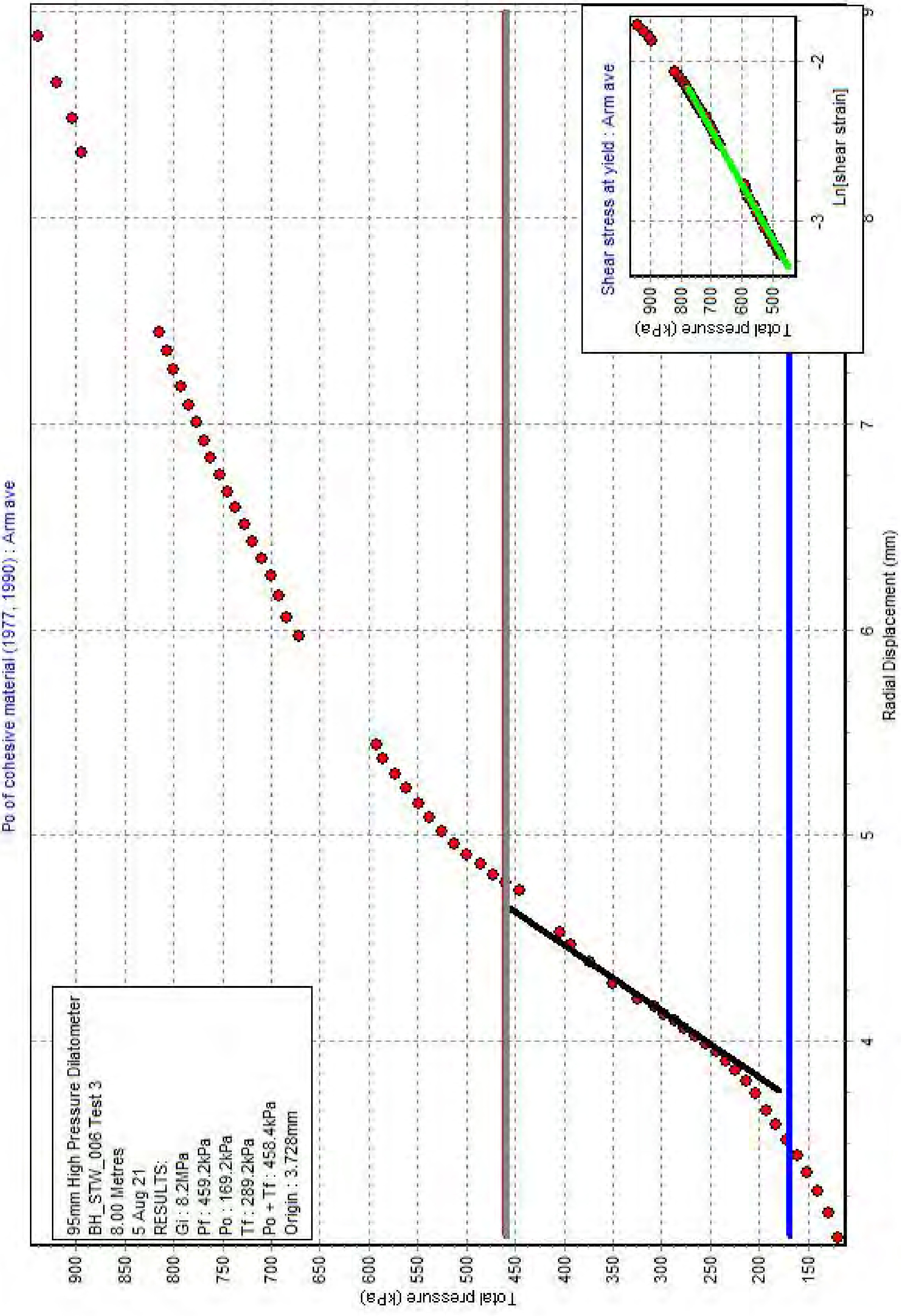


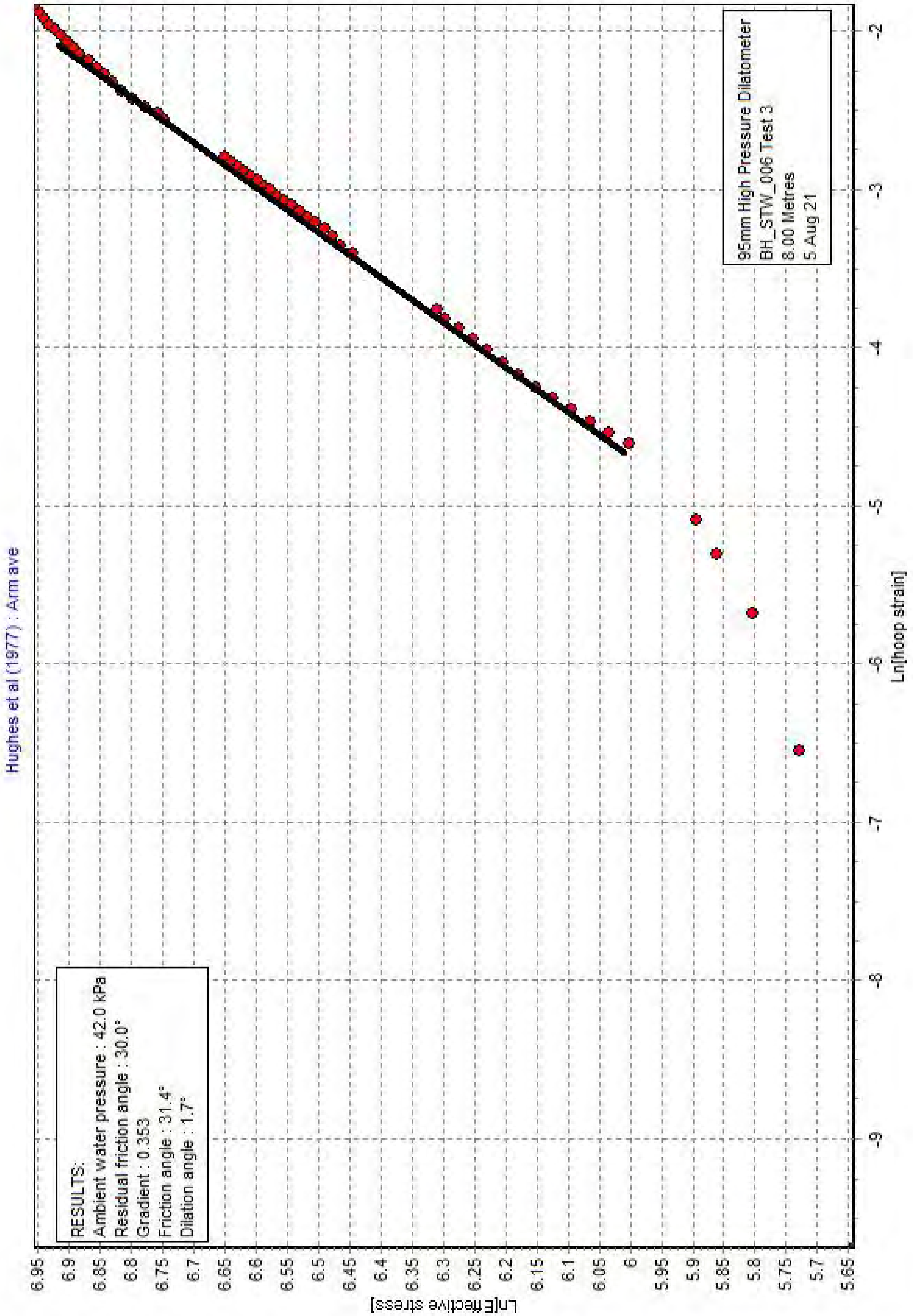

All Pressure Cells vs Time
■ TPC
● PPC A
△ PPC B
B006T02
7.6 metres
05/08/24
Pressure (kPa)
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
-10
-15
-20
Elapsed Time (minutes)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

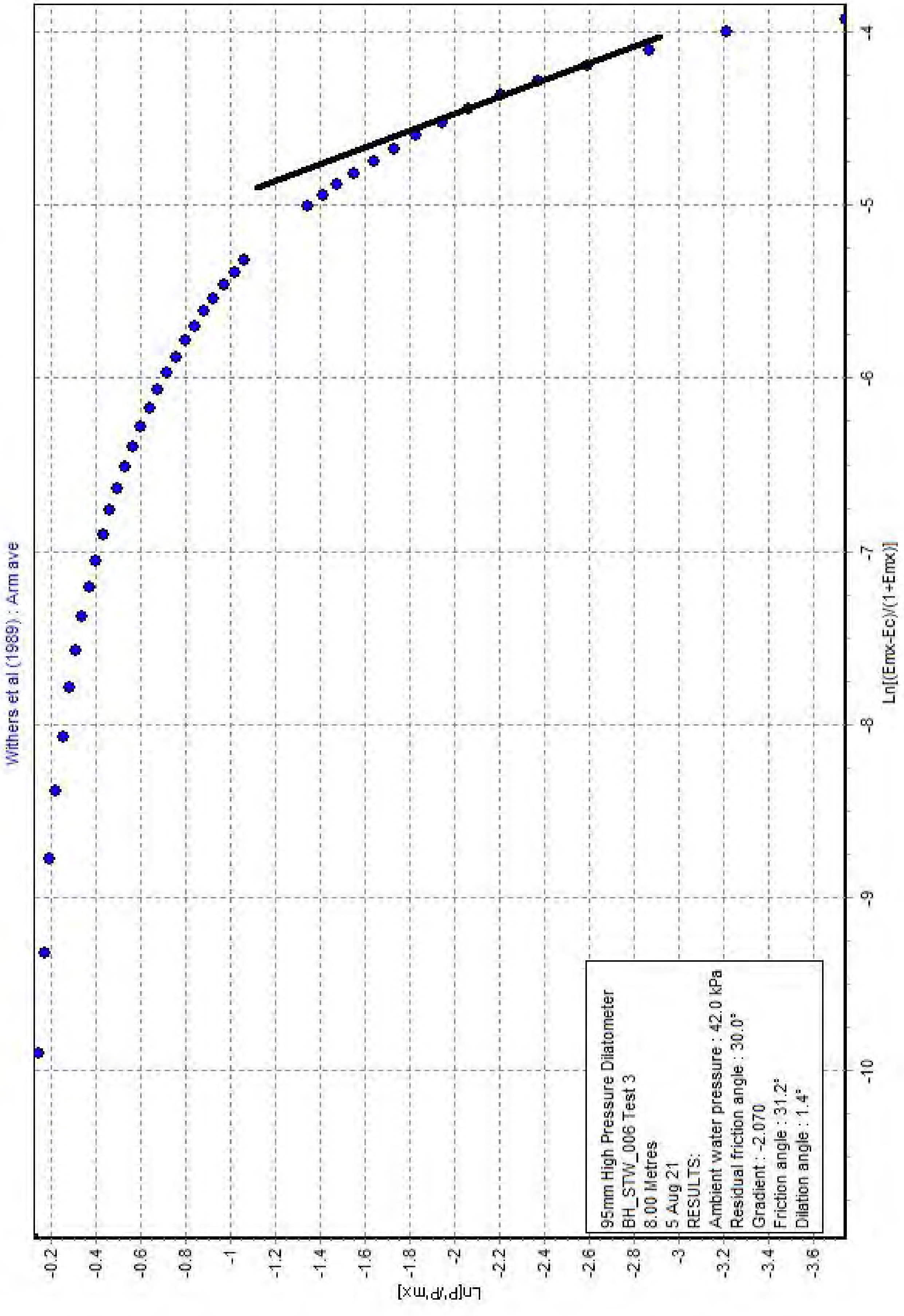
```
BH_STW_006 Test 3 - SUMMARY OF RESULTS
[File made with WinSitu ]

[DETAILS OF TEST]
Project        :   TE8364
Site           :   Cambridge Waste Water Treatment Plant Relocation Project
Borehole       :   BH_STW_006
Test name      :   BH_STW_006 Test 3
Test date      :   5 Aug 21
Test depth     :   8.00 Metres
Water table    :   3.75 Metres
Ambient PWP    :   42.0 kPa
Material       :   Structureless chalk
Probe          :   95mm High Pressure Dilatometer
Diameter       :   97.0 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out
The file includes results from a curve fitting analysis

Analysed by YB/RW on 6 Aug 21

Remarks:

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm)                    :   "Arm ave=4.21"
Po from Marsland & Randolph (kPa)     :   "Arm ave=169.2"
Best estimate of Po (kPa)             :   "Arm ave=109.0"

[UNDRAINED STRENGTH PARAMETERS]
Undrained yield stress (kPa)          :   "Arm ave=459.2"

[DRAINED ANALYSIS OF SANDS]
[Hughes et al 1977]
Constant volume friction angle (°)    :   30.0
Angle of internal friction (°)        :   "Arm ave=31.4"
Dilation angle (°)                    :   "Arm ave=1.7"
Gradient of log-log plot              :   "Arm ave=0.353"

[Withers et al 1989]
Angle of internal friction (°)        :   "Arm ave=31.2"
Dilation angle (°)                    :   "Arm ave=1.4"
Gradient of log-log plot              :   "Arm ave=-2.070"

[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=8.2"
Axis       Loop   Value    Mean Strain  Mean Pc  dE      dPc
           No     (MPa)    (%)          (kPa)    (%)     (kPa)
Arm ave    1      66.7     0.760        316      0.122   81
Arm ave    2      84.2     2.746        464      0.176   148
Arm ave    3      89.3     6.853        628      0.247   221
Arm ave    4      68.3     17.540       494      0.341   233

[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]
Axis       Loop   Intercept  Alpha      Gradient
           No     (MPa)      (MPa)
Arm ave    1      15.373     11.993     0.780
Arm ave    2      9.989      6.584      0.659
Arm ave    3      10.399     6.608      0.635
Arm ave    4      7.610      4.512      0.593


[PARAMETERS USED FOR DRAINED CURVE MODELLING]
{Axis is  Arm ave}
Strain Origin (mm)                    :   4.21
Po (kPa)                              :   109
Cohesion (kPa)                        :   5
Angle of peak friction (deg)          :   31.4
Angle of peak dilation (deg)          :   1.7
Total yield stress (kPa)              :   218
```

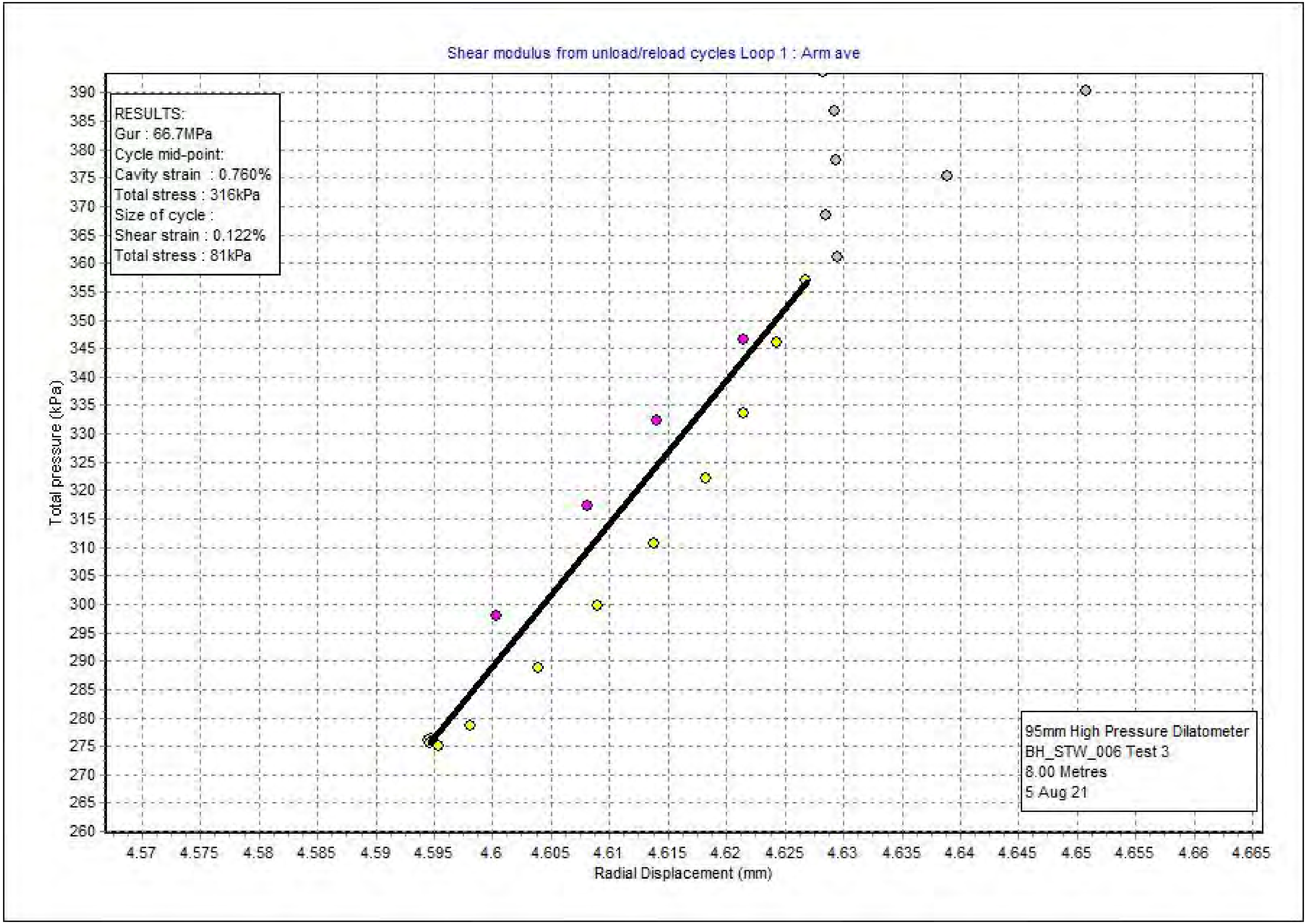
```
BH_STW_006 Test 3 - SUMMARY OF RESULTS
Total limit stress (kPa)            :   1717
G at first yield (MPa)              :   43.9
Non-linear exponent                 :   0.635
Janbu exponent                      :   0.255
Correlation                         :   0.651

Ambient pore water pressure (kPa)   :   24
Residual friction angle (deg)       :   30.0
Poisson's ratio                     :   0.25
```

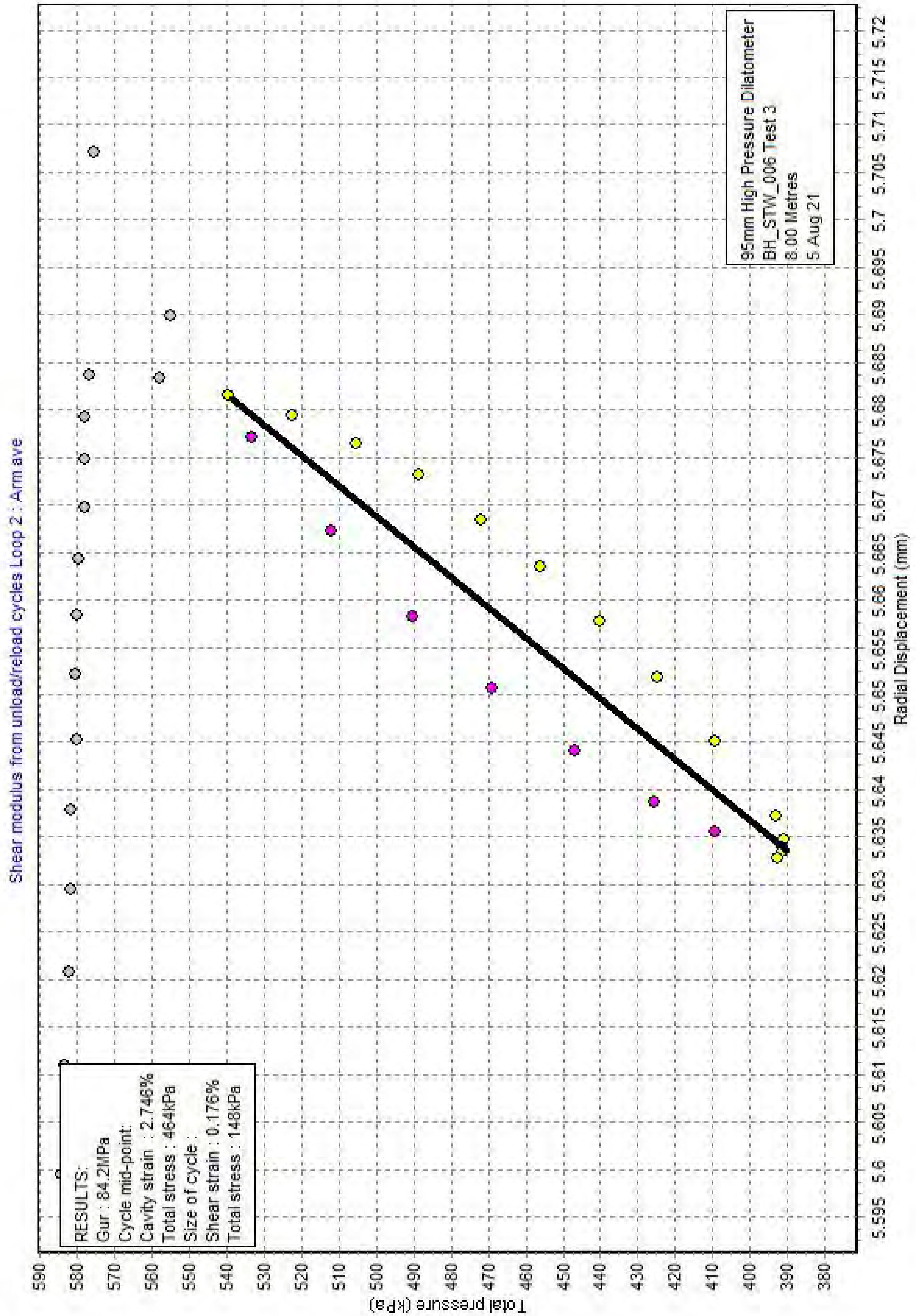

Cavity strain vs Total Pressure : Arm ave
95mm High Pressure Dilatometer
BH_STW_006 Test 3
8.00 Metres
5 Aug 21
Total pressure (kPa)
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
-50
Cavity strain (%)
-2
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

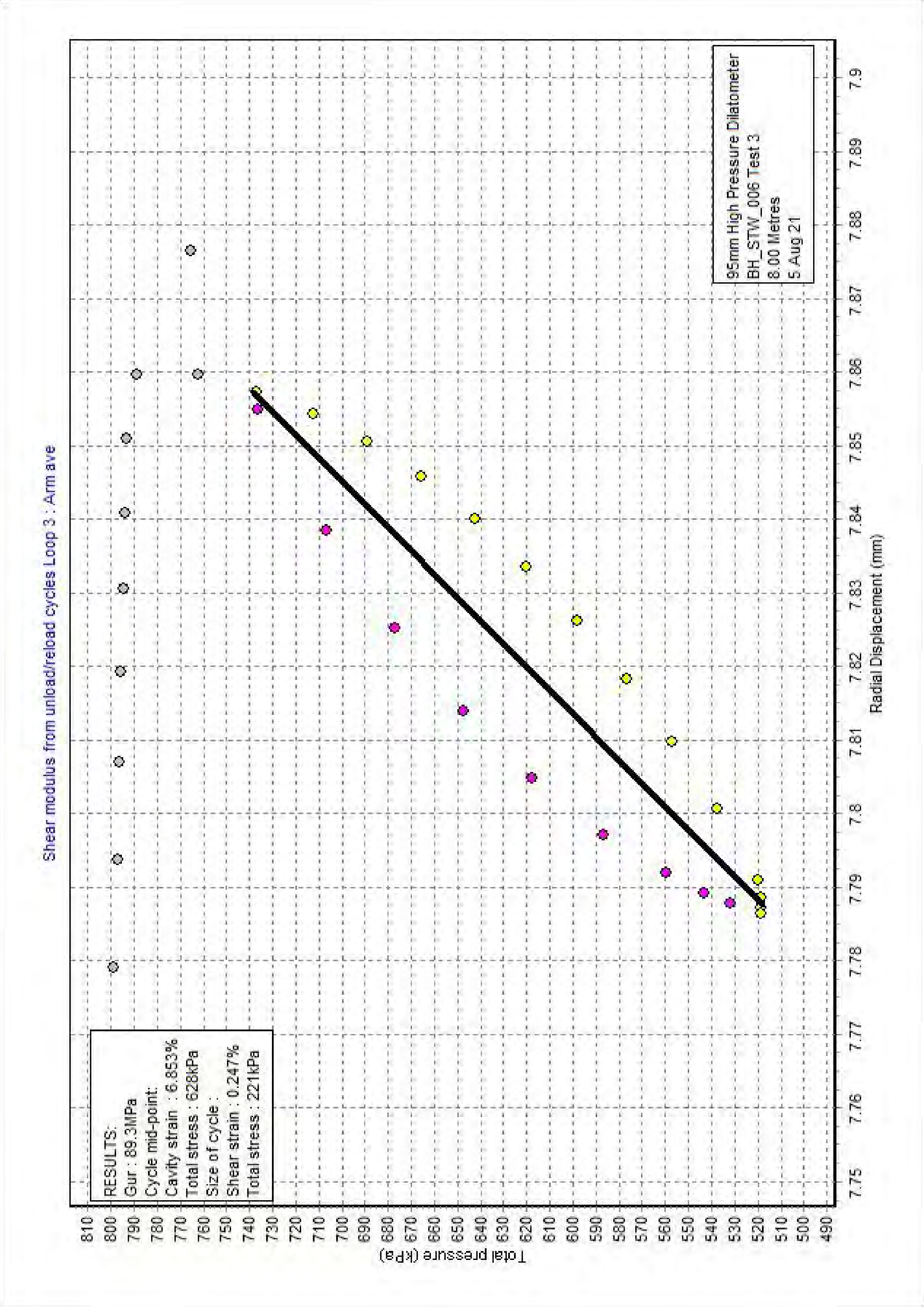

Po of cohesive material (1977, 1990) : Arm ave
95mm High Pressure Dilatometer
BH_STW_006 Test 3
8.00 Metres
5 Aug 21
RESULTS:
Gi : 8.2MPa
Pf : 459.2kPa
Po : 169.2kPa
Tf : 289.2kPa
Po + Tf : 458.4kPa
Origin : 3.728mm
Total pressure (kPa)
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
Radial Displacement (mm)
4
5
6
7
8
9
Shear stress at yield : Arm ave
Total pressure (kPa)
900
800
700
600
500
Ln[shear strain]
-3
-2

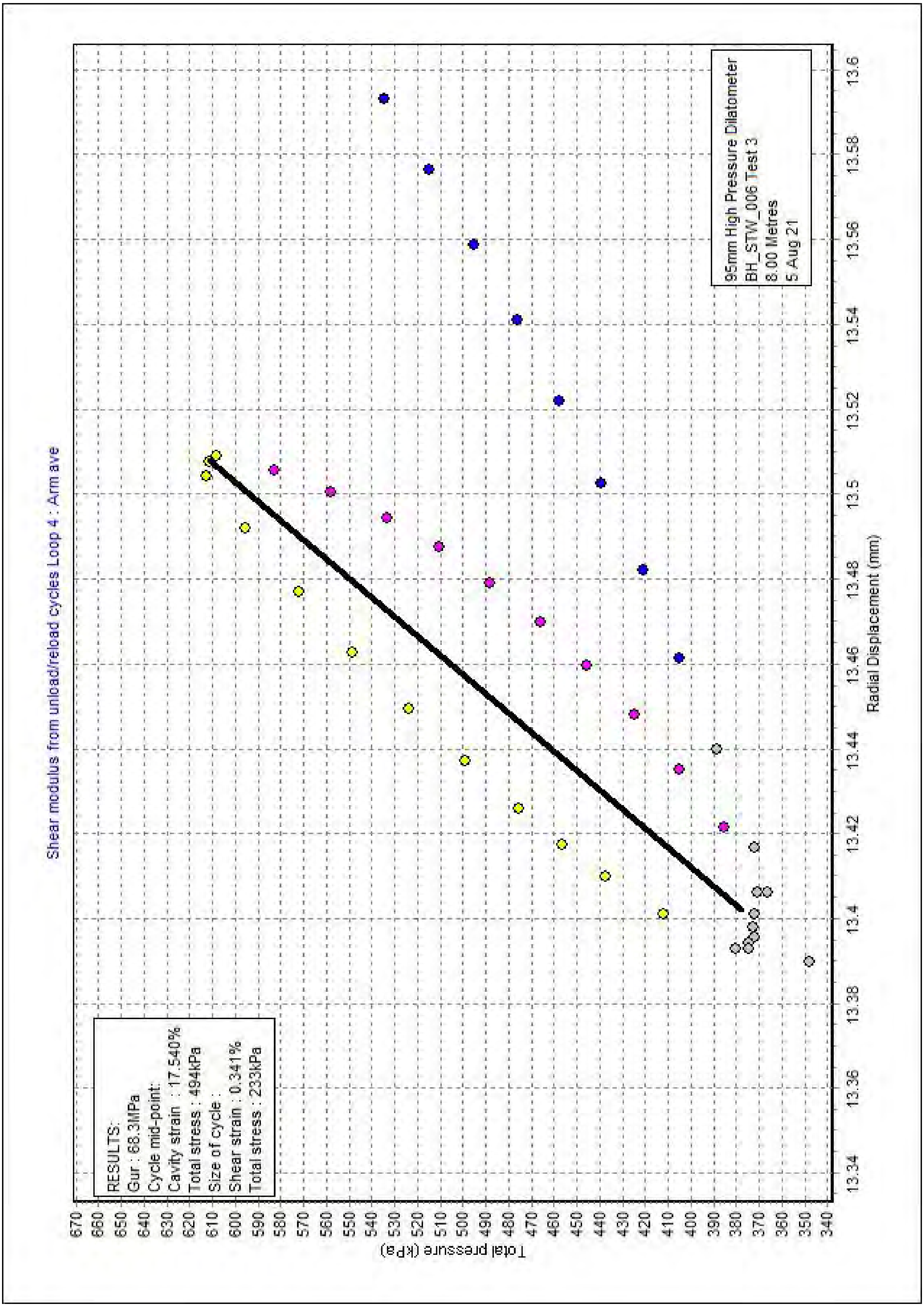

Hughes et al (1977) : Arm ave
95mm High Pressure Dilatometer
BH_STW_006 Test 3
8.00 Metres
5 Aug 21
RESULTS:
Ambient water pressure : 42.0 kPa
Residual friction angle : 30.0°
Gradient : 0.353
Friction angle : 31.4°
Dilation angle : 1.7°
Ln[hoop strain]
-2
-3
-4
-5
-6
-7
-8
-9
Ln[Effective stress]
6.95
6.9
6.85
6.8
6.75
6.7
6.65
6.6
6.55
6.5
6.45
6.4
6.35
6.3
6.25
6.2
6.15
6.1
6.05
6
5.95
5.9
5.85
5.8
5.75
5.7
5.65

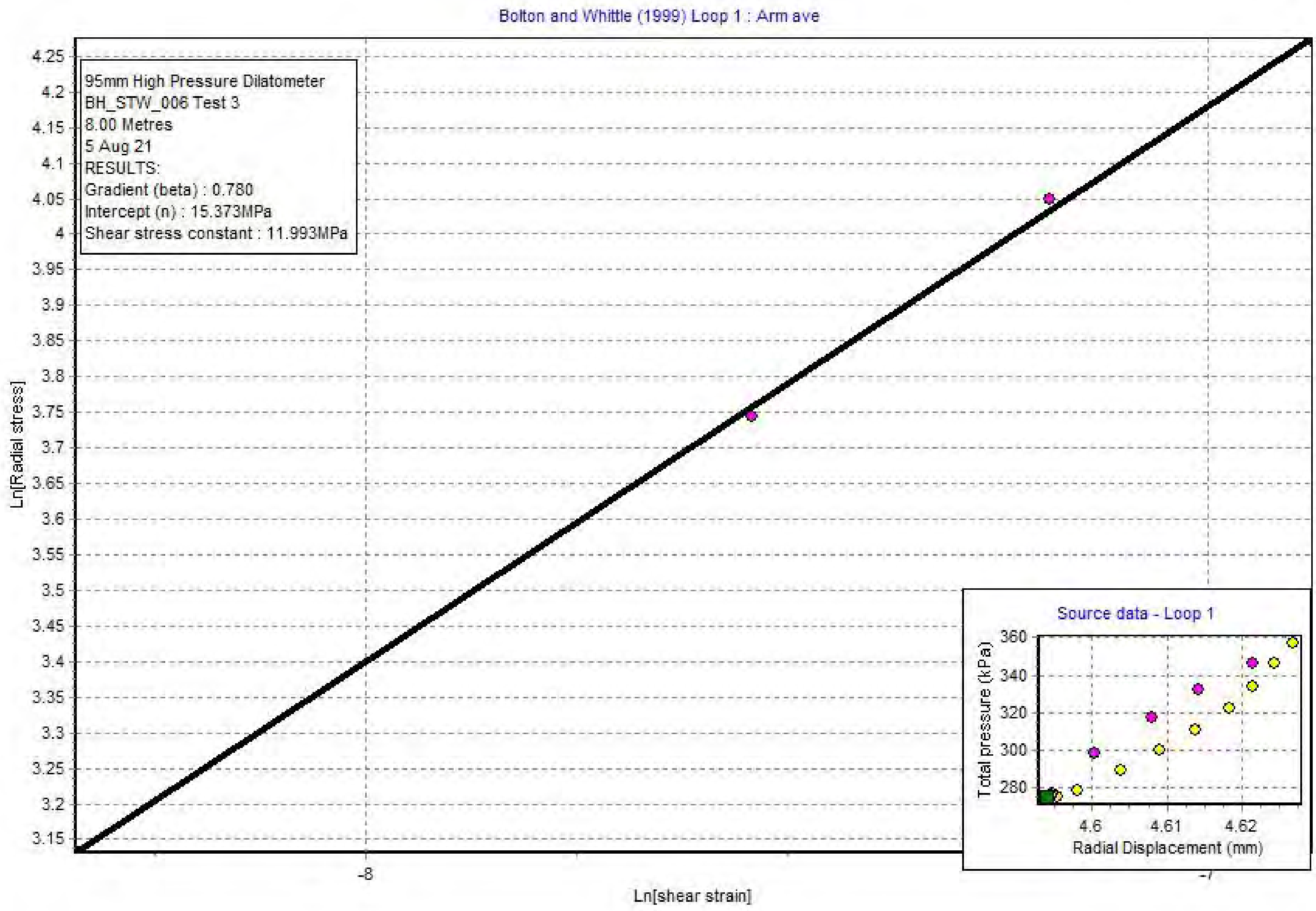

Withers et al (1989) : Arm ave
Ln[(Emx-Ec)/(1+Emx)]
Ln[P'/P'mx]
-4
-5
-6
-7
-8
-9
-10
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-1.8
-2
-2.2
-2.4
-2.6
-2.8
-3
-3.2
-3.4
-3.6
95mm High Pressure Dilatometer
BH_STW_006 Test 3
8.00 Metres
5 Aug 21
RESULTS:
Ambient water pressure : 42.0 kPa
Residual friction angle : 30.0°
Gradient : -2.070
Friction angle : 31.2°
Dilation angle : 1.4°

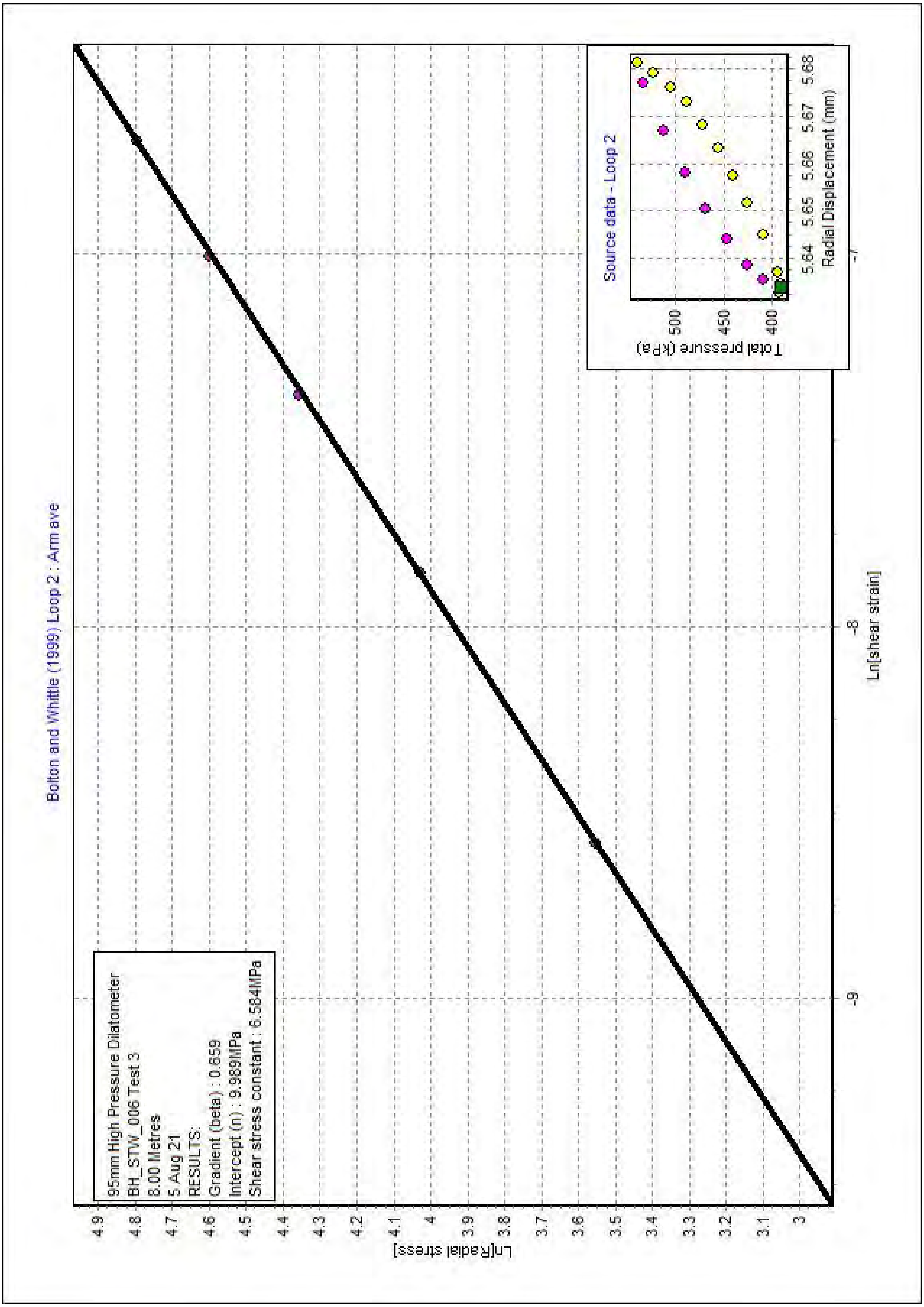

Shear modulus from unload/reload cycles Loop 1 : Arm ave
RESULTS:
Gur : 66.7MPa
Cycle mid-point:
Cavity strain : 0.760%
Total stress : 316kPa
Size of cycle :
Shear strain : 0.122%
Total stress : 81kPa
95mm High Pressure Dilatometer
BH_STW_006 Test 3
8.00 Metres
5 Aug 21
Total pressure (kPa)
390
385
380
375
370
365
360
355
350
345
340
335
330
325
320
315
310
305
300
295
290
285
280
275
270
265
260
Radial Displacement (mm)
4.57
4.575
4.58
4.585
4.59
4.595
4.6
4.605
4.61
4.615
4.62
4.625
4.63
4.635
4.64
4.645
4.65
4.655
4.66
4.665


Shear modulus from unload/reload cycles Loop 2 : Arm ave
95mm High Pressure Dilatometer
BH_STW_006 Test 3
8.00 Metres
5 Aug 21
RESULTS:
Gur : 84.2MPa
Cycle mid-point:
Cavity strain : 2.746%
Total stress : 464kPa
Size of cycle :
Shear strain : 0.176%
Total stress : 148kPa
Radial Displacement (mm)
5.595
5.6
5.605
5.61
5.615
5.62
5.625
5.63
5.635
5.64
5.645
5.65
5.655
5.66
5.665
5.67
5.675
5.68
5.685
5.69
5.695
5.7
5.705
5.71
5.715
5.72
Total pressure (kPa)
590
580
570
560
550
540
530
520
510
500
490
480
470
460
450
440
430
420
410
400
390
380

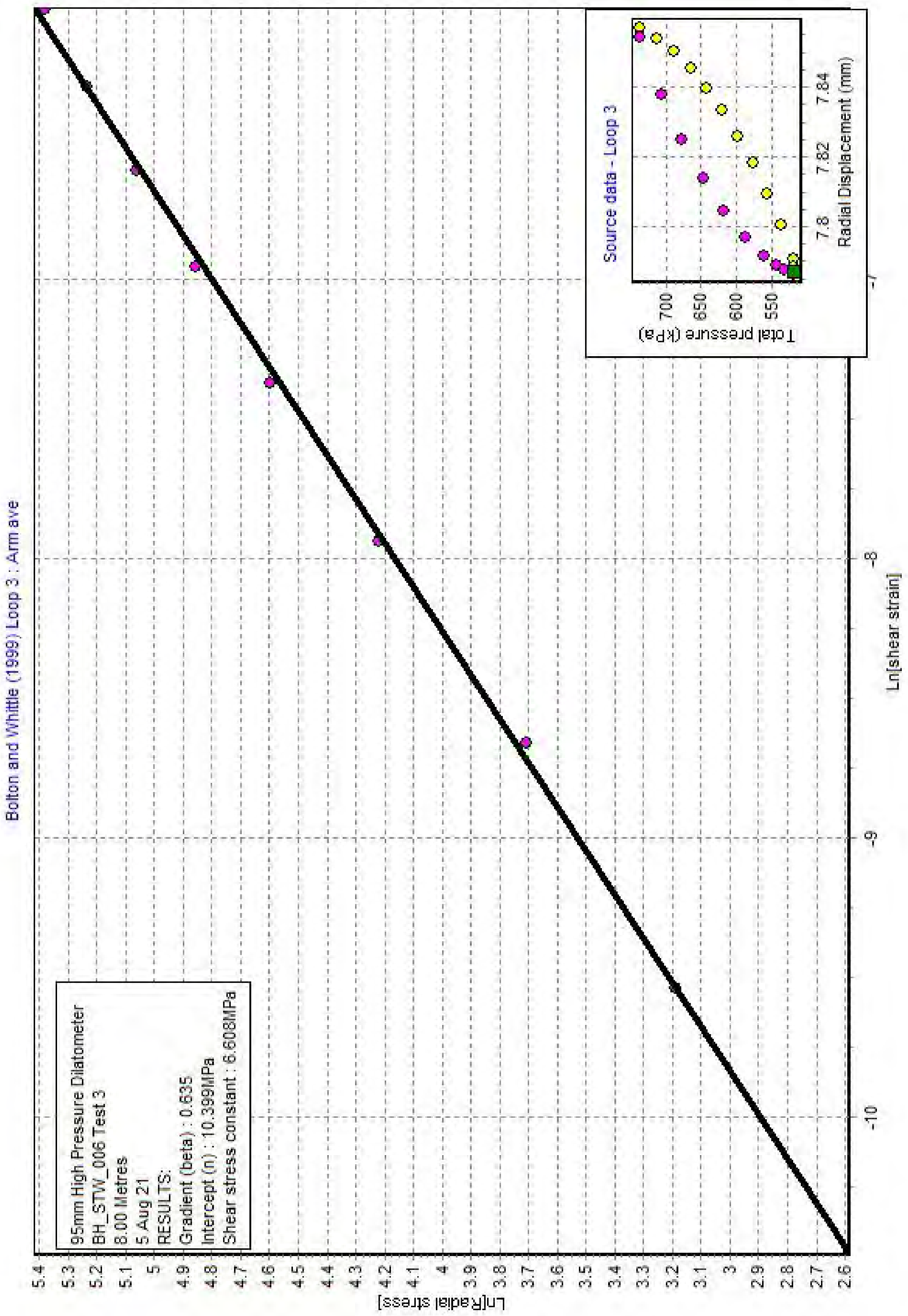

Shear modulus from unload/reload cycles Loop 3 : Arm ave
95mm High Pressure Dilatometer
BH_STW_006 Test 3
8.00 Metres
5 Aug 21
RESULTS:
Gur : 89.3MPa
Cycle mid-point:
Cavity strain : 6.853%
Total stress : 628kPa
Size of cycle :
Shear strain : 0.247%
Total stress : 221kPa
Total pressure (kPa)
810
800
790
780
770
760
750
740
730
720
710
700
690
680
670
660
650
640
630
620
610
600
590
580
570
560
550
540
530
520
510
500
490
Radial Displacement (mm)
7.75
7.76
7.77
7.78
7.79
7.8
7.81
7.82
7.83
7.84
7.85
7.86
7.87
7.88
7.89
7.9


Shear modulus from unload/reload cycles Loop 4 : Arm ave
95mm High Pressure Dilatometer
BH_STW_006 Test 3
8.00 Metres
5 Aug 21
RESULTS:
Gur : 68.3MPa
Cycle mid-point:
Cavity strain : 17.540%
Total stress : 494kPa
Size of cycle :
Shear strain : 0.341%
Total stress : 233kPa
Total pressure (kPa)
670
660
650
640
630
620
610
600
590
580
570
560
550
540
530
520
510
500
490
480
470
460
450
440
430
420
410
400
390
380
370
360
350
340
Radial Displacement (mm)
13.34
13.36
13.38
13.4
13.42
13.44
13.46
13.48
13.5
13.52
13.54
13.56
13.58
13.6

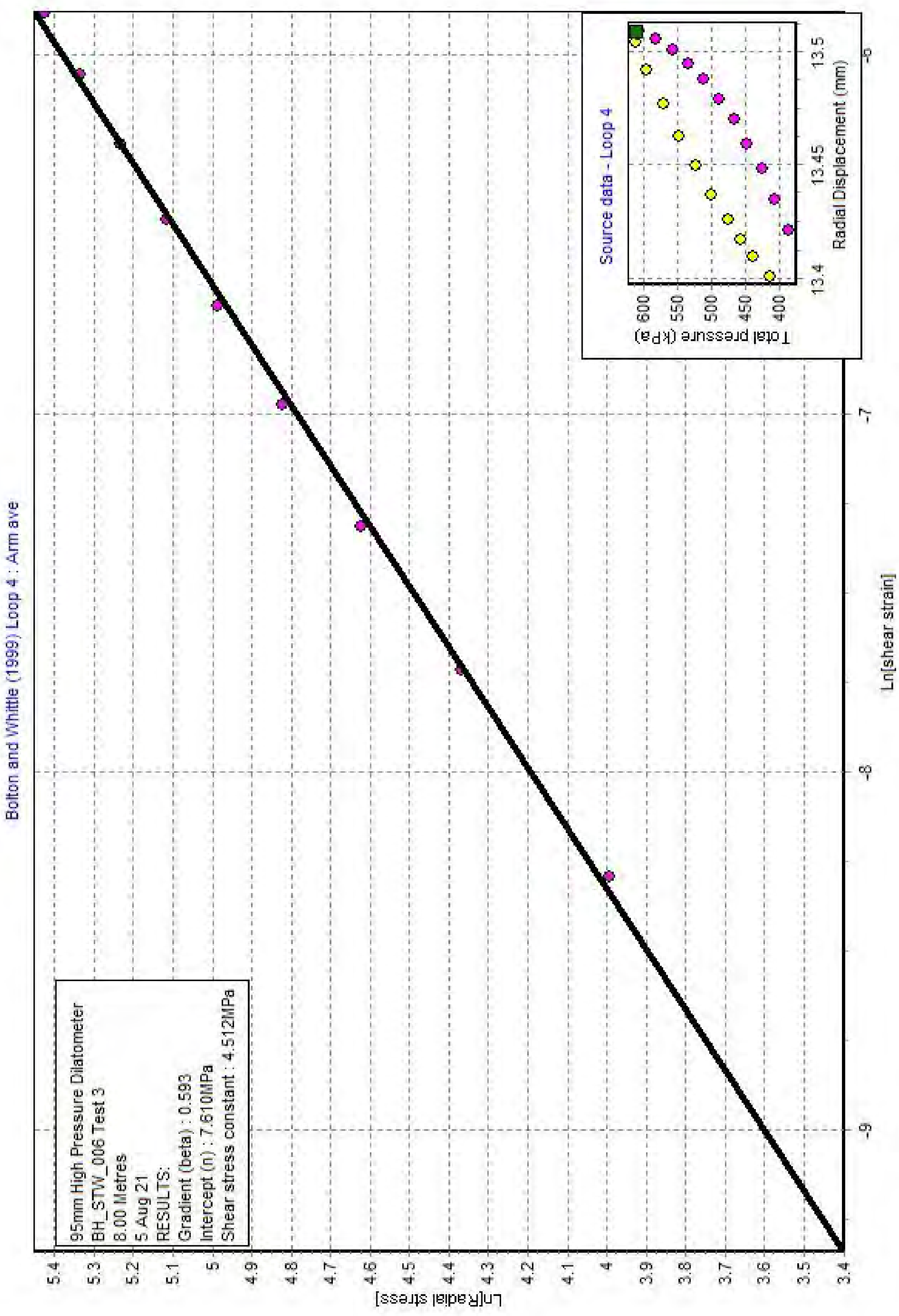

Bolton and Whittle (1999) Loop 1 : Arm ave
95mm High Pressure Dilatometer
BH_STW_006 Test 3
8.00 Metres
5 Aug 21
RESULTS:
Gradient (beta) : 0.780
Intercept (n) : 15.373MPa
Shear stress constant : 11.993MPa
Ln[Radial stress]
4.25
4.2
4.15
4.1
4.05
4
3.95
3.9
3.85
3.8
3.75
3.7
3.65
3.6
3.55
3.5
3.45
3.4
3.35
3.3
3.25
3.2
3.15
-8
-7
Ln[shear strain]
Source data - Loop 1
Total pressure (kPa)
360
340
320
300
280
4.6
4.61
4.62
Radial Displacement (mm)



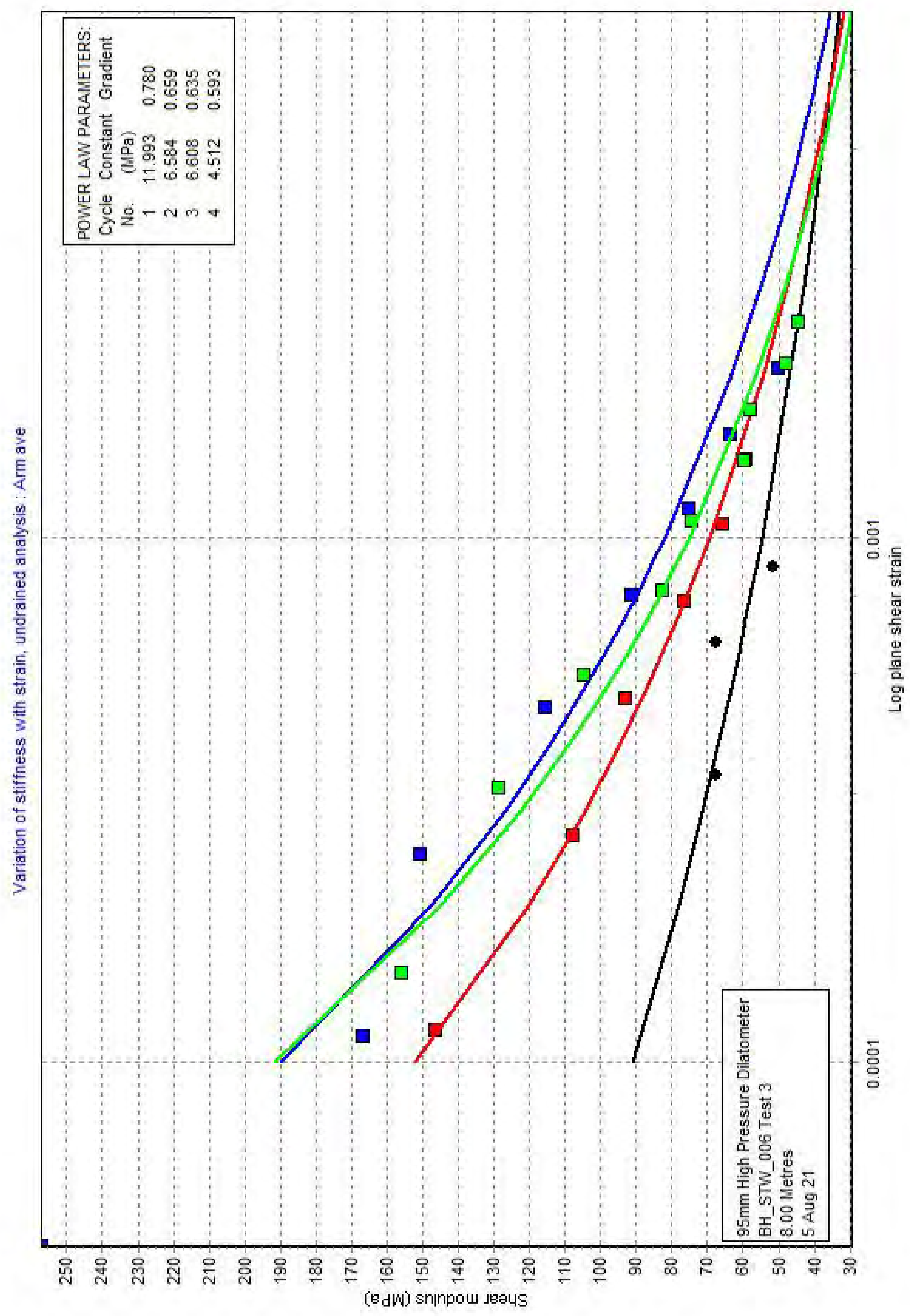
95mm High Pressure Dilatometer
BH_STW_006 Test 3
8.00 Metres
5 Aug 21
RESULTS:
Gradient (beta) : 0.659
Intercept (n) : 9.989MPa
Shear stress constant : 6.584MPa

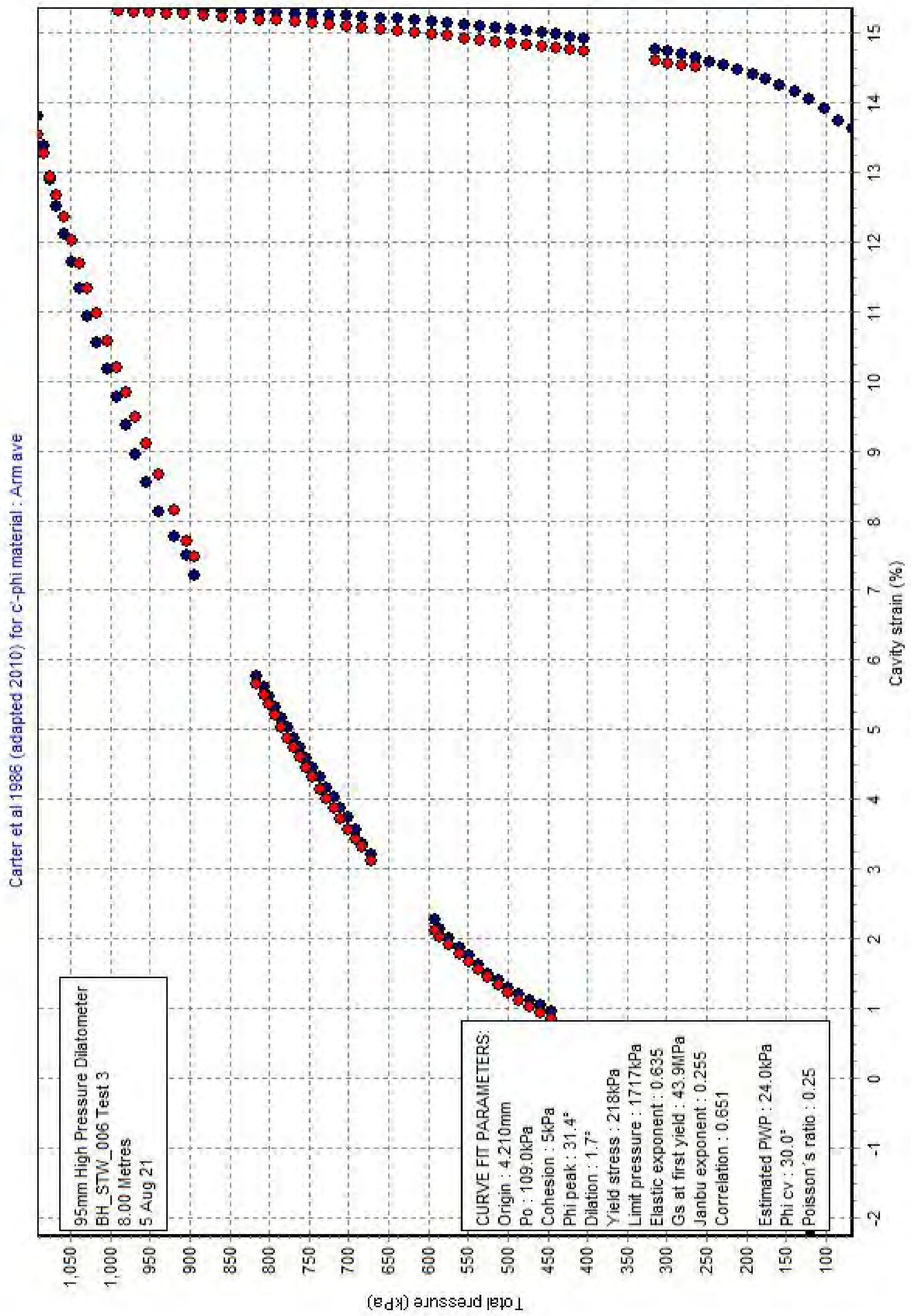


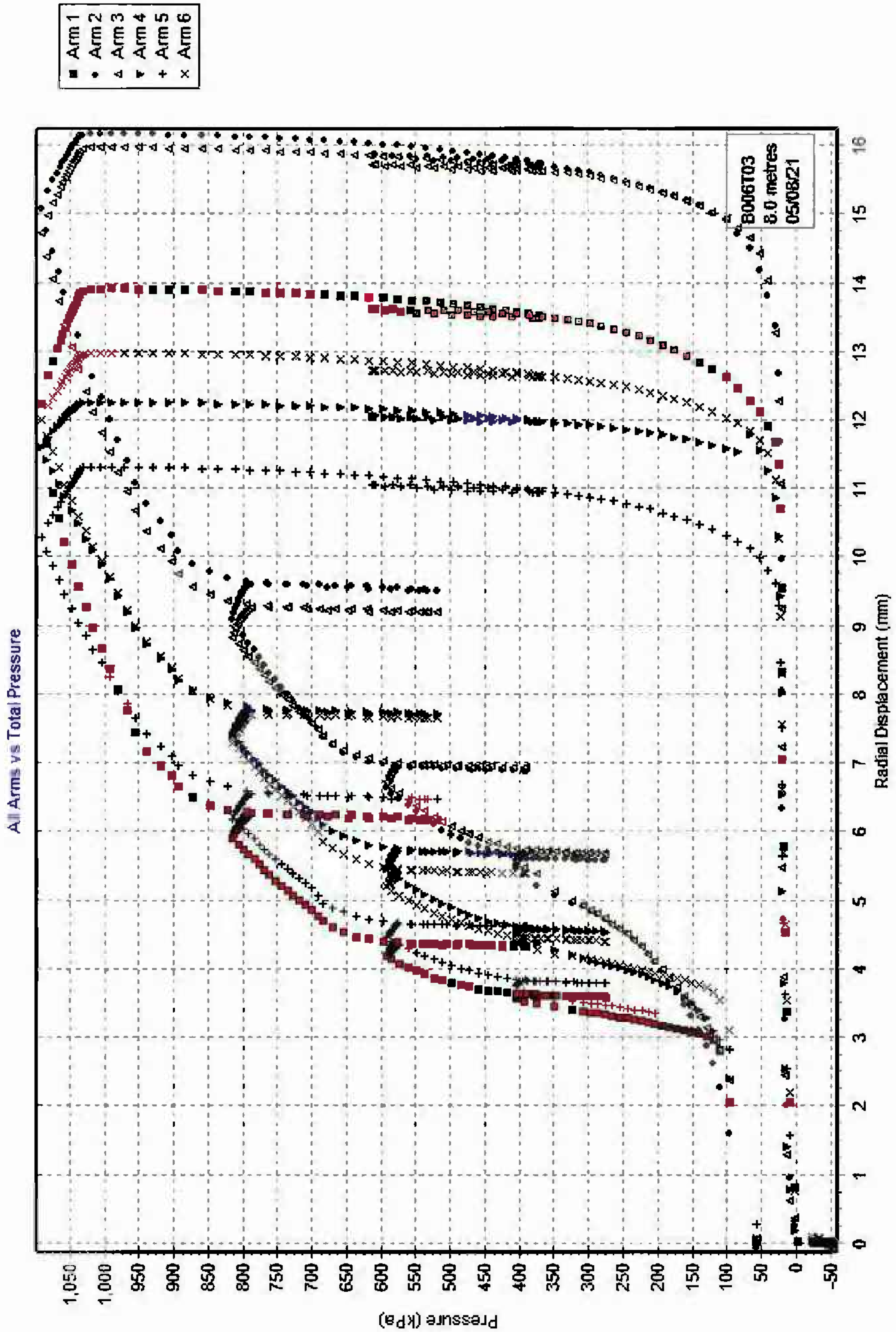
95mm High Pressure Dilatometer
BH_STW_006 Test 3
8.00 Metres
5 Aug 21
RESULTS:
Gradient (beta) : 0.635
Intercept (n) : 10.399MPa
Shear stress constant : 6.608MPa

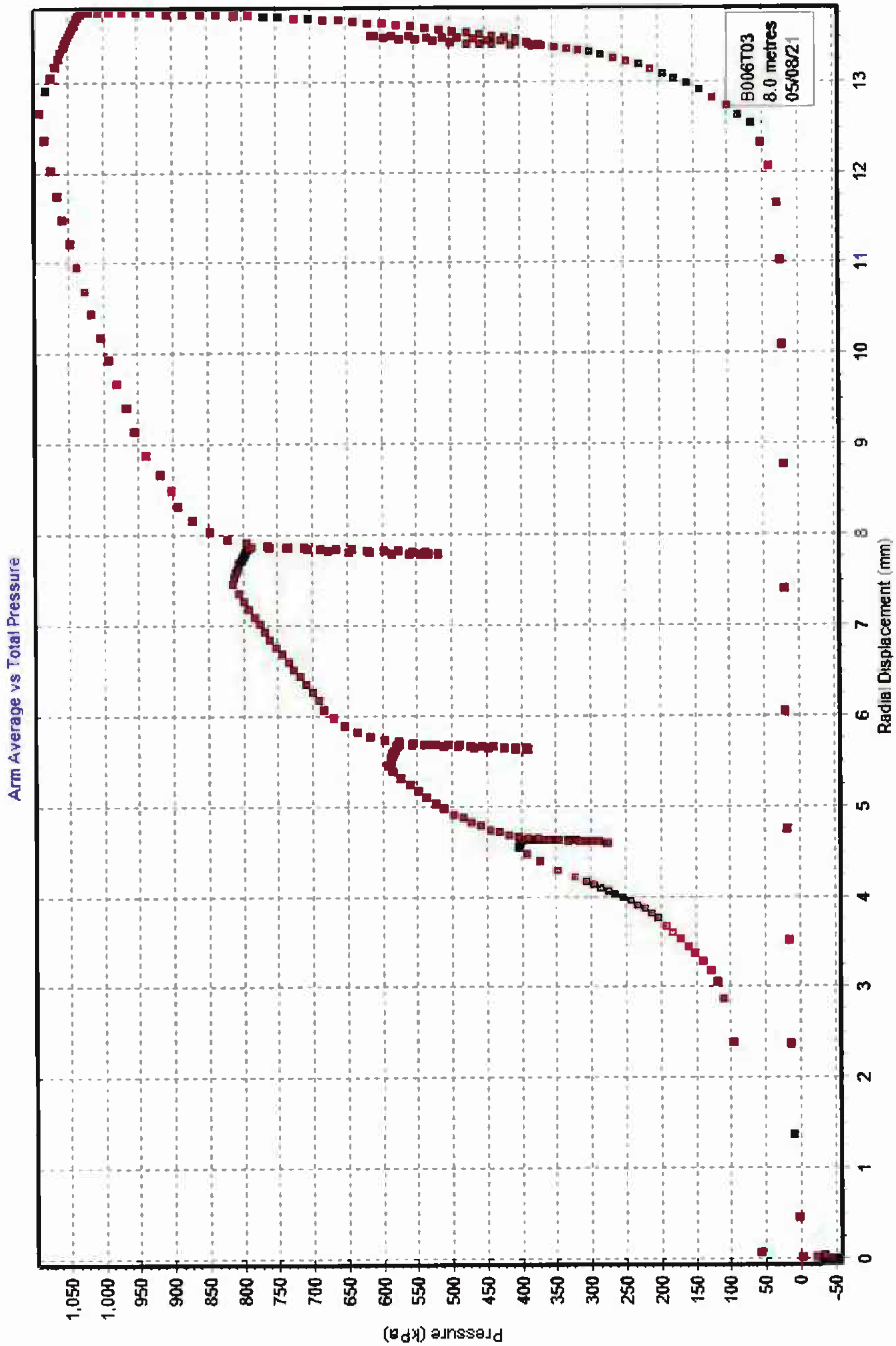


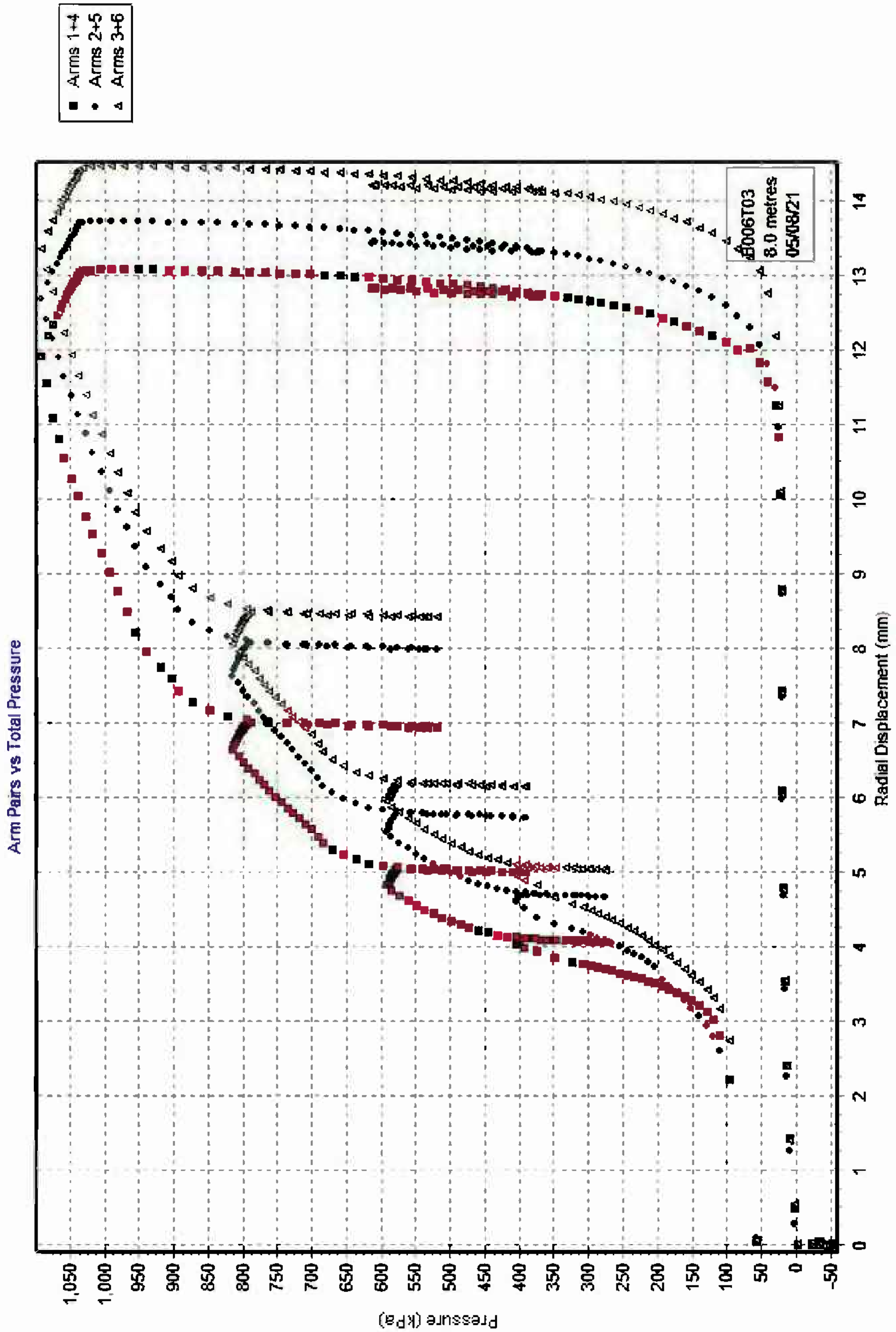
95mm High Pressure Dilatometer
BH_STW_006 Test 3
8.00 Metres
5 Aug 21
RESULTS:
Gradient (beta) : 0.593
Intercept (n) : 7.610MPa
Shear stress constant : 4.512MPa

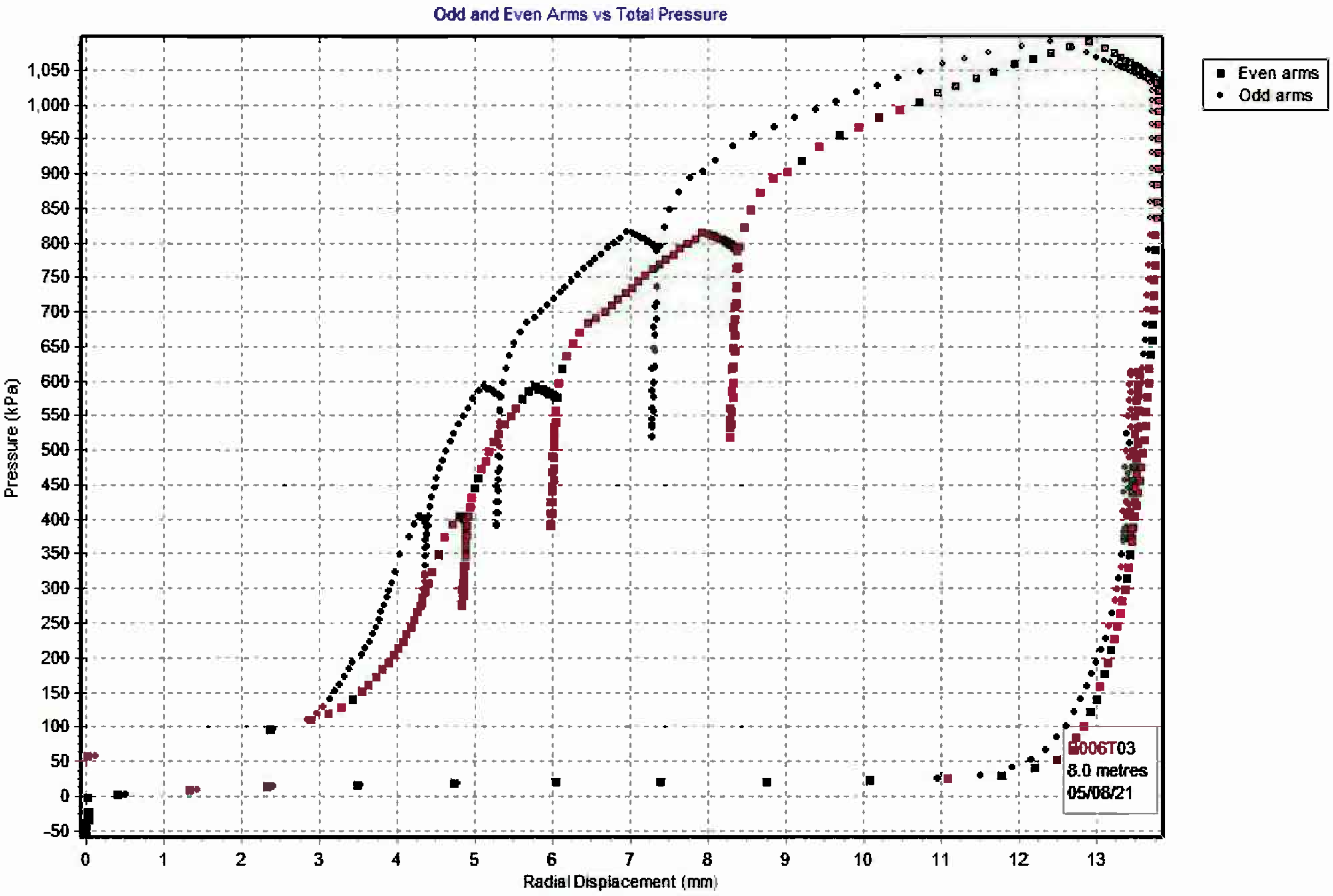

Variation of stiffness with strain, undrained analysis : Arm ave
POWER LAW PARAMETERS:
Cycle No.
Constant (MPa)
Gradient
1 11.993 0.780
2 6.584 0.659
3 6.608 0.635
4 4.512 0.593
95mm High Pressure Dilatometer
BH_STW_006 Test 3
8.00 Metres
5 Aug 21
Shear modulus (MPa)
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
Log plane shear strain
0.0001
0.001


Carter et al 1986 (adapted 2010) for c'-phi material : Arm ave
95mm High Pressure Dilatometer
BH_STW_006 Test 3
8.00 Metres
5 Aug 21
CURVE FIT PARAMETERS:
Origin : 4.210mm
Po : 109.0kPa
Cohesion : 5kPa
Phi peak : 31.4°
Dilation : 1.7°
Yield stress : 218kPa
Limit pressure : 1717kPa
Elastic exponent : 0.635
Gs at first yield : 43.9MPa
Janbu exponent : 0.255
Correlation : 0.651
Estimated PWP : 24.0kPa
Phi cv : 30.0°
Poisson's ratio : 0.25
Total pressure (kPa)
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
Cavity strain (%)
-2
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15


All Arms vs Total Pressure
■ Arm 1
● Arm 2
△ Arm 3
▼ Arm 4
+ Arm 5
× Arm 6
B006T03
8.0 metres
05/08/21
Pressure (kPa)
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
-50
Radial Displacement (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16


Arm Average vs Total Pressure
B006T03
8.0 metres
05/08/21
Radial Displacement (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
Pressure (kPa)
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
-50


Arm Pairs vs Total Pressure
■ Arms 1+4
● Arms 2+5
△ Arms 3+6
B006T03
8.0 metres
05/08/21
Pressure (kPa)
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
-50
Radial Displacement (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14

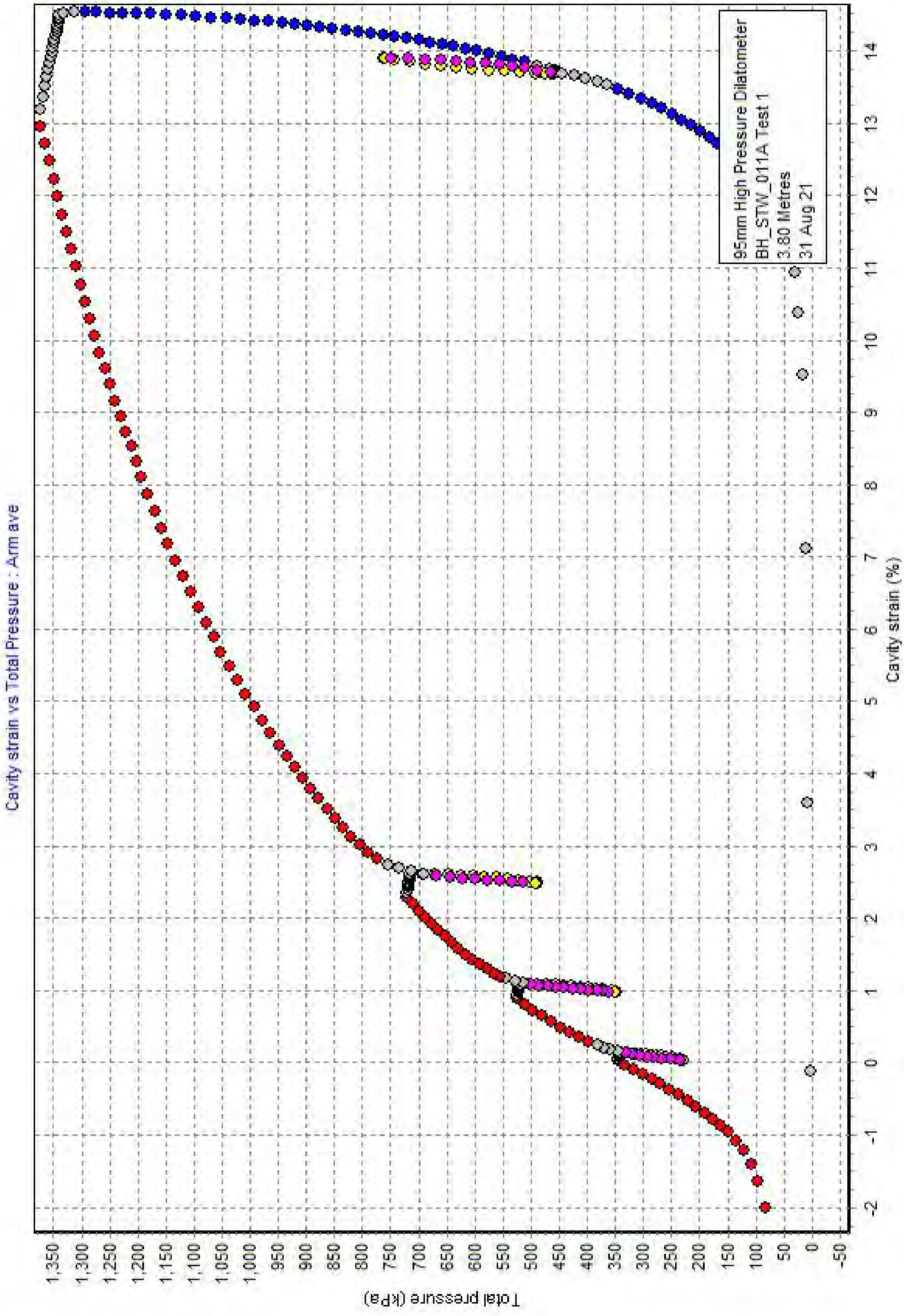

Odd and Even Arms vs Total Pressure
Pressure (kPa)
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
-50
Radial Displacement (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
■ Even arms
• Odd arms
006T03
8.0 metres
05/08/21

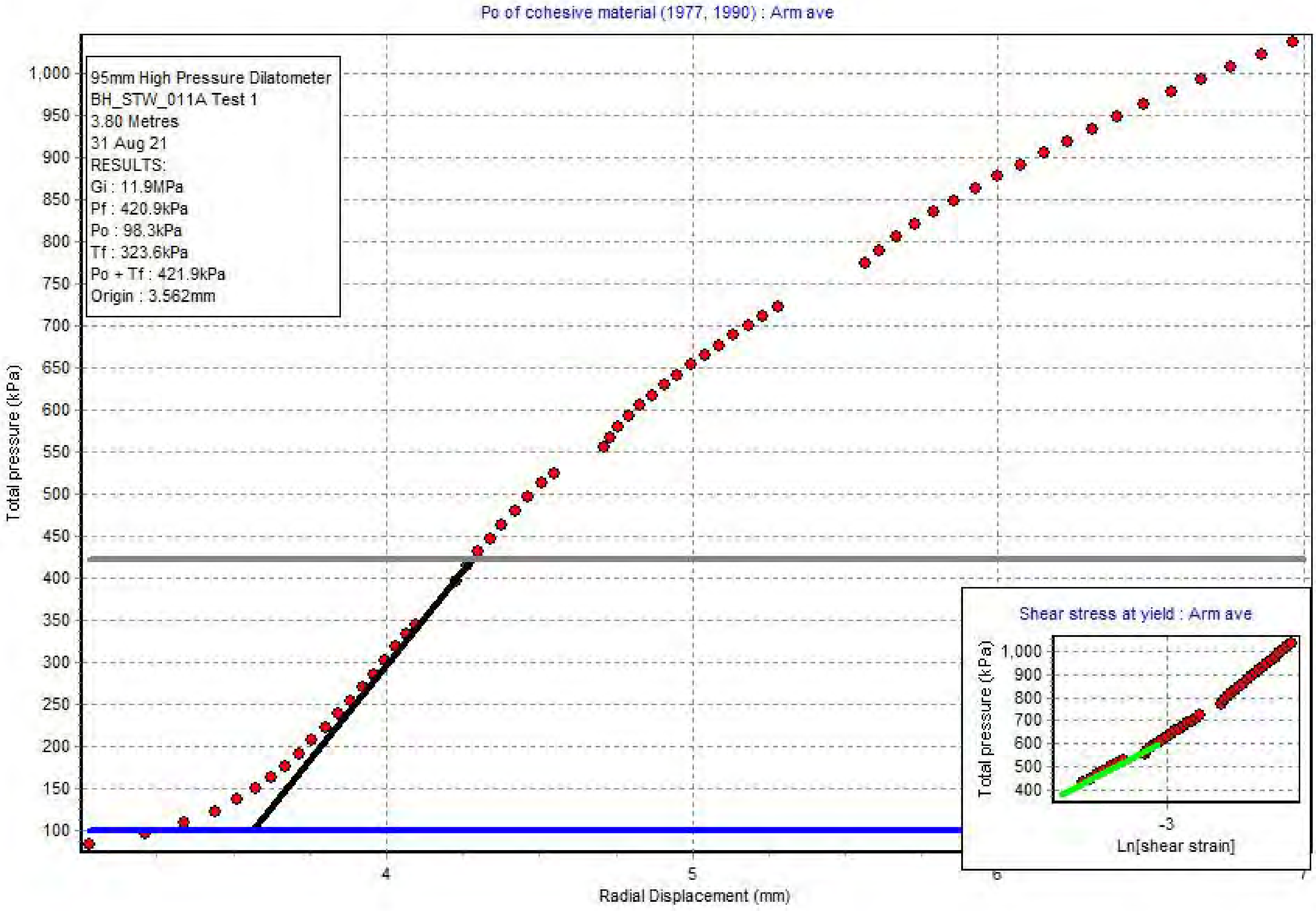
```
BH_STW_011A Test 1 - SUMMARY OF RESULTS
[File made with WinSitu ]

[DETAILS OF TEST]
Project        :   TE8364
Site           :   Cambridge Waste Water Treatment Plant Relocation Project
Borehole       :   BH_STW_011A
Test name      :   BH_STW_011A Test 1
Test date      :   31 Aug 21
Test depth     :   3.80 Metres
Water table    :   3.75 Metres
Ambient PWP    :   0.0 kPa
Material       :   Chalk
Probe          :   95mm High Pressure Dilatometer
Diameter       :   97.0 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out
The file includes results from a curve fitting analysis

Analysed by ES/YB/RW on 31 Aug 21

Remarks:

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm)                 :   "Arm ave=4.07"
Po from Marsland & Randolph (kPa)   :   "Arm ave=98.3"
Best estimate of Po (kPa)          :   "Arm ave=94.0"

[UNDRAINED STRENGTH PARAMETERS]
Undrained yield stress (kPa)       :   "Arm ave=420.9"

[DRAINED ANALYSIS OF SANDS]
[Hughes et al 1977]
Constant volume friction angle (°)  :   32.0
Angle of internal friction (°)      :   "Arm ave=35.6"
Dilation angle (°)                 :   "Arm ave=4.3"
Gradient of log-log plot           :   "Arm ave=0.396"

[Withers et al 1989]
Angle of internal friction (°)      :   "Arm ave=35.8"
Dilation angle (°)                 :   "Arm ave=4.5"
Gradient of log-log plot           :   "Arm ave=-2.476"

[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=11.9"
Axis       Loop   Value    Mean Strain  Mean Pc  dE      dPc
           No     (MPa)    (%)          (kPa)    (%)     (kPa)
Arm ave    1      53.4     0.103        280      0.193   103
Arm ave    2      72.3     1.054        424      0.212   153
Arm ave    3      83.1     2.564        579      0.219   182
Arm ave    4      80.6     13.820       611      0.370   298

[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]
Axis       Loop   Intercept  Alpha      Gradient
           No     (MPa)      (MPa)
Arm ave    1      11.849     8.983      0.758
Arm ave    2      10.261     6.965      0.679
Arm ave    3      15.729     11.224     0.714
Arm ave    4      9.286      5.588      0.602


[PARAMETERS USED FOR DRAINED CURVE MODELLING]
{Axis is  Arm ave}
Strain Origin (mm)                 :   4.07
Po (kPa)                           :   94
Cohesion (kPa)                     :   40
Angle of peak friction (deg)       :   35.6
Angle of peak dilation (deg)       :   4.3
Total yield stress (kPa)           :   253
```

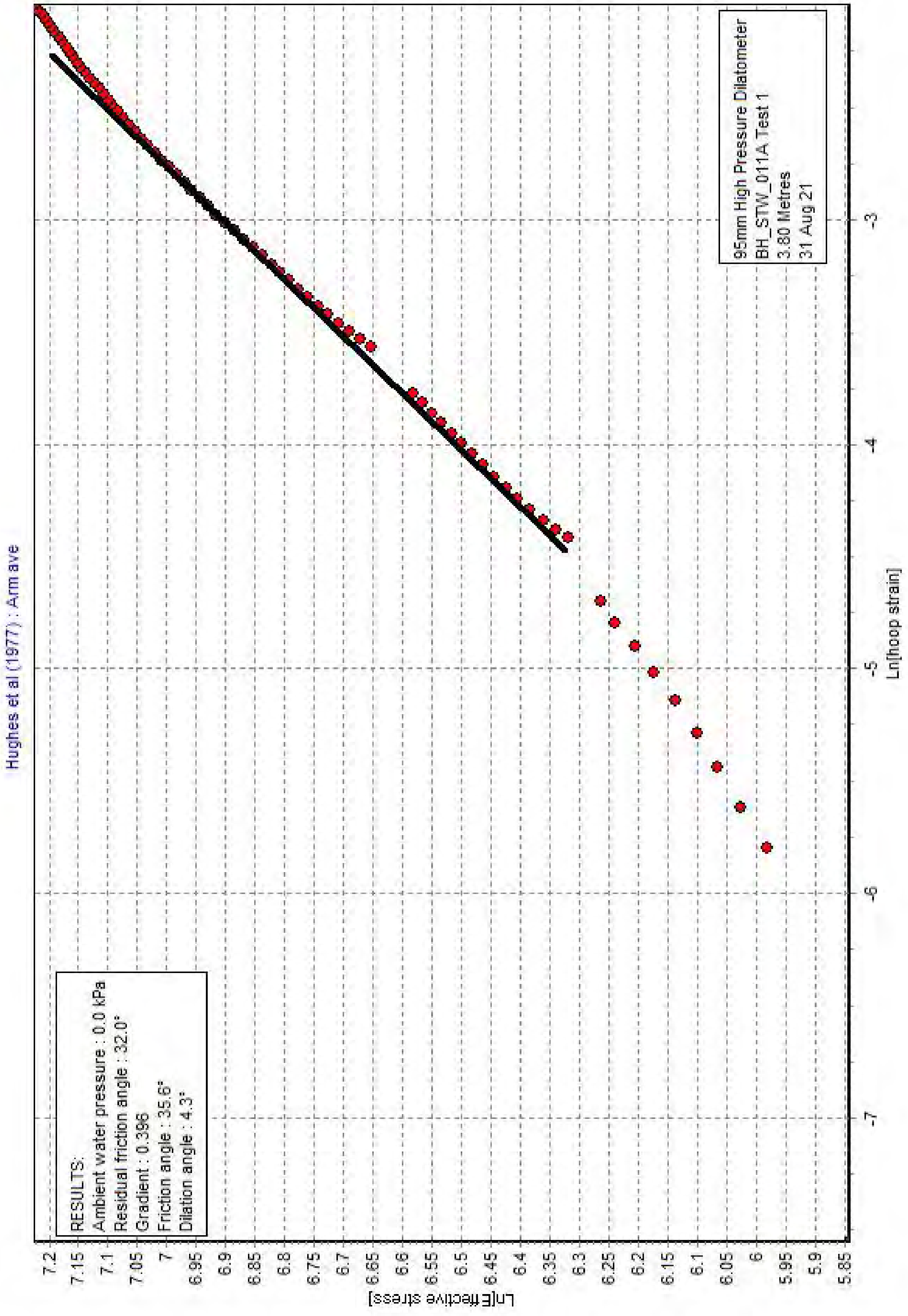
BH_STW_011A Test 1 - SUMMARY OF RESULTS

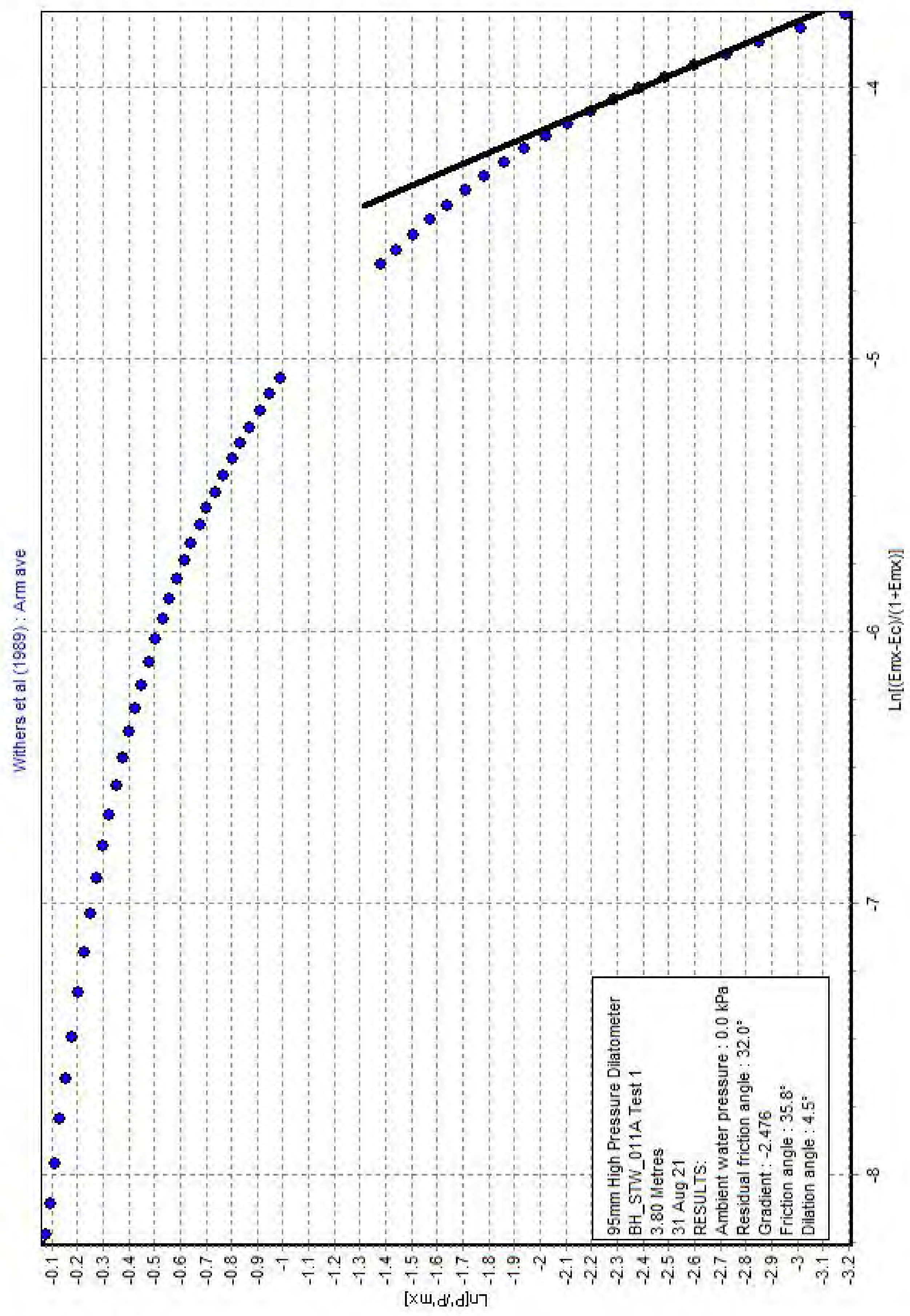
Total limit stress (kPa) : 2526
G at first yield (MPa) : 37.5
Non-linear exponent : 0.714
Janbu exponent : 0.295
Correlation : 0.713

Ambient pore water pressure (kPa) : 0
Residual friction angle (deg) : 32.0
Poisson's ratio : 0.25

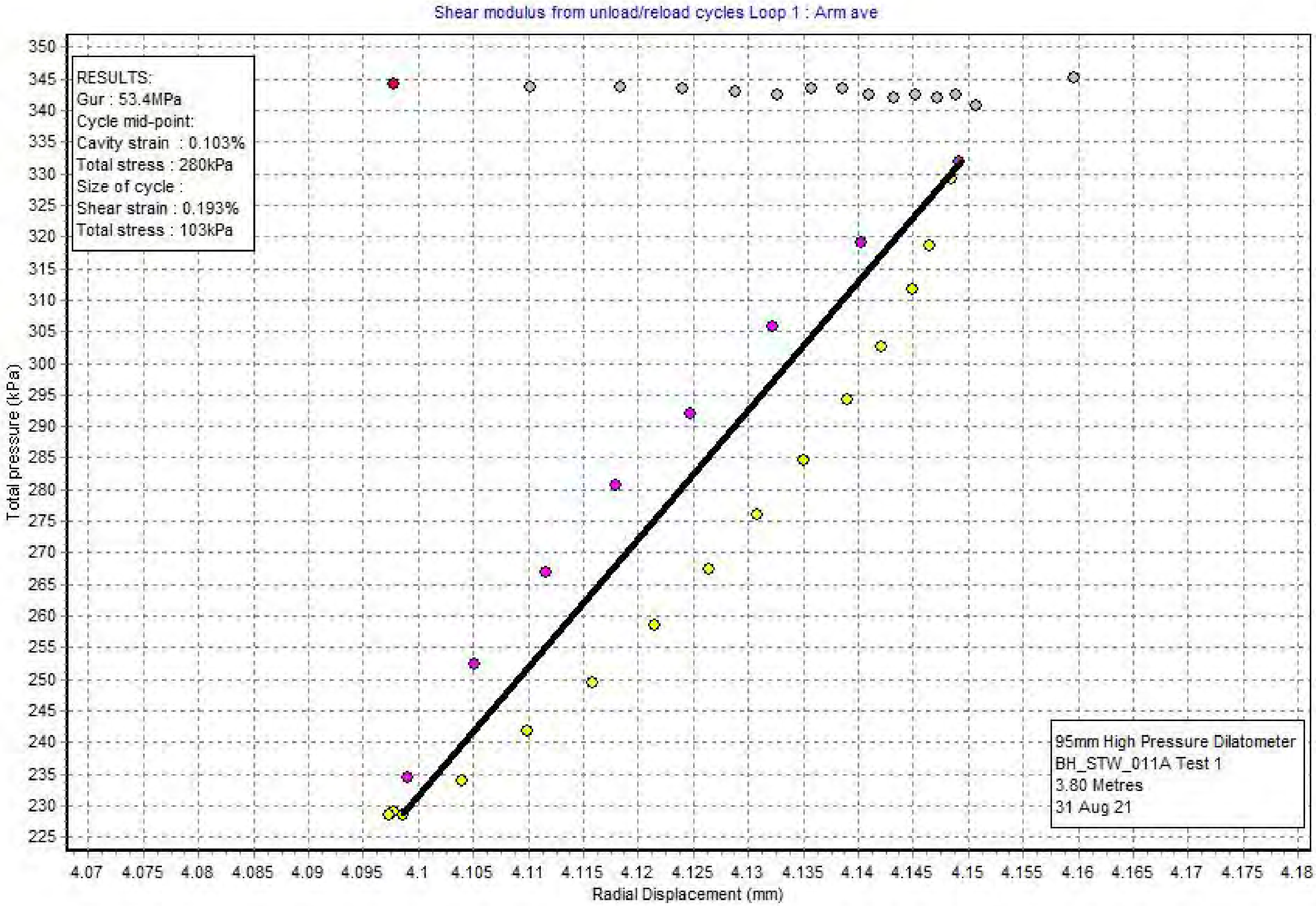

Cavity strain vs Total Pressure : Arm ave
95mm High Pressure Dilatometer
BH_STW_011A Test 1
3.80 Metres
31 Aug 21
Total pressure (kPa)
1,350
1,300
1,250
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
-50
Cavity strain (%)
-2
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14


Po of cohesive material (1977, 1990) : Arm ave
95mm High Pressure Dilatometer
BH_STW_011A Test 1
3.80 Metres
31 Aug 21
RESULTS:
Gi : 11.9MPa
Pf : 420.9kPa
Po : 98.3kPa
Tf : 323.6kPa
Po + Tf : 421.9kPa
Origin : 3.562mm
Total pressure (kPa)
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
4
5
6
7
Radial Displacement (mm)
Shear stress at yield : Arm ave
Total pressure (kPa)
1,000
900
800
700
600
500
400
-3
Ln[shear strain]


Hughes et al (1977) : Arm ave
95mm High Pressure Dilatometer
BH_STW_011A Test 1
3.80 Metres
31 Aug 21
RESULTS:
Ambient water pressure : 0.0 kPa
Residual friction angle : 32.0°
Gradient : 0.396
Friction angle : 35.6°
Dilation angle : 4.3°
Ln[Effective stress]
7.2
7.15
7.1
7.05
7
6.95
6.9
6.85
6.8
6.75
6.7
6.65
6.6
6.55
6.5
6.45
6.4
6.35
6.3
6.25
6.2
6.15
6.1
6.05
6
5.95
5.9
5.85
Ln[hoop strain]
-7
-6
-5
-4
-3

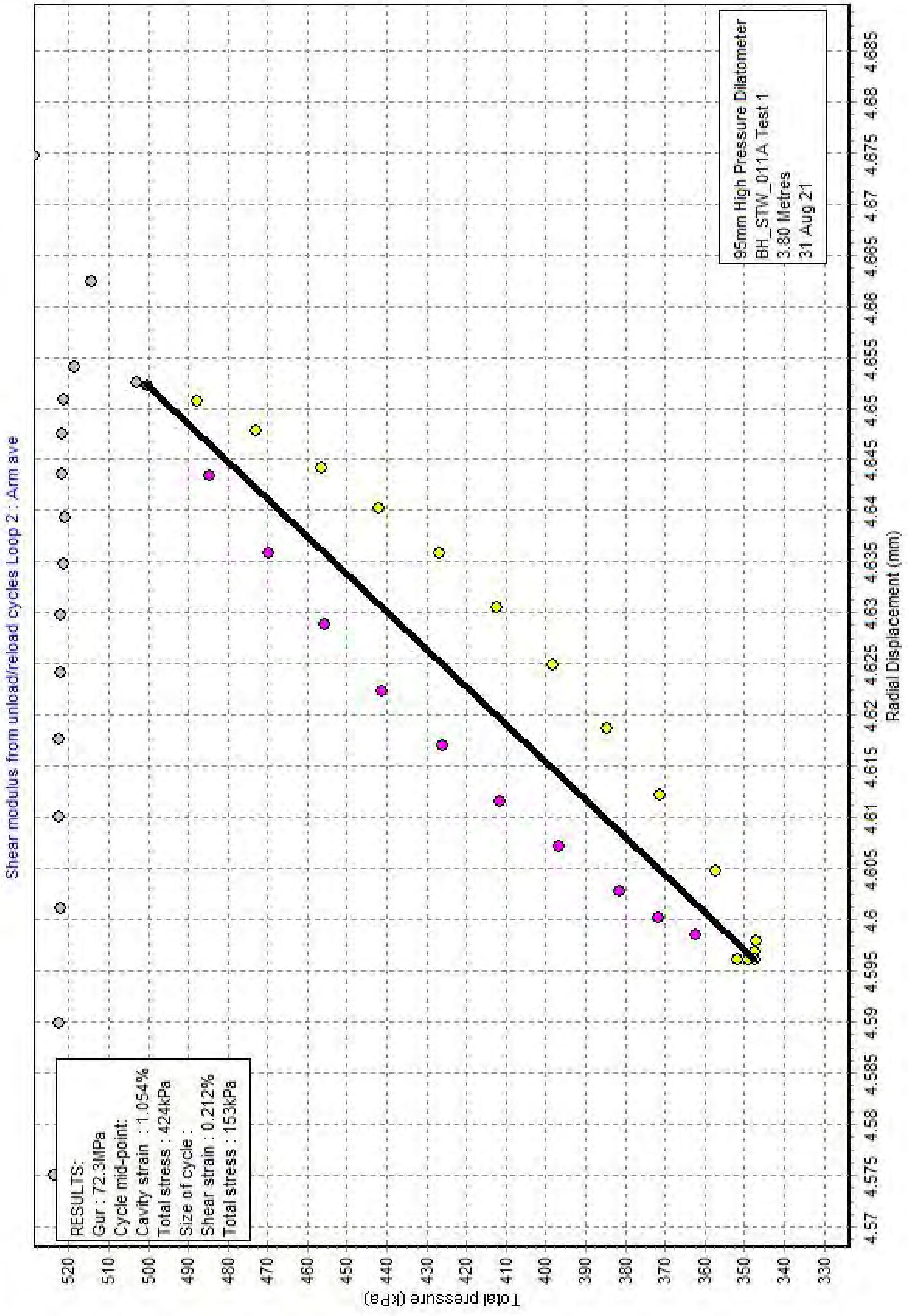


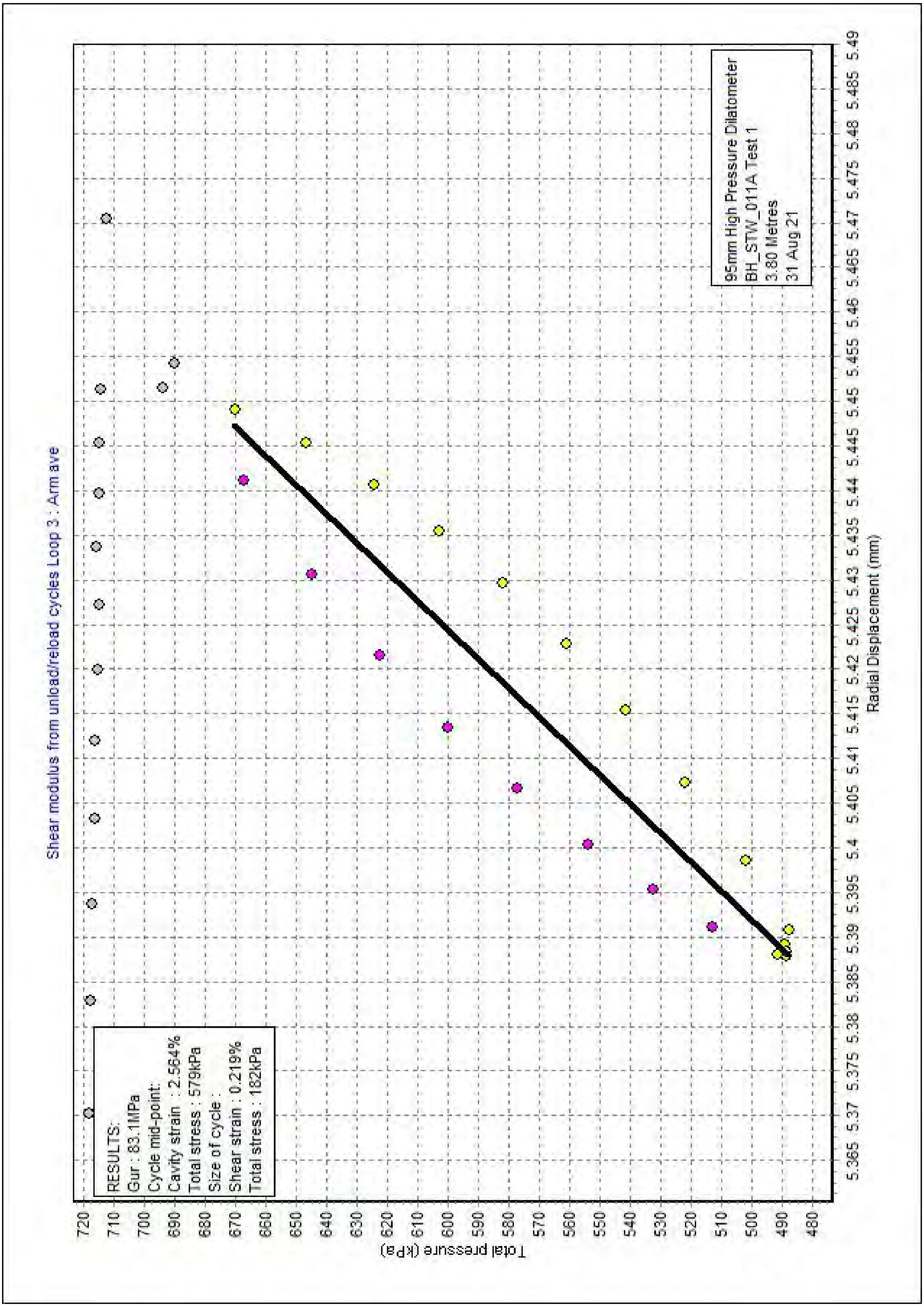
95mm High Pressure Dilatometer
BH_STW_011A Test 1
3.80 Metres
31 Aug 21
RESULTS:
Ambient water pressure : 0.0 kPa
Residual friction angle : 32.0°
Gradient : -2.476
Friction angle : 35.8°
Dilation angle : 4.5°

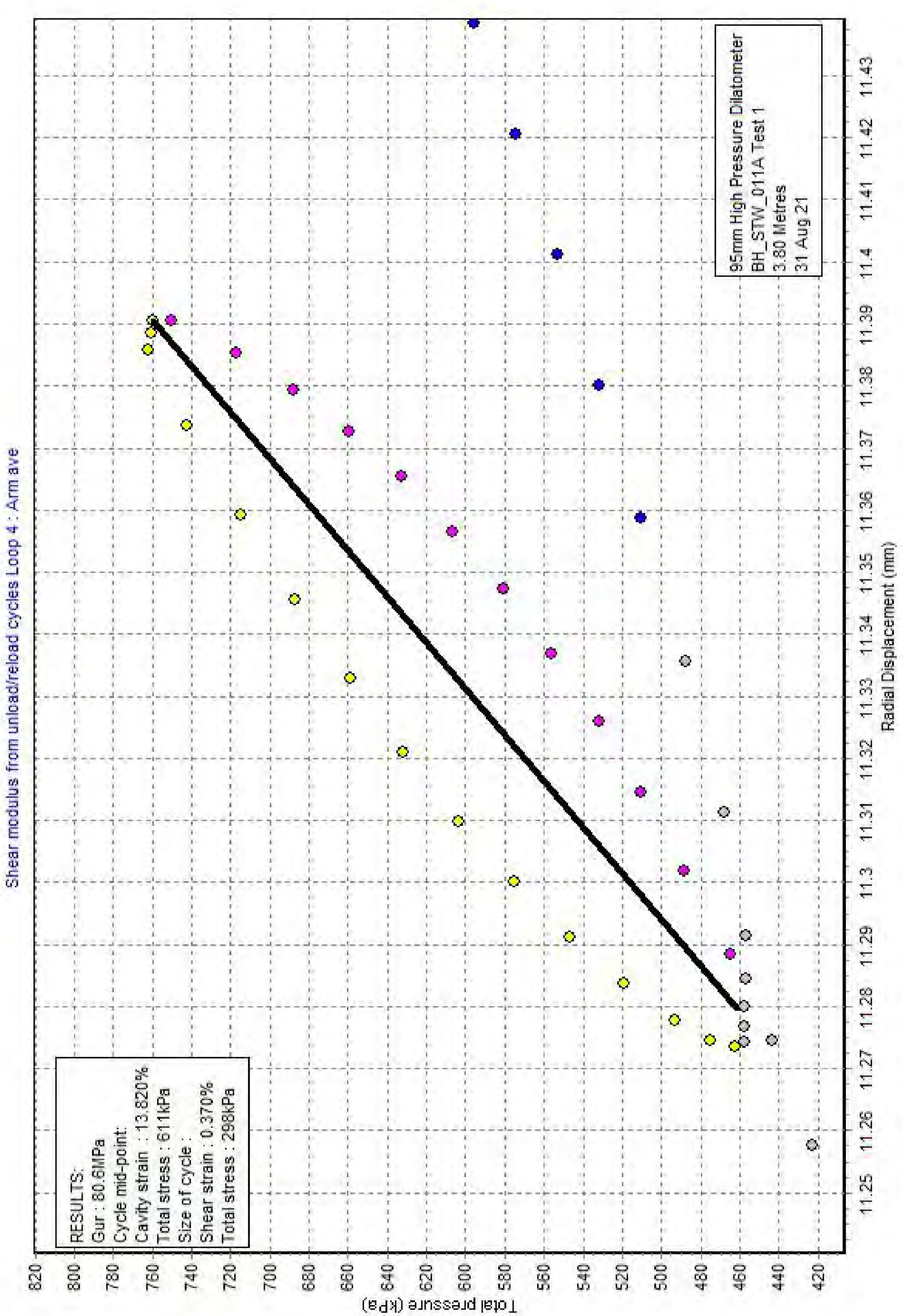

Shear modulus from unload/reload cycles Loop 1 : Arm ave

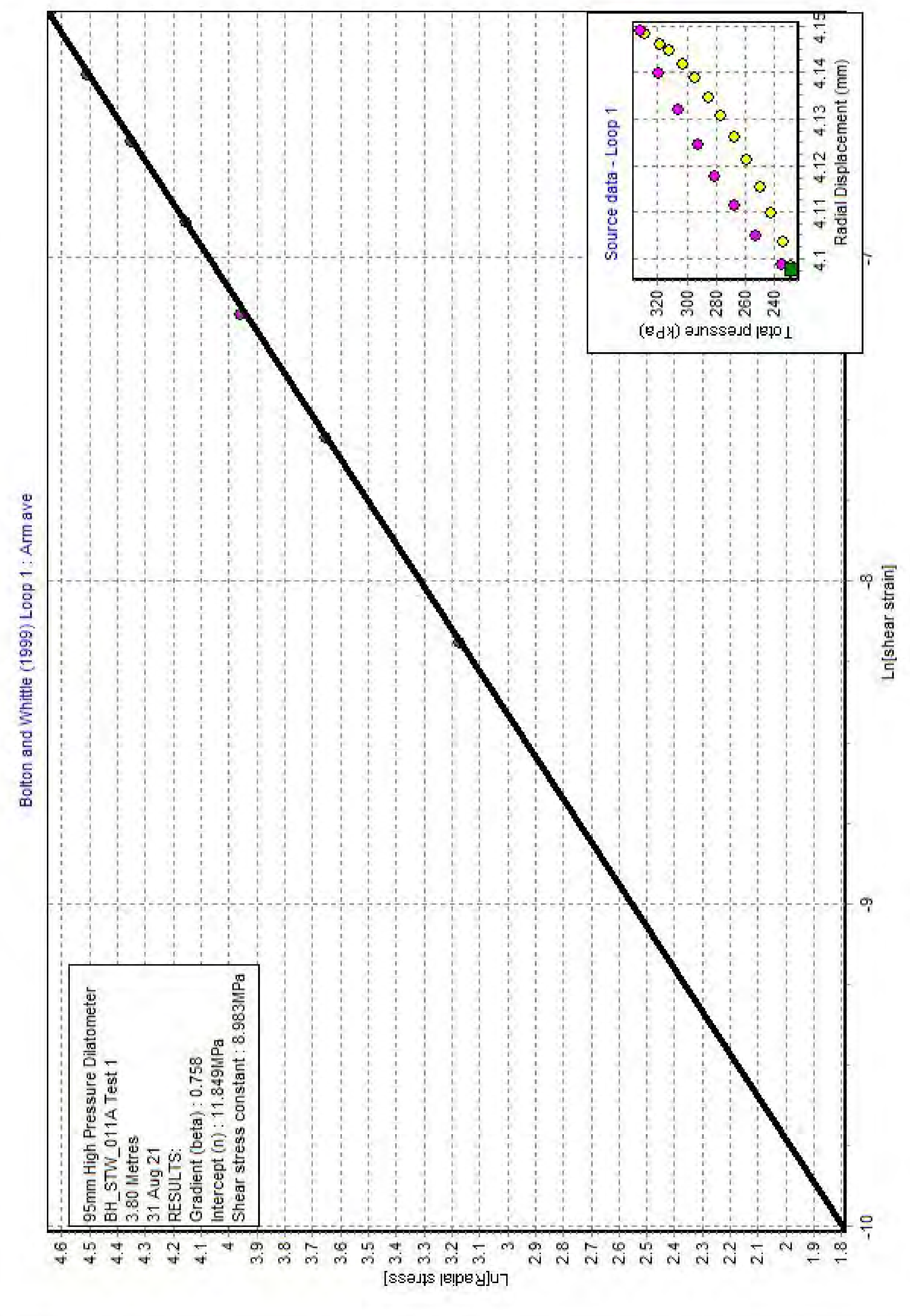
RESULTS:
Gur : 53.4MPa
Cycle mid-point:
Cavity strain : 0.103%
Total stress : 280kPa
Size of cycle :
Shear strain : 0.193%
Total stress : 103kPa

95mm High Pressure Dilatometer
BH_STW_011A Test 1
3.80 Metres
31 Aug 21

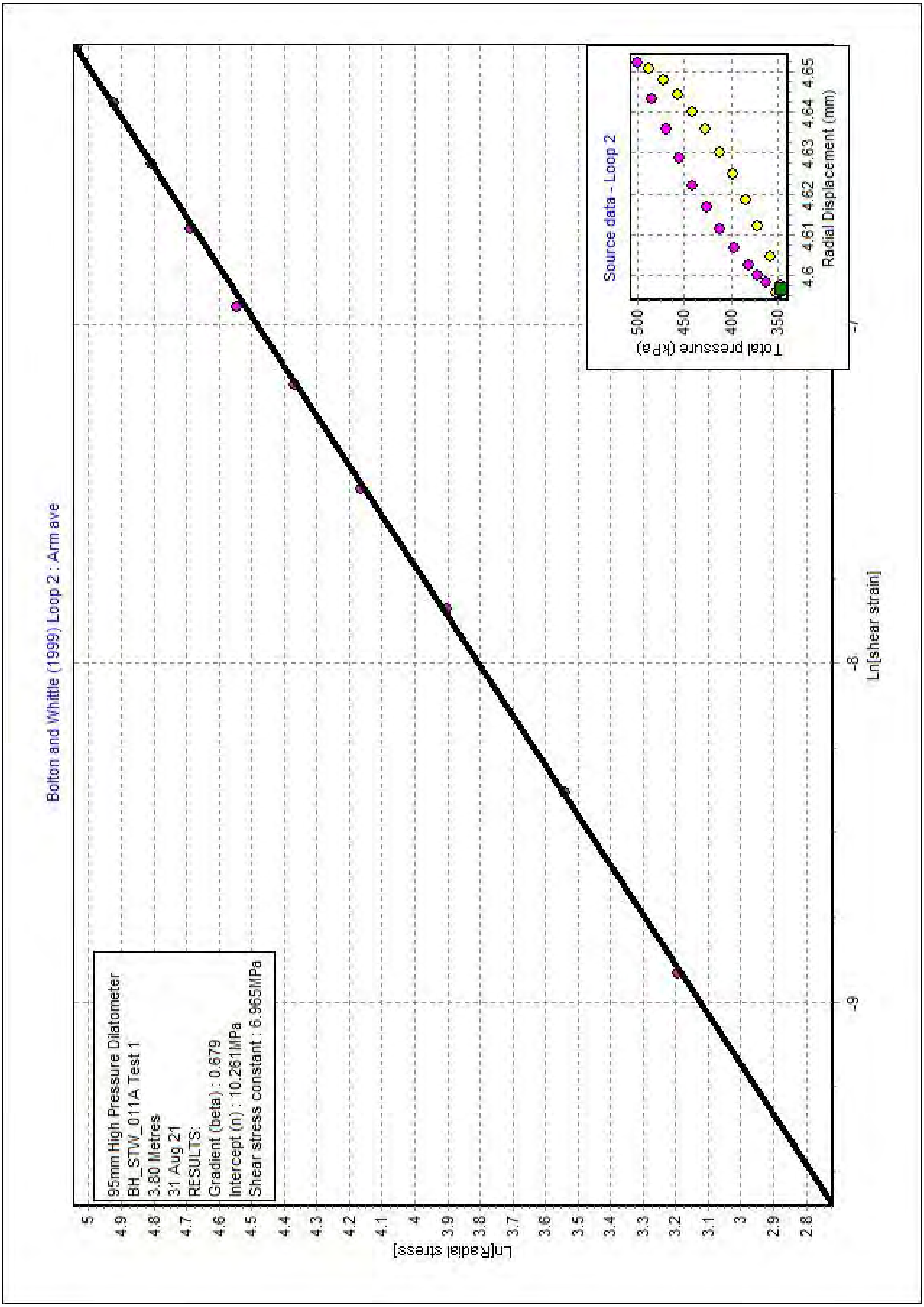

Shear modulus from unload/reload cycles Loop 2 : Arm ave
95mm High Pressure Dilatometer
BH_STW_011A Test 1
3.80 Metres
31 Aug 21
RESULTS:
Gur : 72.3MPa
Cycle mid-point:
Cavity strain : 1.054%
Total stress : 424kPa
Size of cycle :
Shear strain : 0.212%
Total stress : 153kPa
Radial Displacement (mm)
4.57
4.575
4.58
4.585
4.59
4.595
4.6
4.605
4.61
4.615
4.62
4.625
4.63
4.635
4.64
4.645
4.65
4.655
4.66
4.665
4.67
4.675
4.68
4.685
Total pressure (kPa)
520
510
500
490
480
470
460
450
440
430
420
410
400
390
380
370
360
350
340
330

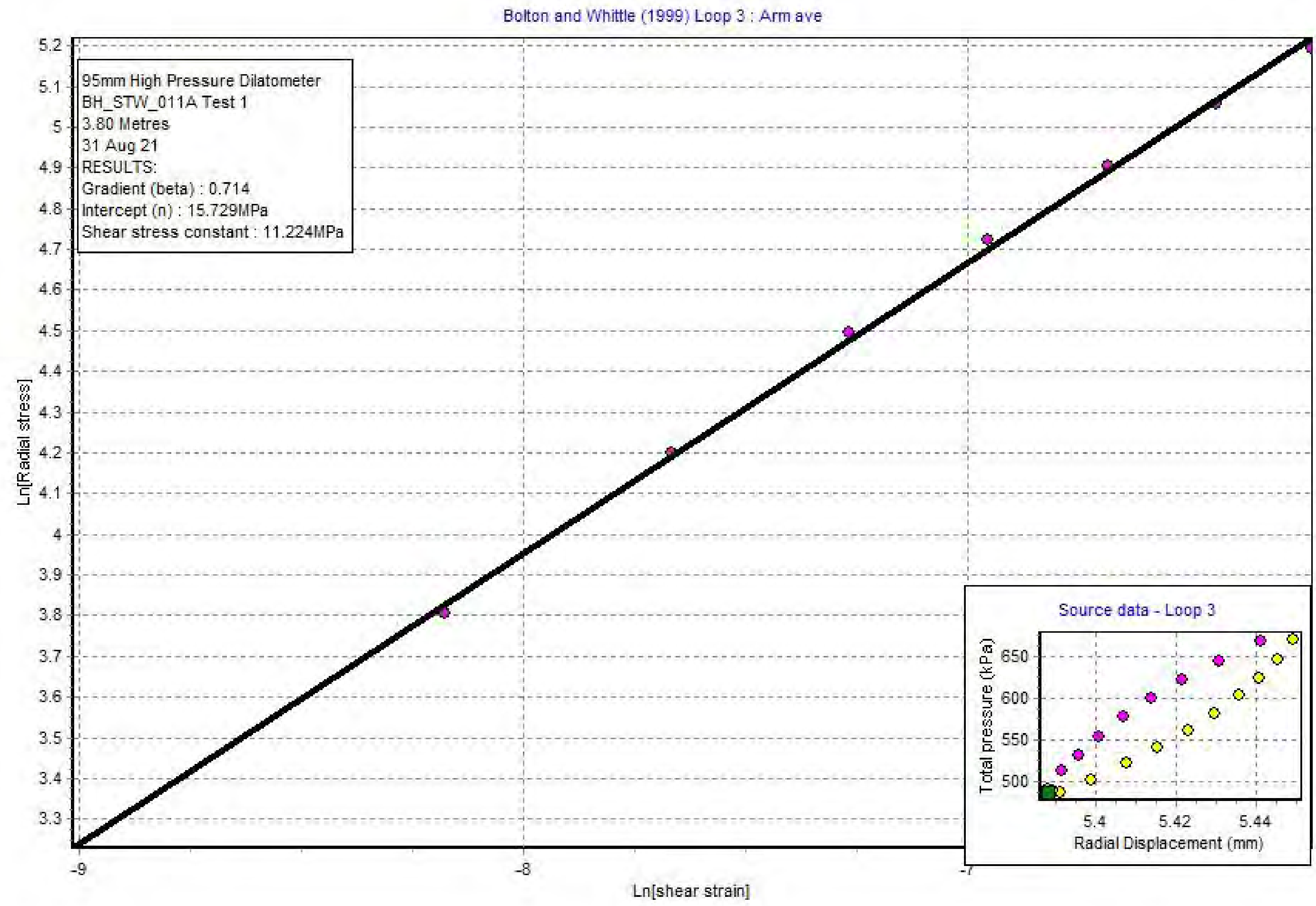

Shear modulus from unload/reload cycles Loop 3 : Arm ave
95mm High Pressure Dilatometer
BH_STW_011A Test 1
3.80 Metres
31 Aug 21
RESULTS:
Gur : 83.1MPa
Cycle mid-point:
Cavity strain : 2.564%
Total stress : 579kPa
Size of cycle :
Shear strain : 0.219%
Total stress : 182kPa
Radial Displacement (mm)
5.365
5.37
5.375
5.38
5.385
5.39
5.395
5.4
5.405
5.41
5.415
5.42
5.425
5.43
5.435
5.44
5.445
5.45
5.455
5.46
5.465
5.47
5.475
5.48
5.485
5.49
Total pressure (kPa)
720
710
700
690
680
670
660
650
640
630
620
610
600
590
580
570
560
550
540
530
520
510
500
490
480


Shear modulus from unload/reload cycles Loop 4 : Arm ave
RESULTS:
Gur : 80.6MPa
Cycle mid-point:
Cavity strain : 13.820%
Total stress : 611kPa
Size of cycle :
Shear strain : 0.370%
Total stress : 298kPa
95mm High Pressure Dilatometer
BH_STW_011A Test 1
3.80 Metres
31 Aug 21
Total pressure (kPa)
820
800
780
760
740
720
700
680
660
640
620
600
580
560
540
520
500
480
460
440
420
Radial Displacement (mm)
11.25
11.26
11.27
11.28
11.29
11.3
11.31
11.32
11.33
11.34
11.35
11.36
11.37
11.38
11.39
11.4
11.41
11.42
11.43

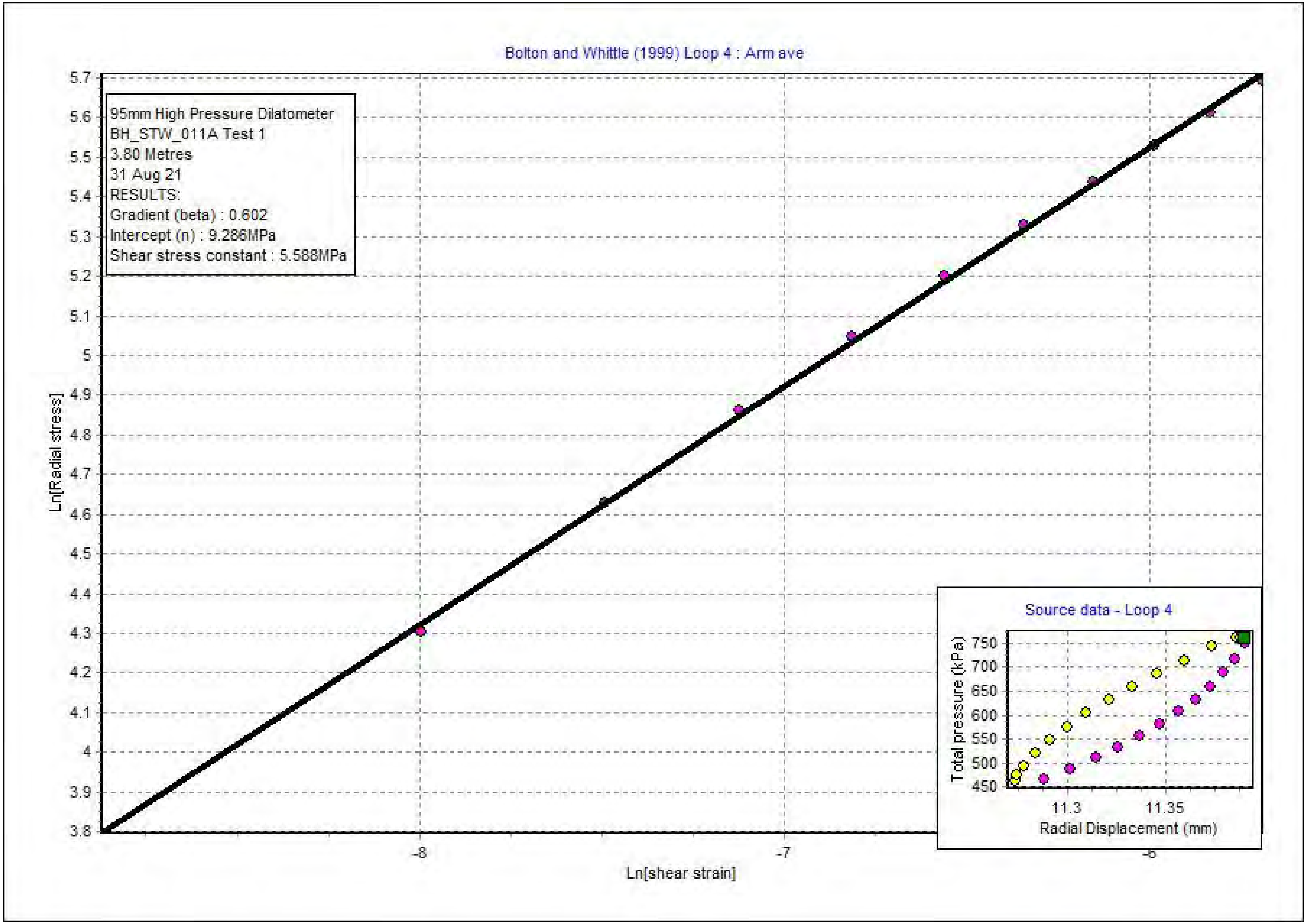


95mm High Pressure Dilatometer
BH_STW_011A Test 1
3.80 Metres
31 Aug 21
RESULTS:
Gradient (beta) : 0.758
Intercept (n) : 11.849MPa
Shear stress constant : 8.983MPa

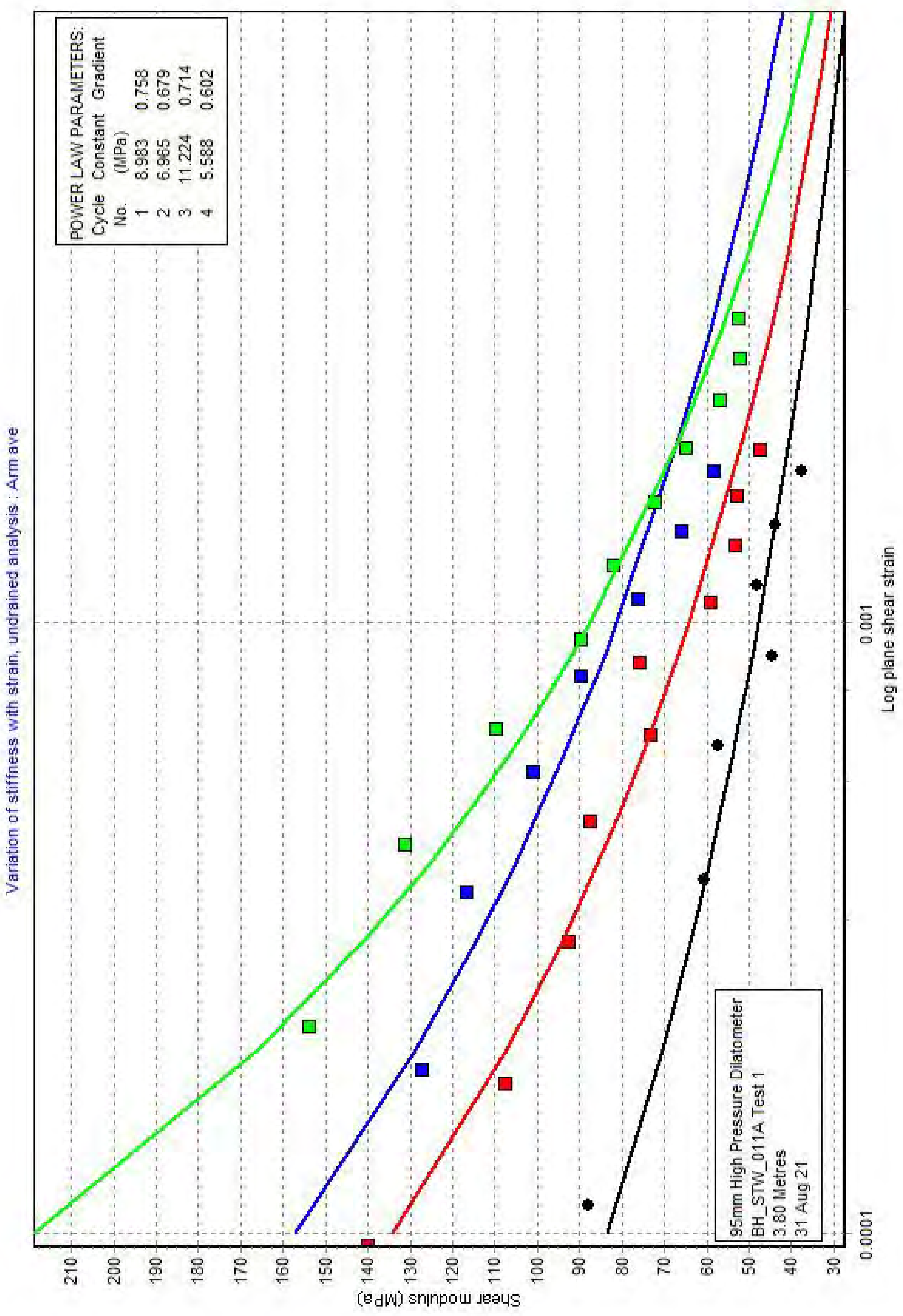

Bolton and Whittle (1999) Loop 2 : Arm ave
95mm High Pressure Dilatometer
BH_STW_011A Test 1
3.80 Metres
31 Aug 21
RESULTS:
Gradient (beta) : 0.679
Intercept (n) : 10.261MPa
Shear stress constant : 6.965MPa
Ln[Radial stress]
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
Ln[shear strain]
-9
-8
-7
Source data - Loop 2
Total pressure (kPa)
500
450
400
350
Radial Displacement (mm)
4.6
4.61
4.62
4.63
4.64
4.65

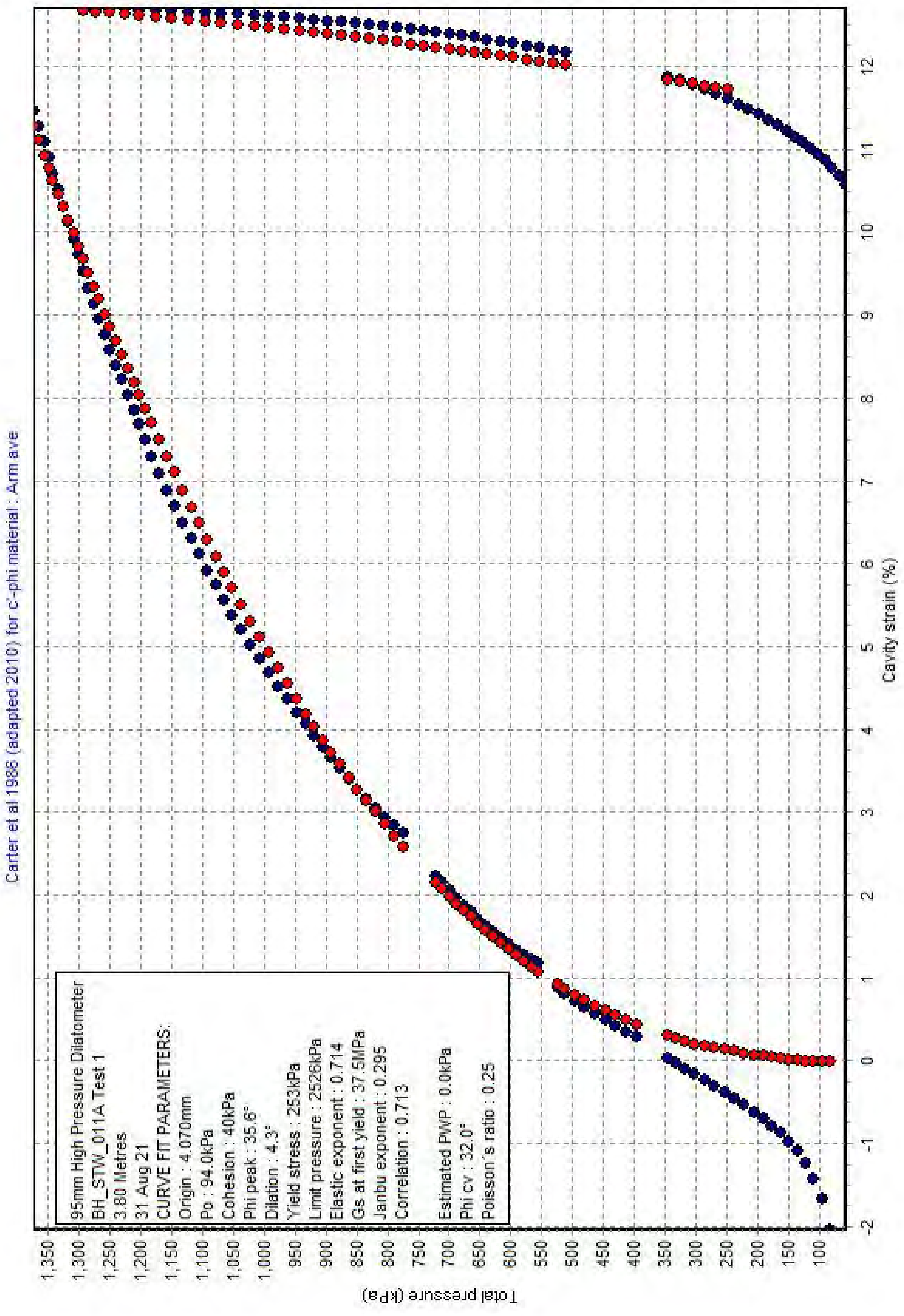


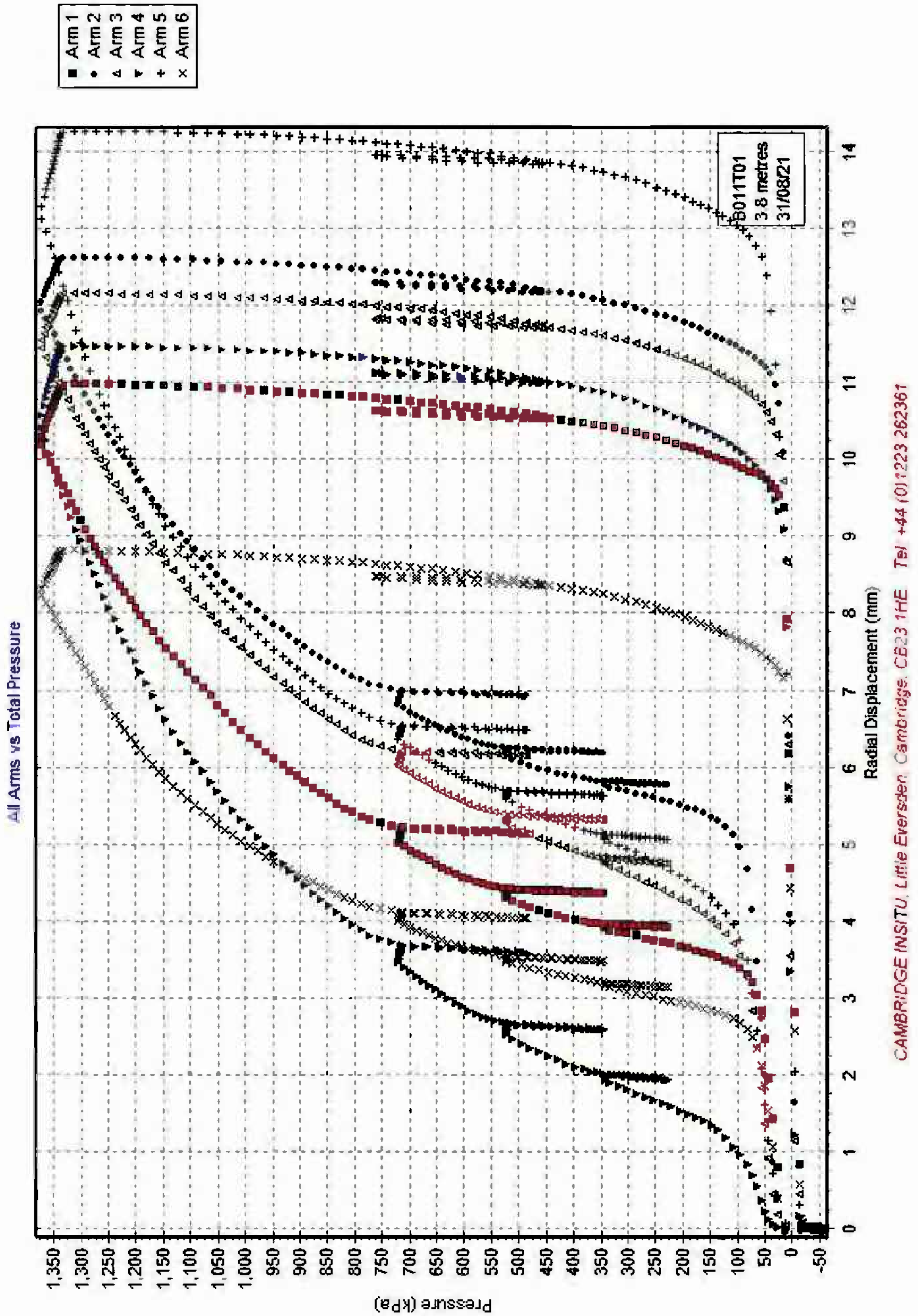
95mm High Pressure Dilatometer
BH_STW_011A Test 1
3.80 Metres
31 Aug 21
RESULTS:
Gradient (beta) : 0.714
Intercept (n) : 15.729MPa
Shear stress constant : 11.224MPa

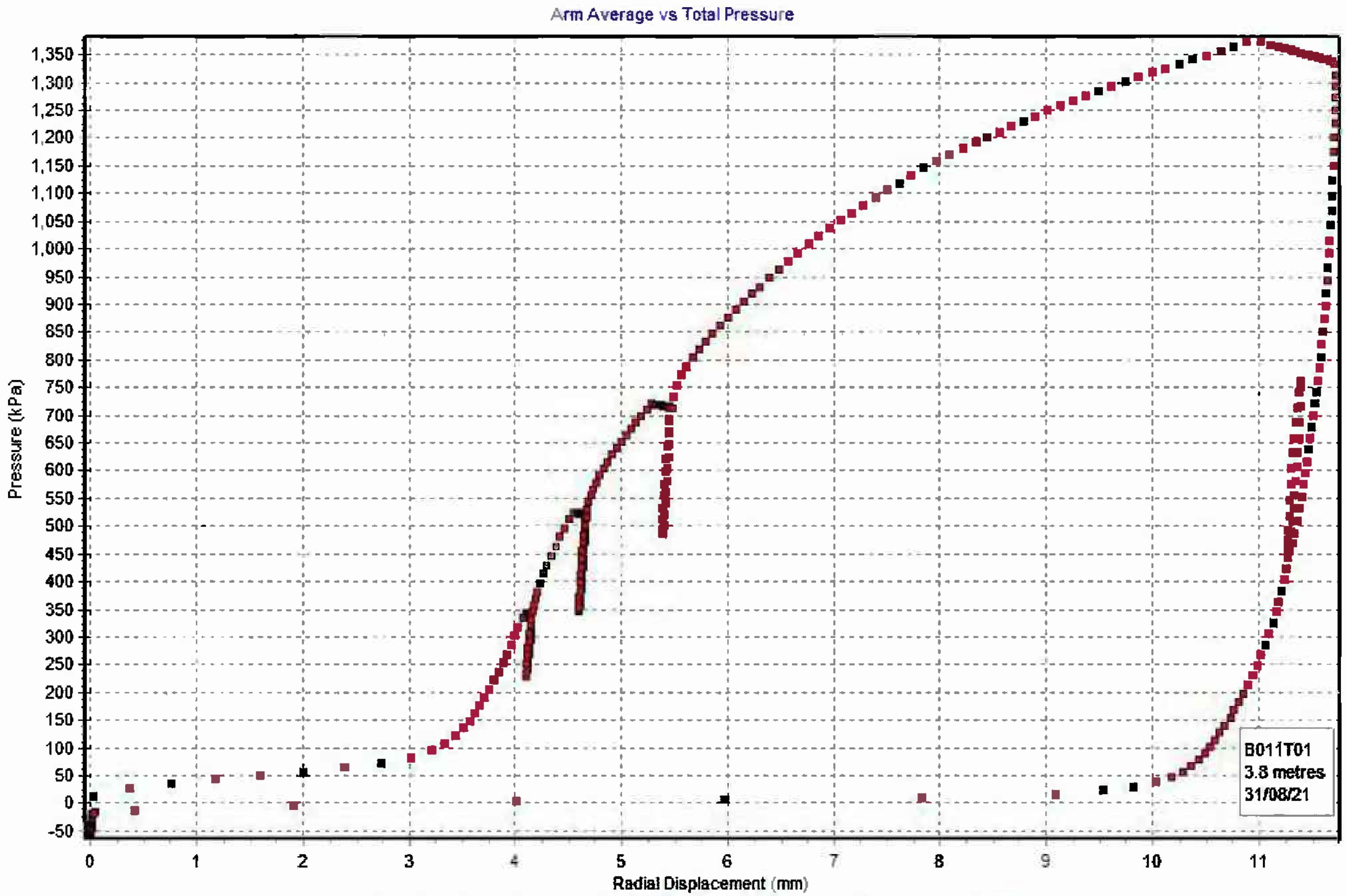


95mm High Pressure Dilatometer
BH_STW_011A Test 1
3.80 Metres
31 Aug 21
RESULTS:
Gradient (beta) : 0.602
Intercept (n) : 9.286MPa
Shear stress constant : 5.588MPa

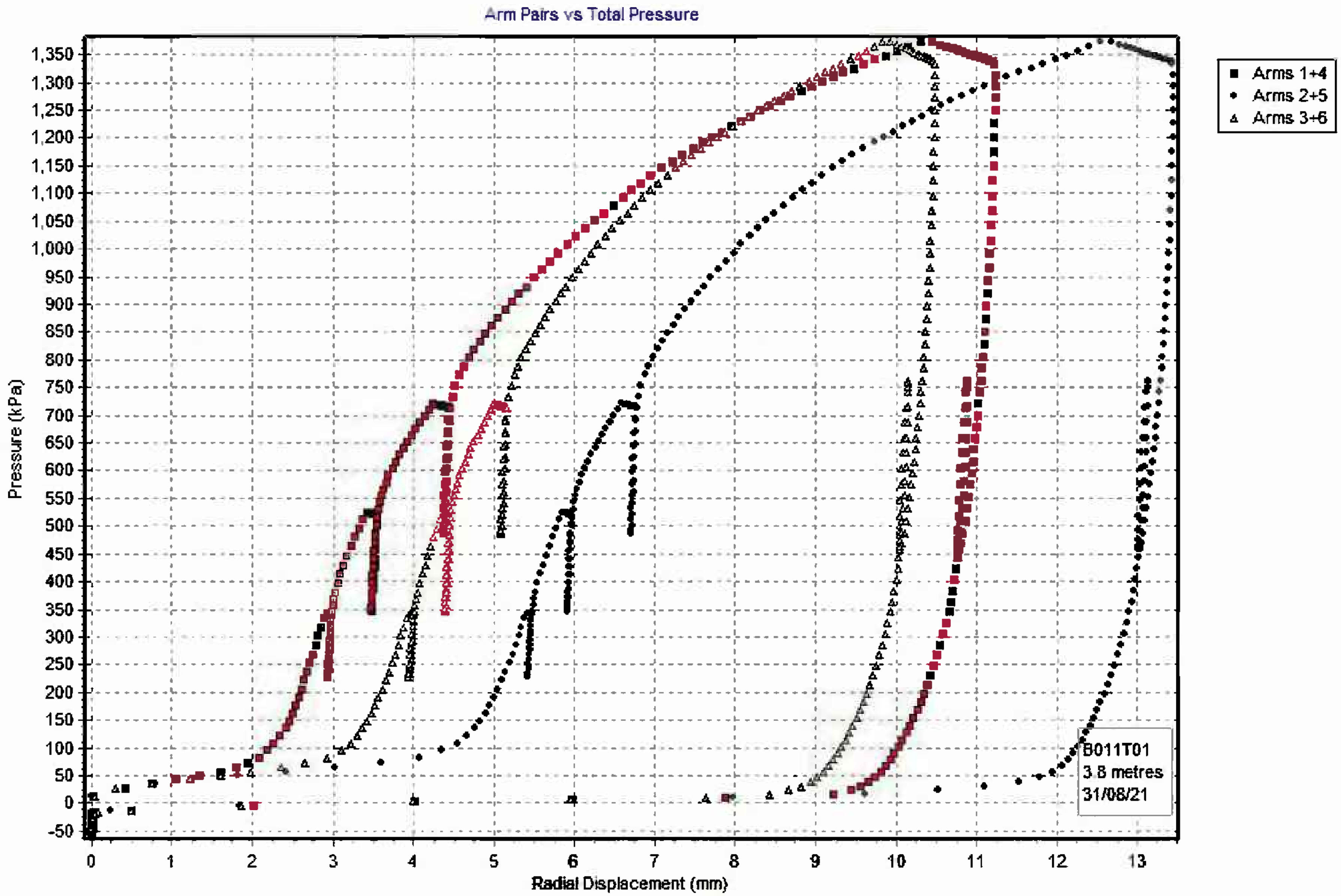

Variation of stiffness with strain, undrained analysis : Arm ave
POWER LAW PARAMETERS:
Cycle Constant Gradient
No. (MPa)
1 8.983 0.758
2 6.965 0.679
3 11.224 0.714
4 5.588 0.602
95mm High Pressure Dilatometer
BH_STW_011A Test 1
3.80 Metres
31 Aug 21
Shear modulus (MPa)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
Log plane shear strain
0.0001
0.001


Carter et al 1986 (adapted 2010) for c'-phi material : Arm ave
95mm High Pressure Dilatometer
BH_STW_011A Test 1
3.80 Metres
31 Aug 21
CURVE FIT PARAMETERS:
Origin : 4.070mm
Po : 94.0kPa
Cohesion : 40kPa
Phi peak : 35.6°
Dilation : 4.3°
Yield stress : 253kPa
Limit pressure : 2526kPa
Elastic exponent : 0.714
Gs at first yield : 37.5MPa
Janbu exponent : 0.295
Correlation : 0.713
Estimated PWP : 0.0kPa
Phi cv : 32.0°
Poisson`s ratio : 0.25
Total pressure (kPa)
1,350
1,300
1,250
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
Cavity strain (%)
-2
-1
0
1
2
3
4
5
6
7
8
9
10
11
12


All Arms vs Total Pressure
■ Arm 1
● Arm 2
▵ Arm 3
▾ Arm 4
+ Arm 5
× Arm 6
B011T01
3.8 metres
31/08/21
Pressure (kPa)
1,350
1,300
1,250
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
-50
Radial Displacement (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel +44 (0)1223 262361



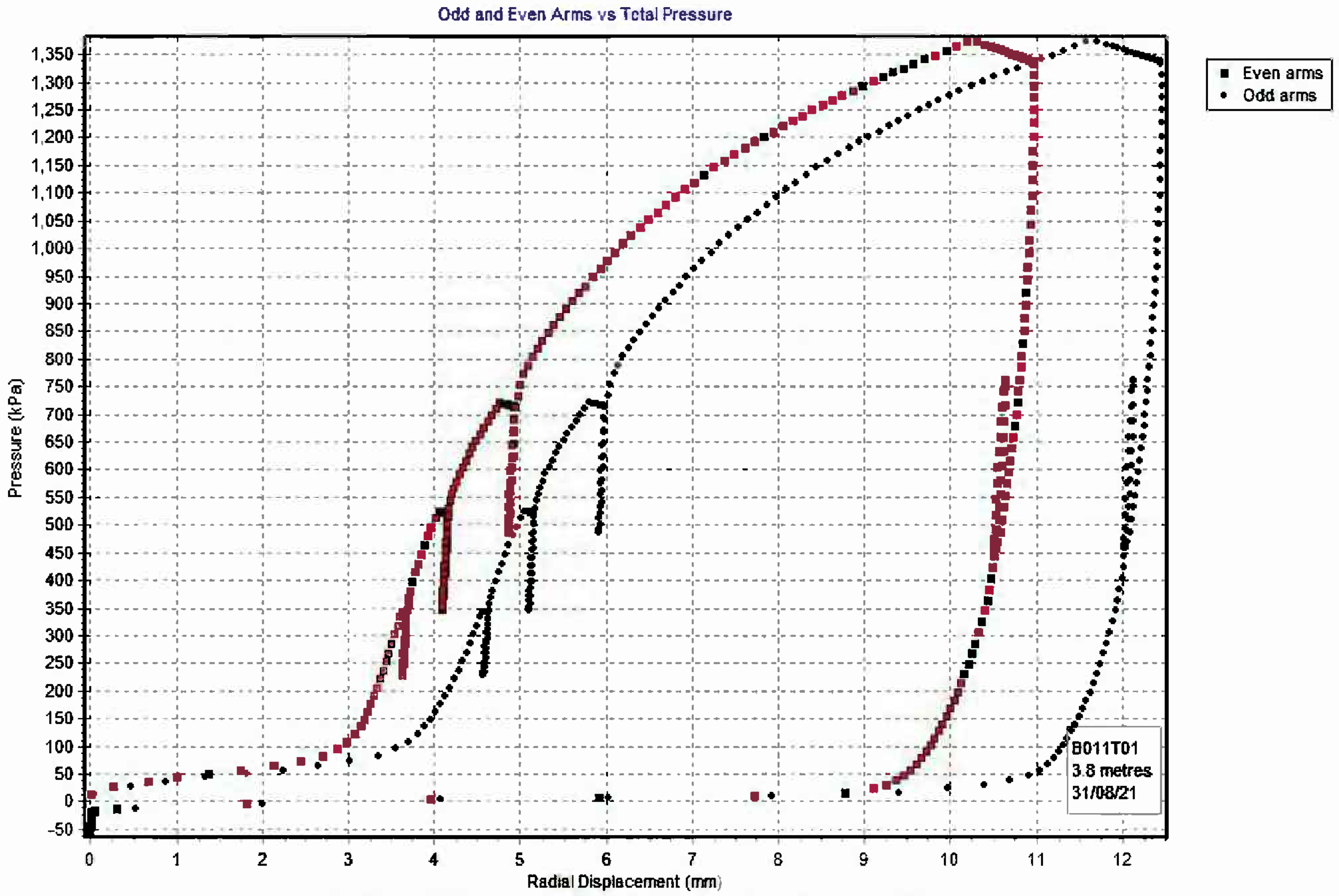
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361



Arm Pairs vs Total Pressure

B011T01
3.8 metres
31/08/21

CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel: +44 (0)1223 262361



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel. +44 (0)1223 262361

B011T02 - TEST & CALIBRATION DETAILS

[PROJECT DETAILS]
Contract name : CWWTPR

[BOREHOLE DETAILS]
Borehole : BH_STW_011a

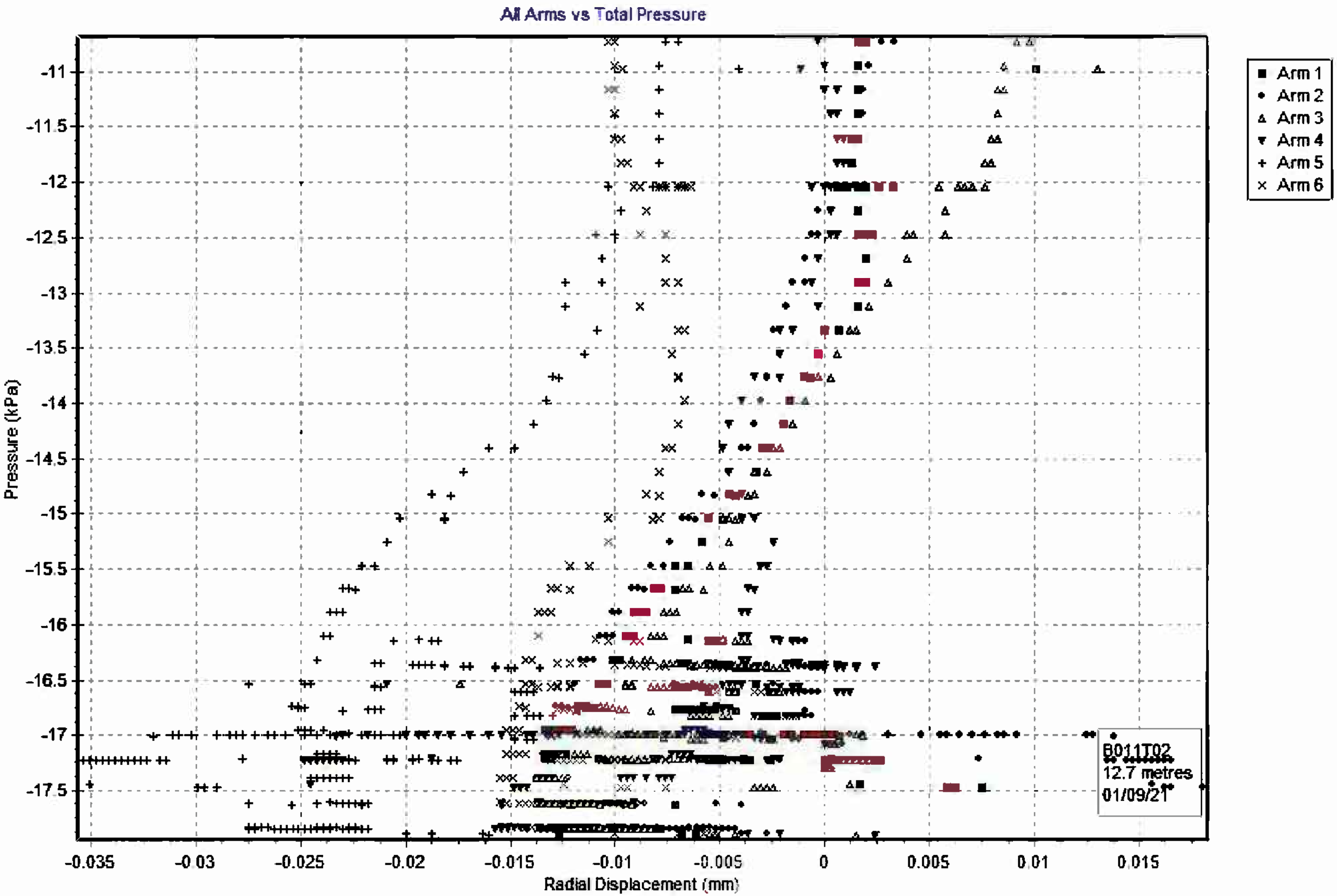
[TEST DETAILS]
Test name : B011T02
Test date : 01/09/21
Depth (M) : 12.70
Material: : Gault Clay
Heading (deg) : n/a
Data Rate (secs) : 6
Start Line : 1
Stop Line : 468

[COMMENTS]
Drilled 60cm, SBPM stopped advancing. Drilling aborted

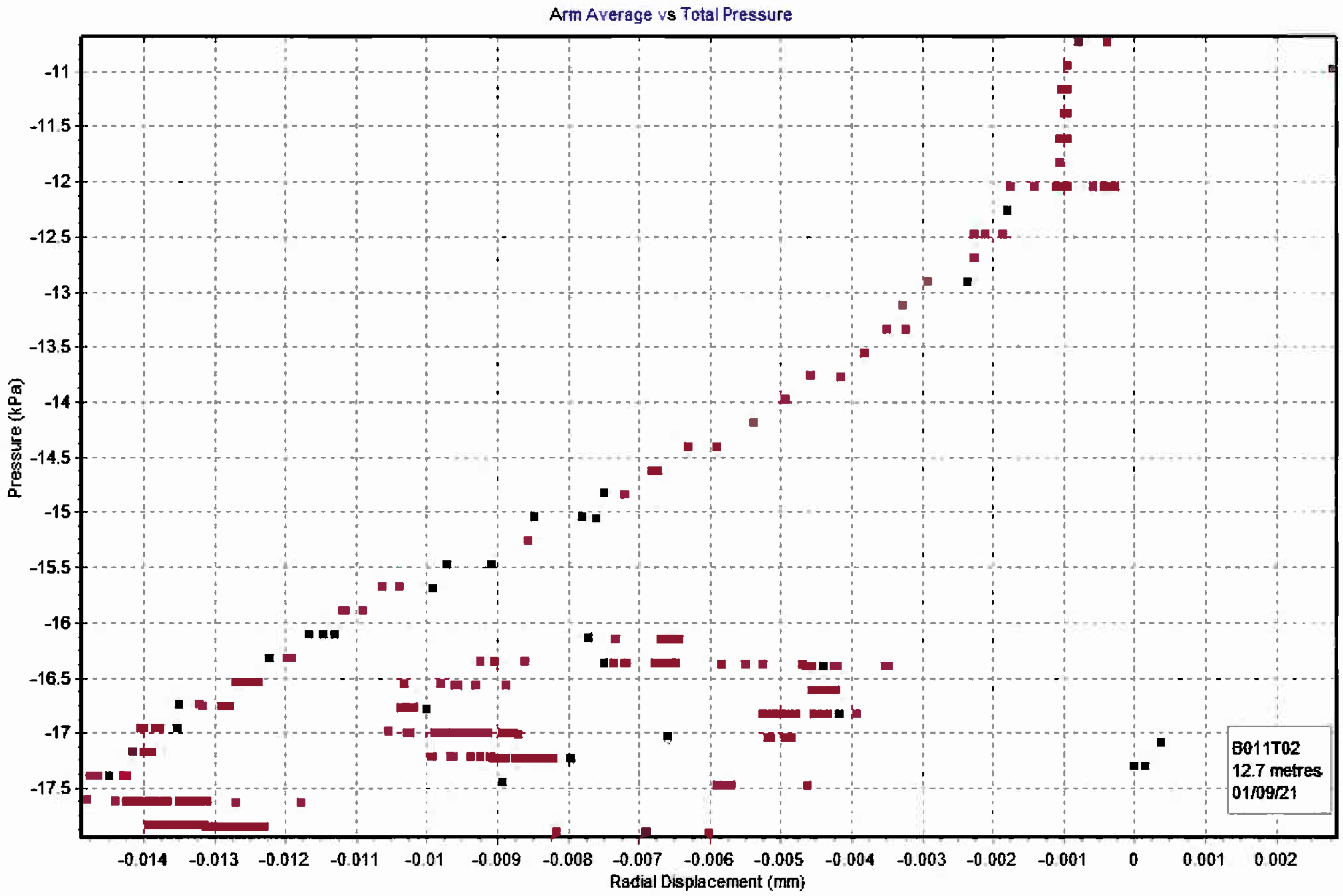
[PROBE DETAILS]
Type : Digital 6 Arm Self Boring Pressuremeter
Diameter over probe : 88.10mm
Diameter under membrane : 79.15mm
CHL strip thickness : 0.5000mm

[CALIBRATION FACTORS]

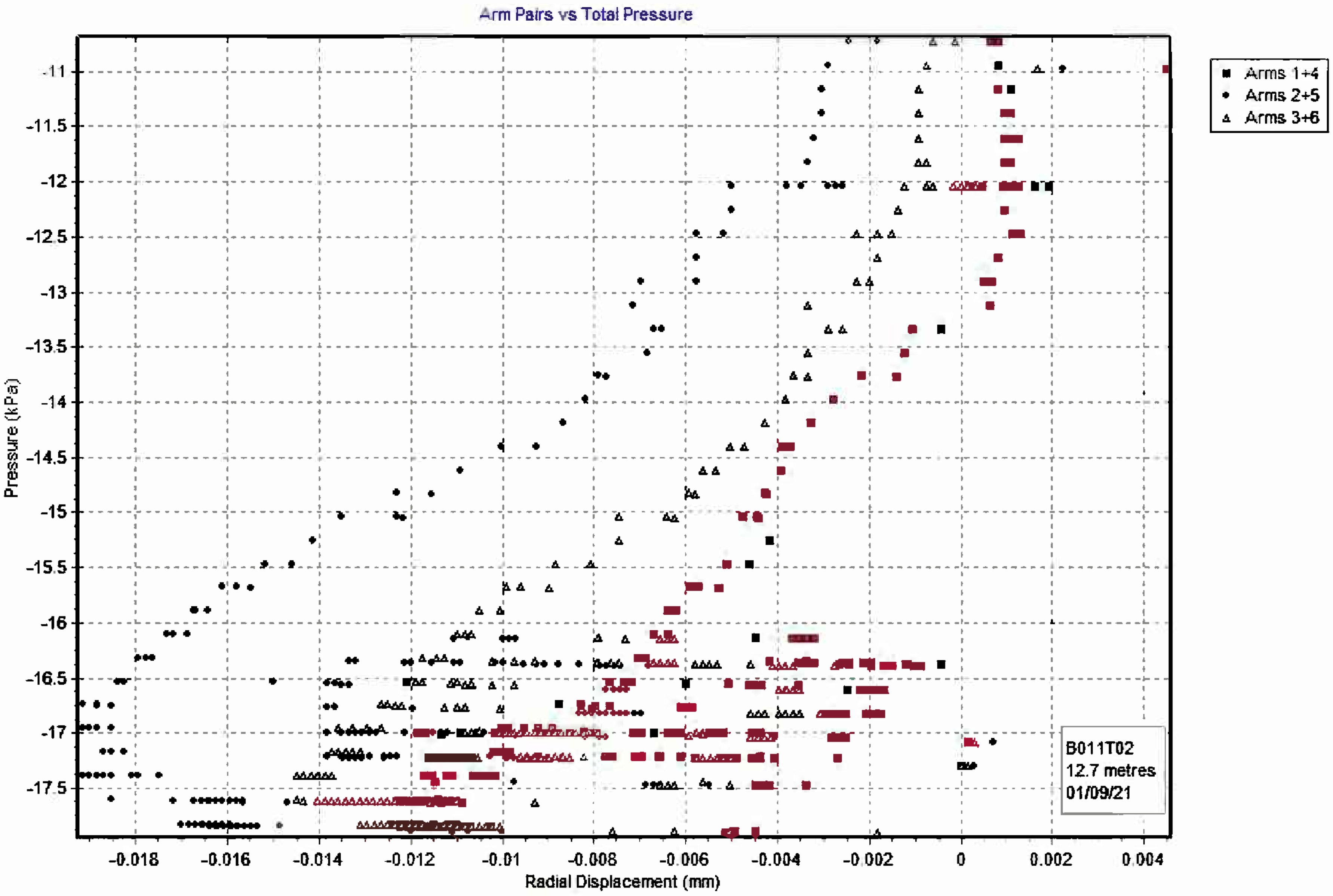
	TRANSDUCERS	MEMBRANE	COMPLIANCE
ARM 1	-81.5 mV and 306.3 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
ARM 2	-931.7 mV and 326.5 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
ARM 3	-328.2 mV and 326.9 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
ARM 4	74.5 mV and 330.0 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
ARM 5	78.7 mV and 330.4 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
ARM 6	-134.9 mV and 329.0 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
PPC A	-2561.5 mV and 402.4 mV/MPa		
PPC B	-2360.5 mV and 388.5 mV/MPa		
TPC	-2379.4 mV and 457.3 mV/MPa		

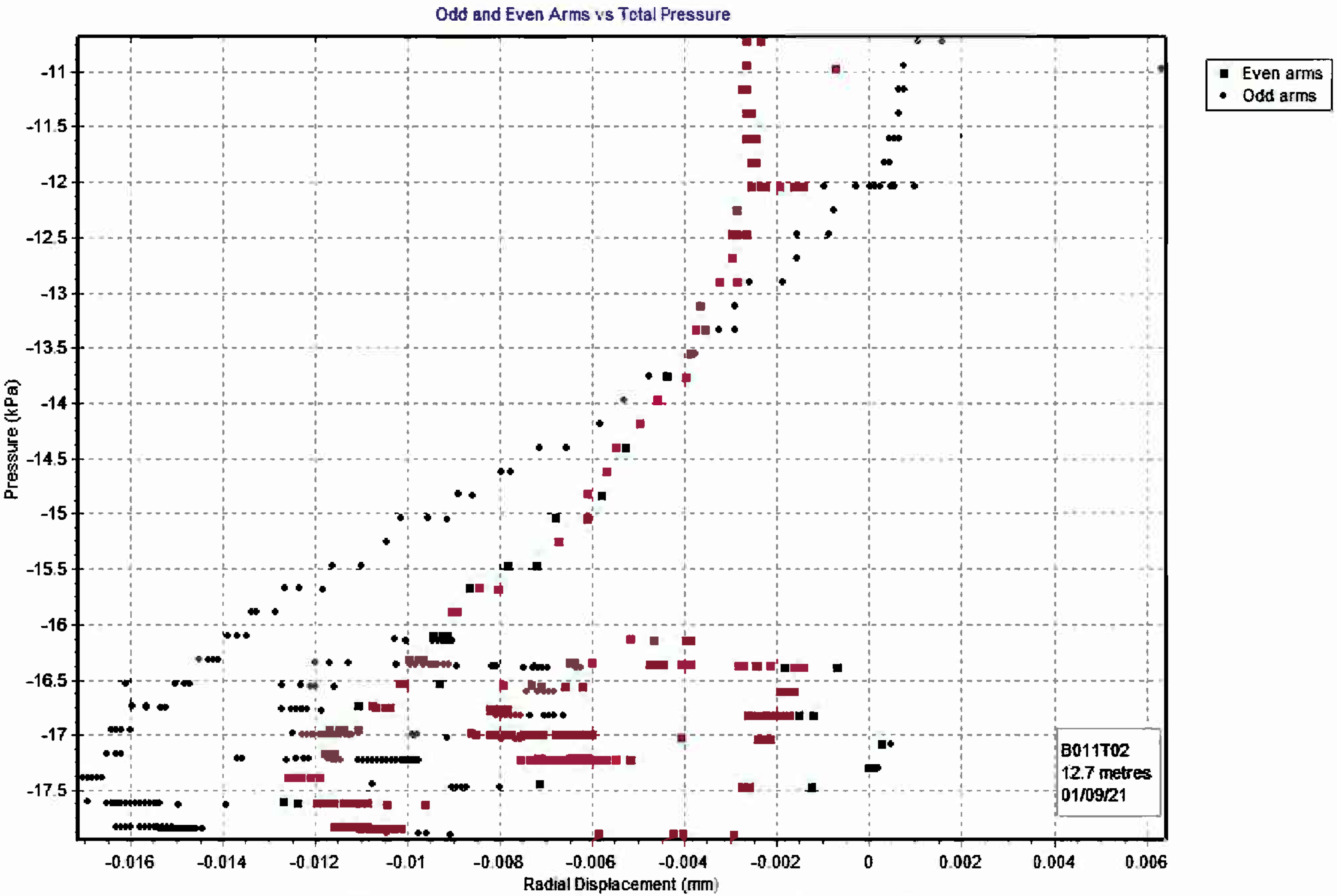


CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361

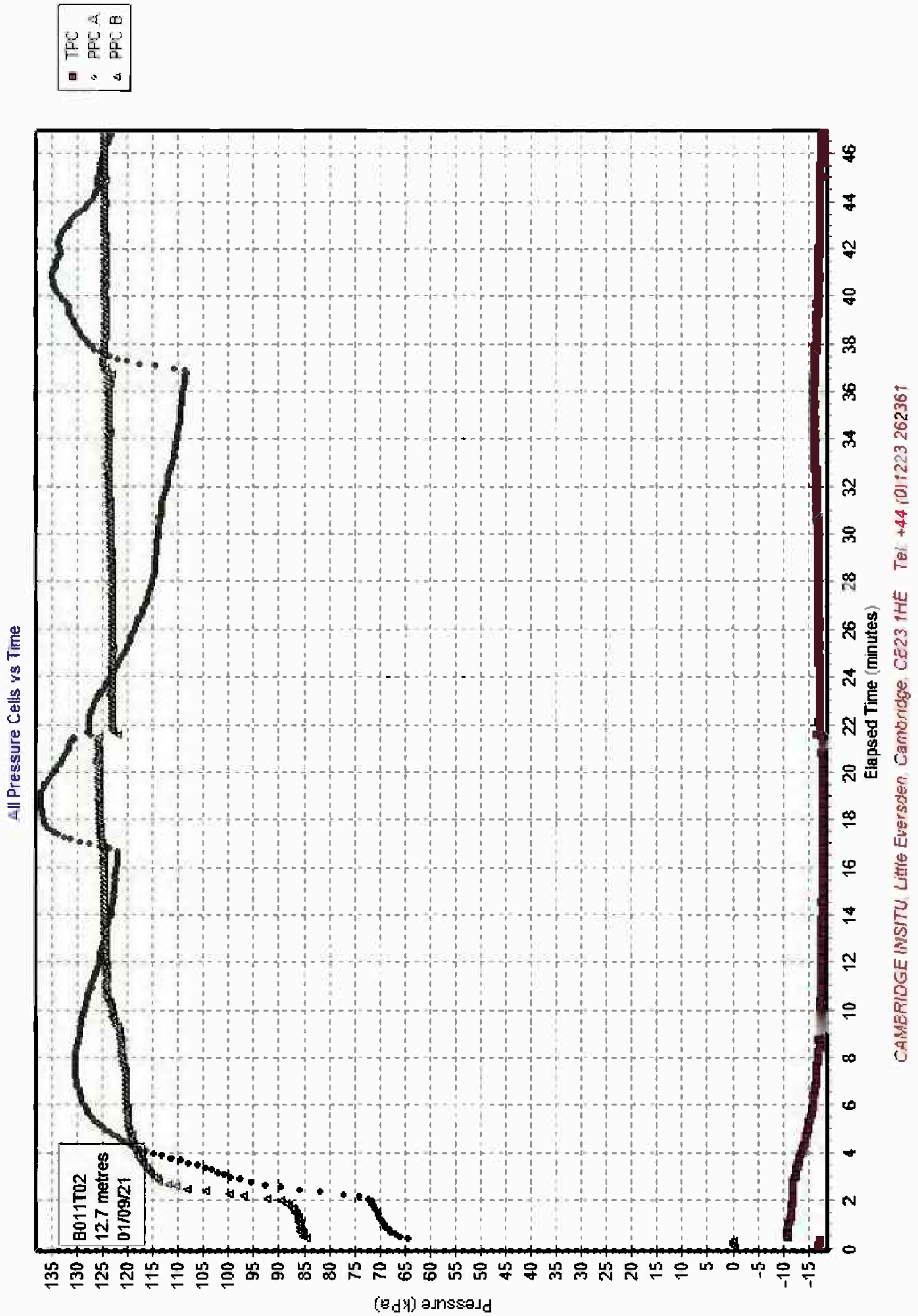


CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel +44 (0)1223 262361


Arm Pairs vs Total Pressure
Pressure (kPa)
-11
-11.5
-12
-12.5
-13
-13.5
-14
-14.5
-15
-15.5
-16
-16.5
-17
-17.5
Radial Displacement (mm)
-0.018
-0.016
-0.014
-0.012
-0.01
-0.008
-0.006
-0.004
-0.002
0
0.002
0.004
■ Arms 1+4
● Arms 2+5
△ Arms 3+6
B011T02
12.7 metres
01/09/21



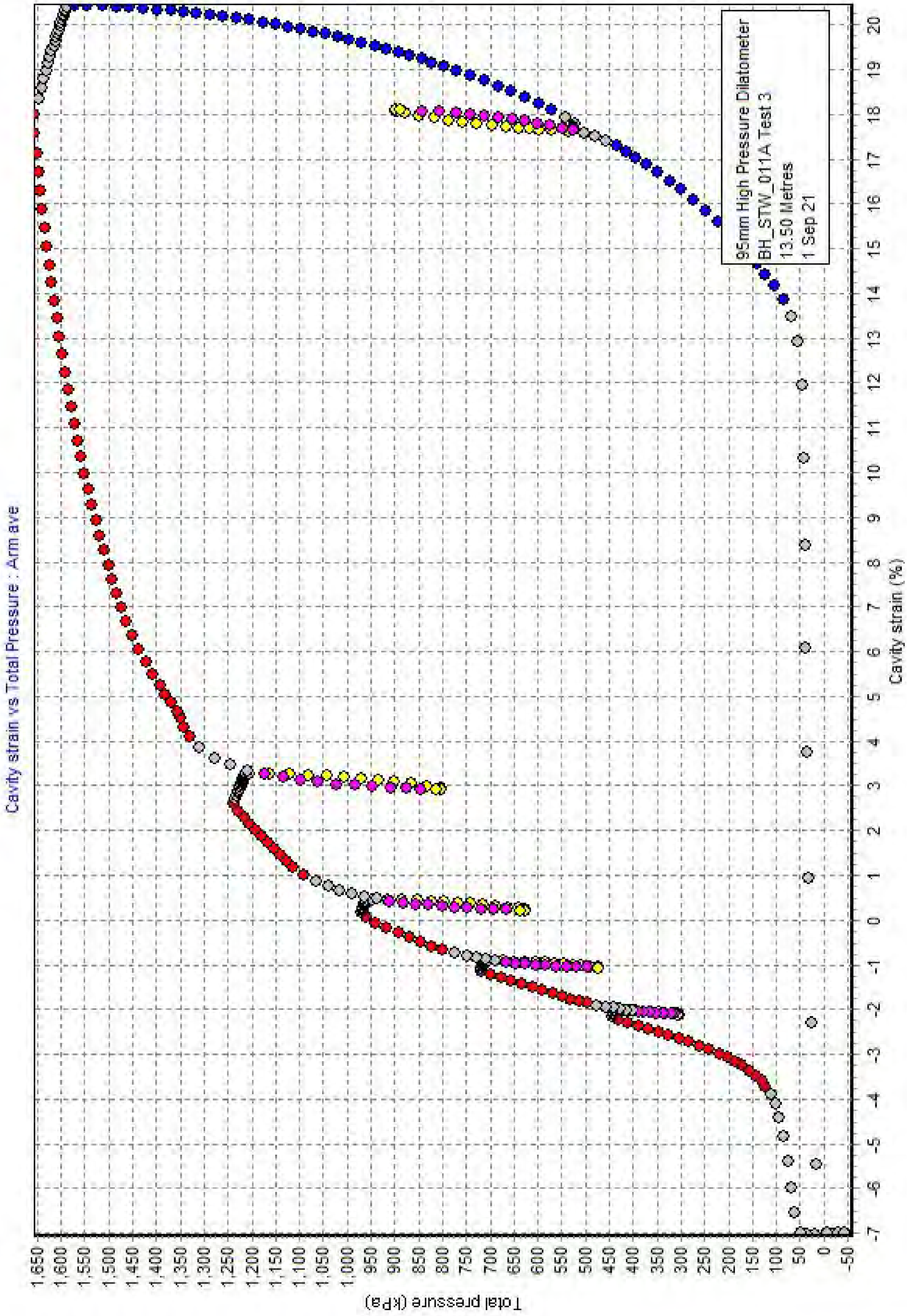
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361

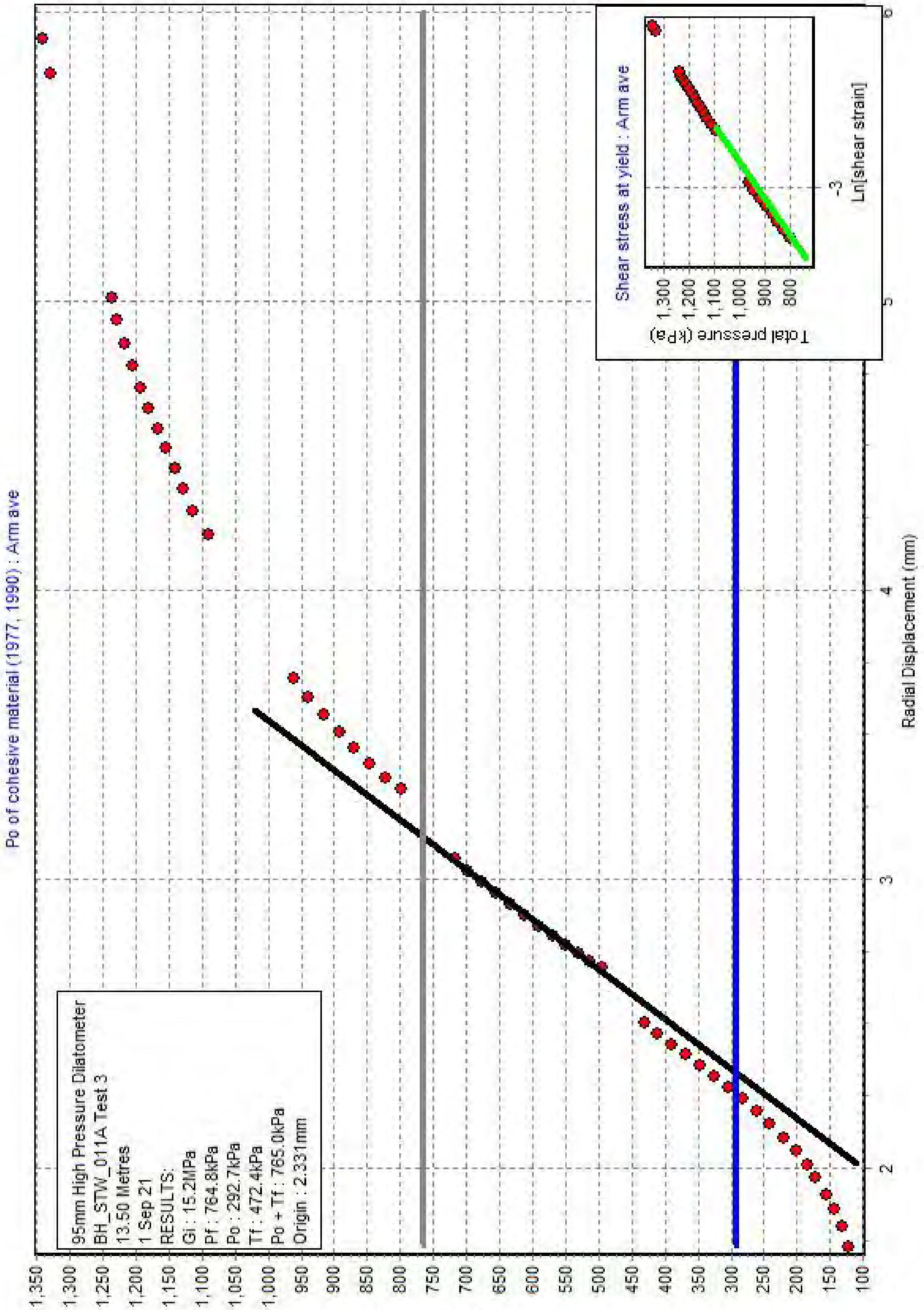


All Pressure Cells vs Time

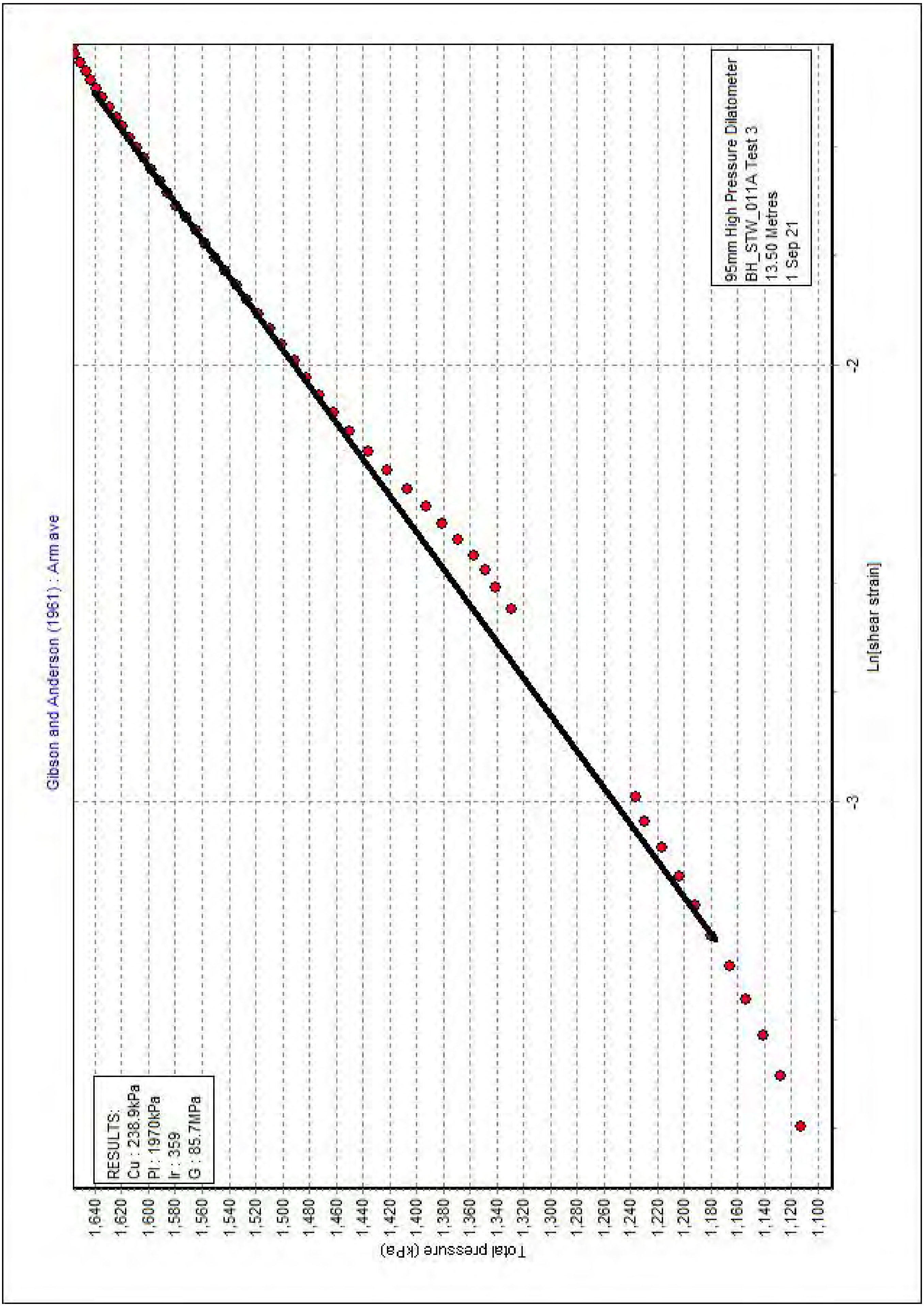
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel +44 (0)1223 262361

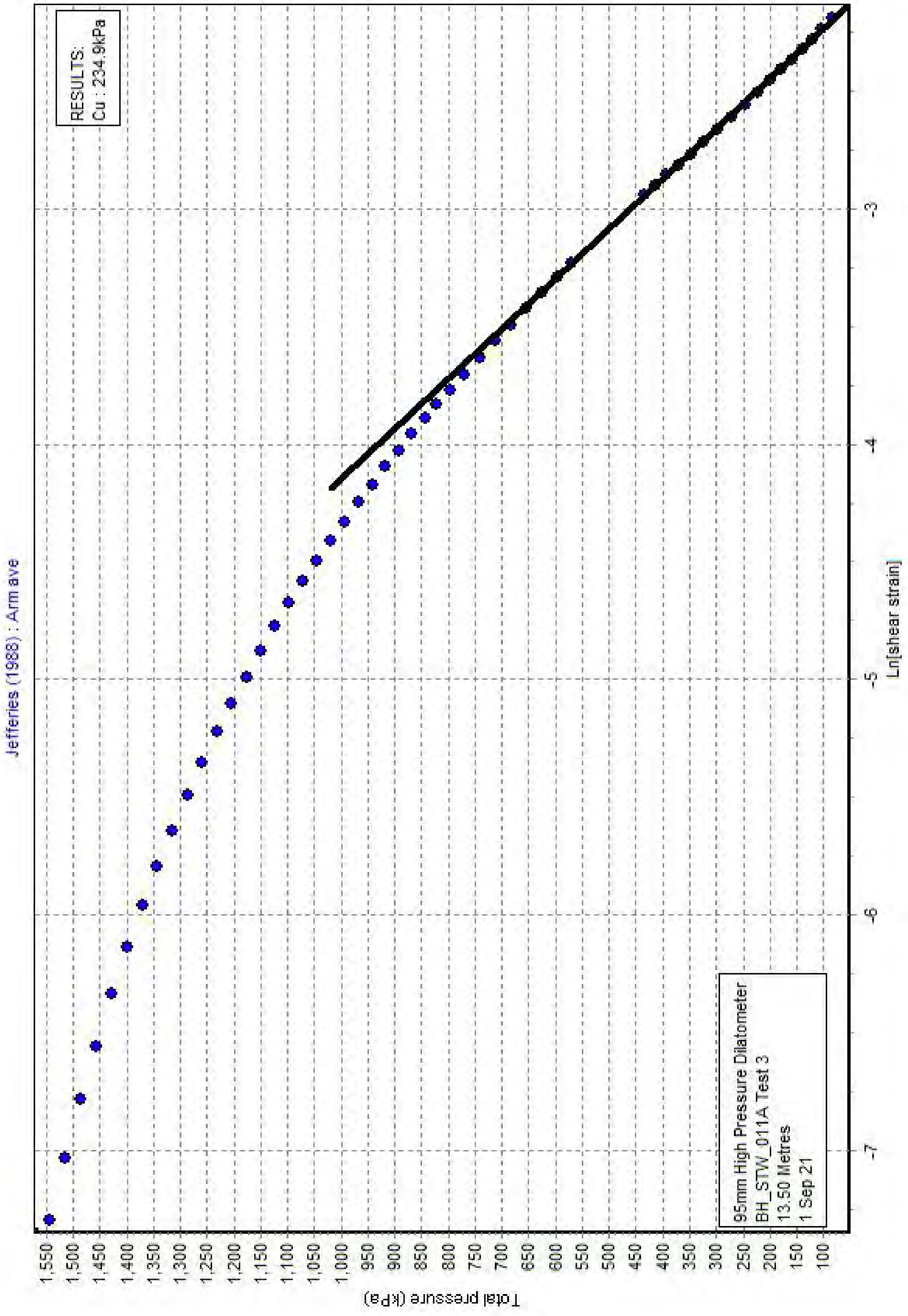
```
BH_STW_011A Test 3 - SUMMARY OF RESULTS
[File made with WinSitu ]

[DETAILS OF TEST]
Project        :   TE8364
Site           :   Cambridge Waste Water Treatment Plant Relocation Project
Borehole       :   BH_STW_011A
Test name      :   BH_STW_011A Test 3
Test date      :   1 Sep 21
Test depth     :   13.50 Metres
Water table    :   3.75 Metres
Ambient PWP    :   92.0 kPa
Material       :   Gault Clay
Probe          :   95mm High Pressure Dilatometer
Diameter       :   97.0 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out
The file includes results from a curve fitting analysis

Analysed by ES/RW on 7 Sep 21

Remarks:  Loop 1 taken too early

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm)                    :   "Arm ave=3.65"
Po from Marsland & Randolph (kPa)     :   "Arm ave=292.7"
Best estimate of Po (kPa)             :   "Arm ave=325.0"

[UNDRAINED STRENGTH PARAMETERS]
Gibson & Anderson 1961 - Cu (kPa)     :   "Arm ave=238.9"
Limit pressure (kPa)                  :   "Arm ave=1970"
Jefferies 1988 - Cu (kPa)             :   "Arm ave=234.9"
Undrained yield stress (kPa)          :   "Arm ave=764.8"

[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=15.2"
Axis       Loop   Value    Mean Strain  Mean Pc  dE      dPc
           No     (MPa)    (%)          (kPa)    (%)     (kPa)
Arm ave    1      58.4     -2.043       346      0.143   84
Arm ave    2      69.5     -0.963       573      0.288   200
Arm ave    3      63.4     0.366        773      0.458   291
Arm ave    4      56.3     3.123        985      0.650   367
Arm ave    5      46.9     17.890       711      0.772   364

[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]
Axis       Loop   Intercept  Alpha      Gradient
           No     (MPa)      (MPa)
Arm ave    1      12.774     9.726      0.761
Arm ave    2      6.242      3.630      0.582
Arm ave    3      6.164      3.438      0.558
Arm ave    4      5.331      2.774      0.520
Arm ave    5      5.727      3.185      0.556


[PARAMETERS USED FOR UNDRAINED CURVE MODELLING]
{Axis is  Arm ave}
Strain Origin (mm)                    :   3.65
Po (kPa)                              :   325
Cu (kPa)                              :   238.9
Limit pressure (kPa)                  :   1970
Non-linear exponent                   :   0.520
Calculated alpha (MPa)                :   3.150
G at yield (MPa)                      :   34.1
```

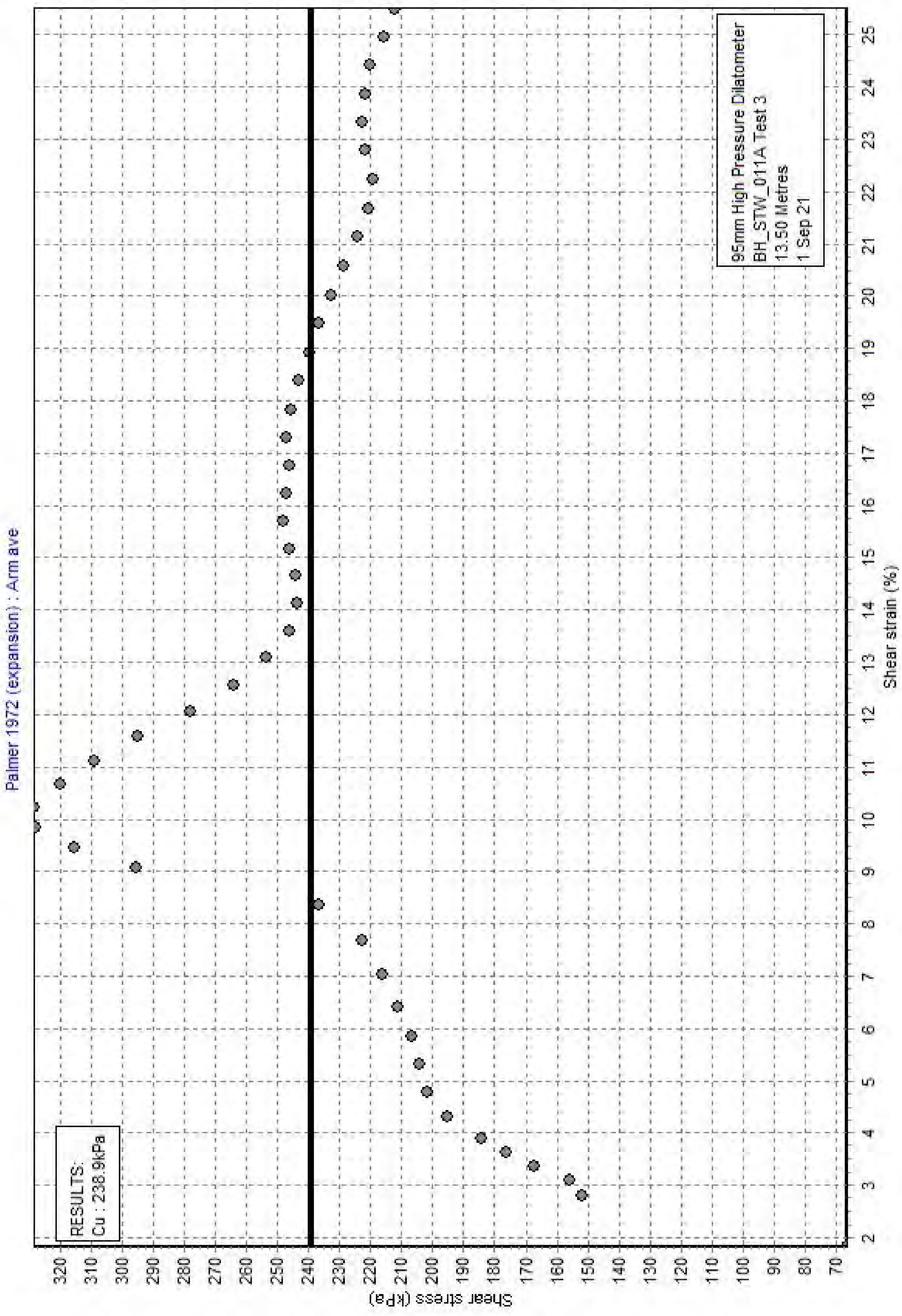

Cavity strain vs Total Pressure : Arm ave
95mm High Pressure Dilatometer
BH_STW_011A Test 3
13.50 Metres
1 Sep 21
Cavity strain (%)
-7
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Total pressure (kPa)
-50
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1,000
1,050
1,100
1,150
1,200
1,250
1,300
1,350
1,400
1,450
1,500
1,550
1,600
1,650

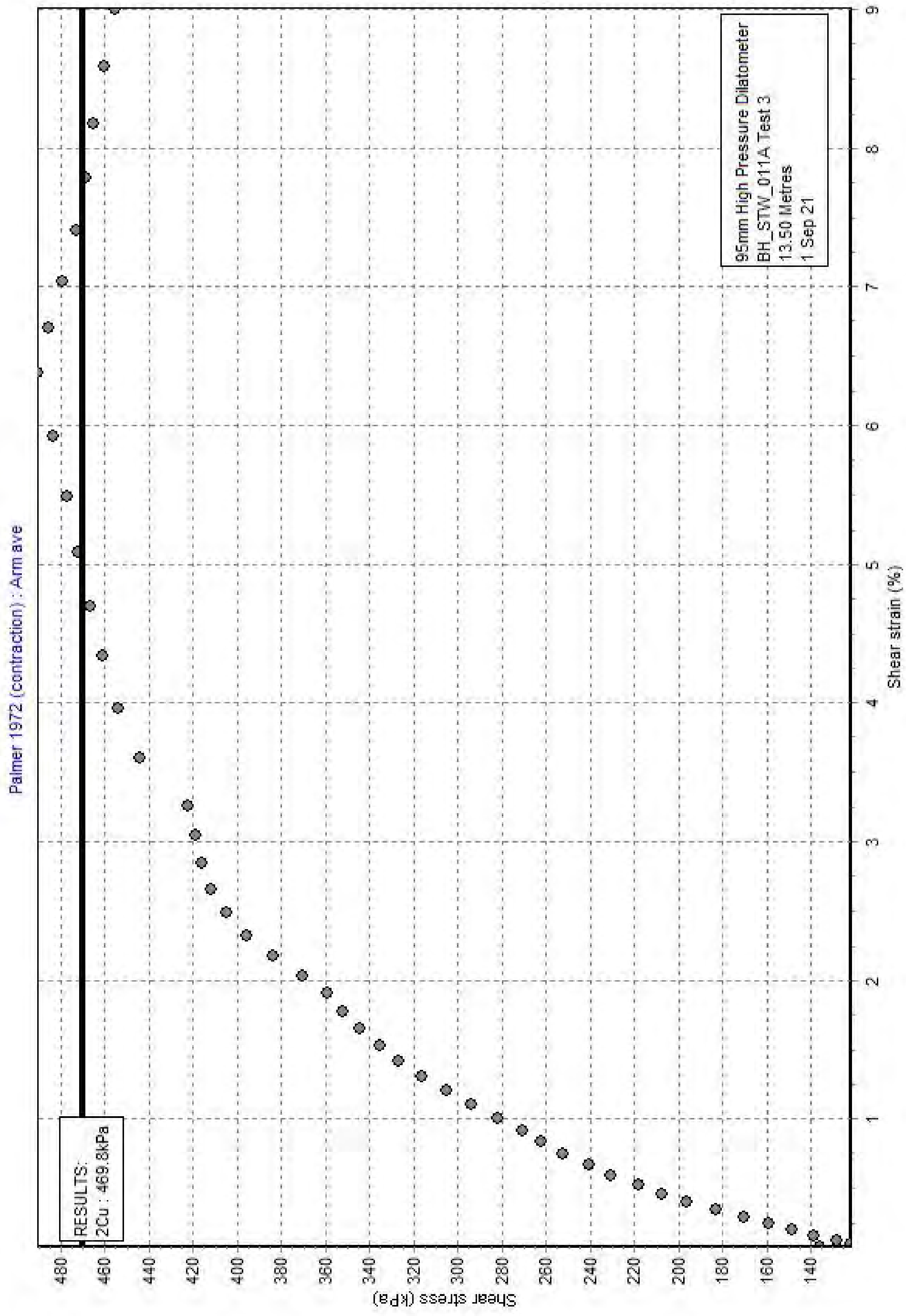


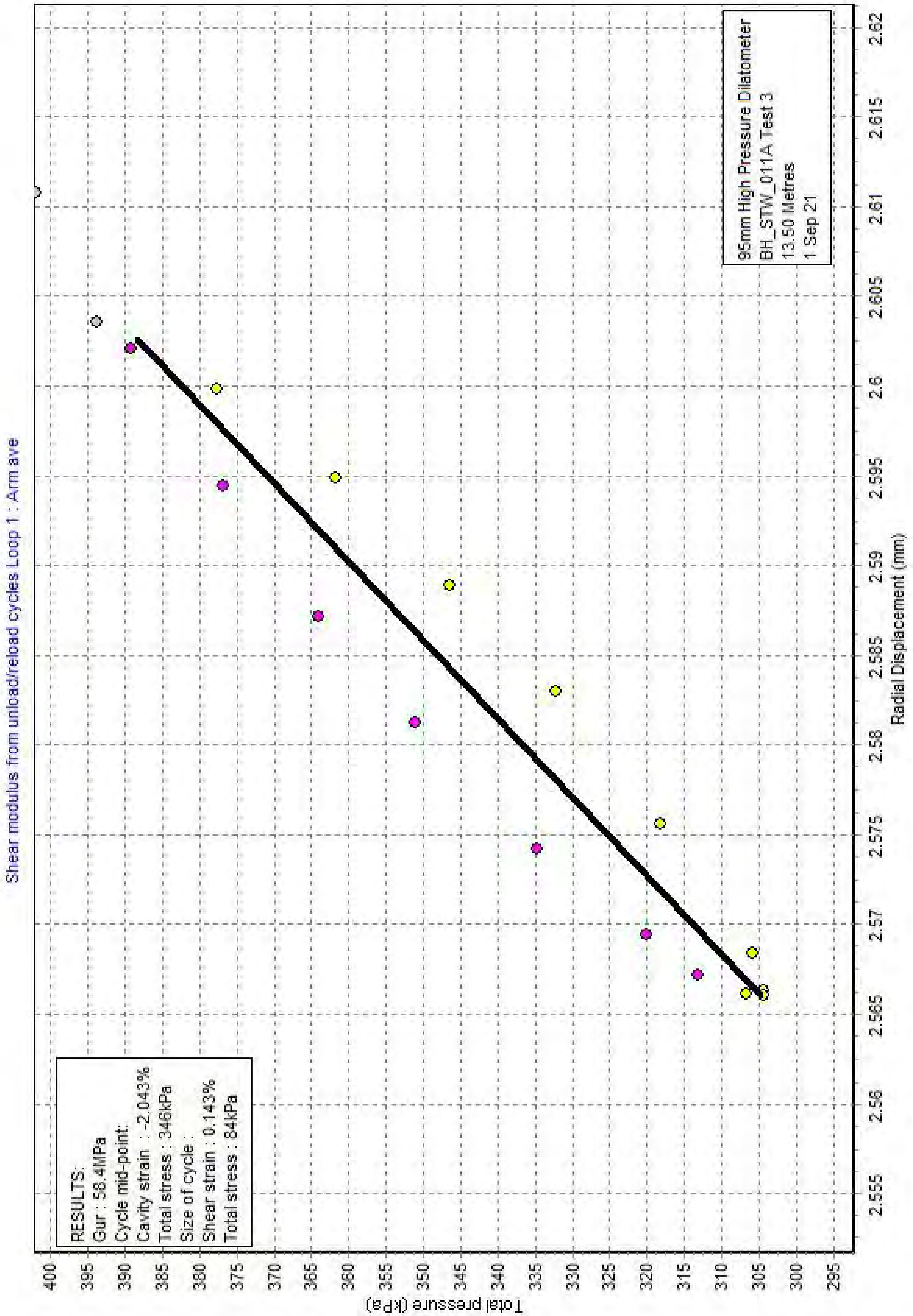
95mm High Pressure Dilatometer
BH_STW_011A Test 3
13.50 Metres
1 Sep 21
RESULTS:
Gi : 15.2MPa
Pf : 764.8kPa
Po : 292.7kPa
Tf : 472.4kPa
Po + Tf : 765.0kPa
Origin : 2.331mm

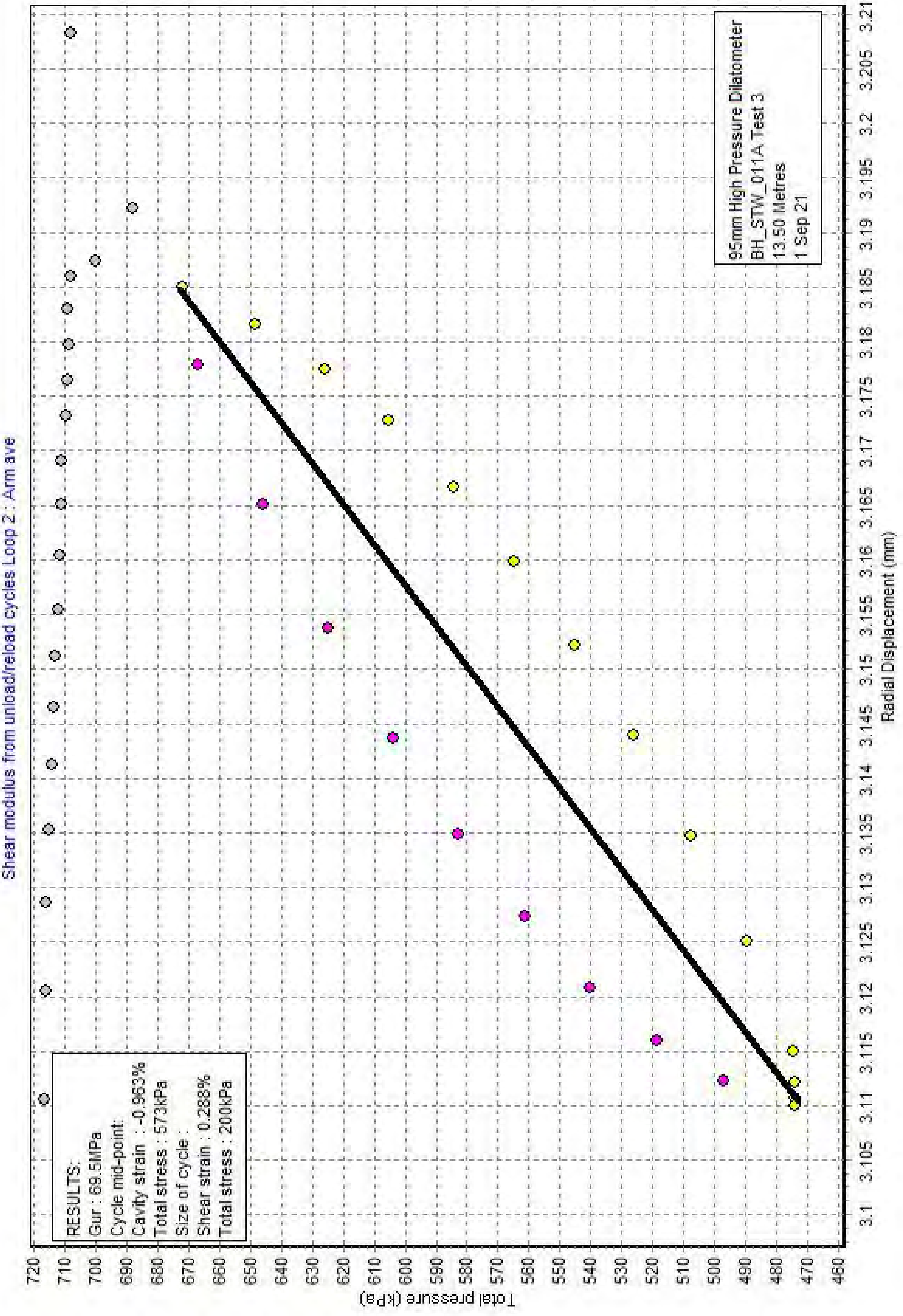

Gibson and Anderson (1961) : Arm ave
RESULTS:
Cu : 238.9kPa
Pl : 1970kPa
Ir : 359
G : 85.7MPa
95mm High Pressure Dilatometer
BH_STW_011A Test 3
13.50 Metres
1 Sep 21
Total pressure (kPa)
1,640
1,620
1,600
1,580
1,560
1,540
1,520
1,500
1,480
1,460
1,440
1,420
1,400
1,380
1,360
1,340
1,320
1,300
1,280
1,260
1,240
1,220
1,200
1,180
1,160
1,140
1,120
1,100
Ln[shear strain]
-2
-3

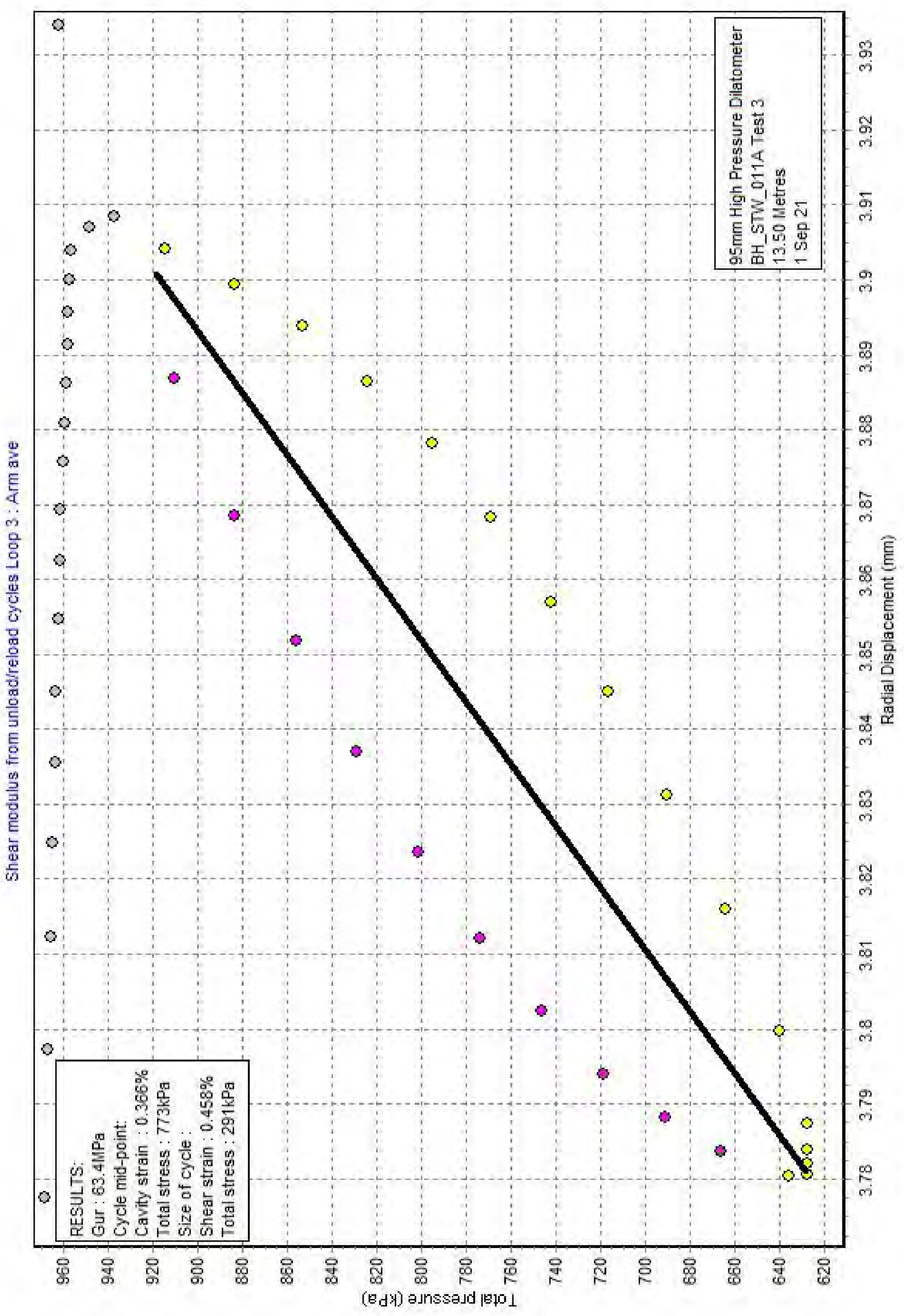

Jefferies (1988) : Arm ave
RESULTS:
Cu : 234.9kPa
95mm High Pressure Dilatometer
BH_STW_011A Test 3
13.50 Metres
1 Sep 21
Ln[shear strain]
-3
-4
-5
-6
-7
Total pressure (kPa)
1,550
1,500
1,450
1,400
1,350
1,300
1,250
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100

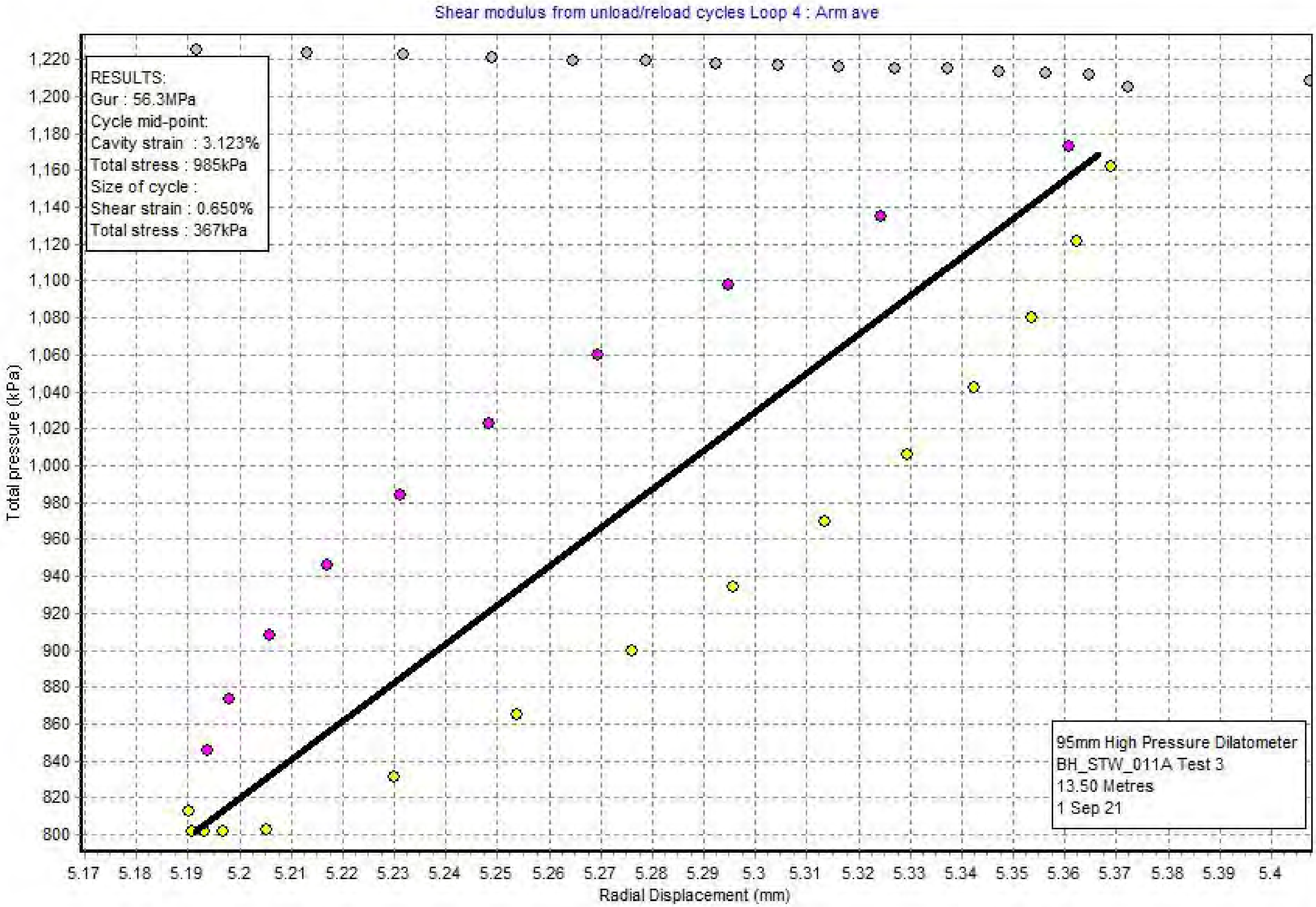

Palmer 1972 (expansion) : Arm ave
RESULTS:
Cu : 238.9kPa
95mm High Pressure Dilatometer
BH_STW_011A Test 3
13.50 Metres
1 Sep 21
Shear strain (%)
Shear stress (kPa)
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
320
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70

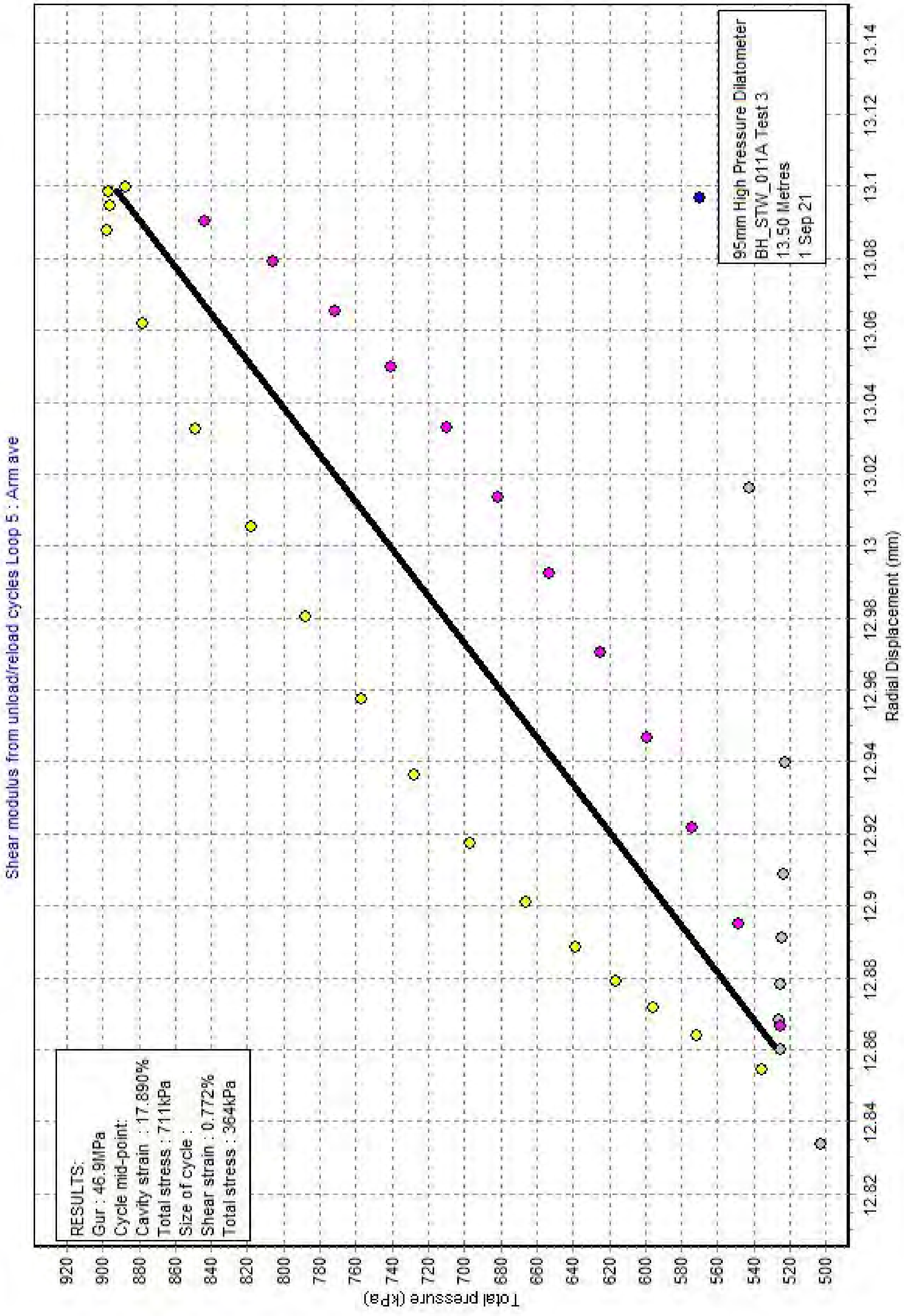

Palmer 1972 (contraction) : Arm ave
RESULTS:
2Cu : 469.8kPa
95mm High Pressure Dilatometer
BH_STW_011A Test 3
13.50 Metres
1 Sep 21
Shear stress (kPa)
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
Shear strain (%)
1
2
3
4
5
6
7
8
9


Shear modulus from unload/reload cycles Loop 1 : Arm ave
95mm High Pressure Dilatometer
BH_STW_011A Test 3
13.50 Metres
1 Sep 21
RESULTS:
Gur : 58.4MPa
Cycle mid-point:
Cavity strain : -2.043%
Total stress : 346kPa
Size of cycle :
Shear strain : 0.143%
Total stress : 84kPa
Radial Displacement (mm)
2.555
2.56
2.565
2.57
2.575
2.58
2.585
2.59
2.595
2.6
2.605
2.61
2.615
2.62
Total pressure (kPa)
400
395
390
385
380
375
370
365
360
355
350
345
340
335
330
325
320
315
310
305
300
295

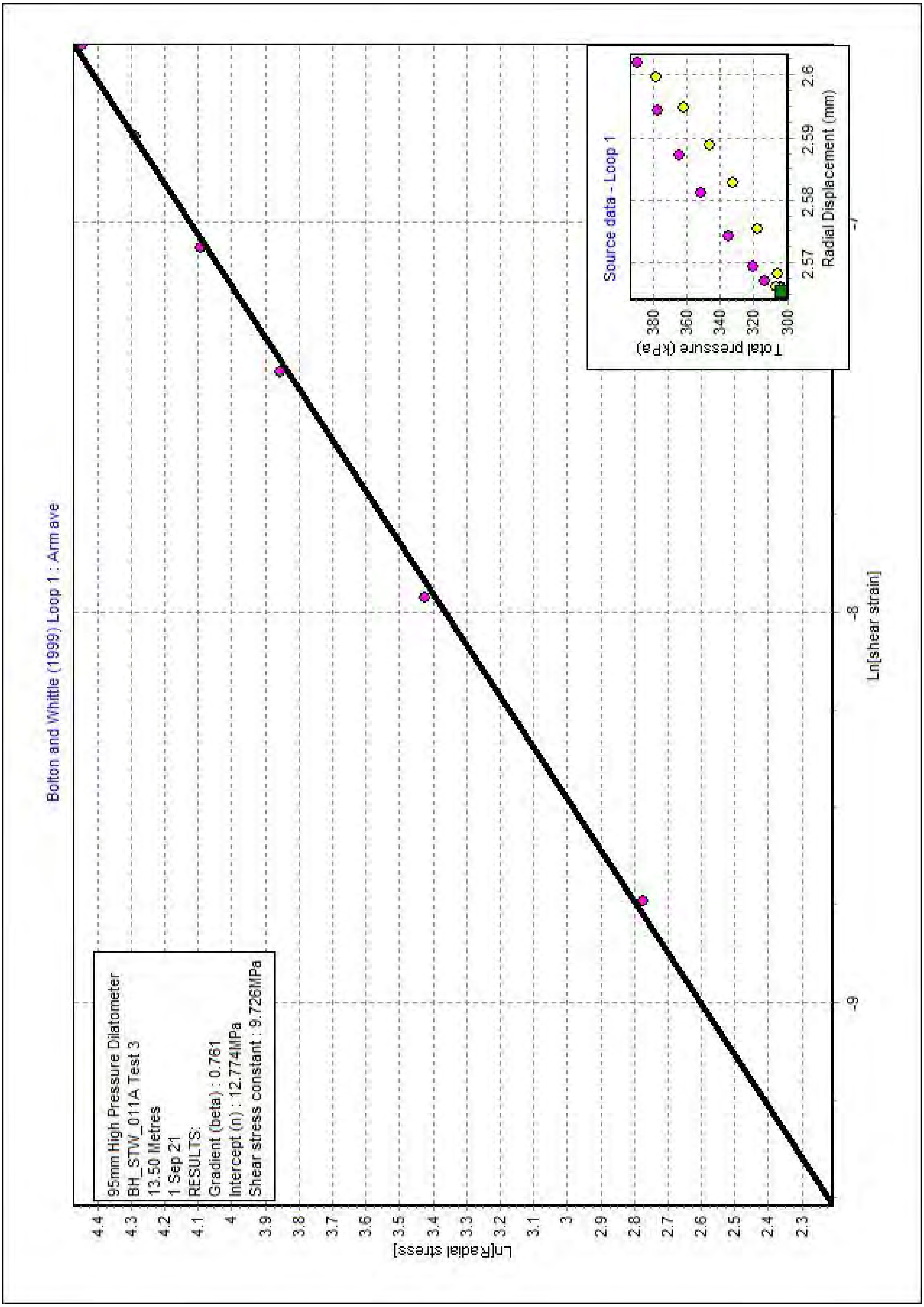

Shear modulus from unload/reload cycles Loop 2 : Arm ave
95mm High Pressure Dilatometer
BH_STW_011A Test 3
13.50 Metres
1 Sep 21
RESULTS:
Gur : 69.5MPa
Cycle mid-point:
Cavity strain : -0.963%
Total stress : 573kPa
Size of cycle :
Shear strain : 0.288%
Total stress : 200kPa
Total pressure (kPa)
720
710
700
690
680
670
660
650
640
630
620
610
600
590
580
570
560
550
540
530
520
510
500
490
480
470
460
Radial Displacement (mm)
3.1
3.105
3.11
3.115
3.12
3.125
3.13
3.135
3.14
3.145
3.15
3.155
3.16
3.165
3.17
3.175
3.18
3.185
3.19
3.195
3.2
3.205
3.21

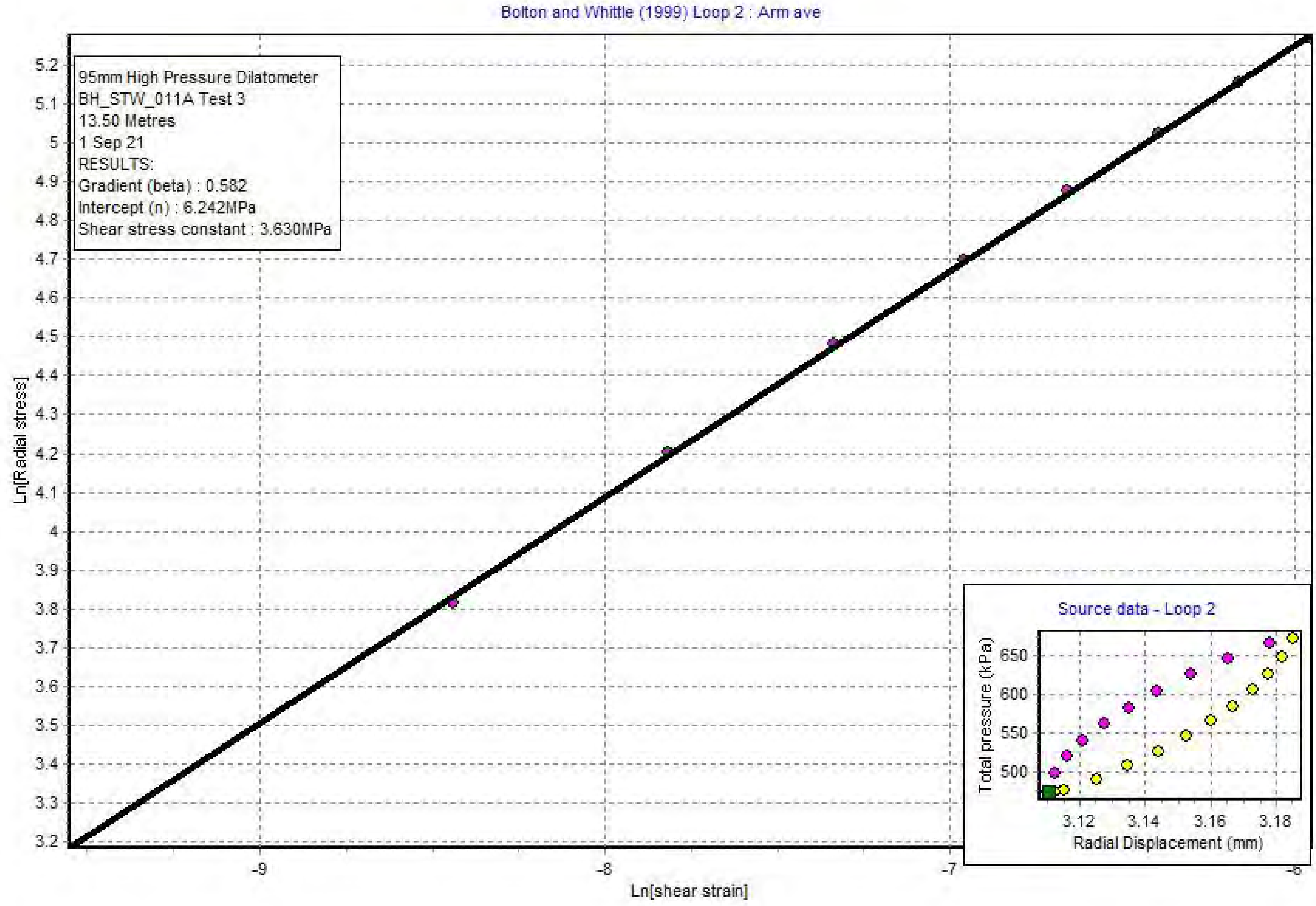

Shear modulus from unload/reload cycles Loop 3 : Arm ave
95mm High Pressure Dilatometer
BH_STW_011A Test 3
13.50 Metres
1 Sep 21
RESULTS:
Gur : 63.4MPa
Cycle mid-point:
Cavity strain : 0.366%
Total stress : 773kPa
Size of cycle :
Shear strain : 0.458%
Total stress : 291kPa
Total pressure (kPa)
960
940
920
900
880
860
840
820
800
780
760
740
720
700
680
660
640
620
Radial Displacement (mm)
3.78
3.79
3.8
3.81
3.82
3.83
3.84
3.85
3.86
3.87
3.88
3.89
3.9
3.91
3.92
3.93

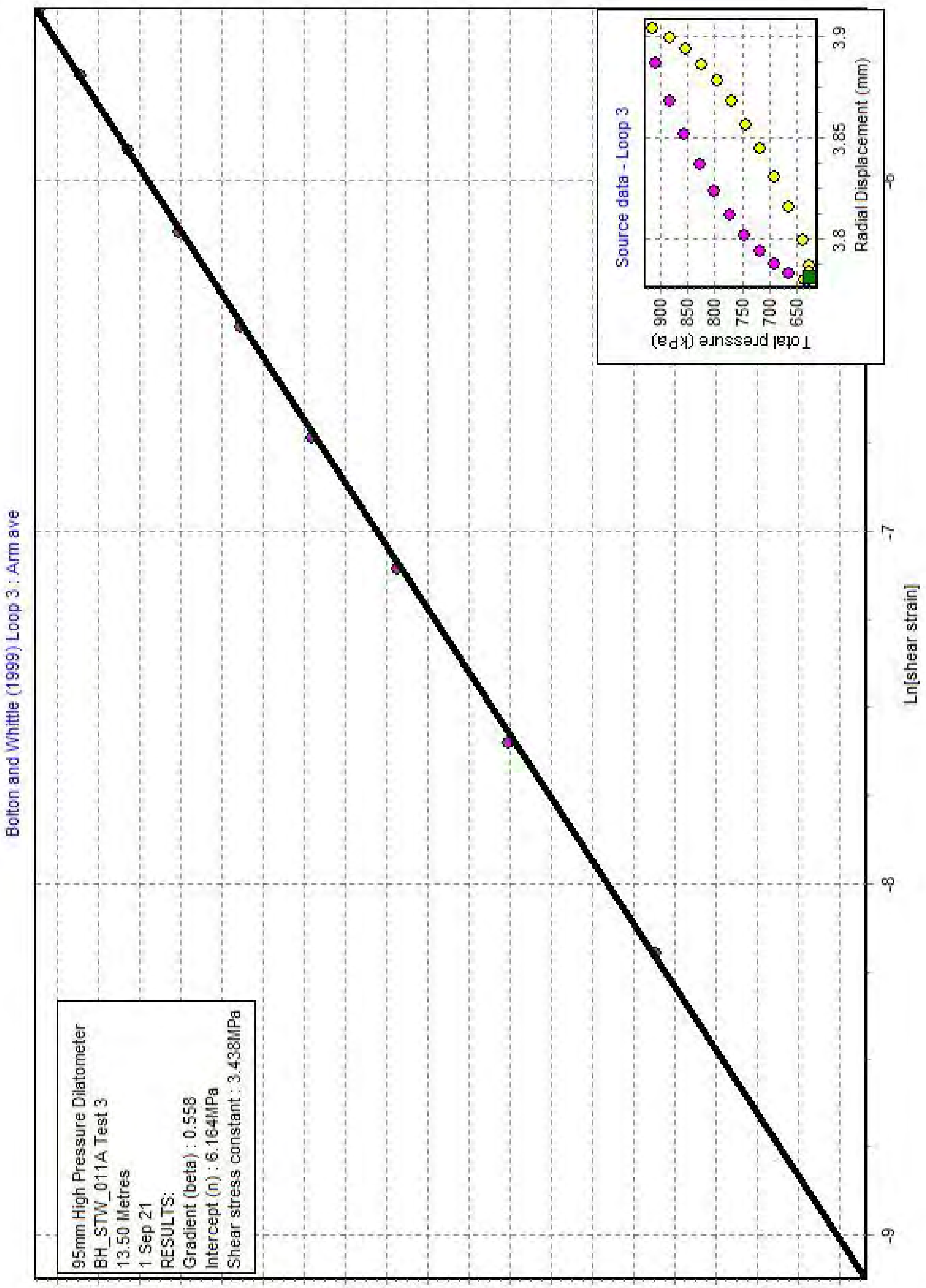

Shear modulus from unload/reload cycles Loop 4 : Arm ave
RESULTS:
Gur : 56.3MPa
Cycle mid-point:
Cavity strain : 3.123%
Total stress : 985kPa
Size of cycle :
Shear strain : 0.650%
Total stress : 367kPa
95mm High Pressure Dilatometer
BH_STW_011A Test 3
13.50 Metres
1 Sep 21
Total pressure (kPa)
1,220
1,200
1,180
1,160
1,140
1,120
1,100
1,080
1,060
1,040
1,020
1,000
980
960
940
920
900
880
860
840
820
800
Radial Displacement (mm)
5.17
5.18
5.19
5.2
5.21
5.22
5.23
5.24
5.25
5.26
5.27
5.28
5.29
5.3
5.31
5.32
5.33
5.34
5.35
5.36
5.37
5.38
5.39
5.4



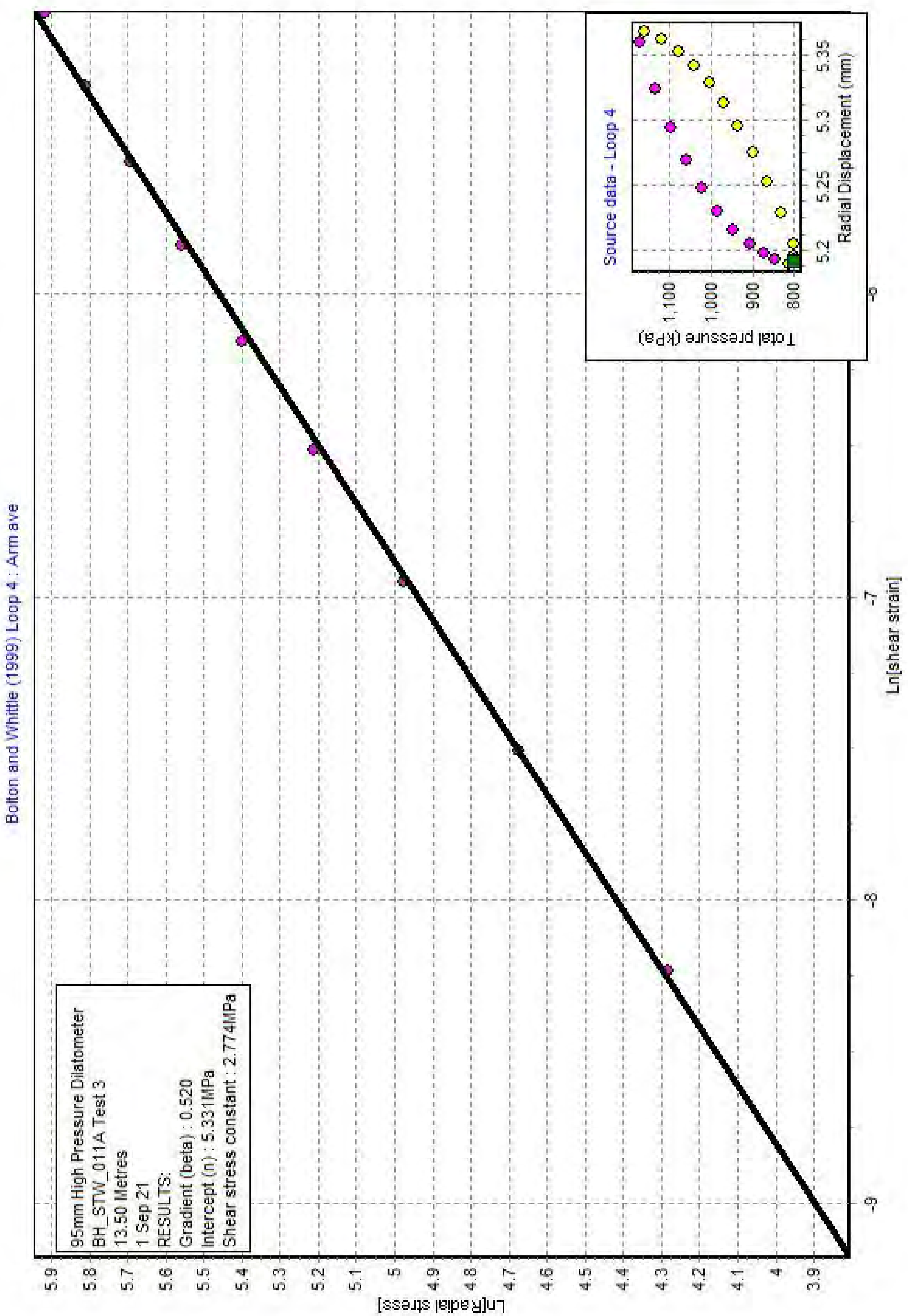
RESULTS:
Gur : 46.9MPa
Cycle mid-point:
Cavity strain : 17.890%
Total stress : 711kPa
Size of cycle :
Shear strain : 0.772%
Total stress : 364kPa

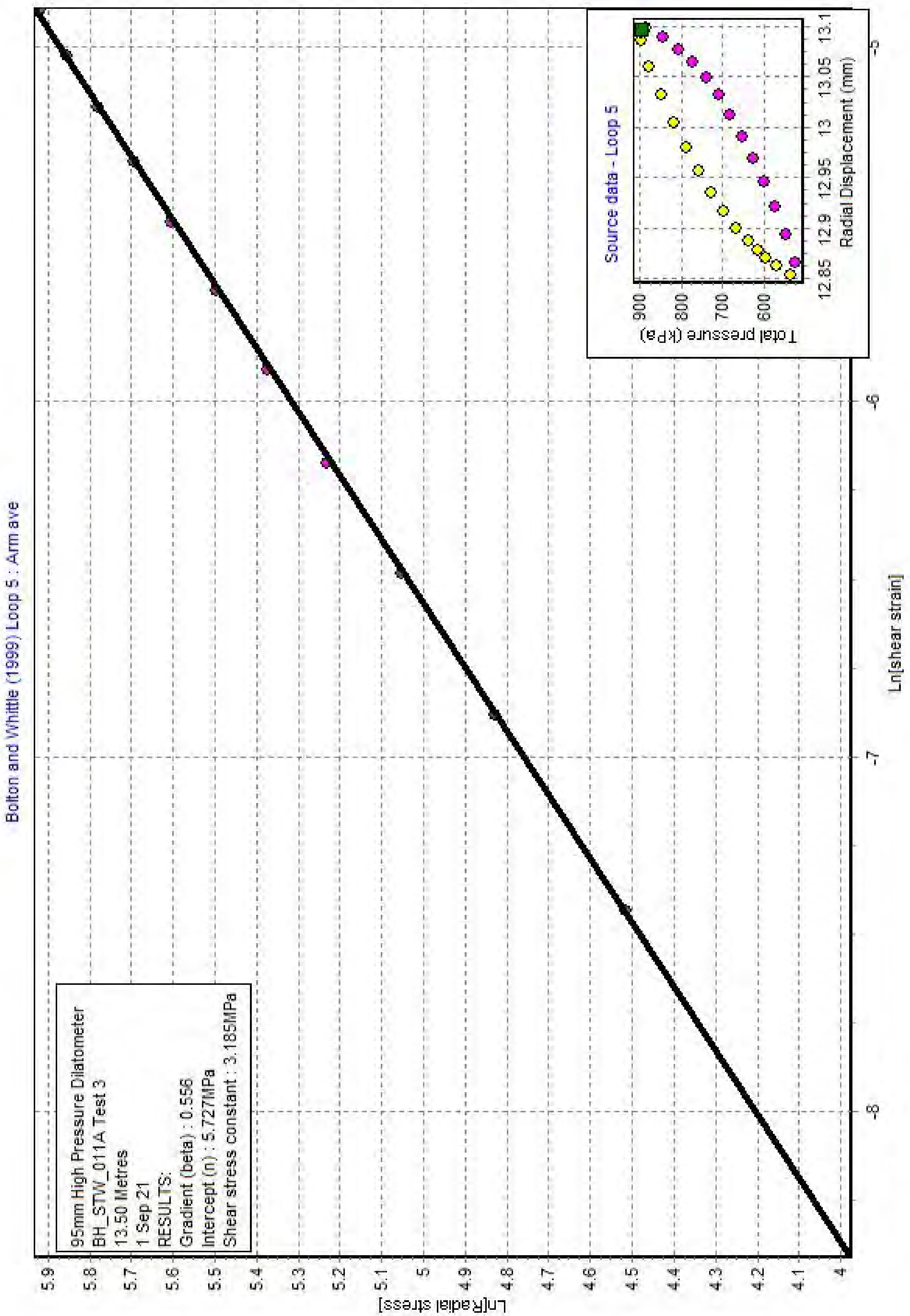

Bolton and Whittle (1999) Loop 1 : Arm ave
95mm High Pressure Dilatometer
BH_STW_011A Test 3
13.50 Metres
1 Sep 21
RESULTS:
Gradient (beta) : 0.761
Intercept (n) : 12.774MPa
Shear stress constant : 9.726MPa
Ln[Radial stress]
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
2.7
2.6
2.5
2.4
2.3
Ln[shear strain]
-9
-8
-7
Source data - Loop 1
Total pressure (kPa)
300
320
340
360
380
Radial Displacement (mm)
2.57
2.58
2.59
2.6

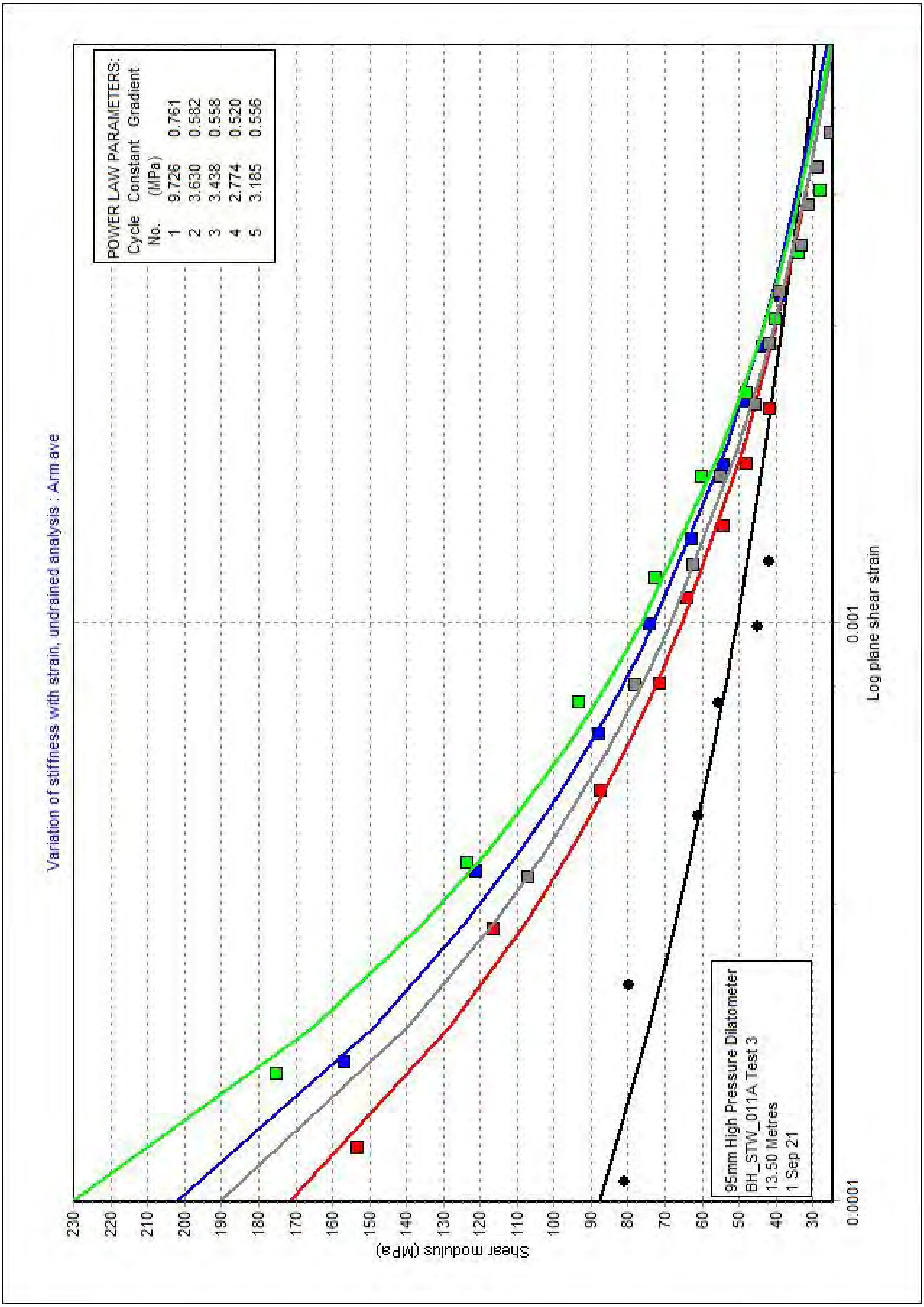

Bolton and Whittle (1999) Loop 2 : Arm ave
95mm High Pressure Dilatometer
BH_STW_011A Test 3
13.50 Metres
1 Sep 21
RESULTS:
Gradient (beta) : 0.582
Intercept (n) : 6.242MPa
Shear stress constant : 3.630MPa
Ln[Radial stress]
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
-9
-8
-7
-6
Ln[shear strain]
Source data - Loop 2
Total pressure (kPa)
650
600
550
500
3.12
3.14
3.16
3.18
Radial Displacement (mm)



95mm High Pressure Dilatometer
BH_STW_011A Test 3
13.50 Metres
1 Sep 21
RESULTS:
Gradient (beta) : 0.558
Intercept (n) : 6.164MPa
Shear stress constant : 3.438MPa


Bolton and Whittle (1999) Loop 4 : Arm ave
95mm High Pressure Dilatometer
BH_STW_011A Test 3
13.50 Metres
1 Sep 21
RESULTS:
Gradient (beta) : 0.520
Intercept (n) : 5.331MPa
Shear stress constant : 2.774MPa
Ln[Radial stress]
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
Ln[shear strain]
-9
-8
-7
-6
Source data - Loop 4
Total pressure (kPa)
1,100
1,000
900
800
Radial Displacement (mm)
5.2
5.25
5.3
5.35


Bolton and Whittle (1999) Loop 5 : Arm ave
95mm High Pressure Dilatometer
BH_STW_011A Test 3
13.50 Metres
1 Sep 21
RESULTS:
Gradient (beta) : 0.556
Intercept (n) : 5.727MPa
Shear stress constant : 3.185MPa
Ln[Radial stress]
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
Ln[shear strain]
-5
-6
-7
-8
Source data - Loop 5
Total pressure (kPa)
900
800
700
600
Radial Displacement (mm)
12.85
12.9
12.95
13
13.05
13.1

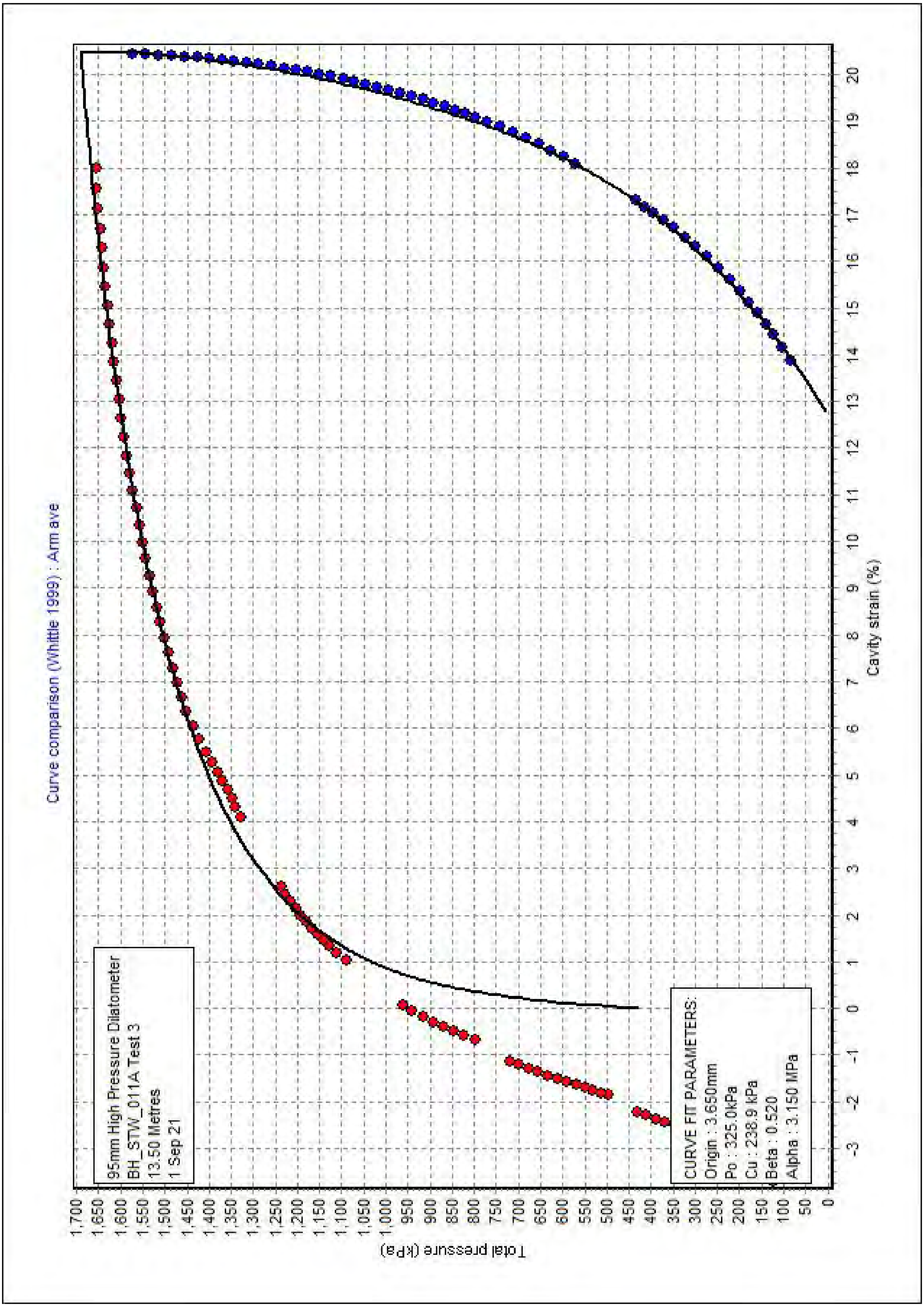


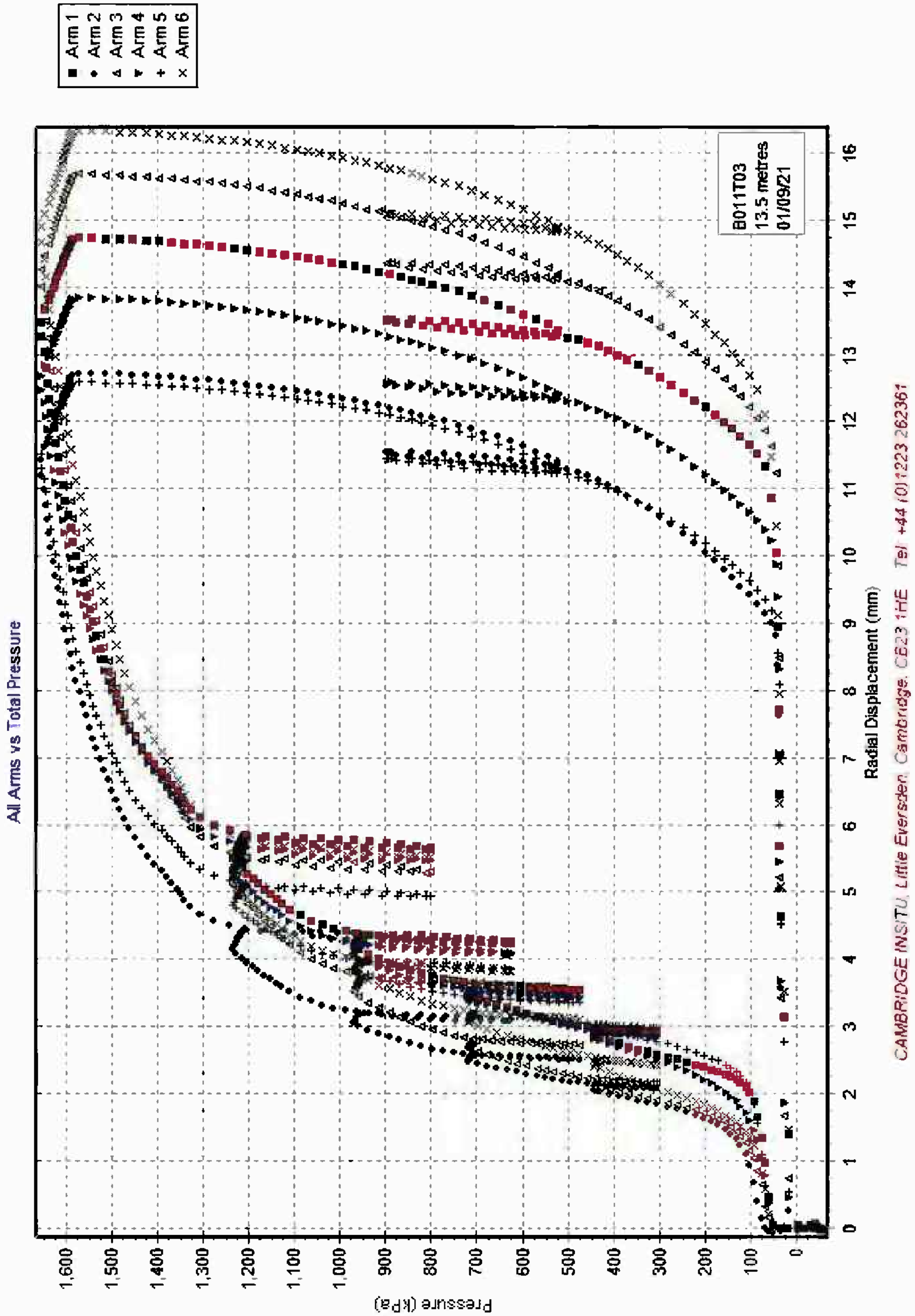
Variation of stiffness with strain, undrained analysis : Arm ave

POWER LAW PARAMETERS:

Cycle No.	Constant (MPa)	Gradient
1	9.726	0.761
2	3.630	0.582
3	3.438	0.558
4	2.774	0.520
5	3.185	0.556

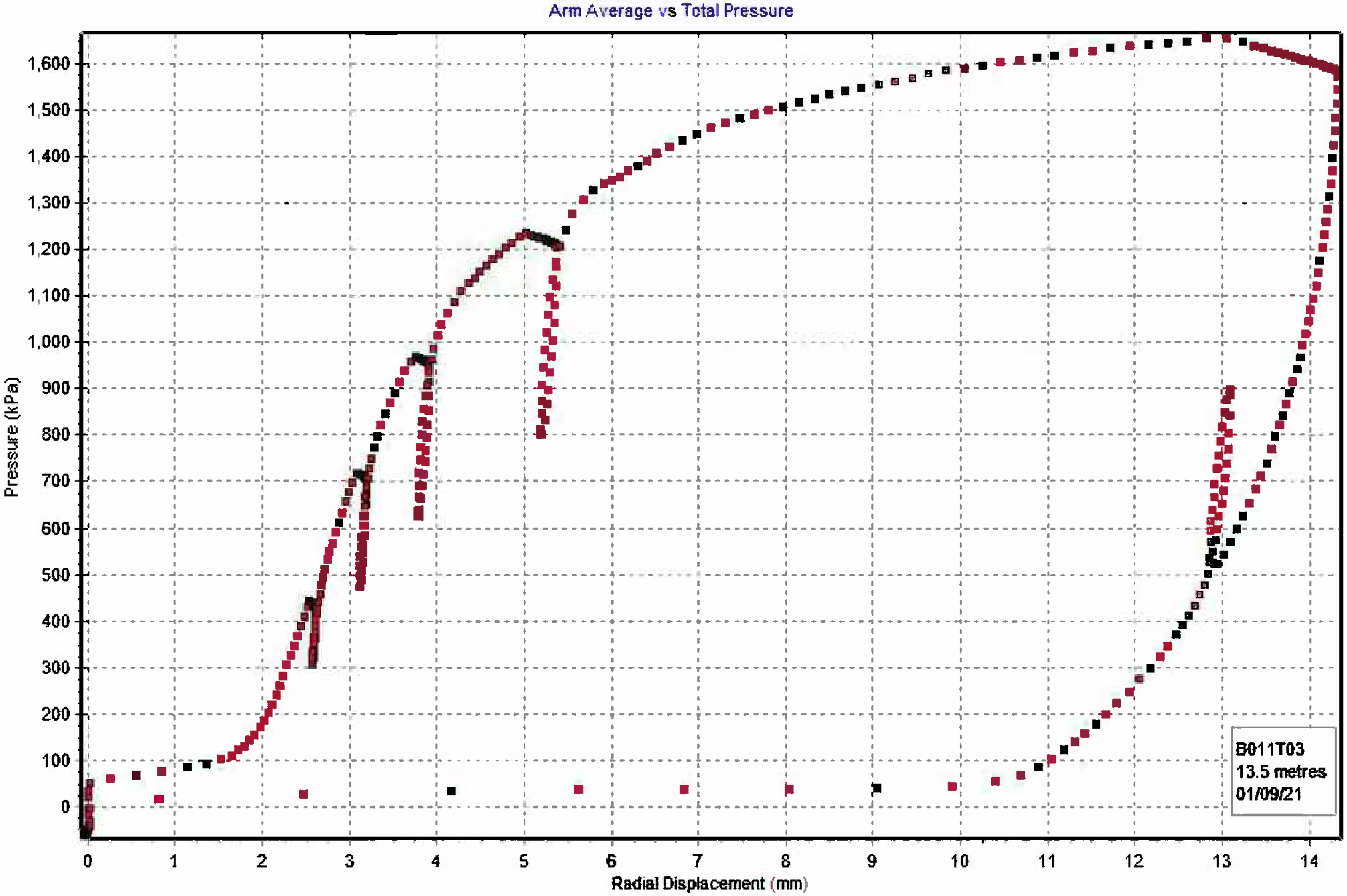
95mm High Pressure Dilatometer
BH_STW_011A Test 3
13.50 Metres
1 Sep 21


Curve comparison (Whittle 1999) : Arm ave
95mm High Pressure Dilatometer
BH_STW_011A Test 3
13.50 Metres
1 Sep 21
CURVE FIT PARAMETERS:
Origin : 3.650mm
Po : 325.0kPa
Cu : 238.9 kPa
Beta : 0.520
Alpha : 3.150 MPa
Total pressure (kPa)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1,000
1,050
1,100
1,150
1,200
1,250
1,300
1,350
1,400
1,450
1,500
1,550
1,600
1,650
1,700
Cavity strain (%)
-3
-2
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

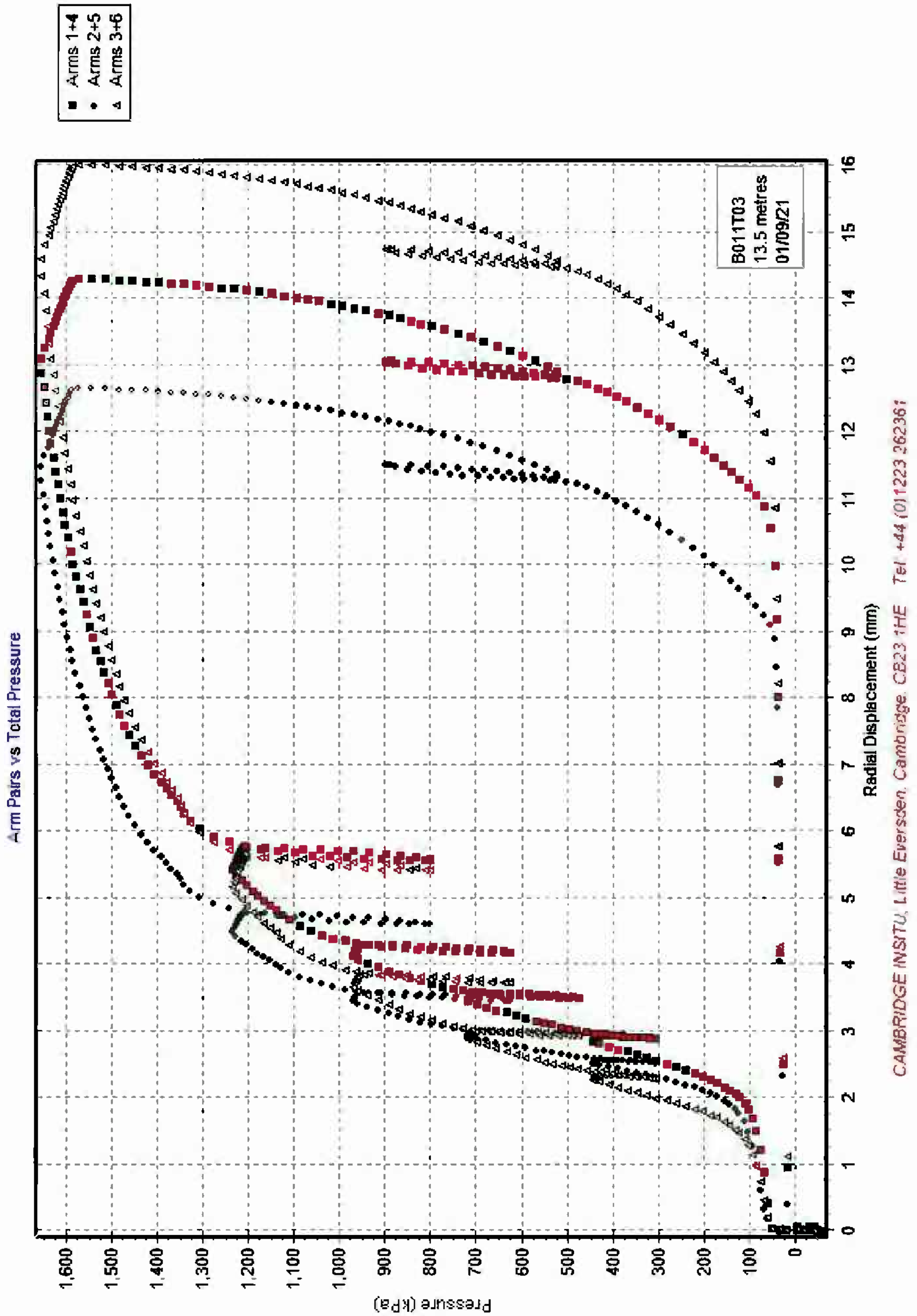

All Arms vs Total Pressure
■ Arm 1
● Arm 2
▲ Arm 3
▼ Arm 4
+ Arm 5
× Arm 6
B011T03
13.5 metres
01/09/21
Radial Displacement (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Pressure (kPa)
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
1,300
1,400
1,500
1,600
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel +44 (0)1223 262361

Cambridge WWTPR

Pressuremeter Testing



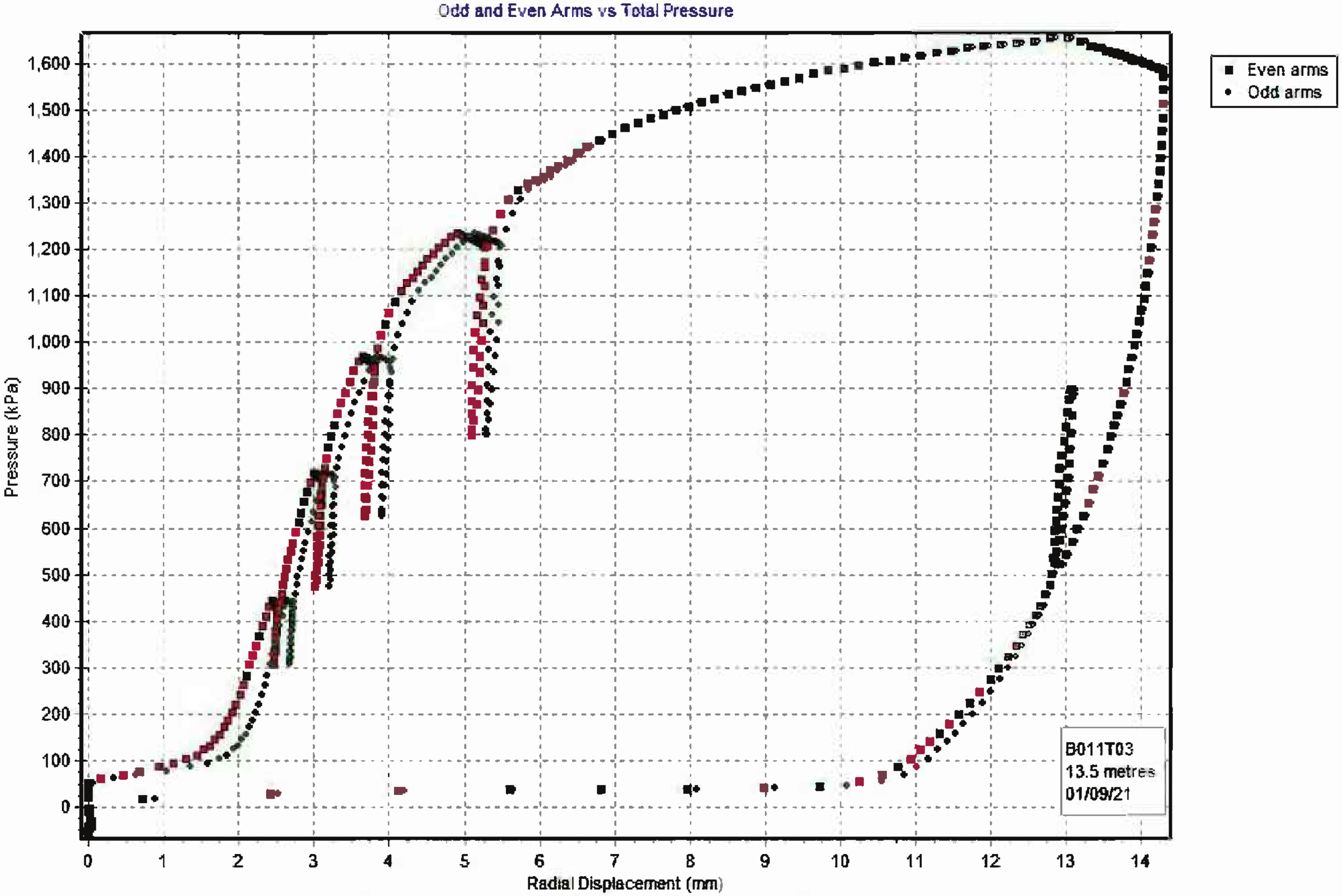
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361


Arm Pairs vs Total Pressure
■ Arms 1+4
● Arms 2+5
▵ Arms 3+6
B011T03
13.5 metres
01/09/21
Pressure (kPa)
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
0
Radial Displacement (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
CAMBRIDGE INSITU, Little Eversden, Cambridge CB23 1HE Tel +44 (01223 262361

CIR1506/21

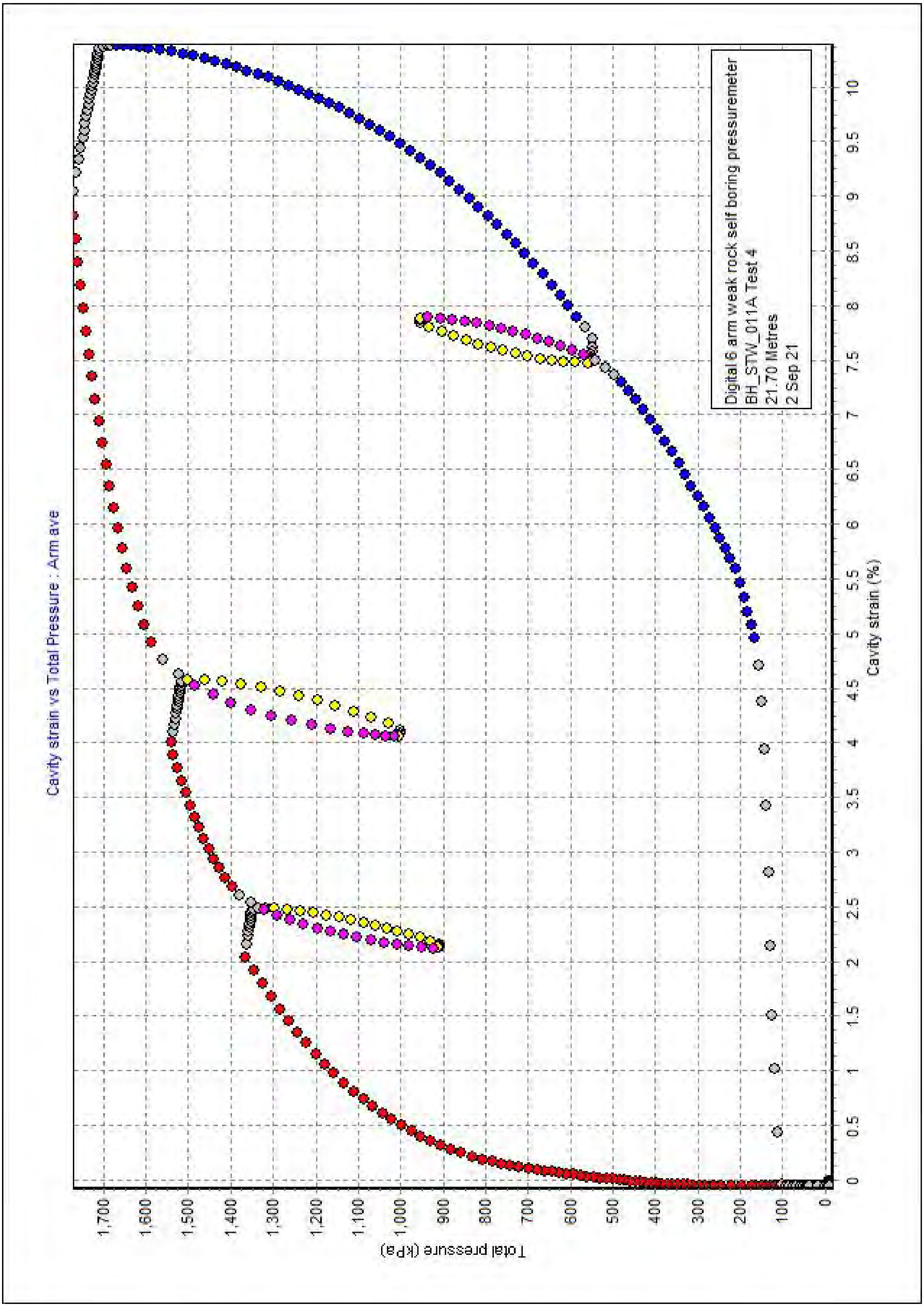
Cambridge WWTPR

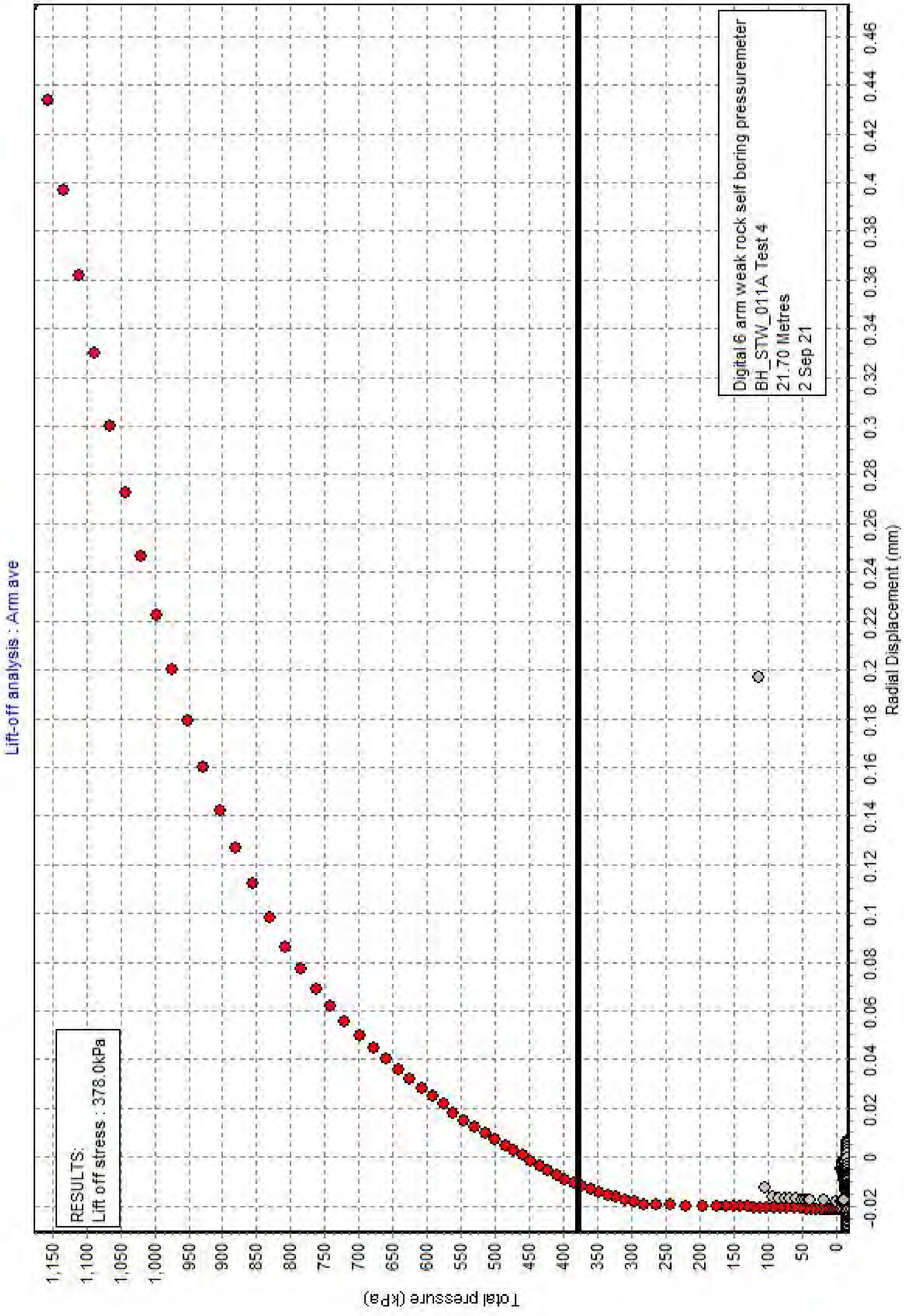
Pressuremeter Testing

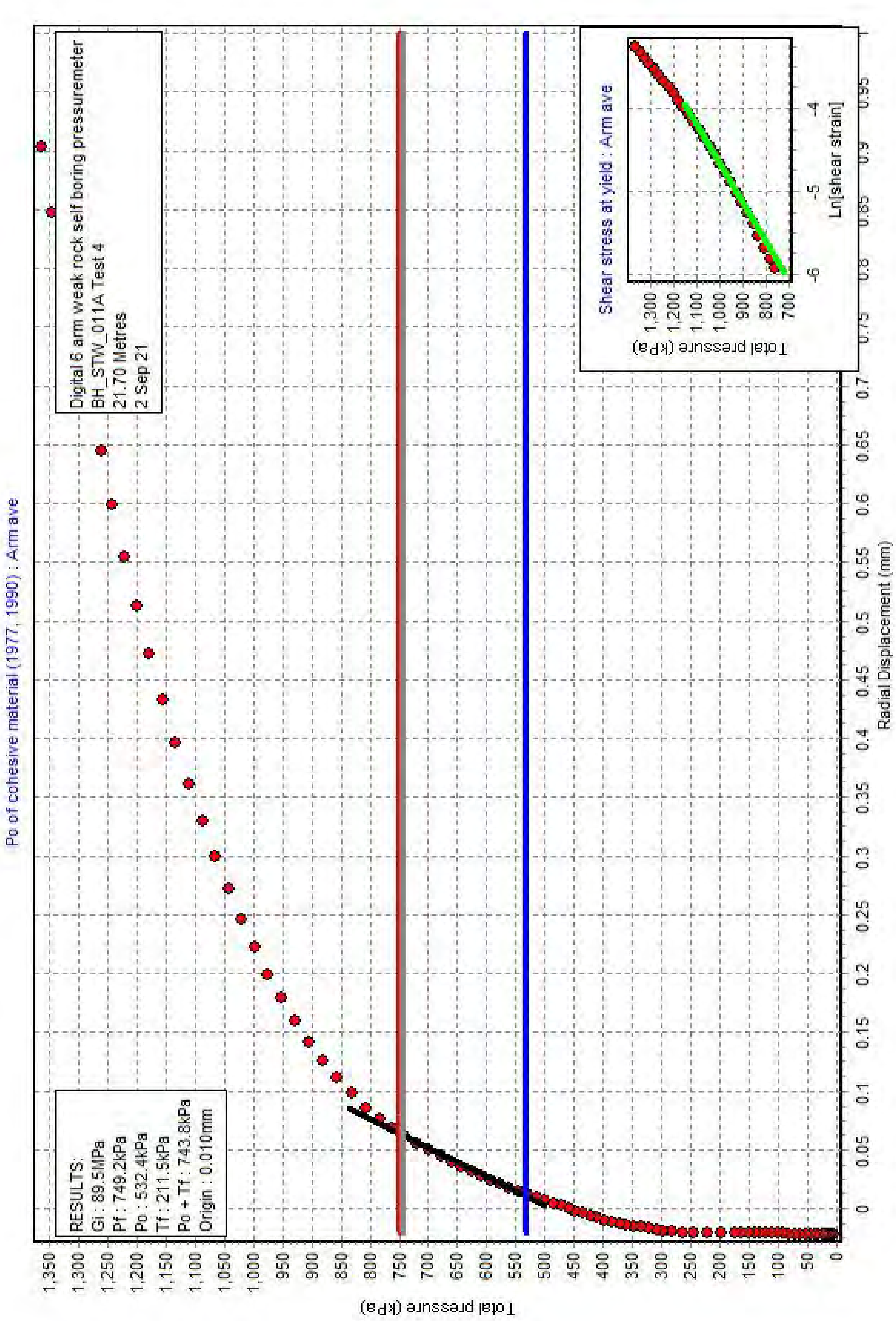


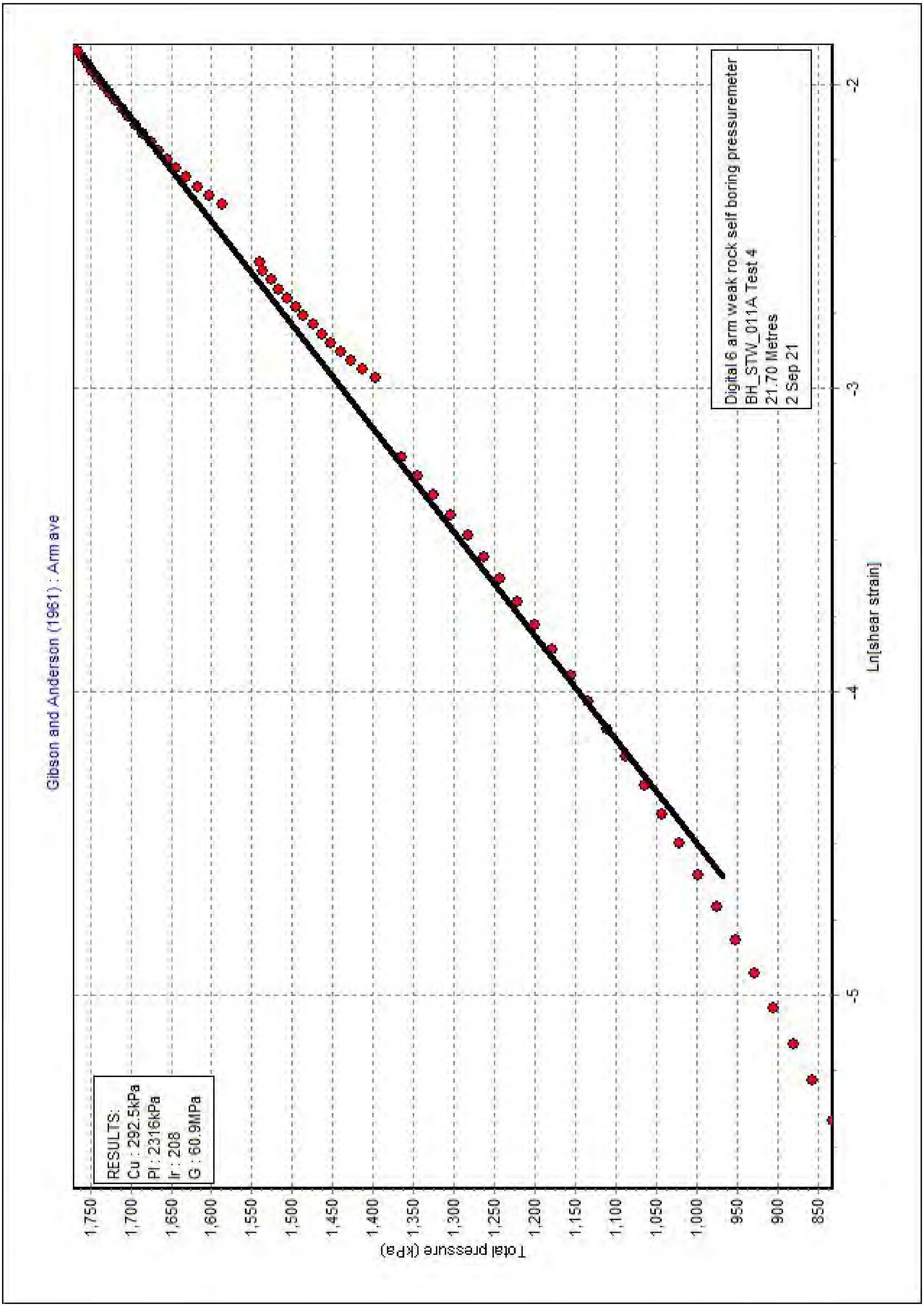
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel: +44 (0)1223 262361

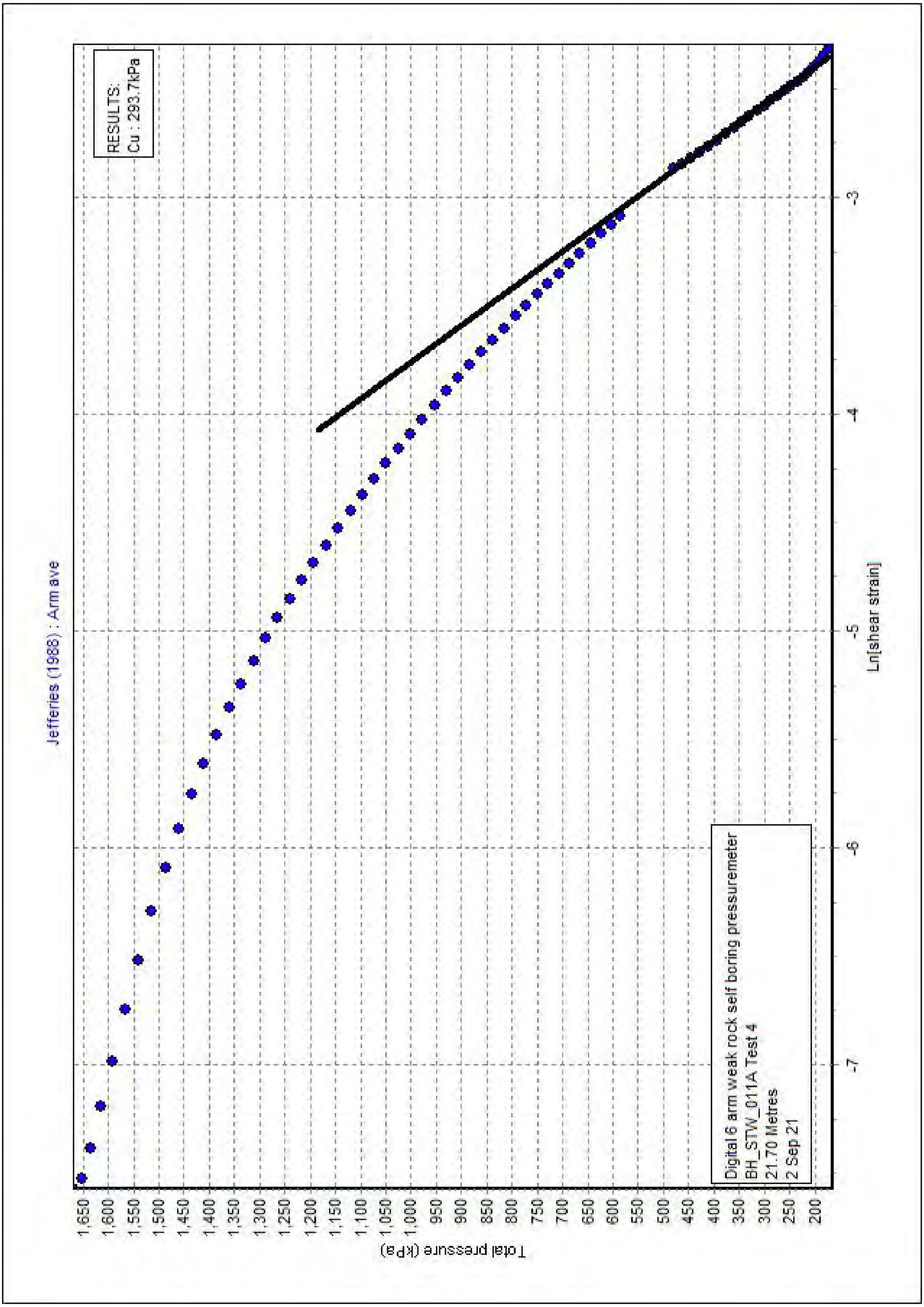
```
BH_STW_011A Test 4 - SUMMARY OF RESULTS
[File made with WinSitu ]

[DETAILS OF TEST]
Project         :   TE8364
Site            :   Cambridge Waste Water Treatment Plant Relocation Project
Borehole        :   BH_STW_011A
Test name       :   BH_STW_011A Test 4
Test date       :   2 Sep 21
Test depth      :   21.70 Metres
Water table     :   3.75 Metres
Ambient PWP     :   176.0 kPa
Material        :   Gault Clay
Probe           :   Digital 6 arm weak rock self boring pressuremeter
Diameter        :   88.1 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out
The file includes results from a curve fitting analysis

Analysed by ES/YB/RW on 7 Sep 21

Remarks:

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm)                     :   "Arm ave=0.00"
Po from Marsland & Randolph (kPa)      :   "Arm ave=532.4"
Po from Lift off (kPa)                 :   "Arm ave=378.0"
Best estimate of Po (kPa)              :   "Arm ave=462.0"

[UNDRAINED STRENGTH PARAMETERS]
Gibson & Anderson 1961 - Cu (kPa)      :   "Arm ave=292.5"
Limit pressure (kPa)                   :   "Arm ave=2316"
Jefferies 1988 - Cu (kPa)              :   "Arm ave=293.7"
Undrained yield stress (kPa)           :   "Arm ave=749.2"

[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=89.5"
Axis       Loop   Value    Mean Strain  Mean Pc  dE      dPc
           No     (MPa)    (%)          (kPa)    (%)     (kPa)
Arm ave    1      58.4     2.313        1115     0.697   408
Arm ave    2      50.5     4.332        1252     0.983   499
Arm ave    3      53.7     7.699        755      0.732   394

[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]
Axis       Loop   Intercept  Alpha      Gradient
           No     (MPa)      (MPa)
Arm ave    1      10.508     6.754      0.643
Arm ave    2      9.784      6.101      0.624
Arm ave    3      7.628      4.484      0.588


[PARAMETERS USED FOR UNDRAINED CURVE MODELLING]
{Axis is  Arm ave}
Strain Origin (mm)                     :   0.00
Po (kPa)                               :   462
Cu (kPa)                               :   292.5
Limit pressure (kPa)                   :   2316
Non-linear exponent                    :   0.588
Calculated alpha (MPa)                 :   4.472
G at yield (MPa)                       :   30.2
```

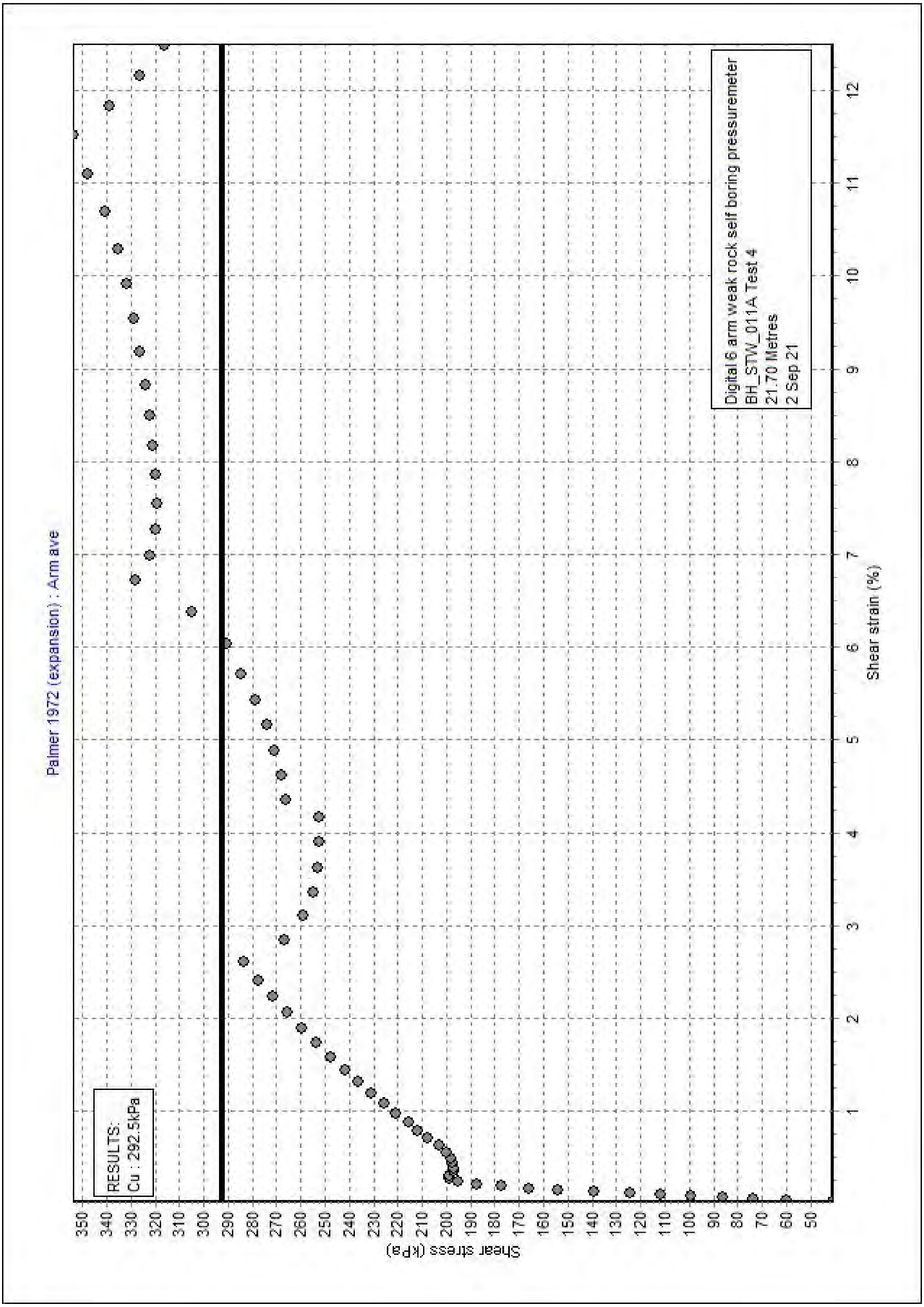

Cavity strain vs Total Pressure : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_011A Test 4
21.70 Metres
2 Sep 21
Cavity strain (%)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
Total pressure (kPa)
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
1,300
1,400
1,500
1,600
1,700

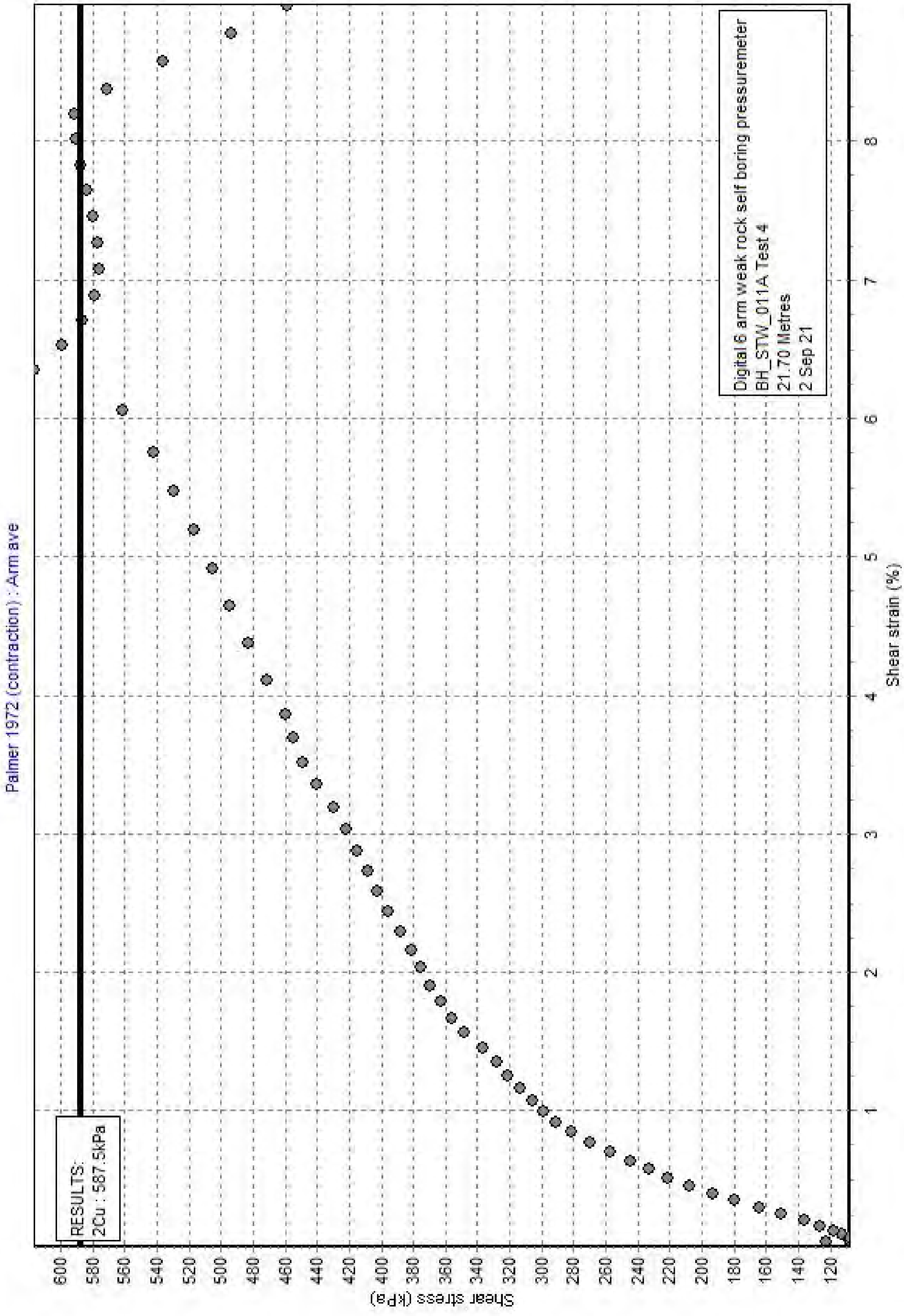

Lift-off analysis : Arm ave
RESULTS:
Lift off stress : 378.0kPa
Digital 6 arm weak rock self boring pressuremeter
BH_STW_011A Test 4
21.70 Metres
2 Sep 21
Total pressure (kPa)
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Radial Displacement (mm)
-0.02
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
0.26
0.28
0.3
0.32
0.34
0.36
0.38
0.4
0.42
0.44
0.46

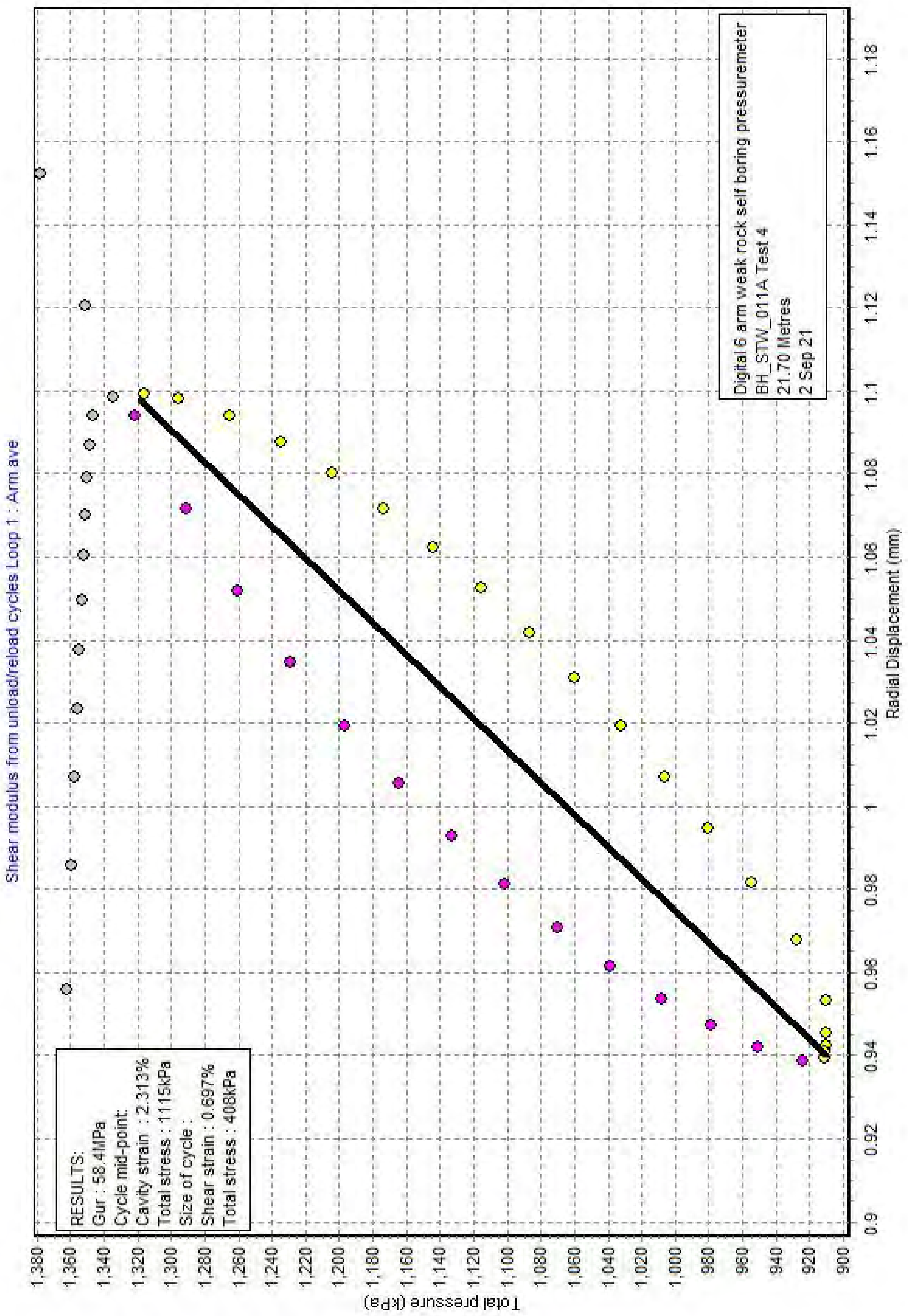

Po of cohesive material (1977, 1990) : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_011A Test 4
21.70 Metres
2 Sep 21
RESULTS:
Gi : 89.5MPa
Pf : 749.2kPa
Po : 532.4kPa
Tf : 211.5kPa
Po + Tf : 743.8kPa
Origin : 0.010mm
Total pressure (kPa)
1,350
1,300
1,250
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Radial Displacement (mm)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0.75
0.8
0.85
0.9
0.95
Shear stress at yield : Arm ave
Total pressure (kPa)
1,300
1,200
1,100
1,000
900
800
700
Ln[shear strain]
-6
-5
-4

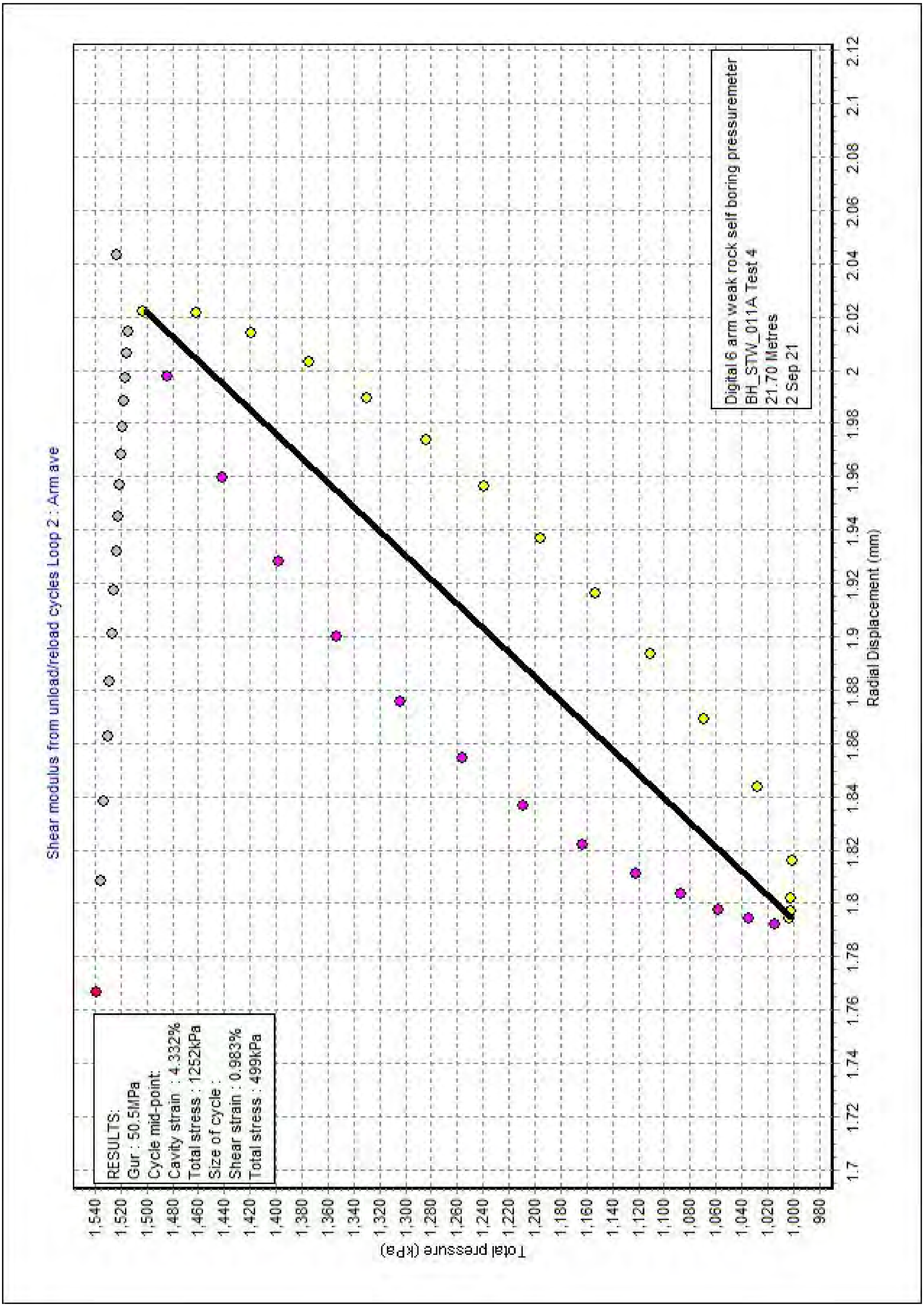

Gibson and Anderson (1961) : Arm ave
RESULTS:
Cu : 292.5kPa
Pl : 2316kPa
Ir : 208
G : 60.9MPa
Digital 6 arm weak rock self boring pressuremeter
BH_STW_011A Test 4
21.70 Metres
2 Sep 21
Total pressure (kPa)
1,750
1,700
1,650
1,600
1,550
1,500
1,450
1,400
1,350
1,300
1,250
1,200
1,150
1,100
1,050
1,000
950
900
850
Ln[shear strain]
-2
-3
-4
-5

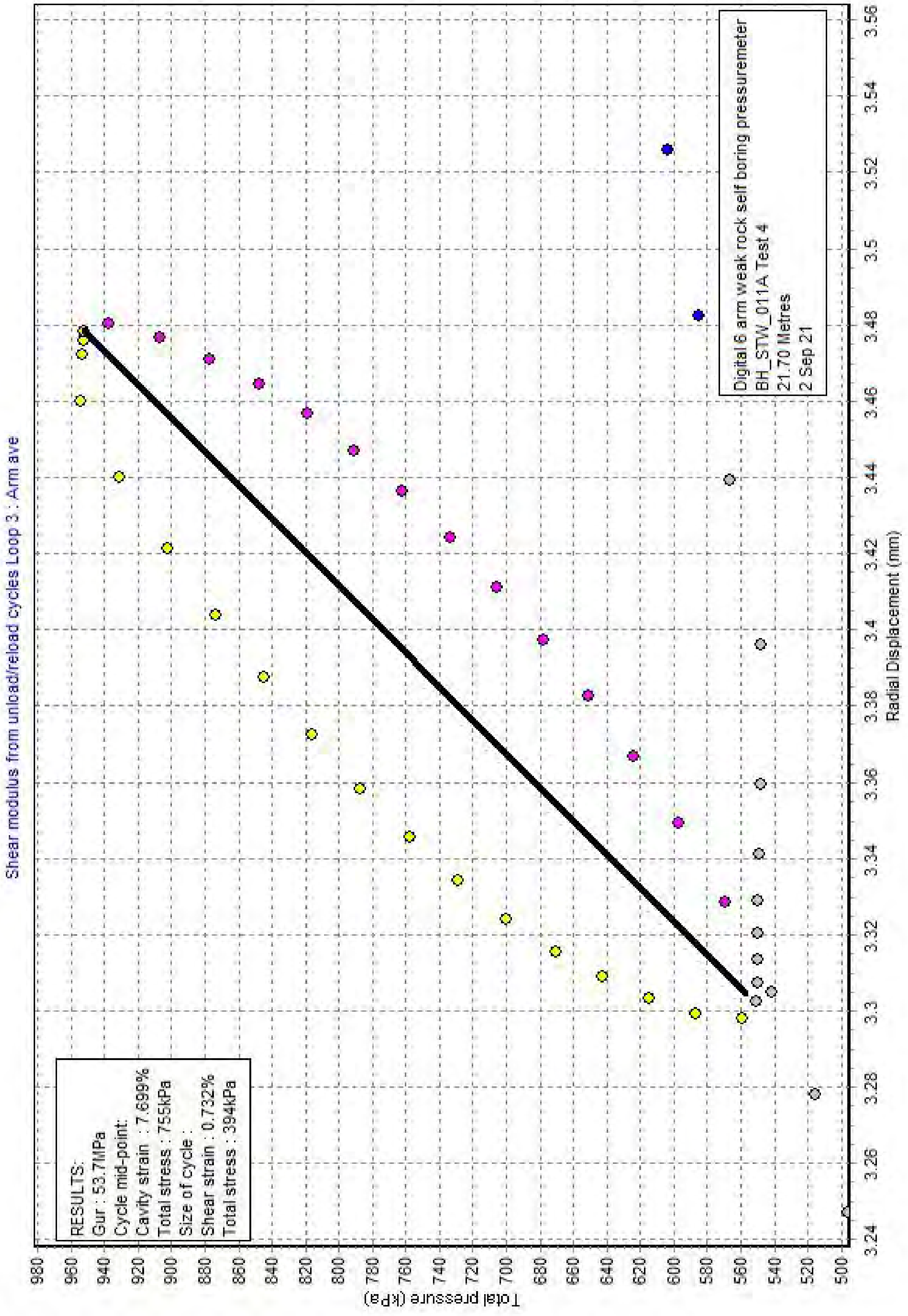

Jefferies (1988) : Arm ave
RESULTS:
Cu : 293.7kPa
Digital 6 arm weak rock self boring pressuremeter
BH_STW_011A Test 4
21.70 Metres
2 Sep 21
Total pressure (kPa)
1,650
1,600
1,550
1,500
1,450
1,400
1,350
1,300
1,250
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
Ln[shear strain]
-7
-6
-5
-4
-3

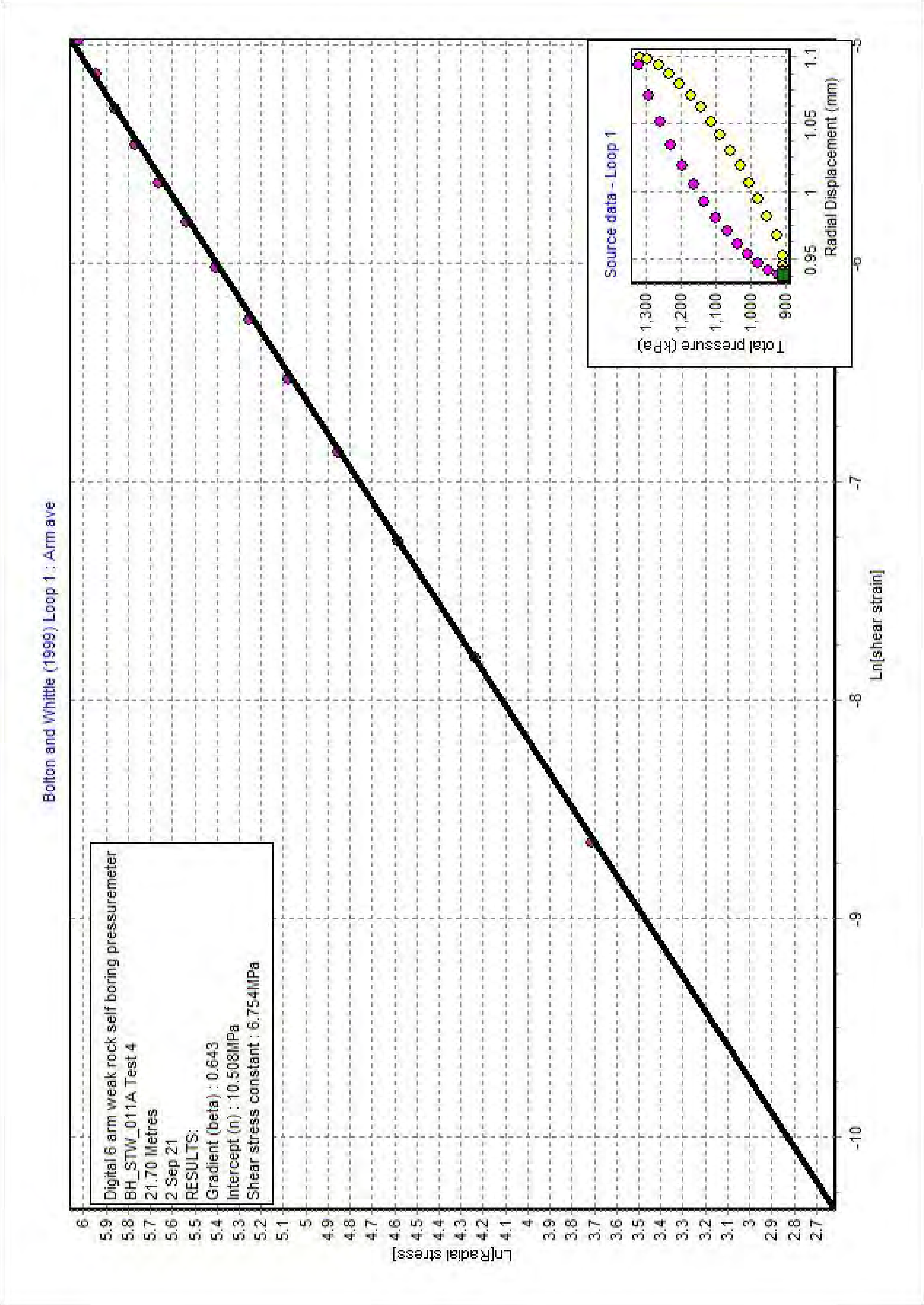

Palmer 1972 (expansion) : Arm ave
RESULTS:
Cu : 292.5kPa
Digital 6 arm weak rock self boring pressuremeter
BH_STW_011A Test 4
21.70 Metres
2 Sep 21
Shear stress (kPa)
350
340
330
320
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
Shear strain (%)
1
2
3
4
5
6
7
8
9
10
11
12

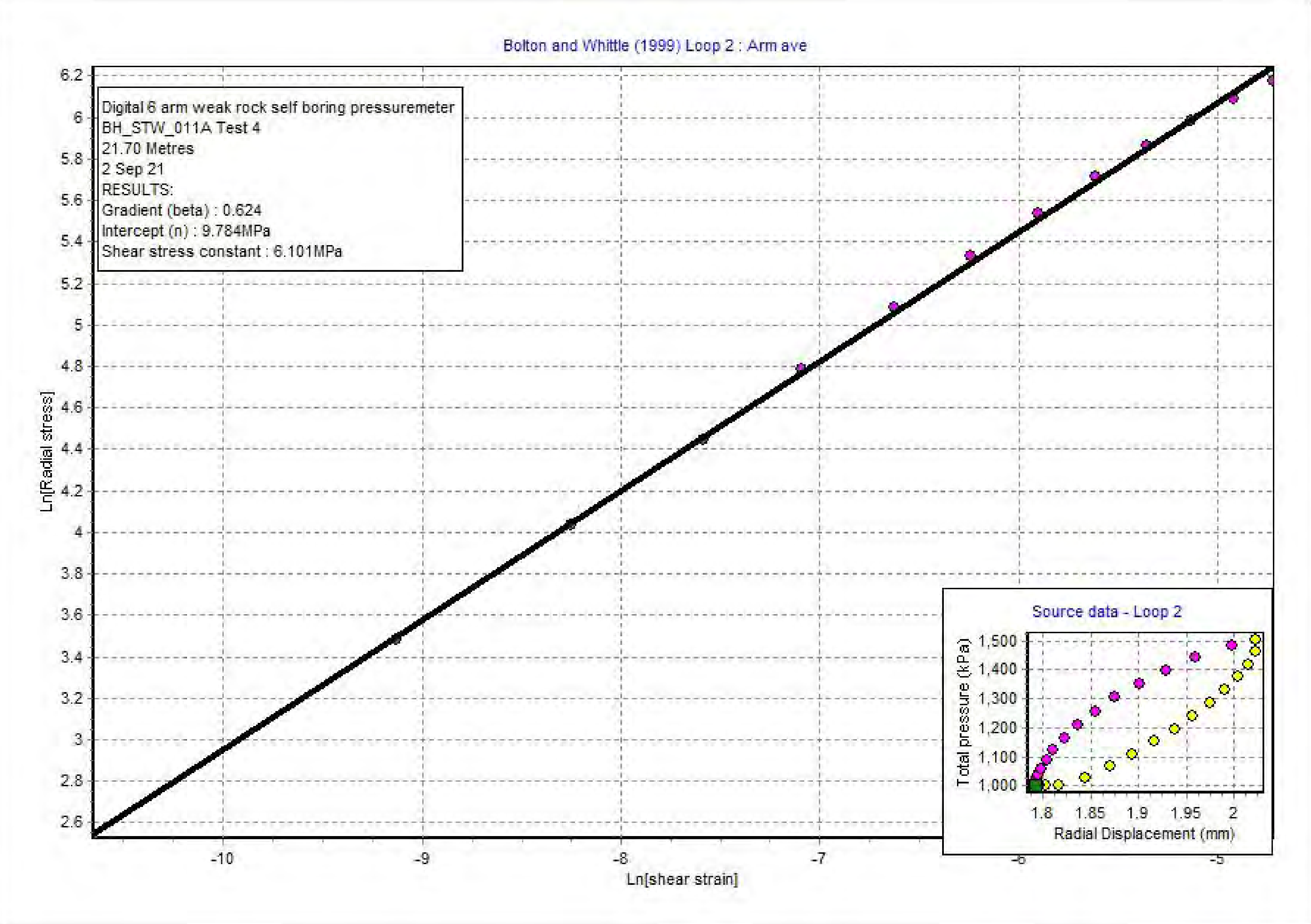

Palmer 1972 (contraction) : Arm ave
RESULTS:
2Cu : 587.5kPa
Digital 6 arm weak rock self boring pressuremeter
BH_STW_011A Test 4
21.70 Metres
2 Sep 21
Shear stress (kPa)
600
580
560
540
520
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
Shear strain (%)
1
2
3
4
5
6
7
8

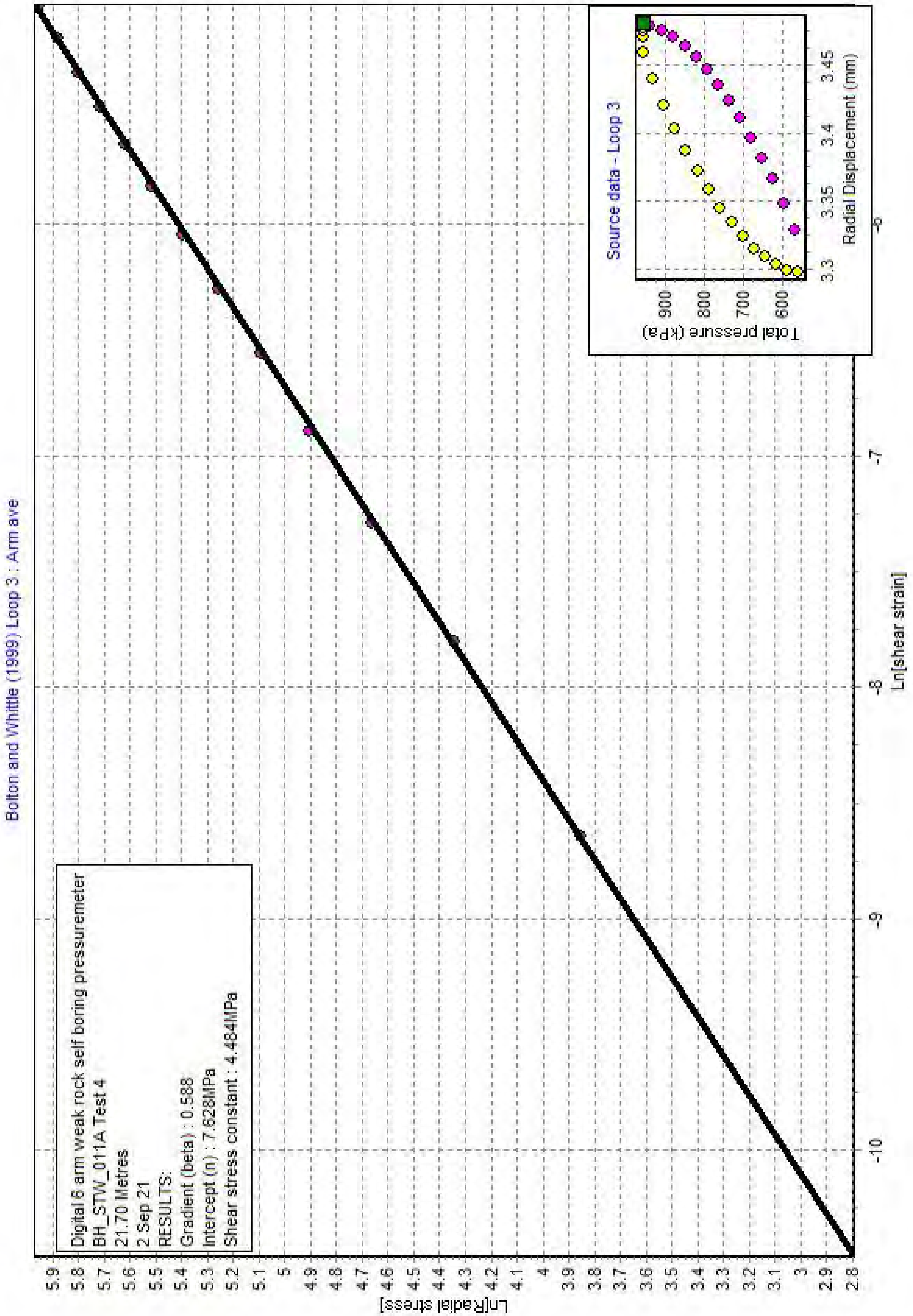

Shear modulus from unload/reload cycles Loop 1 : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_011A Test 4
21.70 Metres
2 Sep 21
RESULTS:
Gur : 58.4MPa
Cycle mid-point:
Cavity strain : 2.313%
Total stress : 1115kPa
Size of cycle :
Shear strain : 0.697%
Total stress : 408kPa
Total pressure (kPa)
1,380
1,360
1,340
1,320
1,300
1,280
1,260
1,240
1,220
1,200
1,180
1,160
1,140
1,120
1,100
1,080
1,060
1,040
1,020
1,000
980
960
940
920
900
Radial Displacement (mm)
0.9
0.92
0.94
0.96
0.98
1
1.02
1.04
1.06
1.08
1.1
1.12
1.14
1.16
1.18


Shear modulus from unload/reload cycles Loop 2 : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_011A Test 4
21.70 Metres
2 Sep 21
RESULTS:
Gur : 50.5MPa
Cycle mid-point:
Cavity strain : 4.332%
Total stress : 1252kPa
Size of cycle :
Shear strain : 0.983%
Total stress : 499kPa
Total pressure (kPa)
1,540
1,520
1,500
1,480
1,460
1,440
1,420
1,400
1,380
1,360
1,340
1,320
1,300
1,280
1,260
1,240
1,220
1,200
1,180
1,160
1,140
1,120
1,100
1,080
1,060
1,040
1,020
1,000
980
Radial Displacement (mm)
1.7
1.72
1.74
1.76
1.78
1.8
1.82
1.84
1.86
1.88
1.9
1.92
1.94
1.96
1.98
2
2.02
2.04
2.06
2.08
2.1
2.12

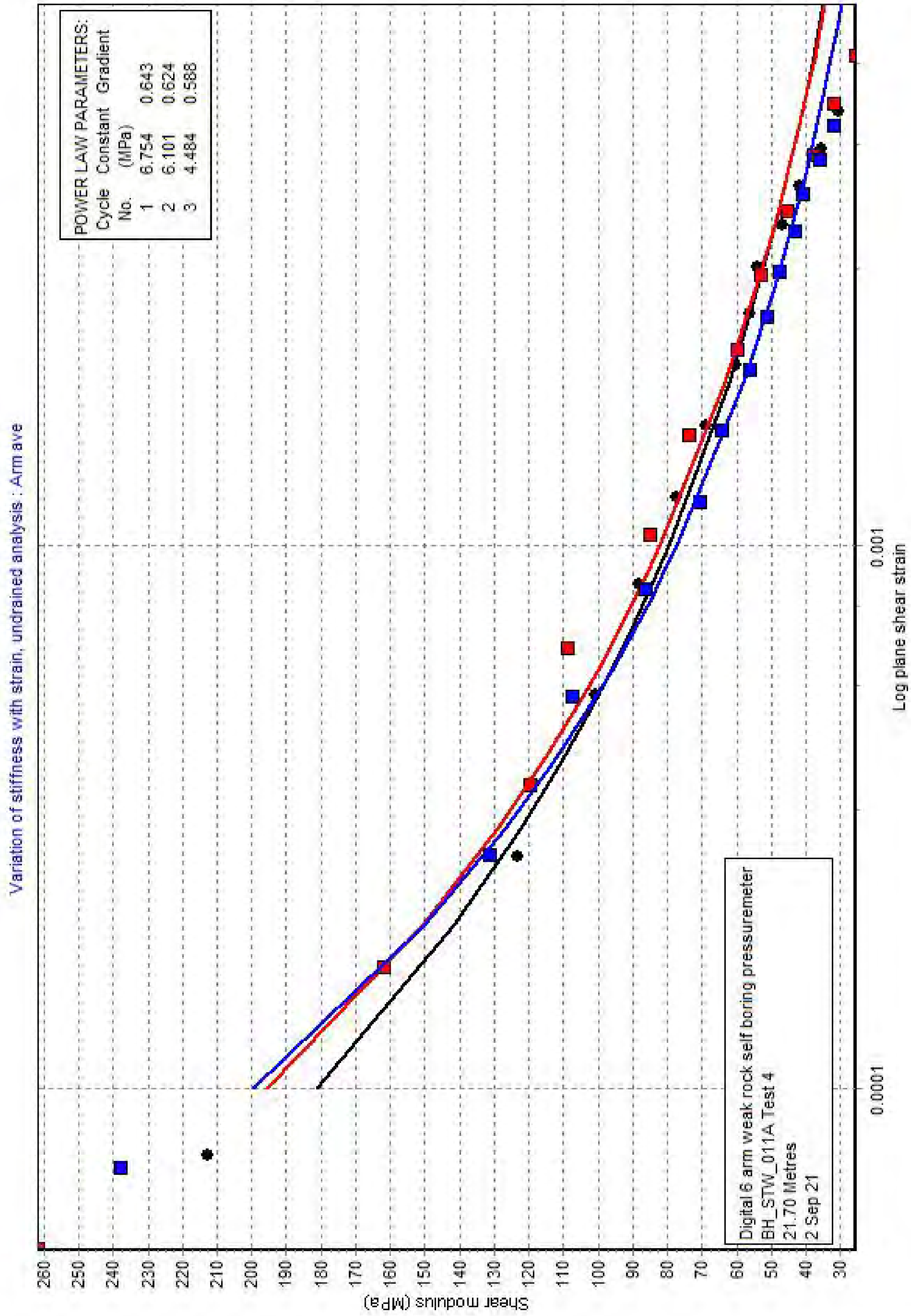

Shear modulus from unload/reload cycles Loop 3 : Arm ave
Total pressure (kPa)
980
960
940
920
900
880
860
840
820
800
780
760
740
720
700
680
660
640
620
600
580
560
540
520
500
Radial Displacement (mm)
3.24
3.26
3.28
3.3
3.32
3.34
3.36
3.38
3.4
3.42
3.44
3.46
3.48
3.5
3.52
3.54
3.56
RESULTS:
Gur : 53.7MPa
Cycle mid-point:
Cavity strain : 7.699%
Total stress : 755kPa
Size of cycle :
Shear strain : 0.732%
Total stress : 394kPa
Digital 6 arm weak rock self boring pressuremeter
BH_STW_011A Test 4
21.70 Metres
2 Sep 21

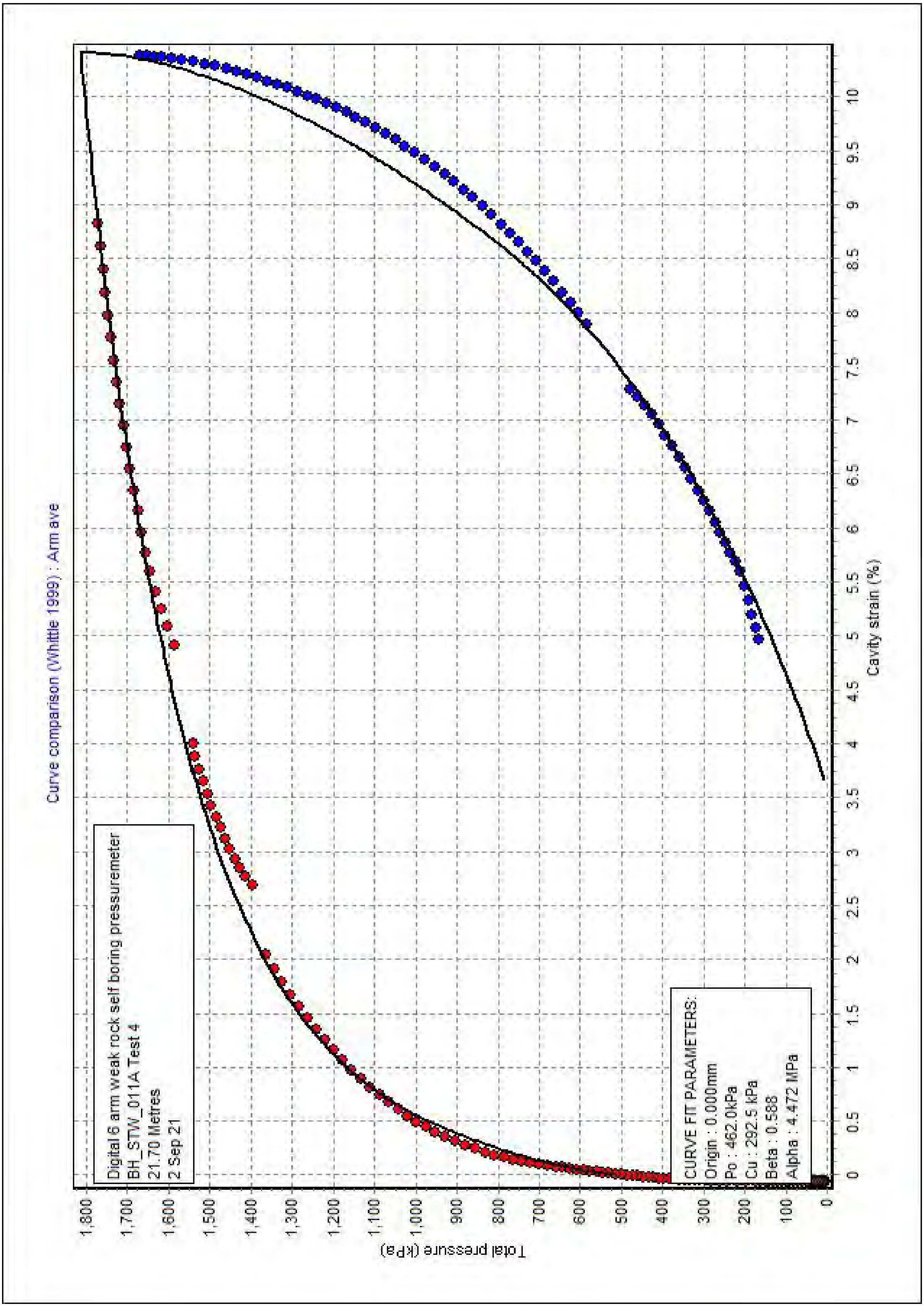

Bolton and Whittle (1999) Loop 1 : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_011A Test 4
21.70 Metres
2 Sep 21
RESULTS:
Gradient (beta) : 0.643
Intercept (n) : 10.508MPa
Shear stress constant : 6.754MPa
Ln[Radial stress]
6
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
2.7
Ln[shear strain]
-10
-9
-8
-7
-6
-5
Source data - Loop 1
Total pressure (kPa)
900
1,000
1,100
1,200
1,300
Radial Displacement (mm)
0.95
1
1.05
1.1

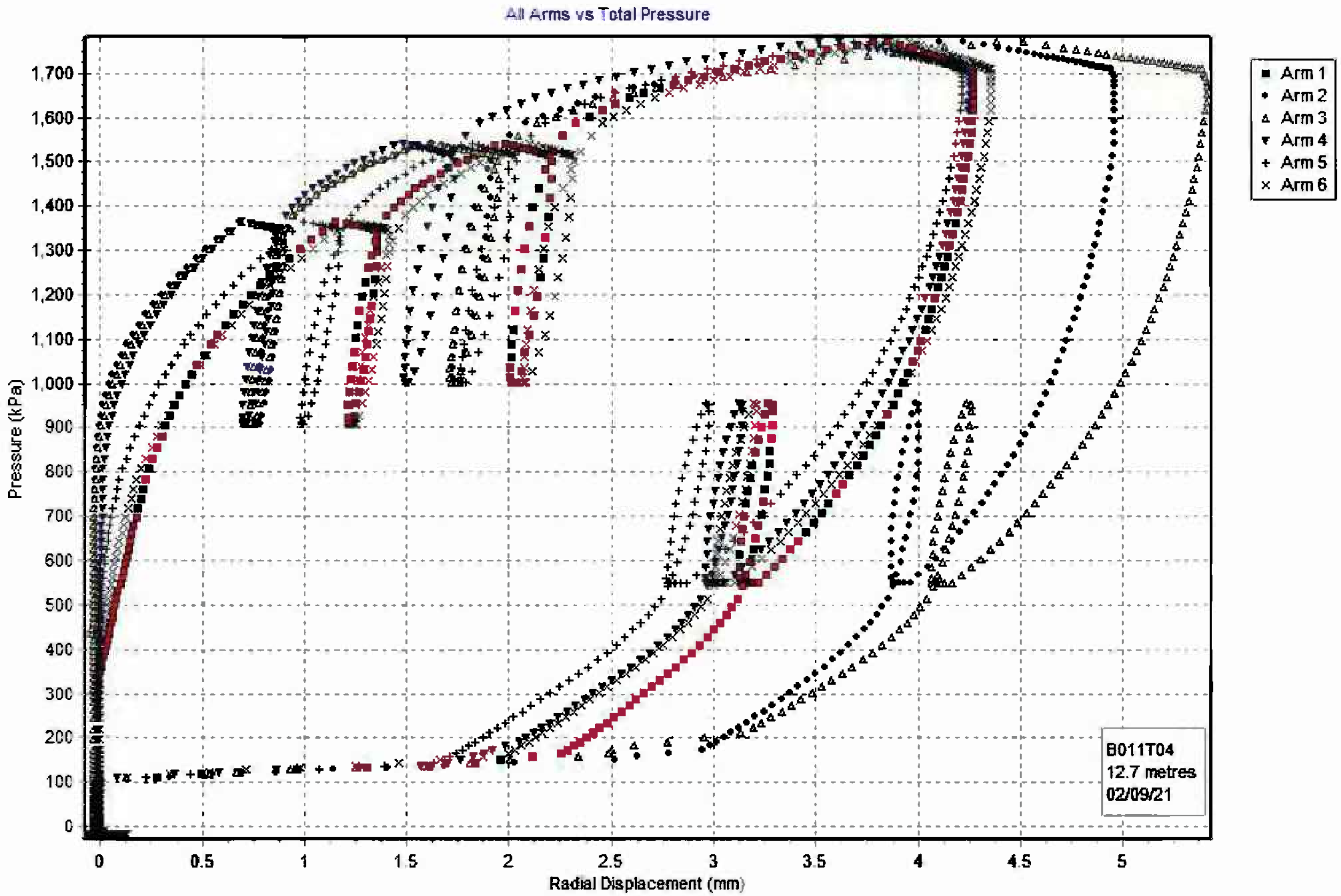

Bolton and Whittle (1999) Loop 2 : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_011A Test 4
21.70 Metres
2 Sep 21
RESULTS:
Gradient (beta) : 0.624
Intercept (n) : 9.784MPa
Shear stress constant : 6.101MPa
Ln[Radial stress]
6.2
6
5.8
5.6
5.4
5.2
5
4.8
4.6
4.4
4.2
4
3.8
3.6
3.4
3.2
3
2.8
2.6
-10
-9
-8
-7
-6
-5
Ln[shear strain]
Source data - Loop 2
Total pressure (kPa)
1,500
1,400
1,300
1,200
1,100
1,000
1.8
1.85
1.9
1.95
2
Radial Displacement (mm)



Digital 6 arm weak rock self boring pressuremeter
BH_STW_011A Test 4
21.70 Metres
2 Sep 21
RESULTS:
Gradient (beta) : 0.588
Intercept (n) : 7.628MPa
Shear stress constant : 4.484MPa


Variation of stiffness with strain, undrained analysis : Arm ave
POWER LAW PARAMETERS:
Cycle No. | Constant (MPa) | Gradient
1 | 6.754 | 0.643
2 | 6.101 | 0.624
3 | 4.484 | 0.588
Digital 6 arm weak rock self boring pressuremeter
BH_STW_011A Test 4
21.70 Metres
2 Sep 21
Shear modulus (MPa)
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
Log plane shear strain
0.0001
0.001


Curve comparison (Whittle 1999) : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_011A Test 4
21.70 Metres
2 Sep 21
CURVE FIT PARAMETERS:
Origin : 0.000mm
Po : 462.0kPa
Cu : 292.5 kPa
Beta : 0.588
Alpha : 4.472 MPa
Total pressure (kPa)
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
1,300
1,400
1,500
1,600
1,700
1,800
Cavity strain (%)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10

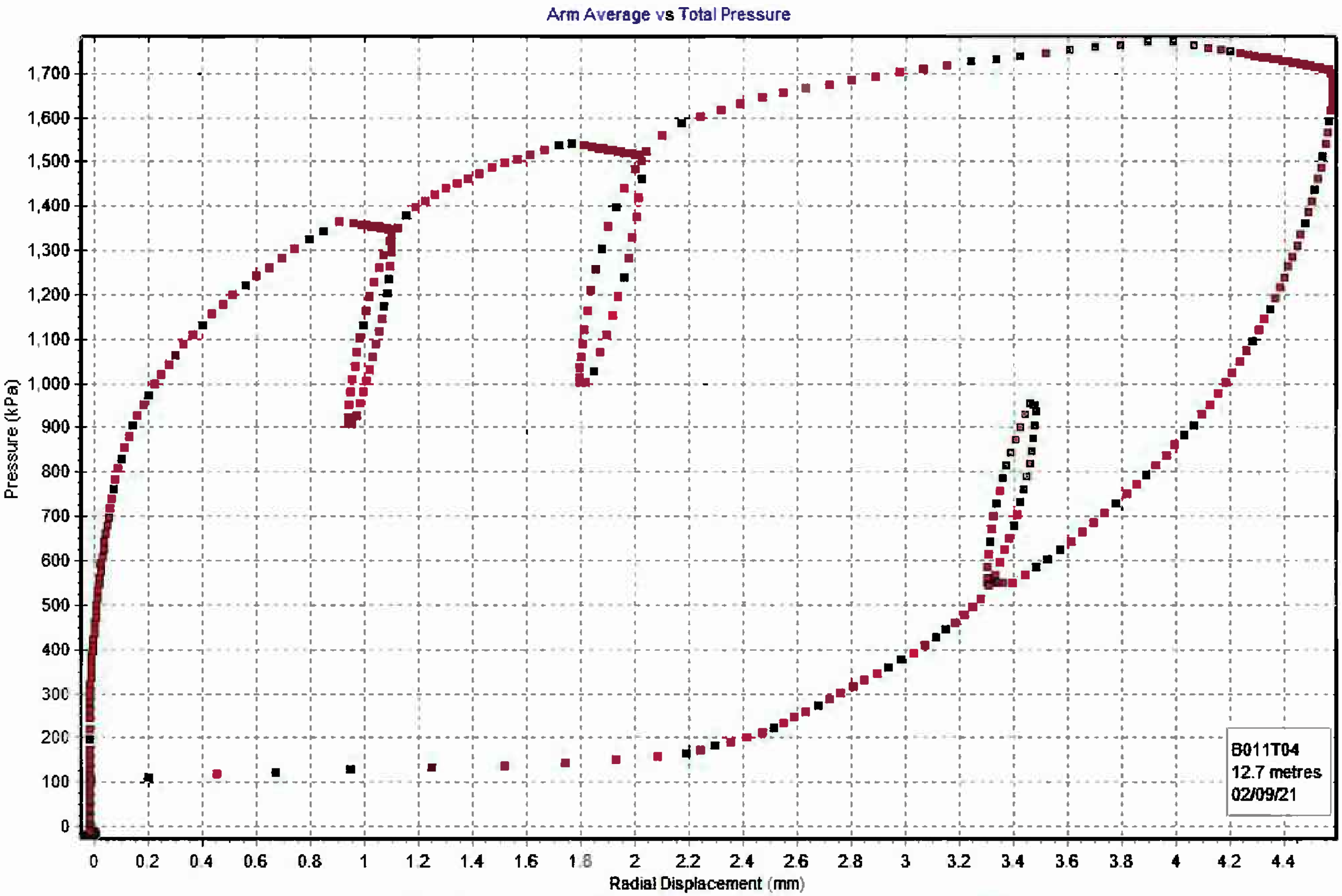


CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel +44 (0)1223 262361

CIR1506/21

Cambridge WWTPR

Pressuremeter Testing

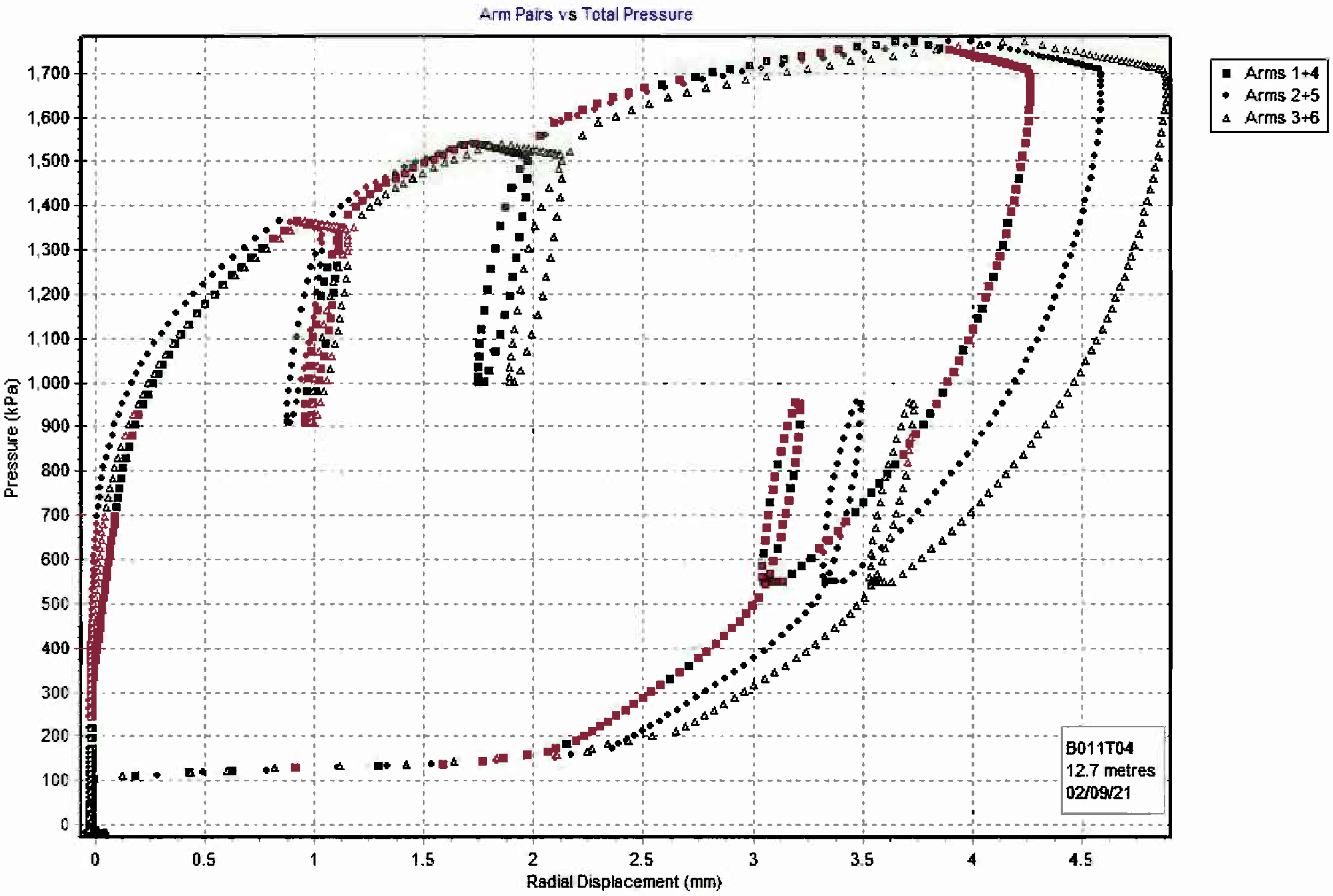


CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel +44 (0)1223 262361

CIR1506/21

Cambridge WWTPR

Pressuremeter Testing

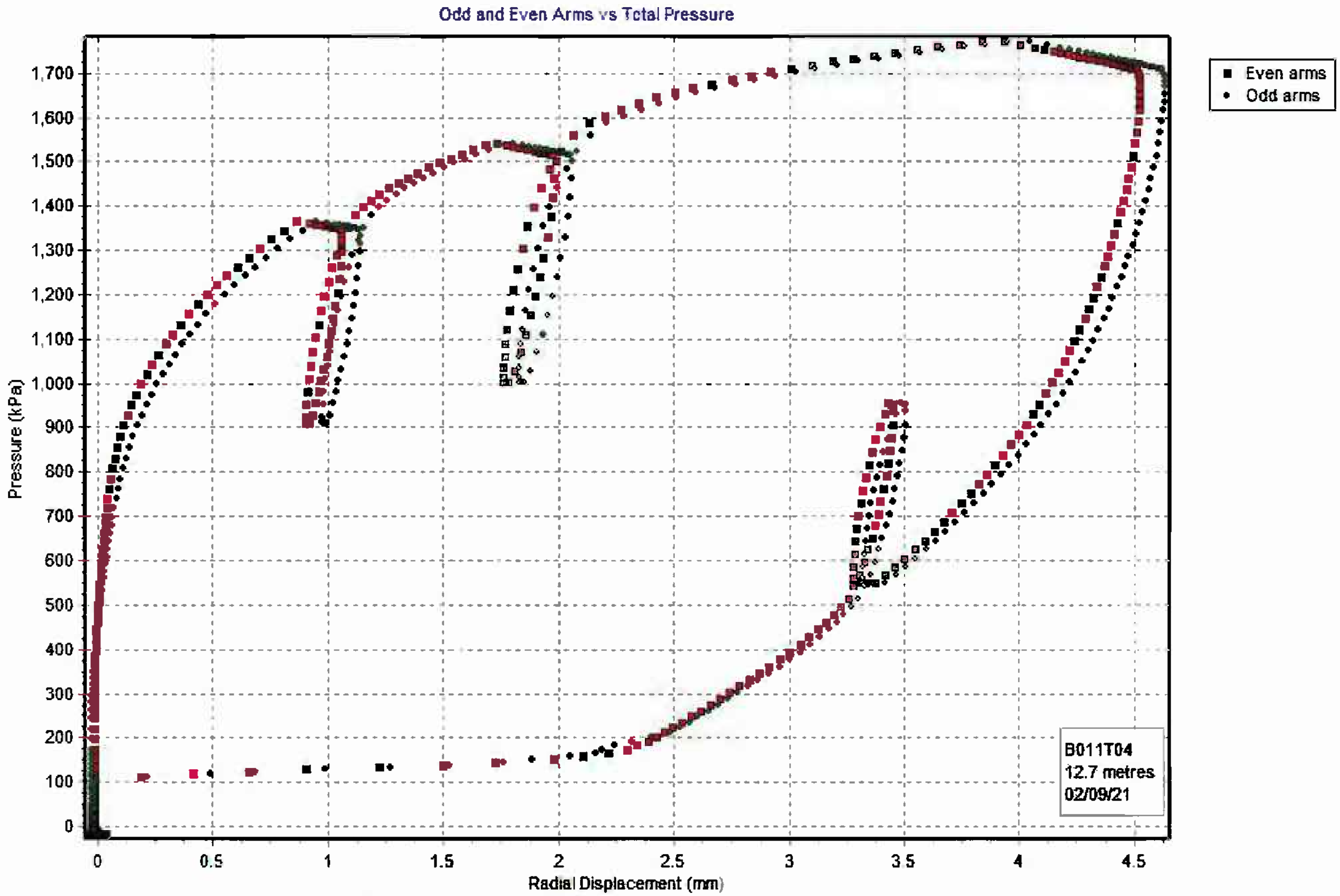


CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361

CIR1506/21

Cambridge WWTPR

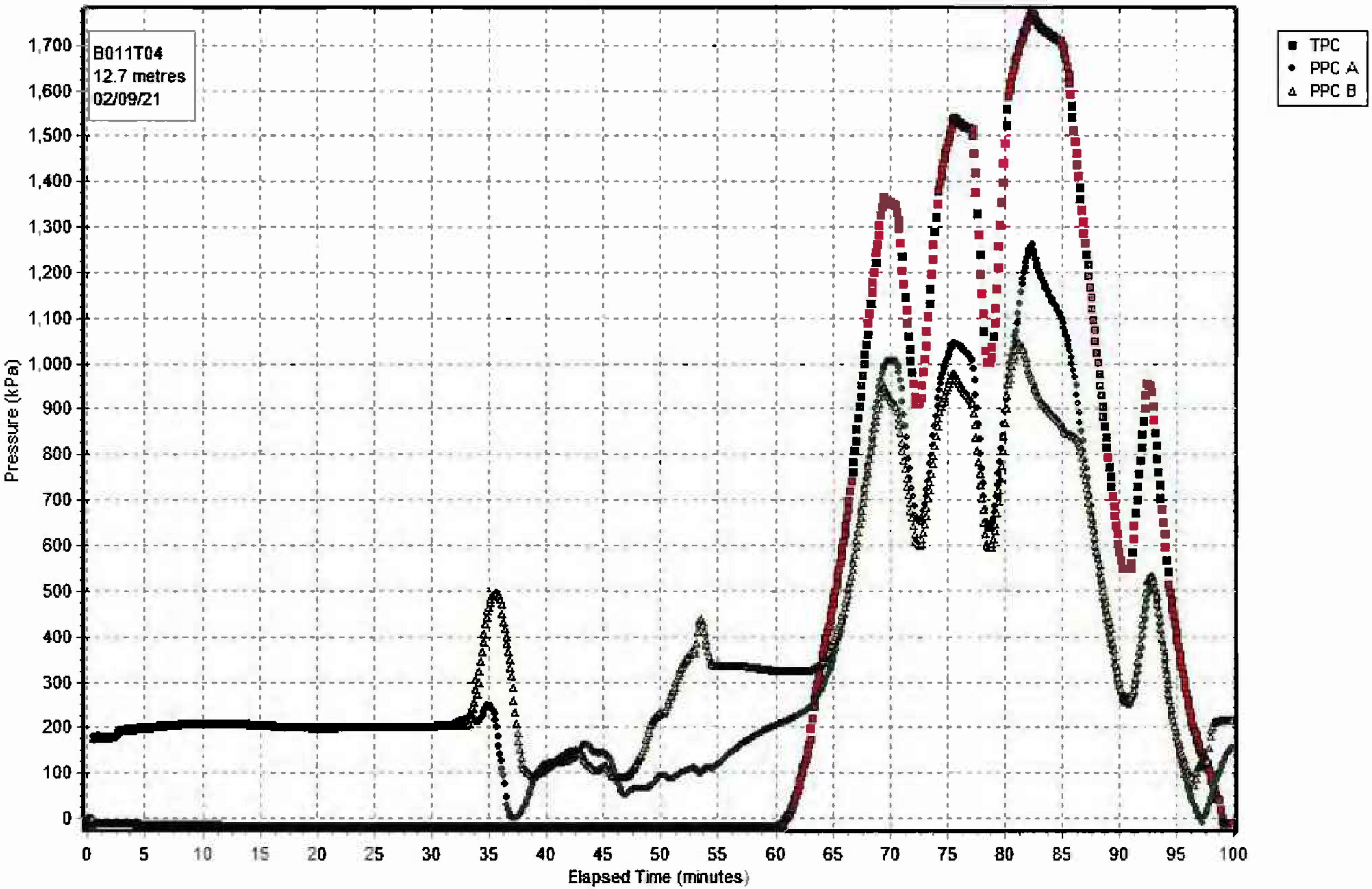
Pressuremeter Testing


Odd and Even Arms vs Total Pressure

B011T04
12.7 metres
02/09/21

CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361

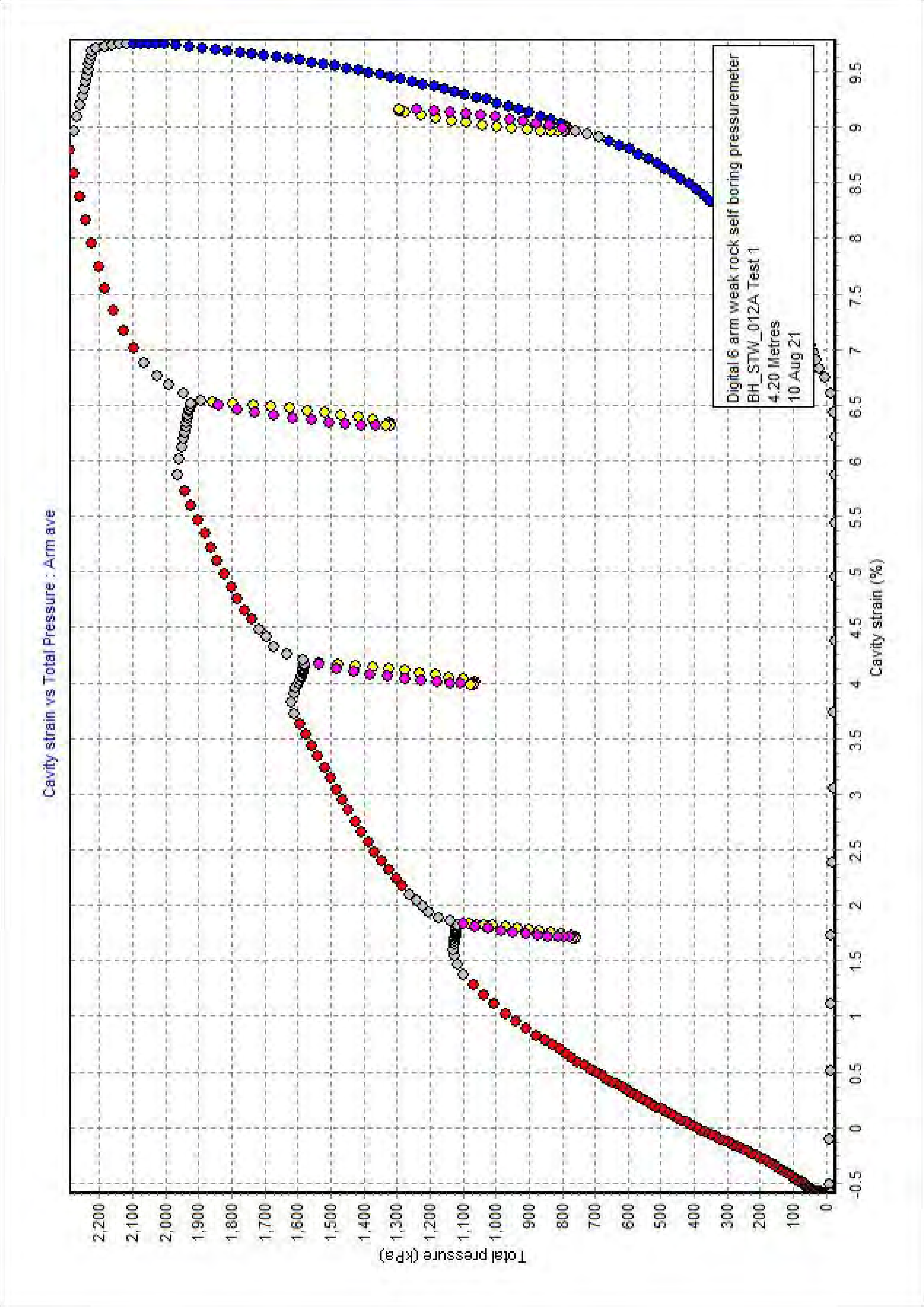
All Pressure Cells vs Time

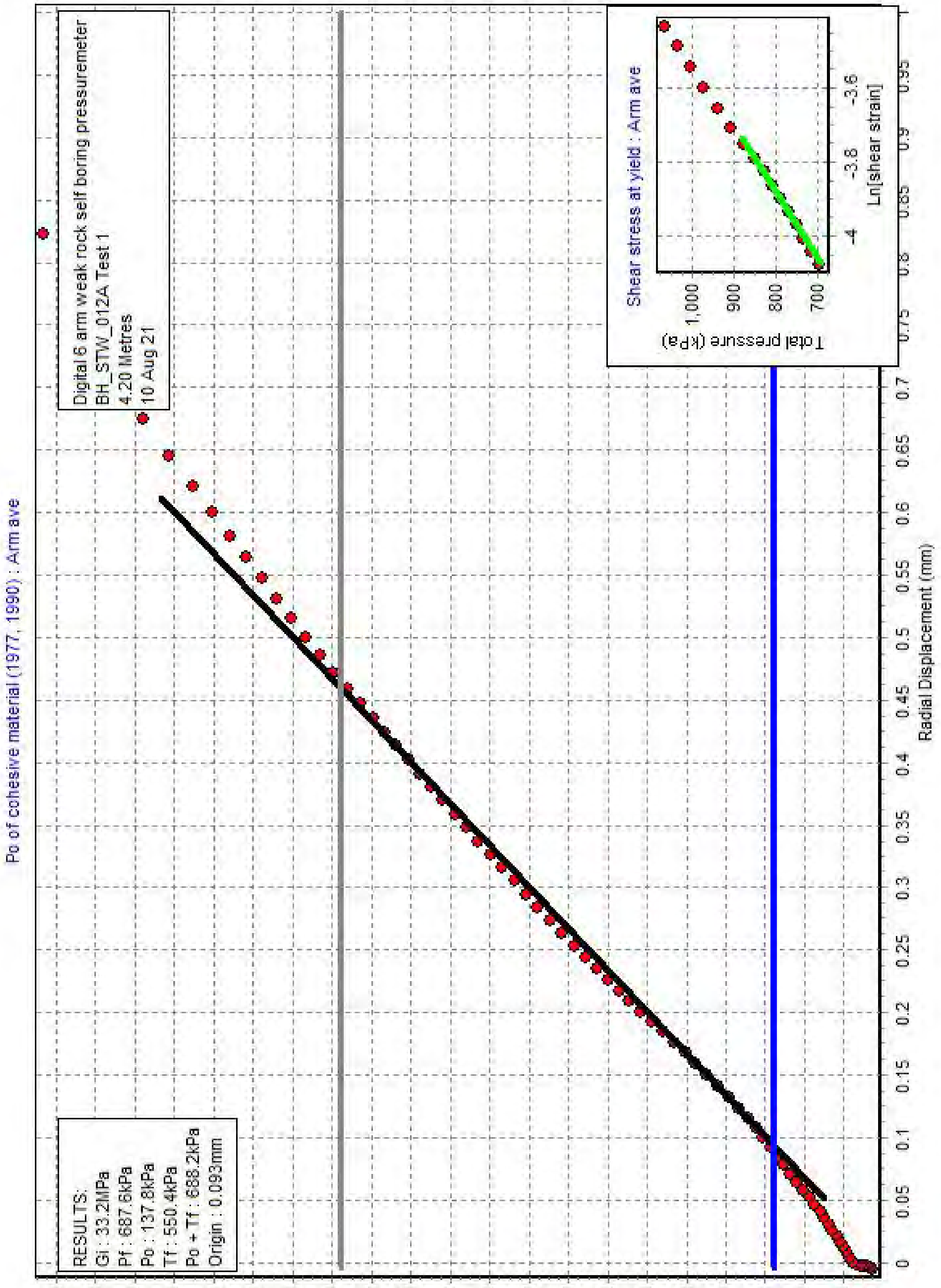


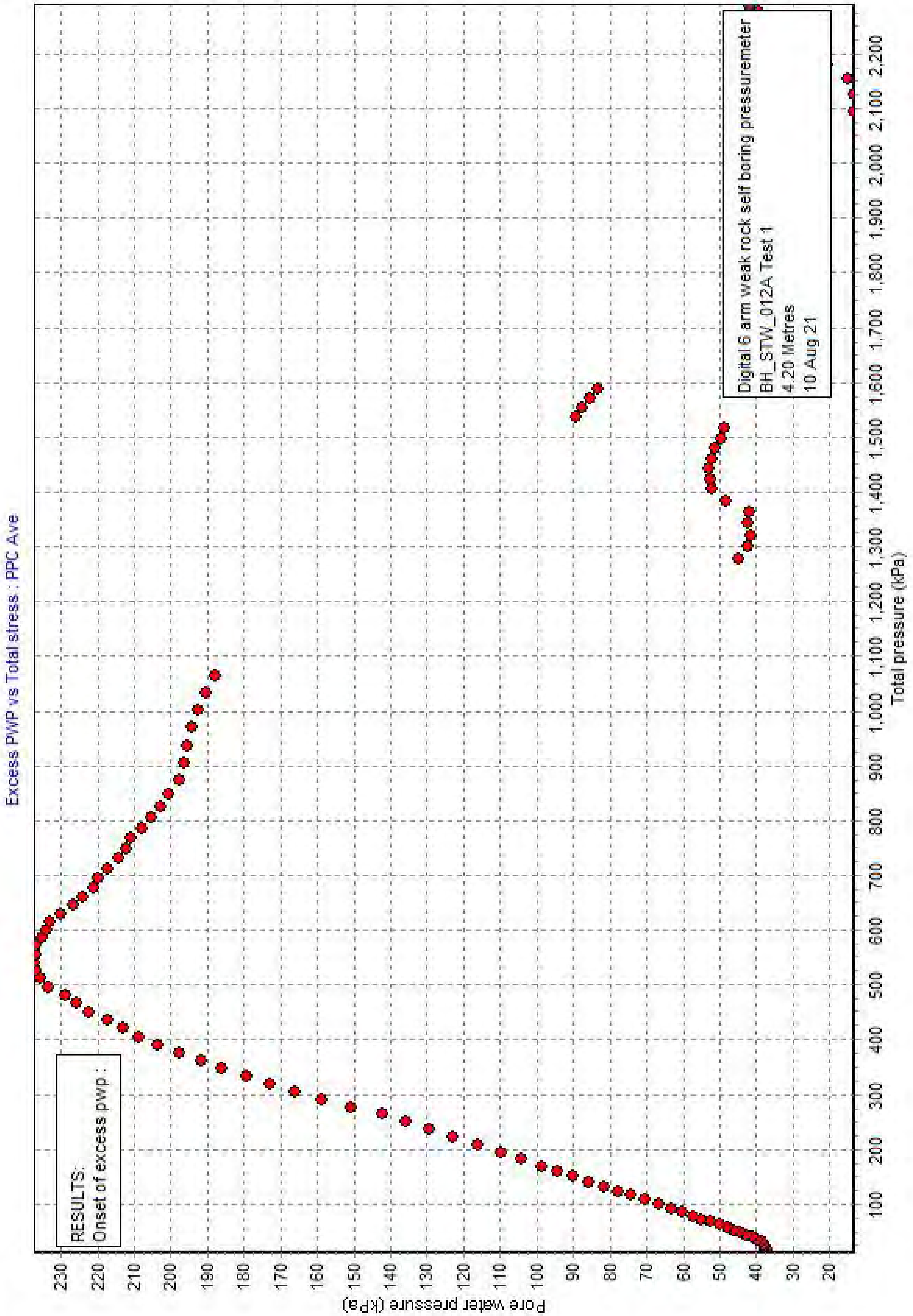
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361

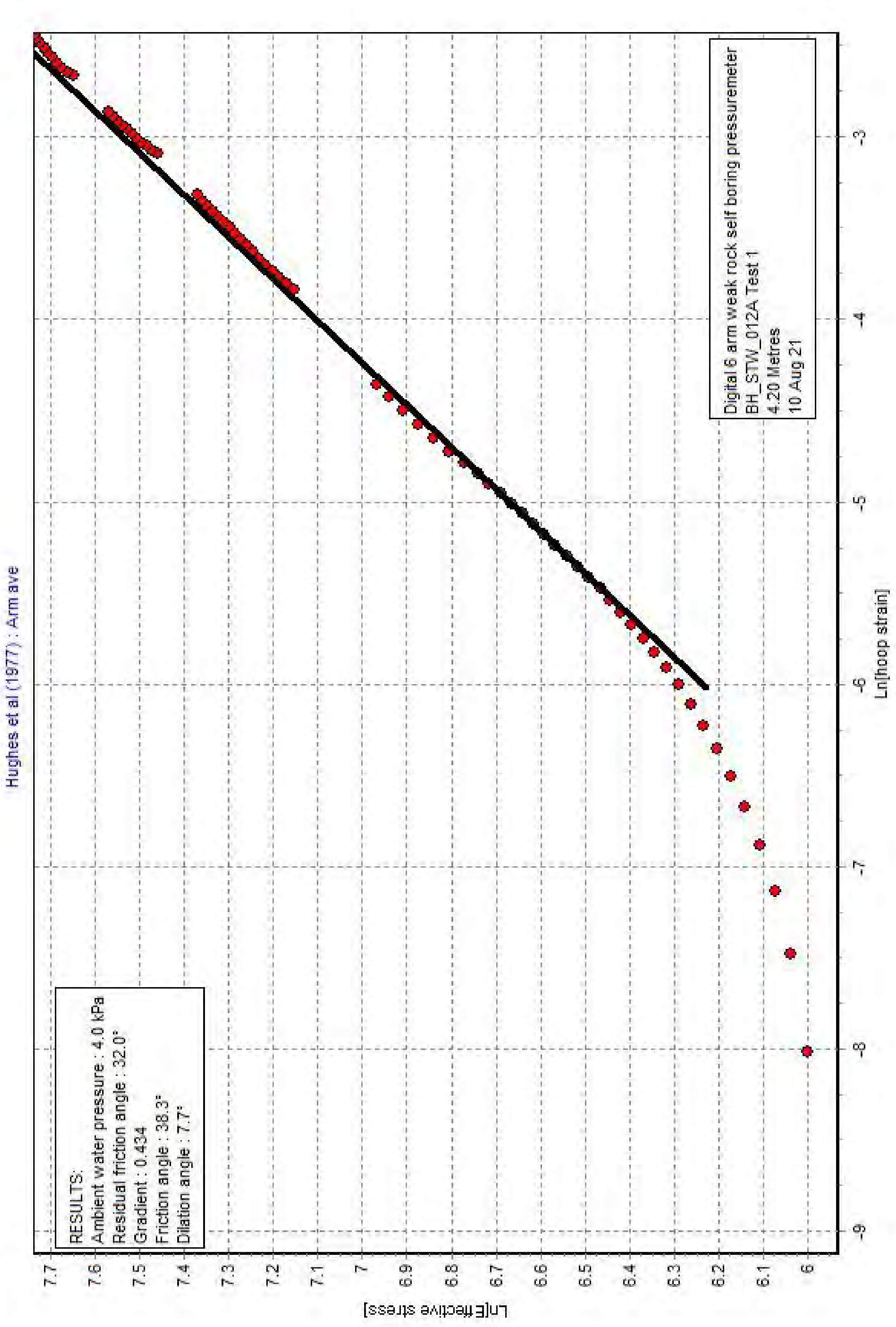
```
BH_STW_012A Test 1 - SUMMARY OF RESULTS
[File made with WinSitu ]

[DETAILS OF TEST]
Project        :   TE8364
Site           :   Cambridge Waste Water Treatment Plant Relocation Project
Borehole       :   BH_STW_012A
Test name      :   BH_STW_012A Test 1
Test date      :   10 Aug 21
Test depth     :   4.20 Metres
Water table    :   3.75 Metres
Ambient PWP    :   4.0 kPa
Material       :   Structureless chalk
Probe          :   Digital 6 arm weak rock self boring pressuremeter
Diameter       :   88.1 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out
The file includes results from a curve fitting analysis

Analysed by SP/RW on 10 Aug 21

Remarks:

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm)                  :   "Arm ave=0.25"
Po from Marsland & Randolph (kPa)   :   "Arm ave=137.8"
Best estimate of Po (kPa)           :   "Arm ave=97.0"

[UNDRAINED STRENGTH PARAMETERS]
Undrained yield stress (kPa)        :   "Arm ave=687.6"

[DRAINED ANALYSIS OF SANDS]
[Hughes et al 1977]
Constant volume friction angle (°)  :   32.0
Angle of internal friction (°)      :   "Arm ave=38.3"
Dilation angle (°)                  :   "Arm ave=7.7"
Gradient of log-log plot            :   "Arm ave=0.434"

[Withers et al 1989]
Angle of internal friction (°)      :   "Arm ave=38.0"
Dilation angle (°)                  :   "Arm ave=7.3"
Gradient of log-log plot            :   "Arm ave=-2.593"

[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=33.2"
Axis       Loop   Value    Mean Strain  Mean Pc  dE      dPc
           No     (MPa)    (%)          (kPa)    (%)     (kPa)
Arm ave    1      142.0    1.780        926      0.238   339
Arm ave    2      131.9    4.094        1299     0.357   471
Arm ave    3      138.5    6.431        1587     0.386   536
Arm ave    4      138.1    9.076        1043     0.357   493

[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]
Axis       Loop   Intercept  Alpha      Gradient
           No     (MPa)      (MPa)
Arm ave    1      20.758     14.026     0.676
Arm ave    2      21.876     14.587     0.667
Arm ave    3      14.239     8.303      0.583
Arm ave    4      16.429     10.061     0.612


[PARAMETERS USED FOR DRAINED CURVE MODELLING]
{Axis is  Arm ave}
Strain Origin (mm)                  :   0.25
Po (kPa)                            :   97
Cohesion (kPa)                      :   60
Angle of peak friction (deg)        :   38.3
Angle of peak dilation (deg)        :   7.7
Total yield stress (kPa)            :   324
```

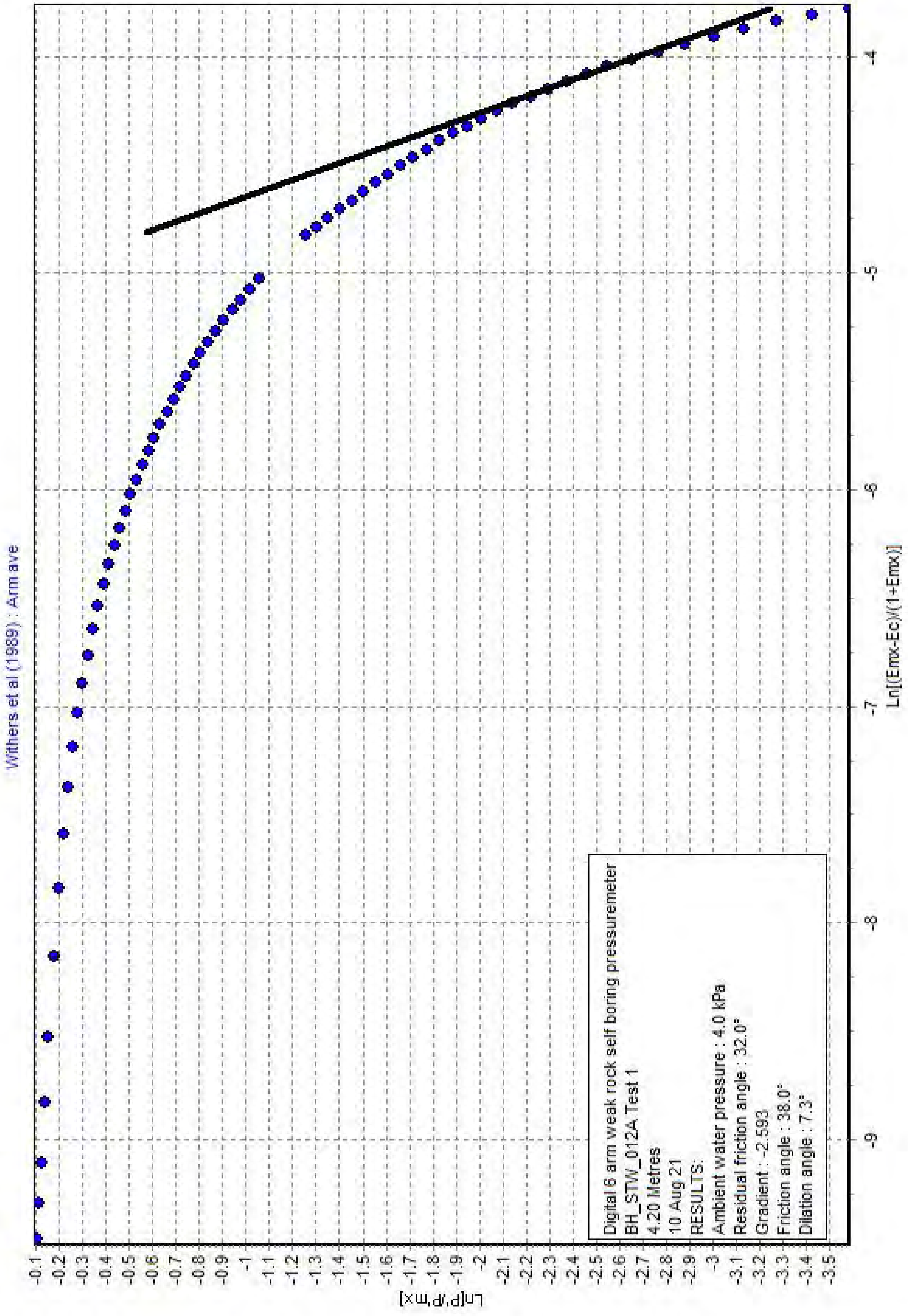
```
BH_STW_012A Test 1 - SUMMARY OF RESULTS
Total limit stress (kPa)            :   5251
G at first yield (MPa)              :   97.2
Non-linear exponent                 :   0.667
Janbu exponent                      :   0.109
Correlation                         :   0.631

Ambient pore water pressure (kPa)   :   4
Residual friction angle (deg)       :   32.0
Poisson's ratio                     :   0.25
```


Cavity strain vs Total Pressure : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 1
4.20 Metres
10 Aug 21
Total pressure (kPa)
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
1,300
1,400
1,500
1,600
1,700
1,800
1,900
2,000
2,100
2,200
Cavity strain (%)
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5

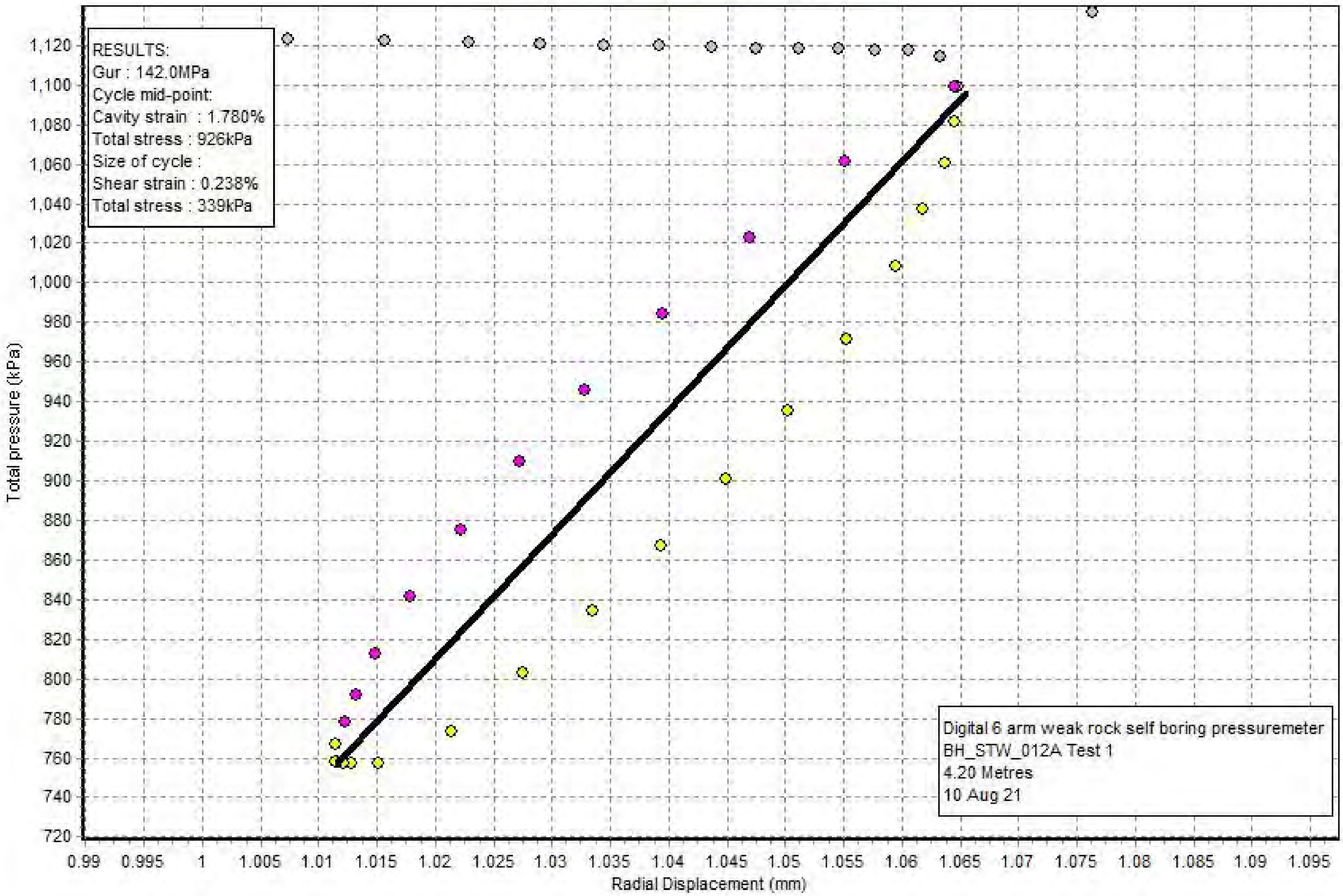

Po of cohesive material (1977, 1990) : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 1
4.20 Metres
10 Aug 21
RESULTS:
Gi : 33.2MPa
Pf : 687.6kPa
Po : 137.8kPa
Tf : 550.4kPa
Po + Tf : 688.2kPa
Origin : 0.093mm
Total pressure (kPa)
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
Radial Displacement (mm)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0.75
0.8
0.85
0.9
0.95
Shear stress at yield : Arm ave
Total pressure (kPa)
1,000
900
800
700
Ln[shear strain]
-4
-3.8
-3.6


Excess PWP vs Total stress : PPC Ave
RESULTS:
Onset of excess pwp :
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 1
4.20 Metres
10 Aug 21
Pore water pressure (kPa)
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
Total pressure (kPa)
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
1,300
1,400
1,500
1,600
1,700
1,800
1,900
2,000
2,100
2,200


Hughes et al (1977) : Arm ave
RESULTS:
Ambient water pressure : 4.0 kPa
Residual friction angle : 32.0°
Gradient : 0.434
Friction angle : 38.3°
Dilation angle : 7.7°
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 1
4.20 Metres
10 Aug 21
Ln[Effective stress]
7.7
7.6
7.5
7.4
7.3
7.2
7.1
7
6.9
6.8
6.7
6.6
6.5
6.4
6.3
6.2
6.1
6
Ln[hoop strain]
-9
-8
-7
-6
-5
-4
-3

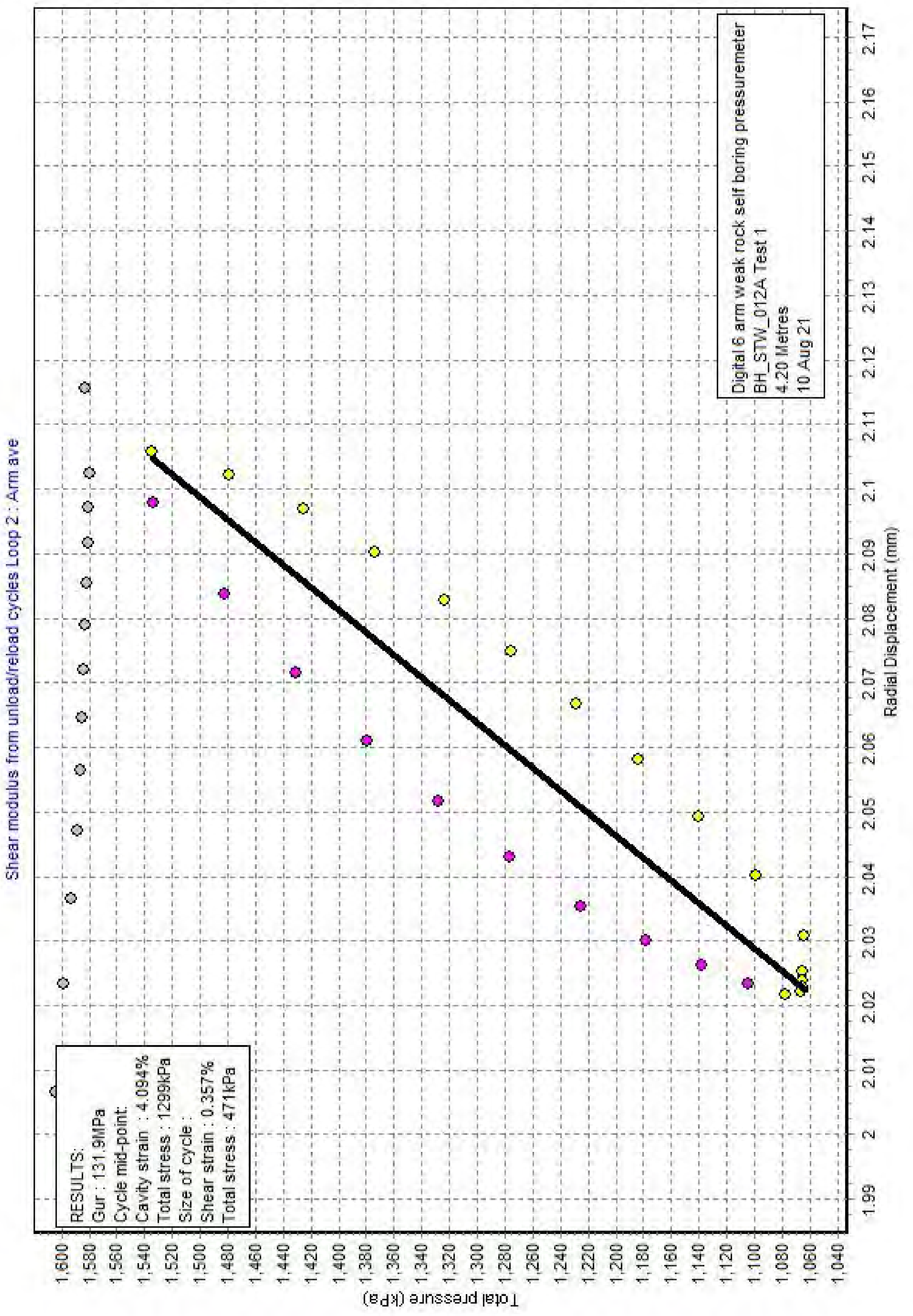

Withers et al (1989) : Arm ave
Ln[(Emx-Ec)/(1+Emx)]
Ln[P'/P'mx]
-4
-5
-6
-7
-8
-9
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1
-1.1
-1.2
-1.3
-1.4
-1.5
-1.6
-1.7
-1.8
-1.9
-2
-2.1
-2.2
-2.3
-2.4
-2.5
-2.6
-2.7
-2.8
-2.9
-3
-3.1
-3.2
-3.3
-3.4
-3.5
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 1
4.20 Metres
10 Aug 21
RESULTS:
Ambient water pressure : 4.0 kPa
Residual friction angle : 32.0°
Gradient : -2.593
Friction angle : 38.0°
Dilation angle : 7.3°

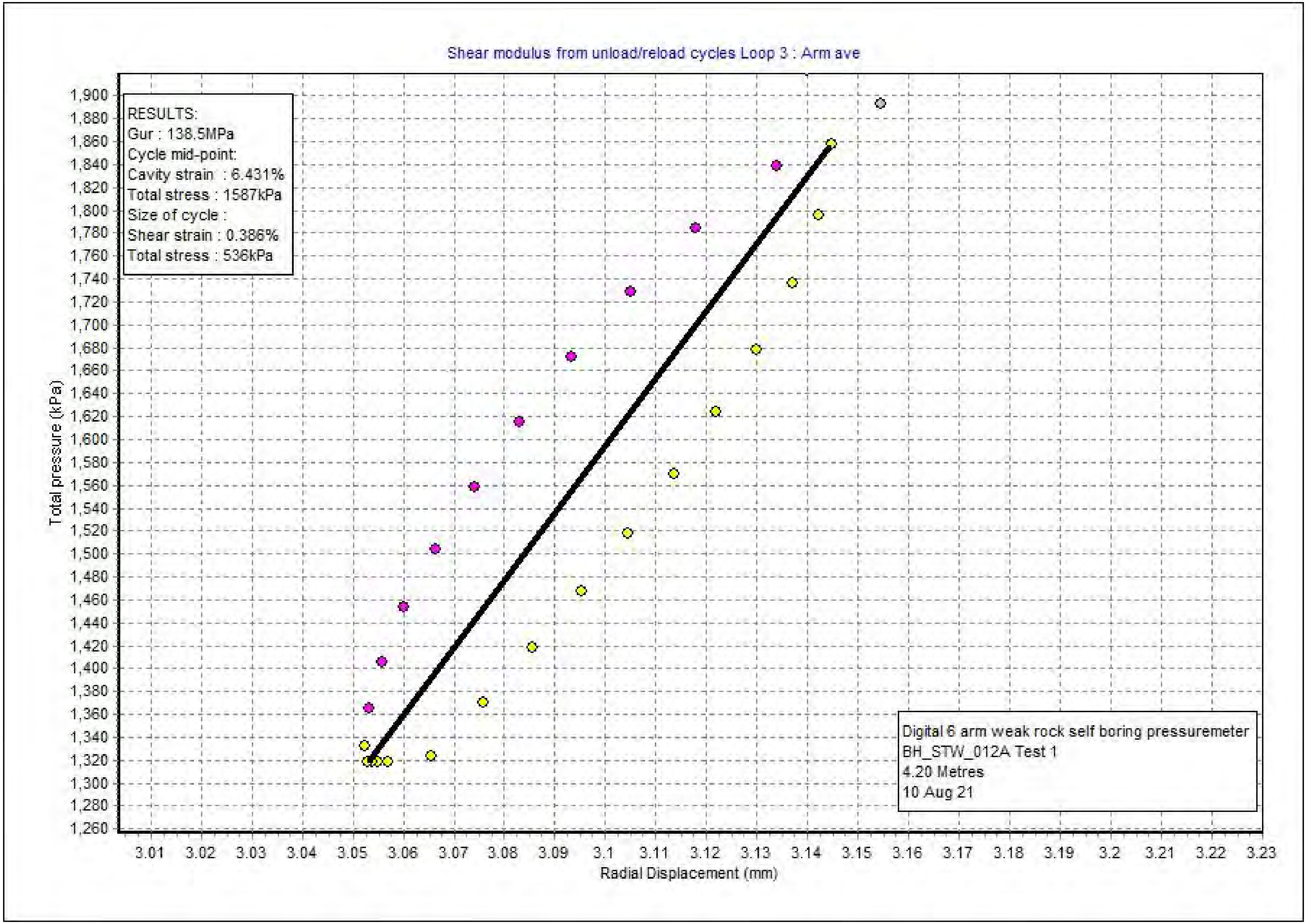
Shear modulus from unload/reload cycles Loop 1 : Arm ave

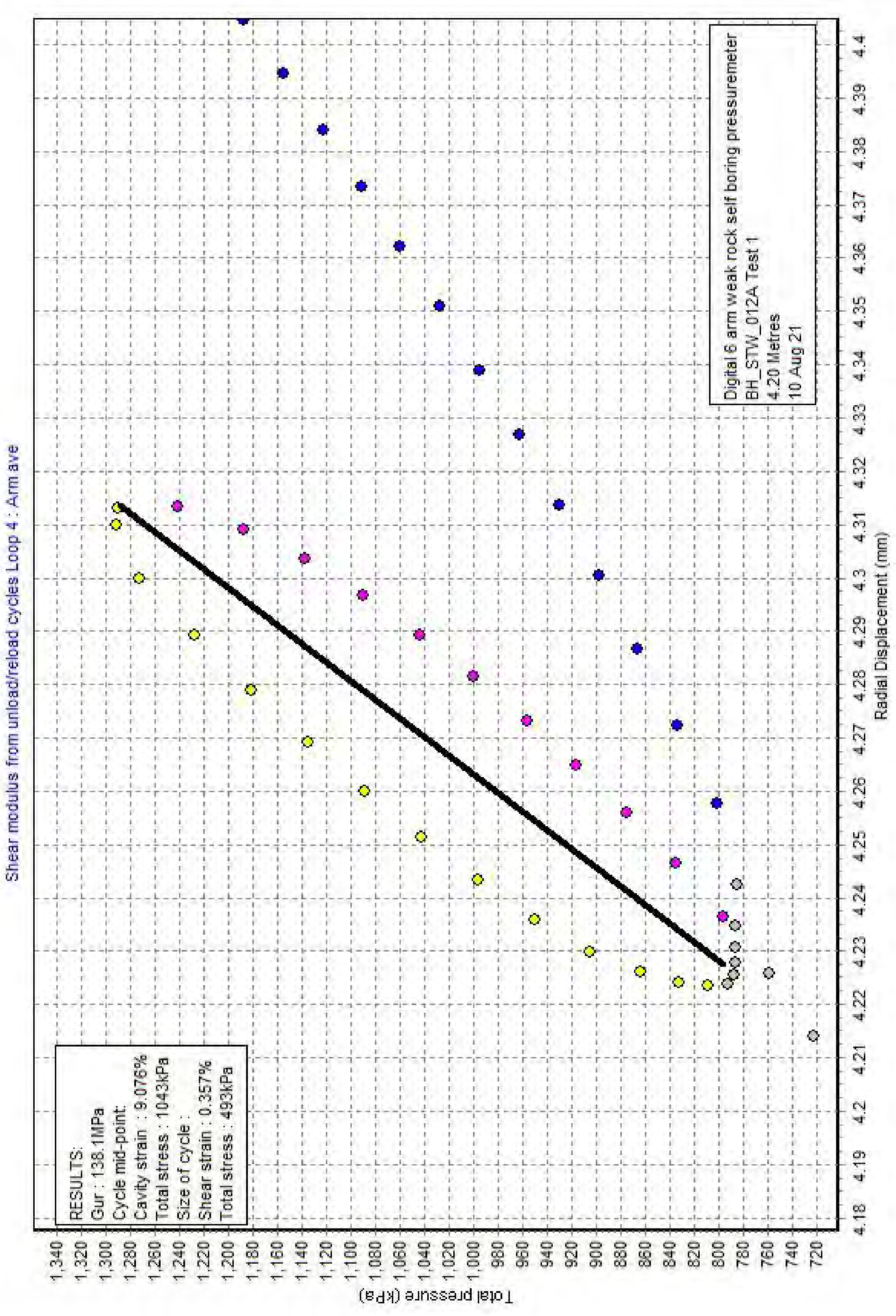


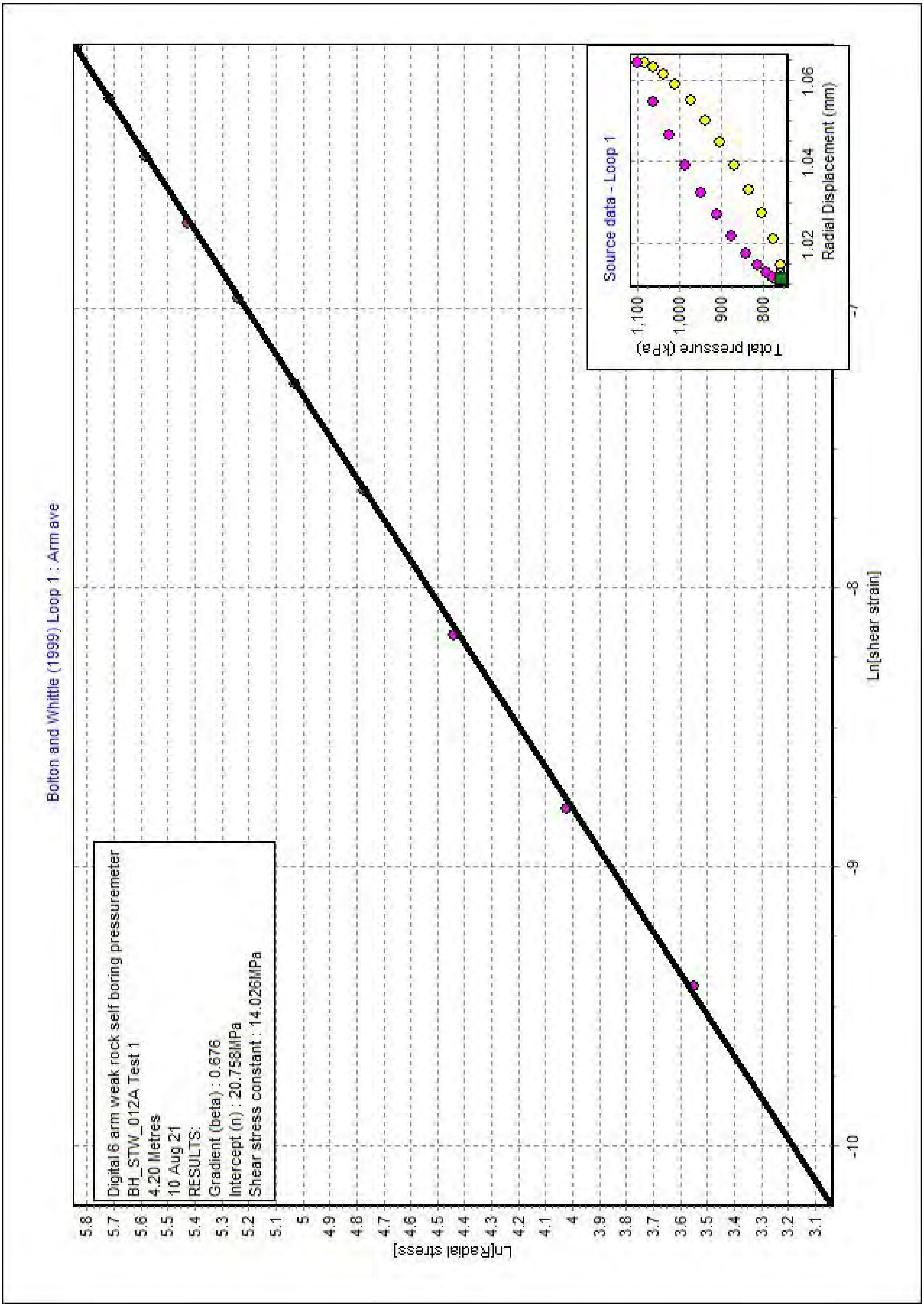
RESULTS:
Gur : 142.0MPa
Cycle mid-point:
Cavity strain : 1.780%
Total stress : 926kPa
Size of cycle :
Shear strain : 0.238%
Total stress : 339kPa

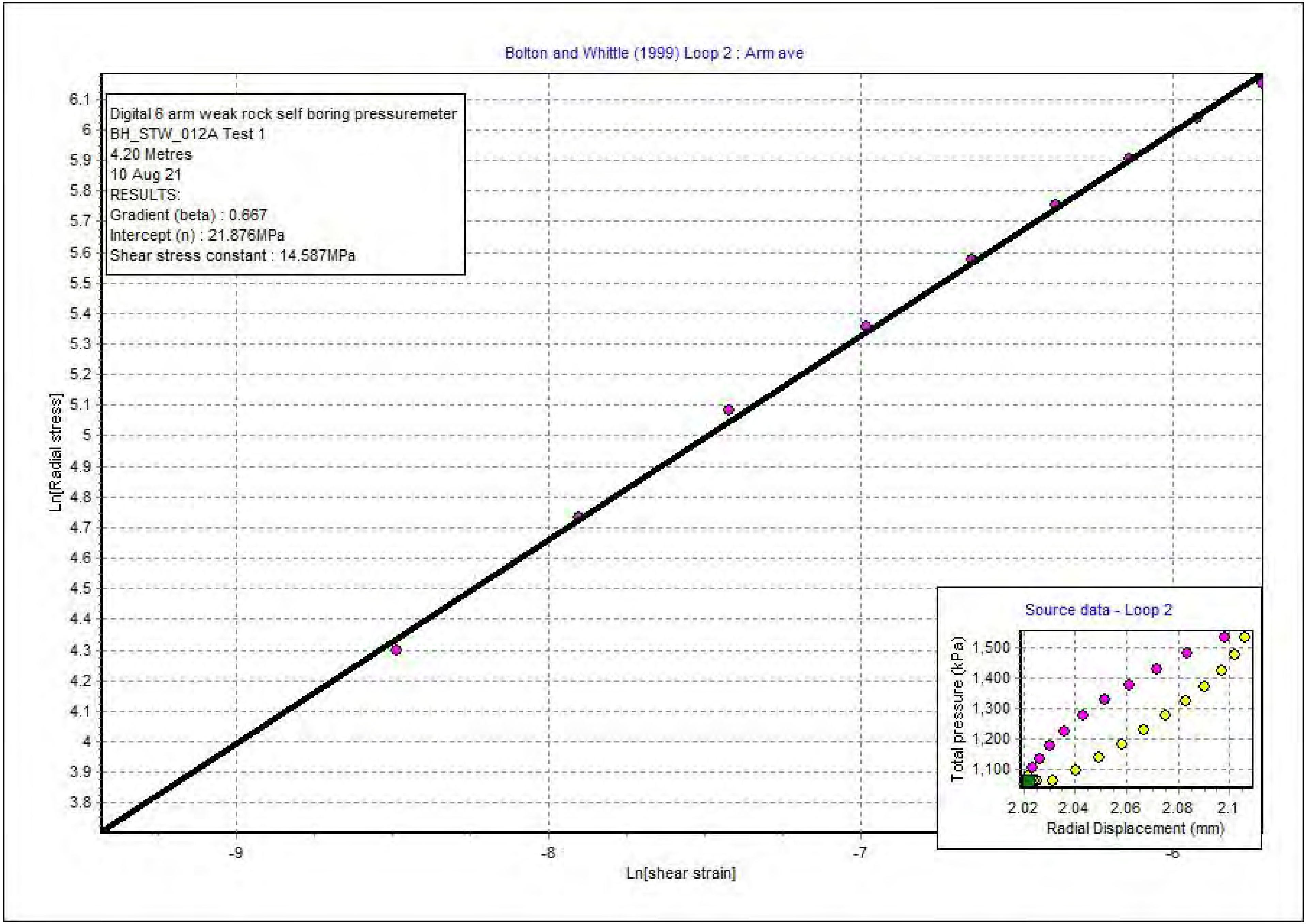
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 1
4.20 Metres
10 Aug 21


Shear modulus from unload/reload cycles Loop 2 : Arm ave
RESULTS:
Gur : 131.9MPa
Cycle mid-point:
Cavity strain : 4.094%
Total stress : 1299kPa
Size of cycle :
Shear strain : 0.357%
Total stress : 471kPa
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 1
4.20 Metres
10 Aug 21
Total pressure (kPa)
1,600
1,580
1,560
1,540
1,520
1,500
1,480
1,460
1,440
1,420
1,400
1,380
1,360
1,340
1,320
1,300
1,280
1,260
1,240
1,220
1,200
1,180
1,160
1,140
1,120
1,100
1,080
1,060
1,040
Radial Displacement (mm)
1.99
2
2.01
2.02
2.03
2.04
2.05
2.06
2.07
2.08
2.09
2.1
2.11
2.12
2.13
2.14
2.15
2.16
2.17

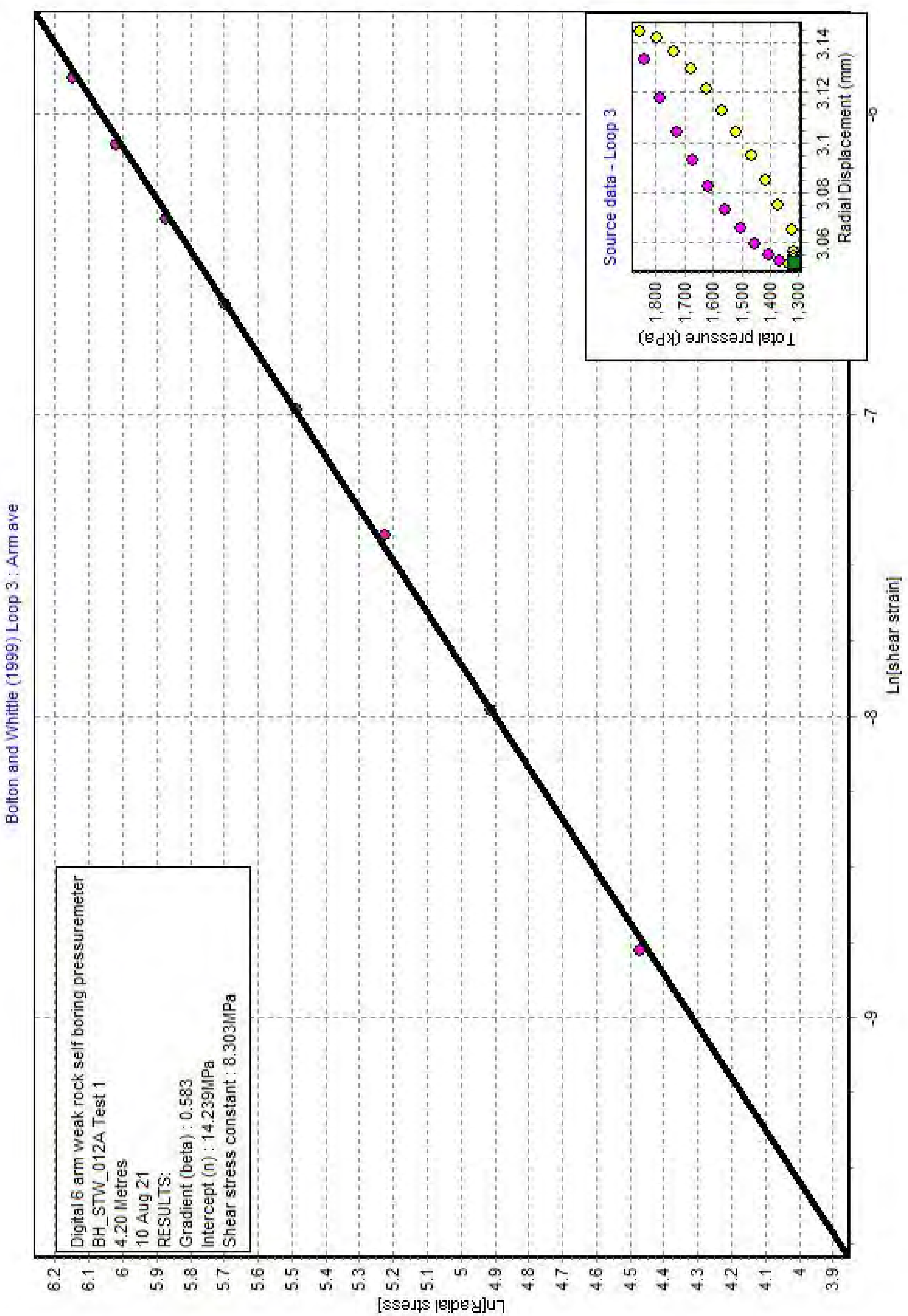

Shear modulus from unload/reload cycles Loop 3 : Arm ave
RESULTS:
Gur : 138.5MPa
Cycle mid-point:
Cavity strain : 6.431%
Total stress : 1587kPa
Size of cycle :
Shear strain : 0.386%
Total stress : 536kPa
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 1
4.20 Metres
10 Aug 21
Total pressure (kPa)
1,900
1,880
1,860
1,840
1,820
1,800
1,780
1,760
1,740
1,720
1,700
1,680
1,660
1,640
1,620
1,600
1,580
1,560
1,540
1,520
1,500
1,480
1,460
1,440
1,420
1,400
1,380
1,360
1,340
1,320
1,300
1,280
1,260
Radial Displacement (mm)
3.01
3.02
3.03
3.04
3.05
3.06
3.07
3.08
3.09
3.1
3.11
3.12
3.13
3.14
3.15
3.16
3.17
3.18
3.19
3.2
3.21
3.22
3.23

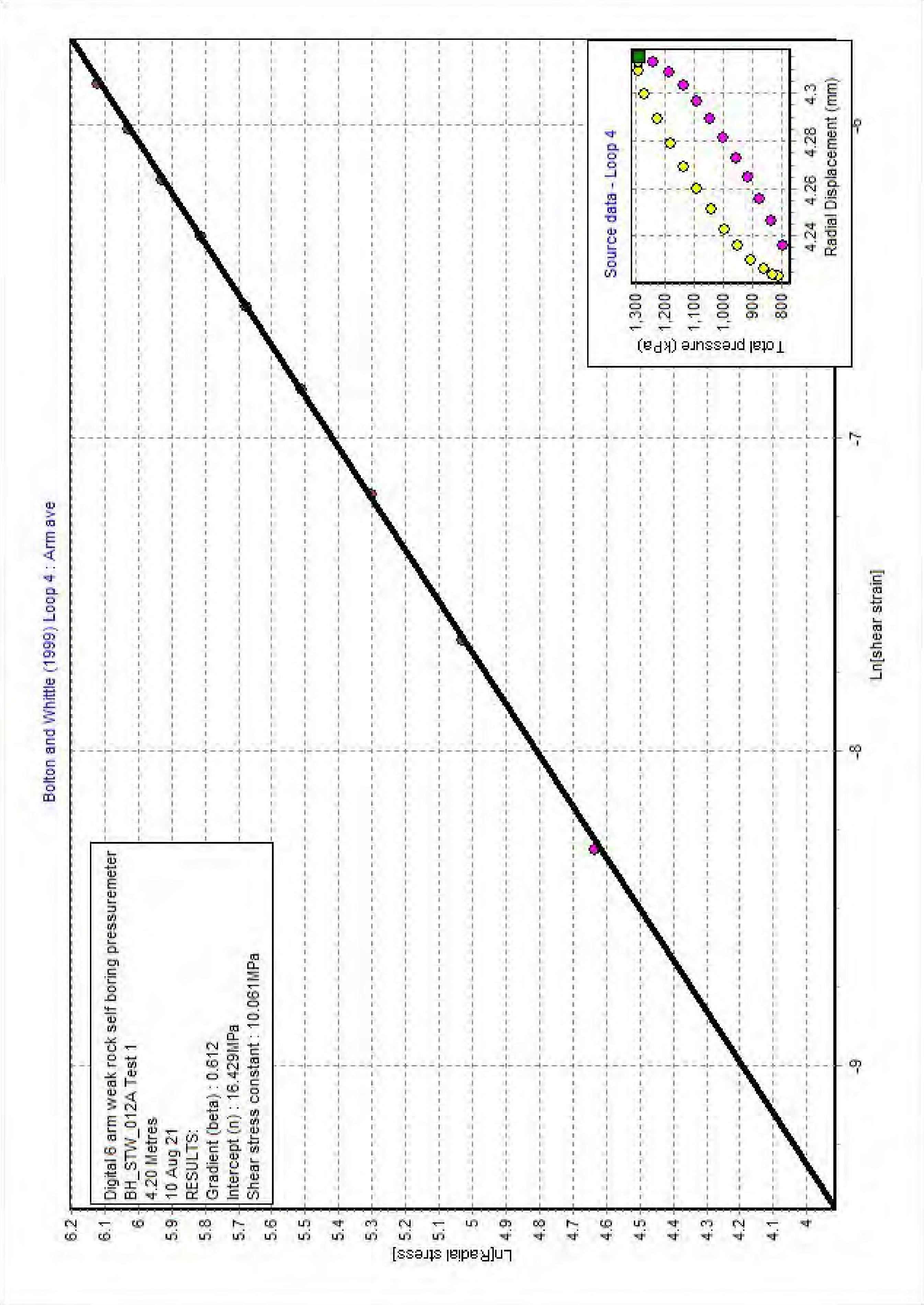

Shear modulus from unload/reload cycles Loop 4 : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 1
4.20 Metres
10 Aug 21
RESULTS:
Gur : 138.1MPa
Cycle mid-point:
Cavity strain : 9.076%
Total stress : 1043kPa
Size of cycle :
Shear strain : 0.357%
Total stress : 493kPa
Radial Displacement (mm)
4.18
4.19
4.2
4.21
4.22
4.23
4.24
4.25
4.26
4.27
4.28
4.29
4.3
4.31
4.32
4.33
4.34
4.35
4.36
4.37
4.38
4.39
4.4
Total pressure (kPa)
1,340
1,320
1,300
1,280
1,260
1,240
1,220
1,200
1,180
1,160
1,140
1,120
1,100
1,080
1,060
1,040
1,020
1,000
980
960
940
920
900
880
860
840
820
800
780
760
740
720

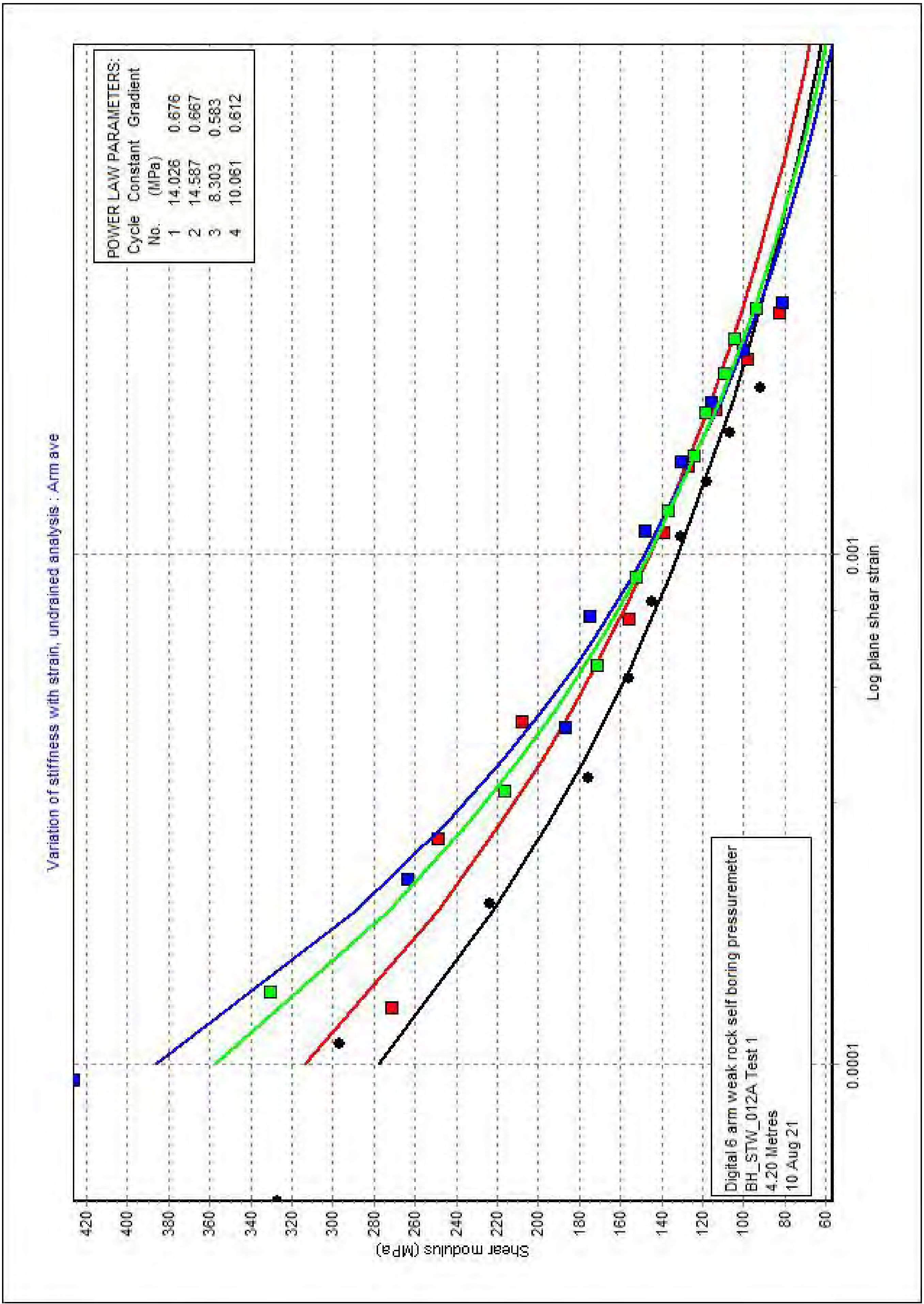

Bolton and Whittle (1999) Loop 1 : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 1
4.20 Metres
10 Aug 21
RESULTS:
Gradient (beta) : 0.676
Intercept (n) : 20.758MPa
Shear stress constant : 14.026MPa
Ln[Radial stress]
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
Ln[shear strain]
-10
-9
-8
-7
Source data - Loop 1
Total pressure (kPa)
1,100
1,000
900
800
Radial Displacement (mm)
1.02
1.04
1.06

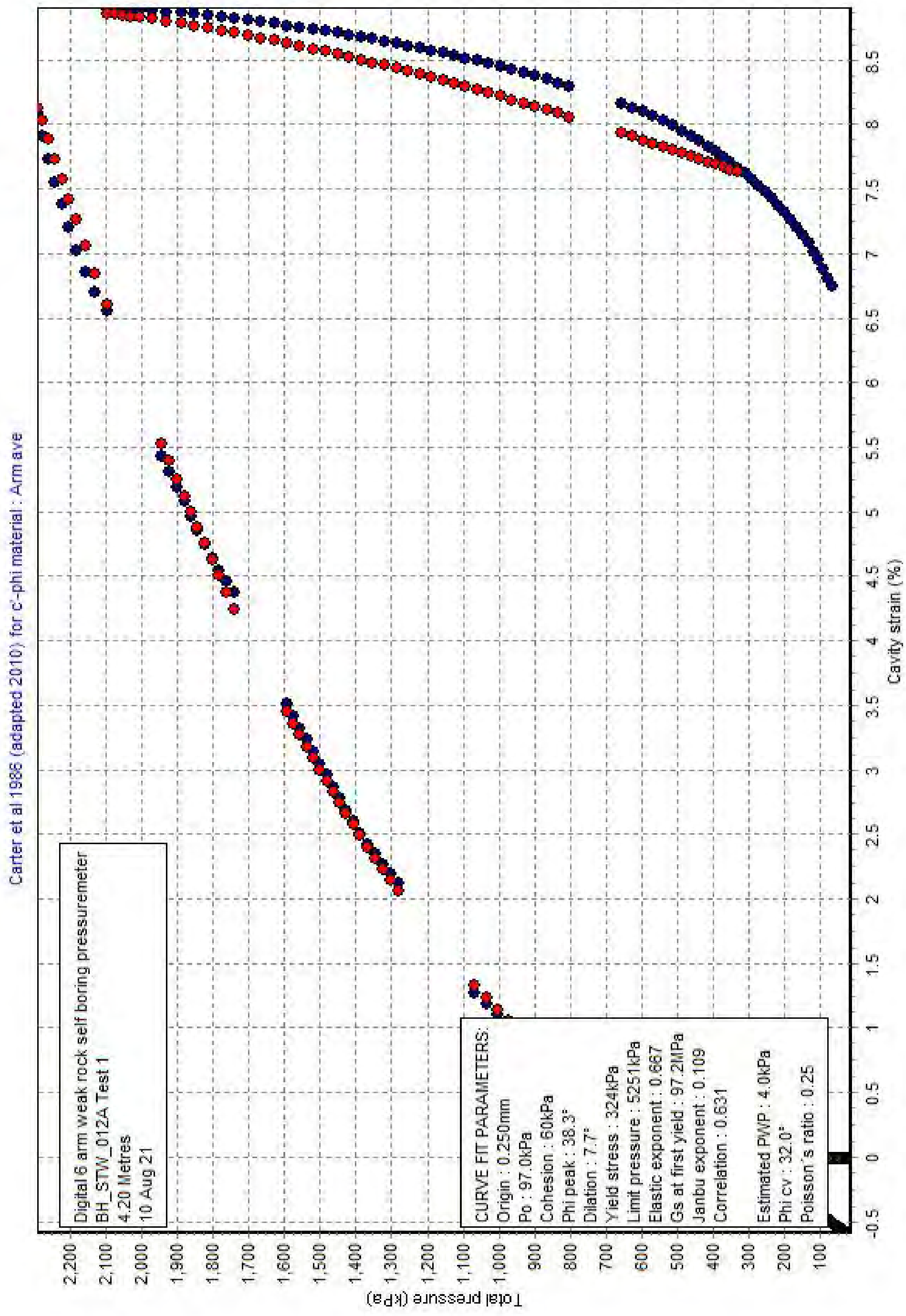


Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 1
4.20 Metres
10 Aug 21
RESULTS:
Gradient (beta) : 0.667
Intercept (n) : 21.876MPa
Shear stress constant : 14.587MPa


Bolton and Whittle (1999) Loop 3 : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 1
4.20 Metres
10 Aug 21
RESULTS:
Gradient (beta) : 0.583
Intercept (n) : 14.239MPa
Shear stress constant : 8.303MPa
Ln[Radial stress]
6.2
6.1
6
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
Ln[shear strain]
-9
-8
-7
-6
Source data - Loop 3
Total pressure (kPa)
1,800
1,700
1,600
1,500
1,400
1,300
Radial Displacement (mm)
3.06
3.08
3.1
3.12
3.14


Bolton and Whittle (1999) Loop 4 : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 1
4.20 Metres
10 Aug 21
RESULTS:
Gradient (beta) : 0.612
Intercept (n) : 16.429MPa
Shear stress constant : 10.061MPa
Ln[Radial stress]
6.2
6.1
6
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
Ln[shear strain]
-9
-8
-7
-6
Source data - Loop 4
Total pressure (kPa)
1,300
1,200
1,100
1,000
900
800
Radial Displacement (mm)
4.24
4.26
4.28
4.3

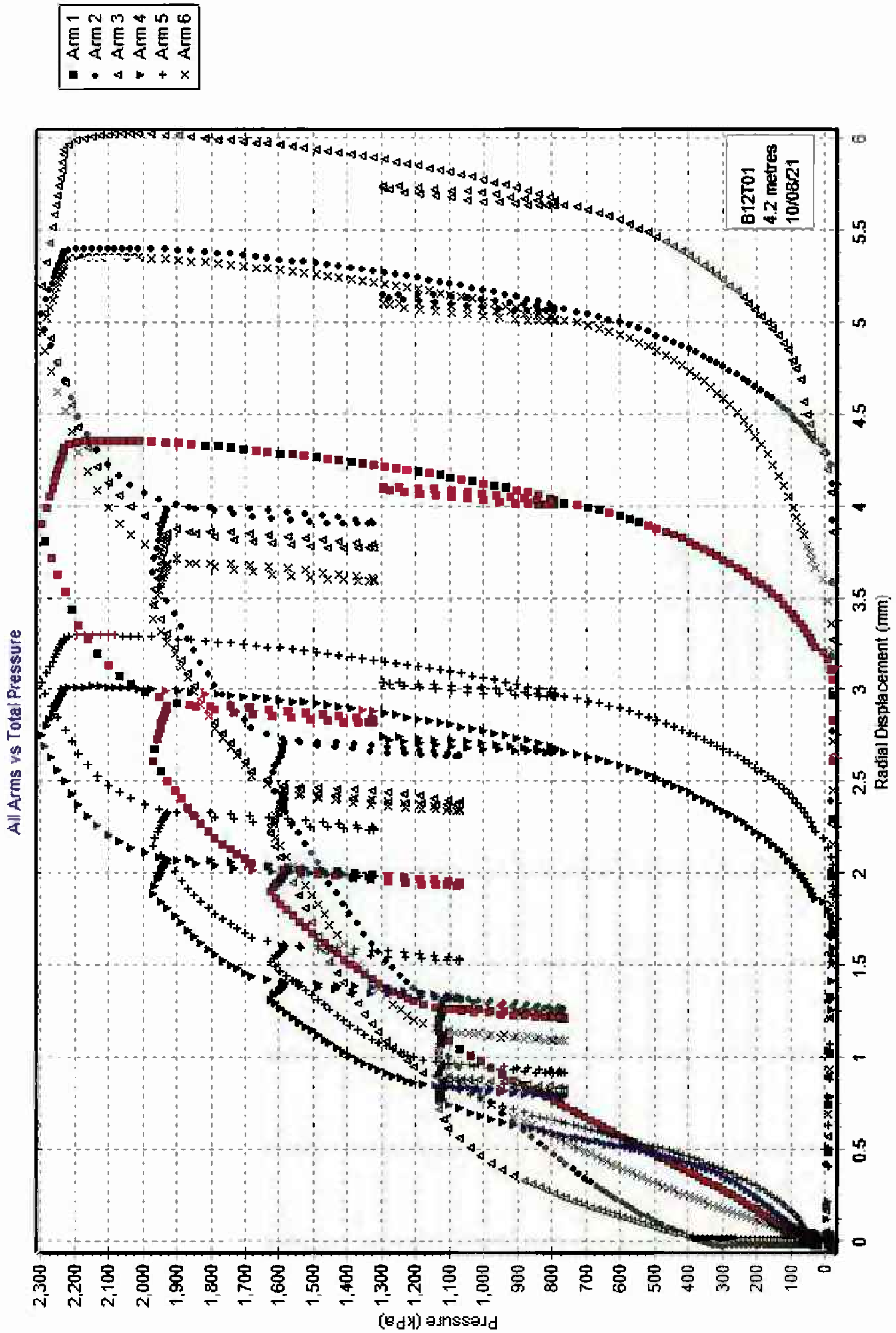

Variation of stiffness with strain, undrained analysis : Arm ave
POWER LAW PARAMETERS:
Cycle No. | Constant (MPa) | Gradient
1 | 14.026 | 0.676
2 | 14.587 | 0.667
3 | 8.303 | 0.583
4 | 10.061 | 0.612
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 1
4.20 Metres
10 Aug 21
Shear modulus (MPa)
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
Log plane shear strain
0.0001
0.001

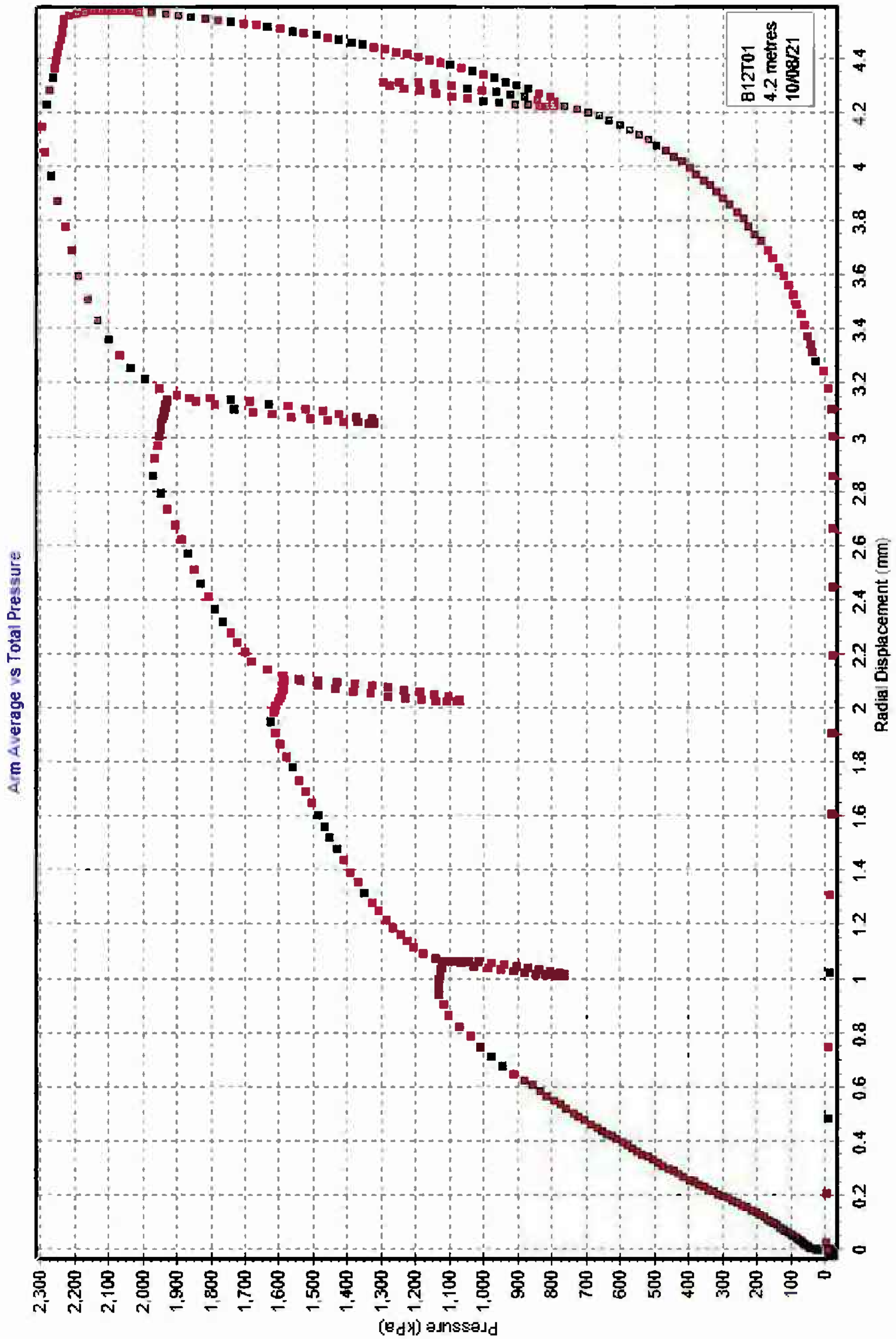


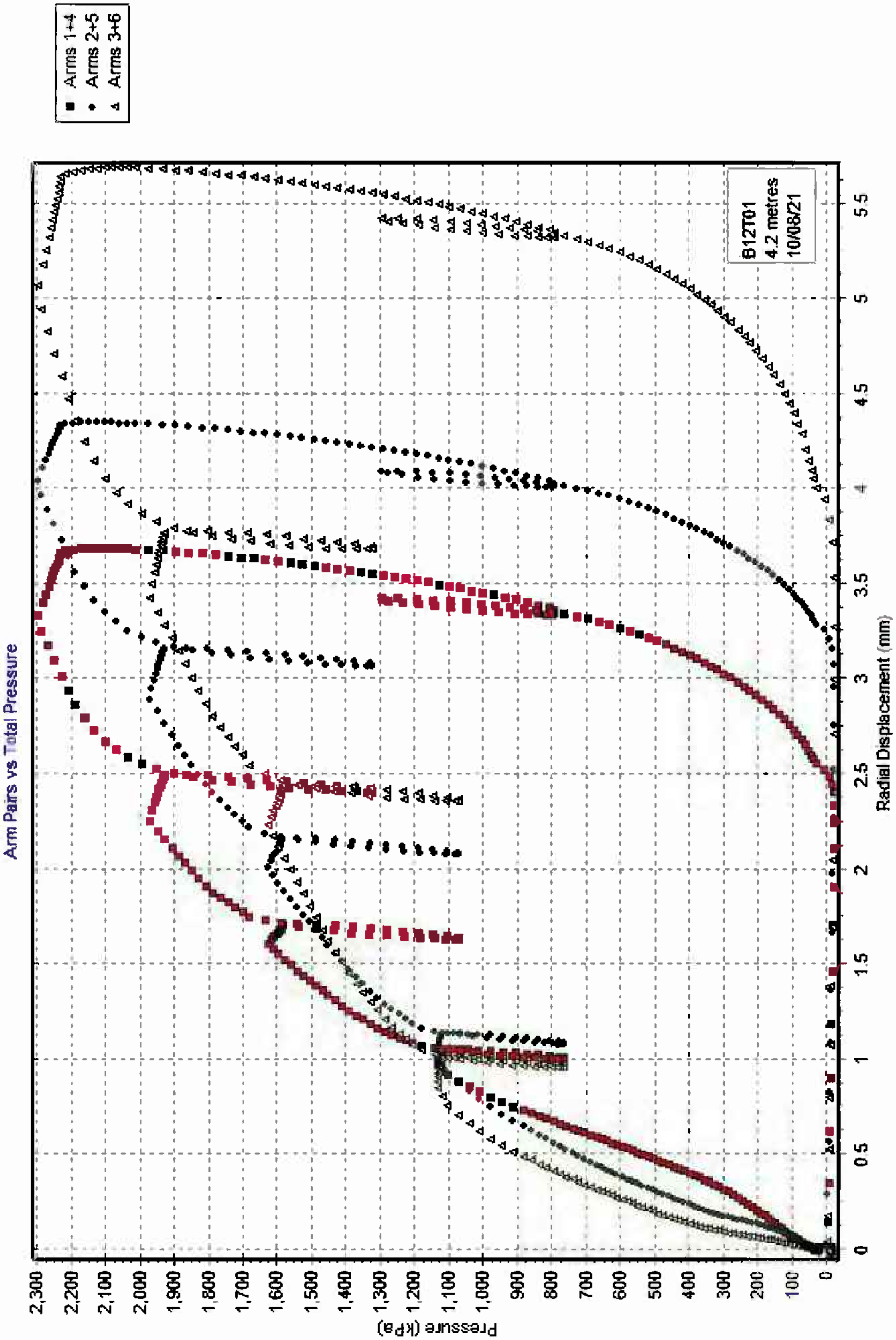
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 1
4.20 Metres
10 Aug 21

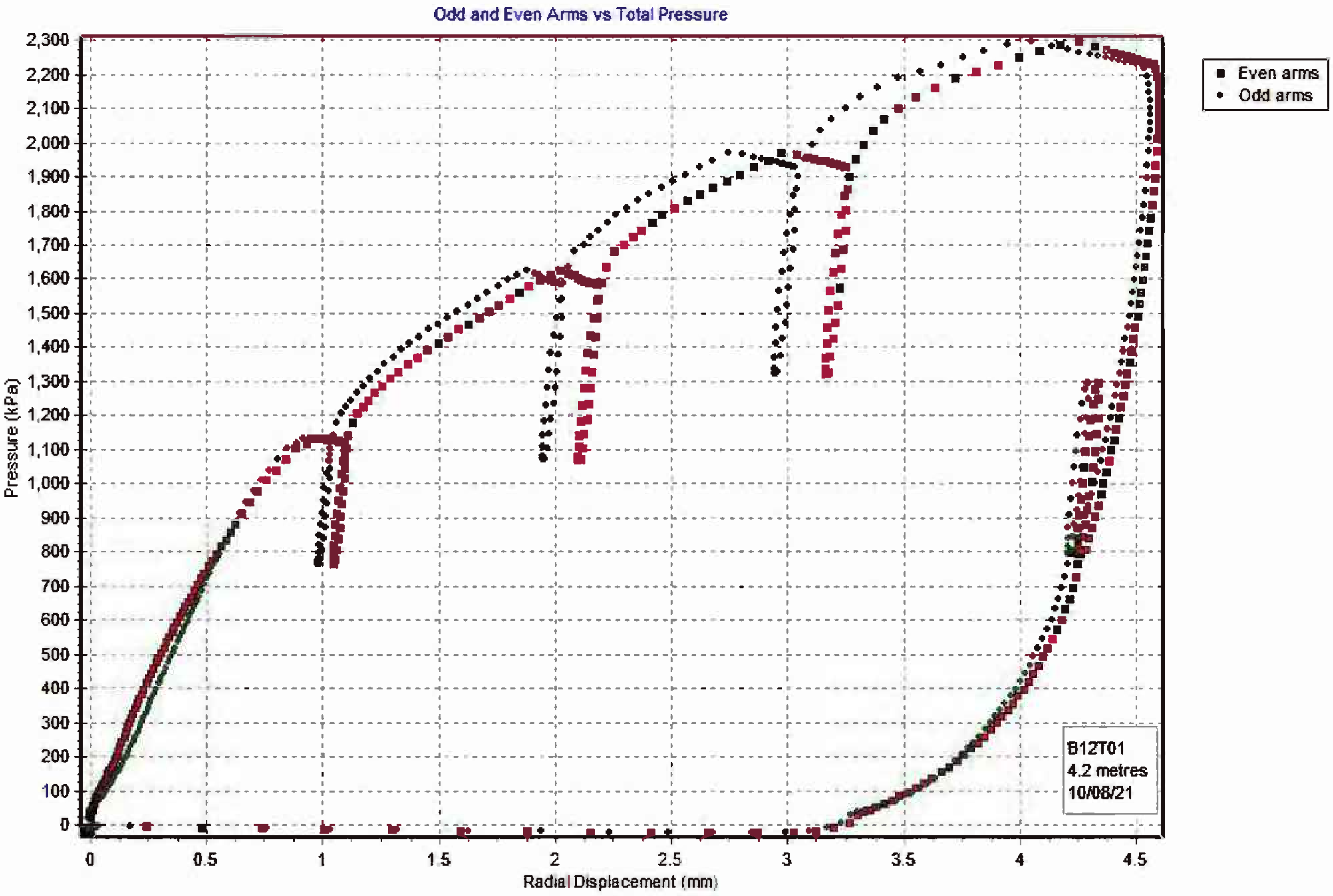
CURVE FIT PARAMETERS:
Origin : 0.250mm
Po : 97.0kPa
Cohesion : 60kPa
Phi peak : 38.3°
Dilation : 7.7°
Yield stress : 324kPa
Limit pressure : 5251kPa
Elastic exponent : 0.667
Gs at first yield : 97.2MPa
Janbu exponent : 0.109
Correlation : 0.631

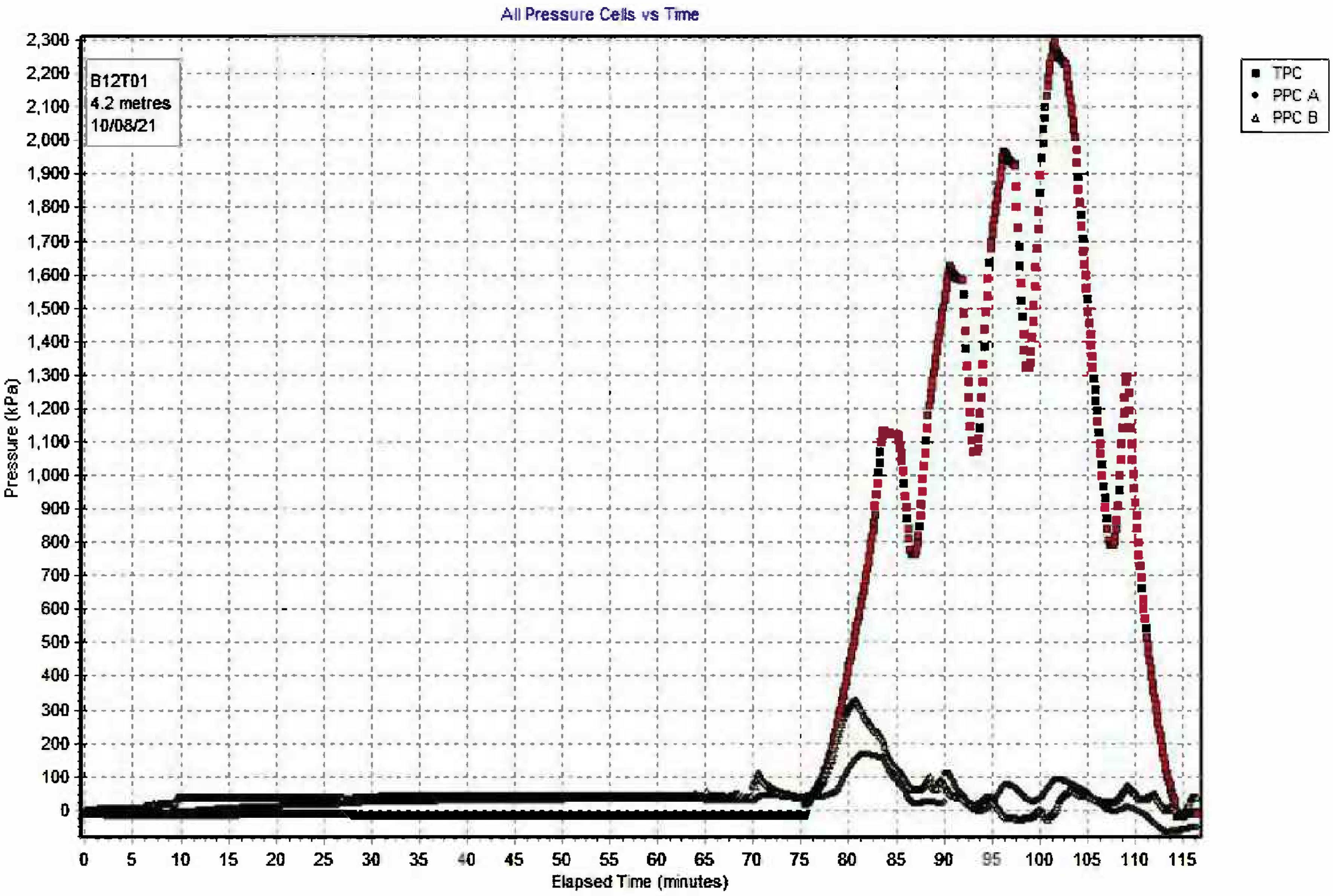
Estimated PWP : 4.0kPa
Phi cv : 32.0°
Poisson's ratio : 0.25


All Arms vs Total Pressure
■ Arm 1
● Arm 2
▵ Arm 3
▾ Arm 4
+ Arm 5
× Arm 6
B12T01
4.2 metres
10/08/21
Radial Displacement (mm)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
Pressure (kPa)
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
1,300
1,400
1,500
1,600
1,700
1,800
1,900
2,000
2,100
2,200
2,300


Arm Average vs Total Pressure
B12T01
4.2 metres
10/08/21
Pressure (kPa)
2,300
2,200
2,100
2,000
1,900
1,800
1,700
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
0
Radial Displacement (mm)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
3.6
3.8
4
4.2
4.4


Arm Pairs vs Total Pressure
■ Arms 1+4
● Arms 2+5
▵ Arms 3+6
B12T01
4.2 metres
10/08/21
Pressure (kPa)
2,300
2,200
2,100
2,000
1,900
1,800
1,700
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
0
Radial Displacement (mm)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5

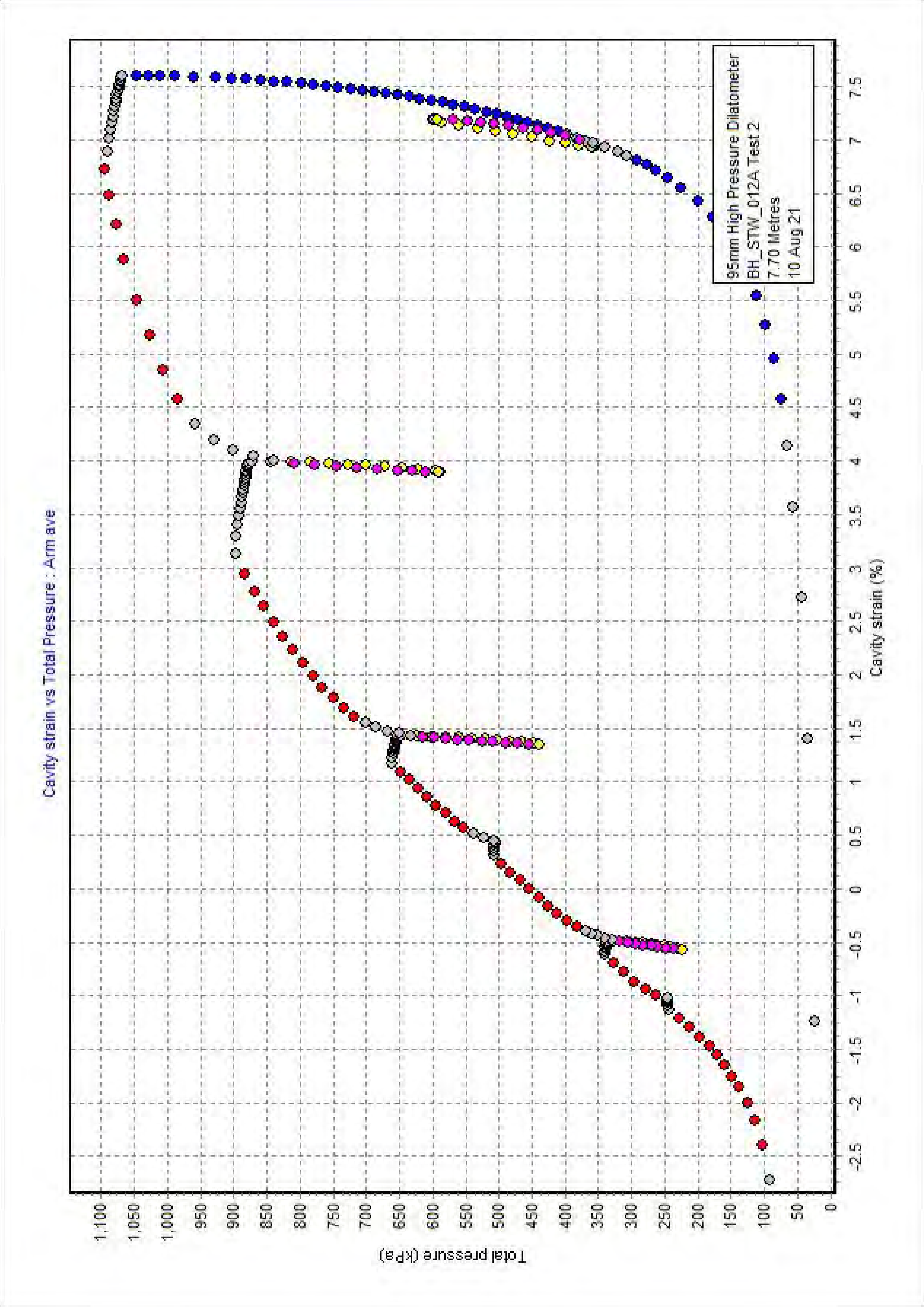

Odd and Even Arms vs Total Pressure
Pressure (kPa)
2,300
2,200
2,100
2,000
1,900
1,800
1,700
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Radial Displacement (mm)
■ Even arms
• Odd arms
B12T01
4.2 metres
10/08/21

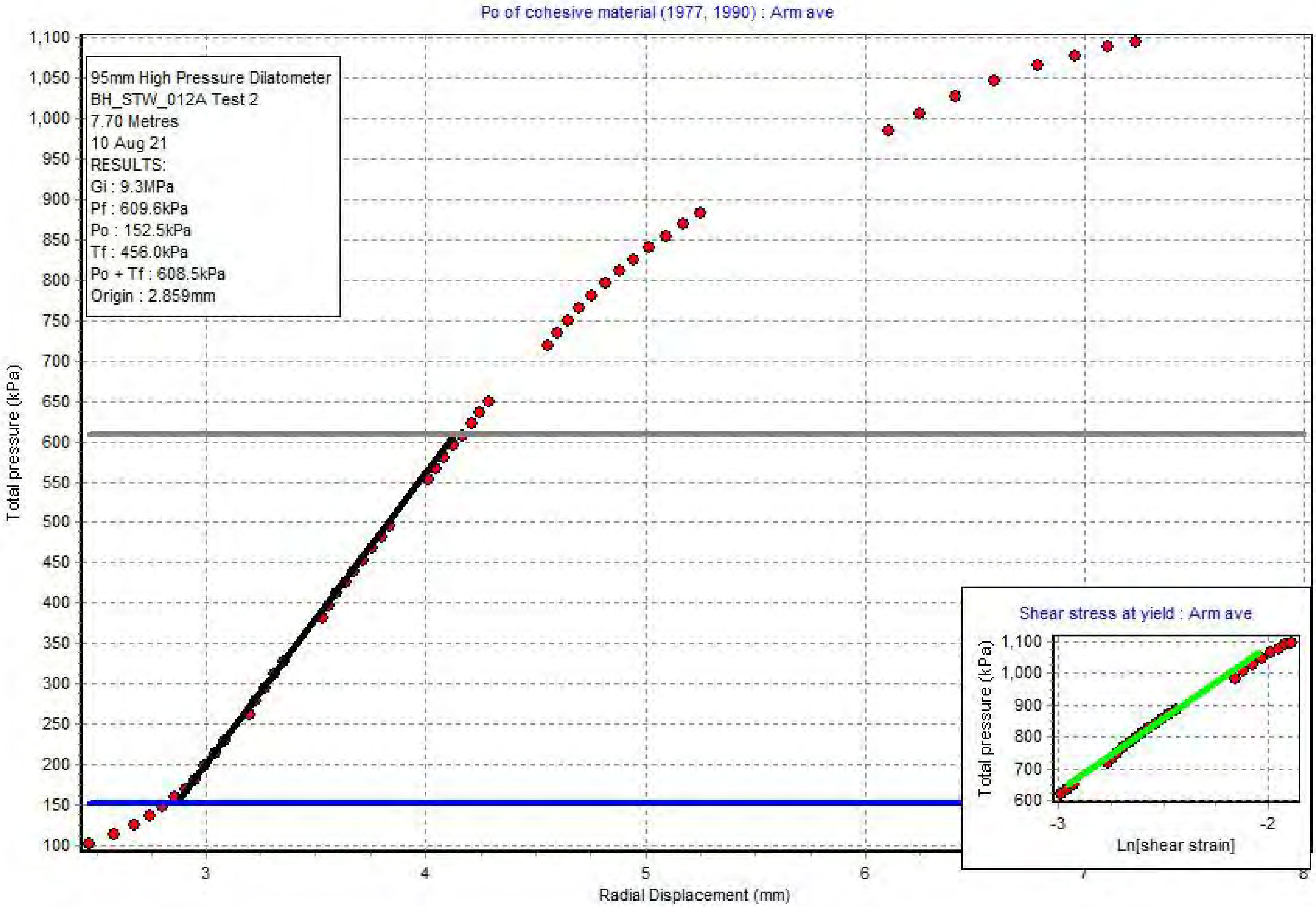

All Pressure Cells vs Time
B12T01
4.2 metres
10/08/21
■ TPC
● PPC A
▵ PPC B
Pressure (kPa)
2,300
2,200
2,100
2,000
1,900
1,800
1,700
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
0
Elapsed Time (minutes)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
115

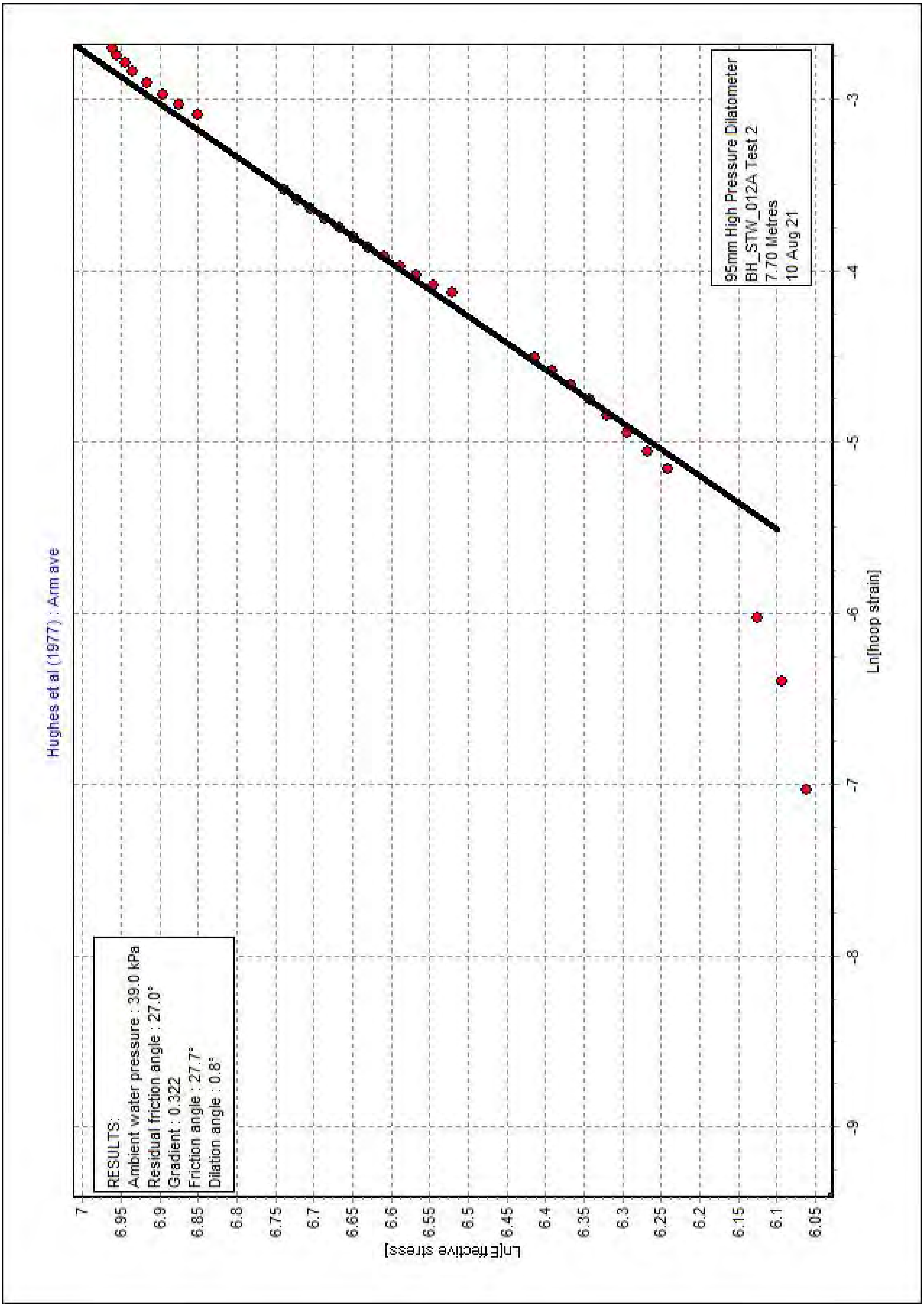
```
BH_STW_012A Test 2 - SUMMARY OF RESULTS
[File made with WinSitu ]

[DETAILS OF TEST]
Project        :   TE8364
Site           :   Cambridge Waste Water Treatment Plant Relocation Project,
Borehole       :   BH_STW_012A
Test name      :   BH_STW_012A Test 2
Test date      :   10 Aug 21
Test depth     :   7.70 Metres
Water table    :   3.75 Metres
Ambient PWP    :   39.0 kPa
Material       :   Structureless chalk
Probe          :   95mm High Pressure Dilatometer
Diameter       :   97.0 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out
The file includes results from a curve fitting analysis

Analysed by SP/RW on 11 Aug 21

Remarks:  Cycle 1 too early to be representative

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm)                  :   "Arm ave=3.71"
Po from Marsland & Randolph (kPa)   :   "Arm ave=152.5"
Best estimate of Po (kPa)           :   "Arm ave=91.0"

[UNDRAINED STRENGTH PARAMETERS]
Undrained yield stress (kPa)        :   "Arm ave=609.6"

[DRAINED ANALYSIS OF SANDS]
[Hughes et al 1977]
Constant volume friction angle (°)  :   27.0
Angle of internal friction (°)      :   "Arm ave=27.7"
Dilation angle (°)                  :   "Arm ave=0.8"
Gradient of log-log plot            :   "Arm ave=0.322"

[Withers et al 1989]
Angle of internal friction (°)      :   "Arm ave=26.8"
Dilation angle (°)                  :   "Arm ave=-0.2"
Gradient of log-log plot            :   "Arm ave=-1.652"

[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=9.3"
Axis       Loop   Value    Mean Strain  Mean Pc  dE      dPc
           No     (MPa)    (%)          (kPa)    (%)     (kPa)
Arm ave    1      59.2     -0.519       271      0.163   97
Arm ave    2      126.5    1.401        531      0.147   186
Arm ave    3      129.5    3.955        701      0.173   224
Arm ave    4      53.3     7.095        488      0.412   220

[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]
Axis       Loop   Intercept  Alpha      Gradient
           No     (MPa)      (MPa)
Arm ave    1      25.714     22.372     0.870
Arm ave    2      17.728     12.341     0.696
Arm ave    3      17.952     12.192     0.679
Arm ave    4      7.073      4.327      0.612


[PARAMETERS USED FOR DRAINED CURVE MODELLING]
{Axis is  Arm ave}
Strain Origin (mm)                  :   3.71
Po (kPa)                            :   147
Cohesion (kPa)                      :   23
Angle of peak friction (deg)        :   27.7
Angle of peak dilation (deg)        :   0.8
Total yield stress (kPa)            :   280
```

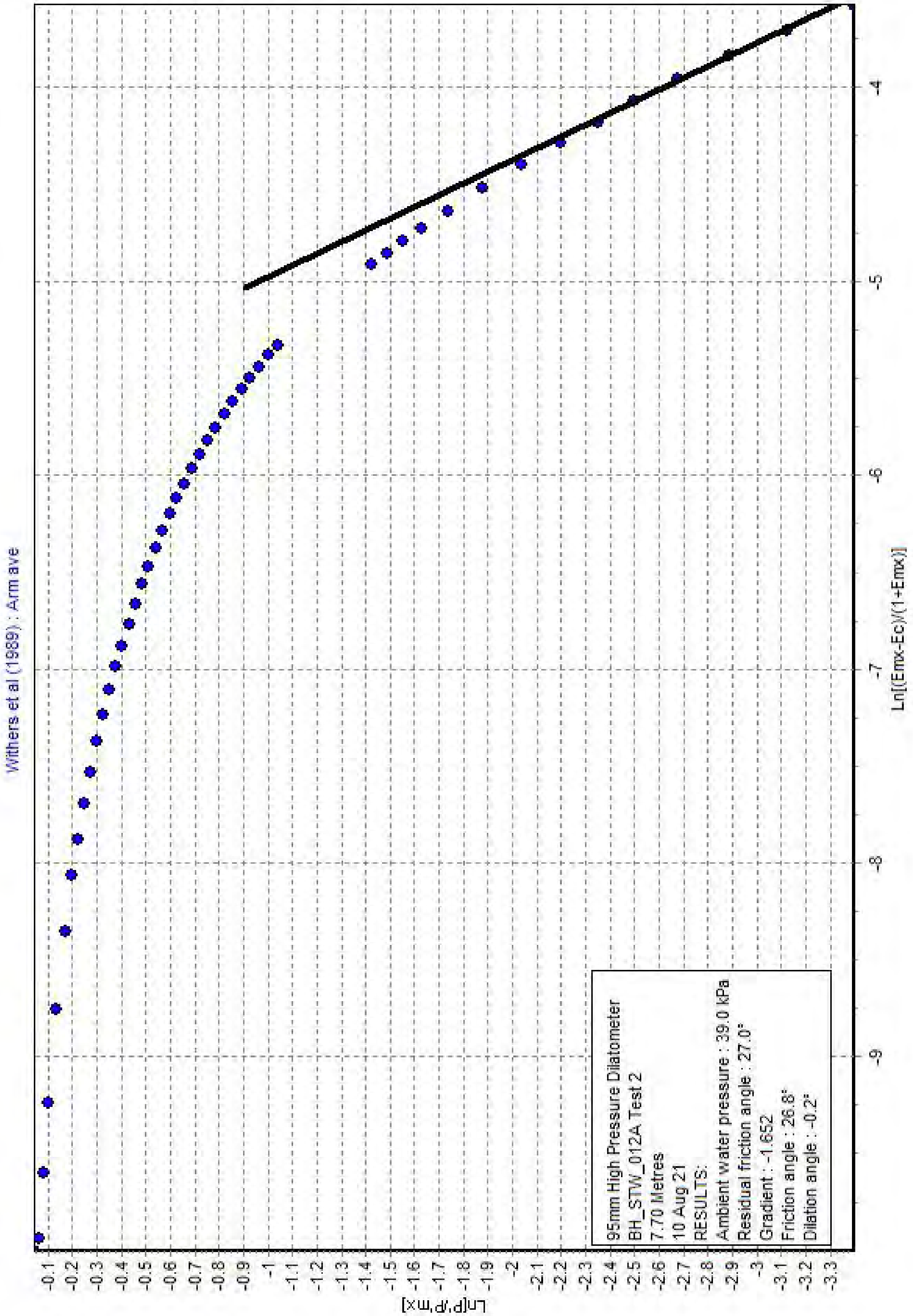
BH_STW_012A Test 2 - SUMMARY OF RESULTS

```
Total limit stress (kPa)            :   2128
G at first yield (MPa)              :   70.6
Non-linear exponent                 :   0.679
Janbu exponent                      :   0.229
Correlation                         :   0.151

Ambient pore water pressure (kPa)   :   39
Residual friction angle (deg)       :   27.0
Poisson's ratio                     :   0.25
```

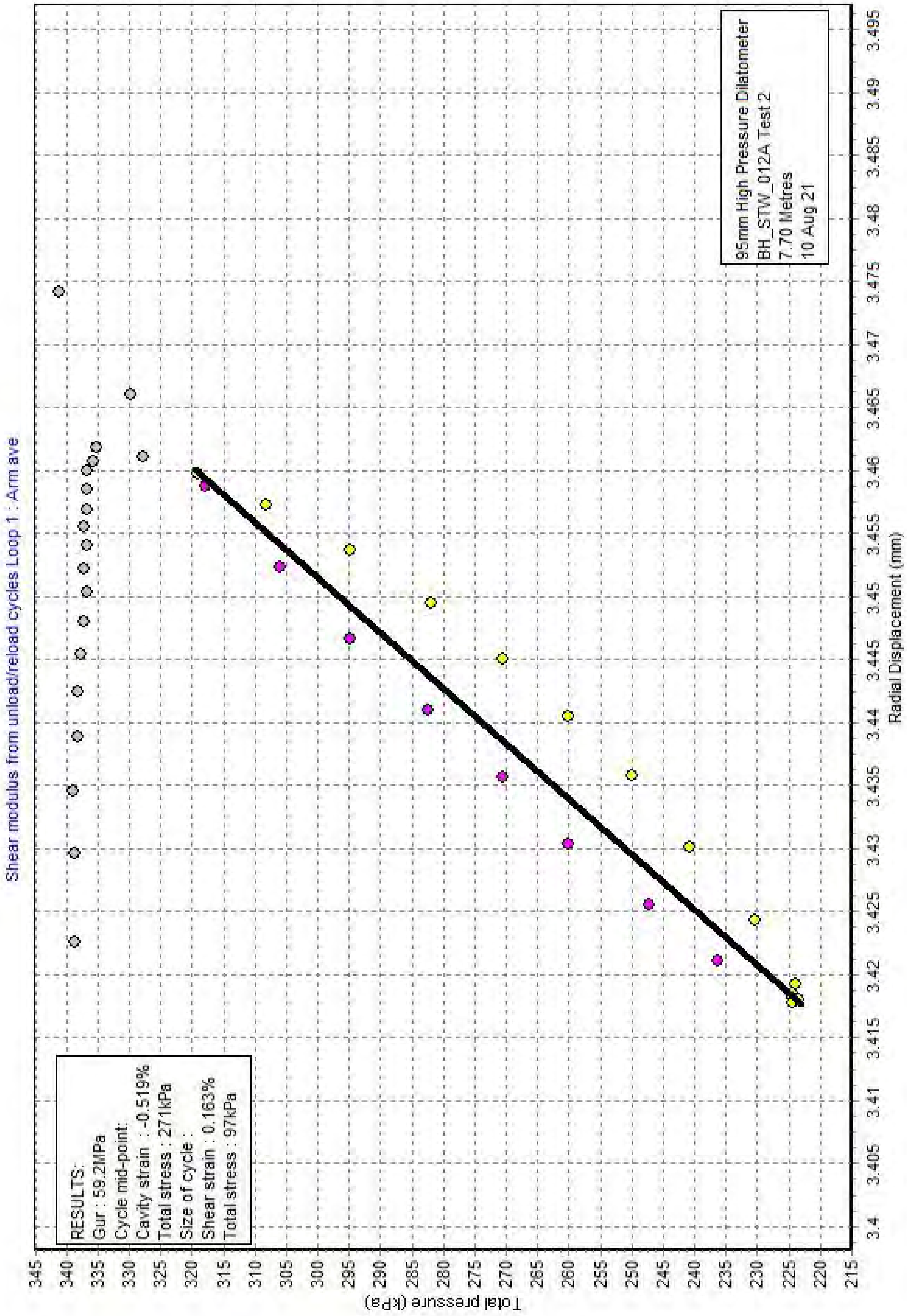

Cavity strain vs Total Pressure : Arm ave
95mm High Pressure Dilatometer
BH_STW_012A Test 2
7.70 Metres
10 Aug 21
Total pressure (kPa)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1,000
1,050
1,100
Cavity strain (%)
-2.5
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5

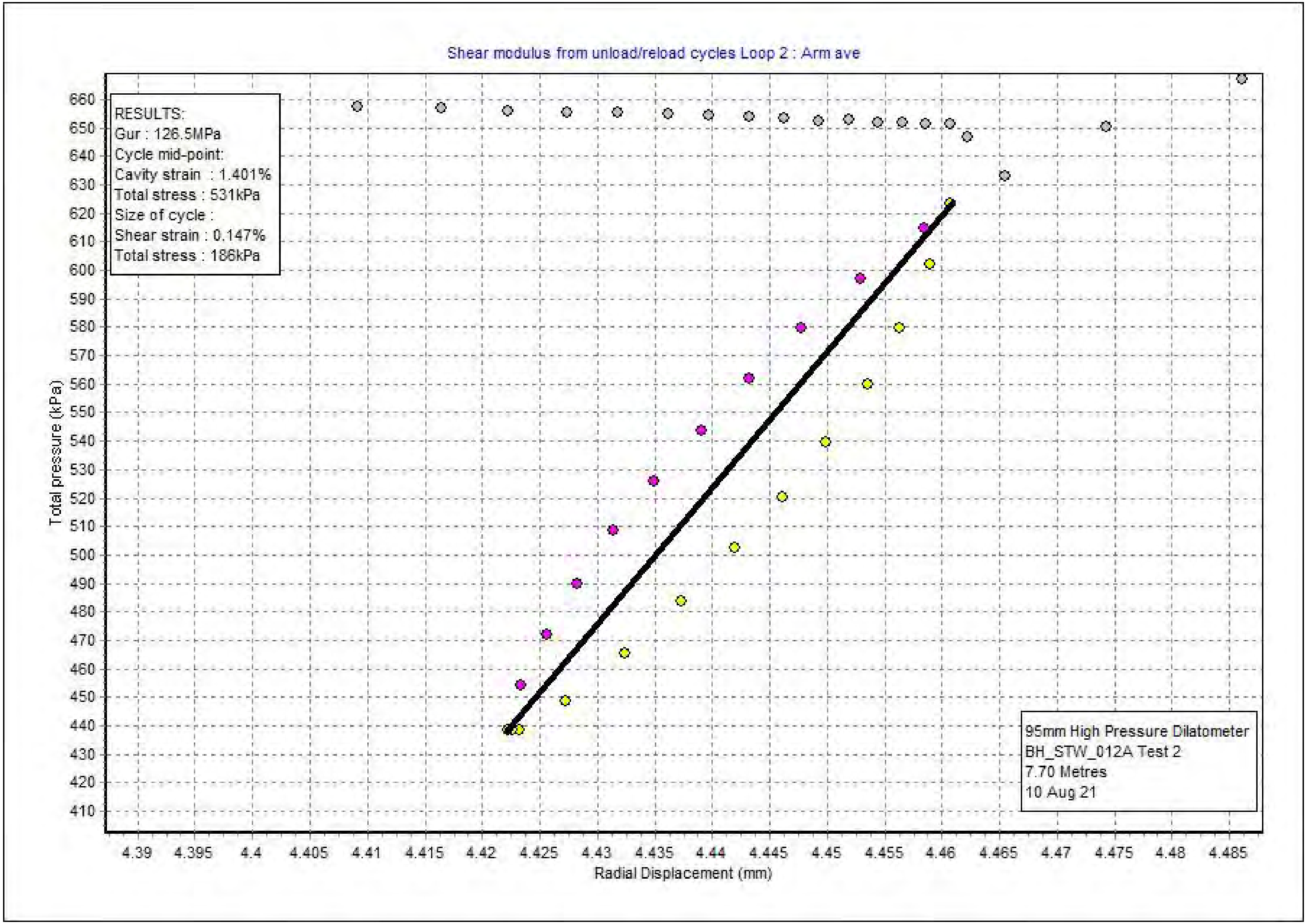

Po of cohesive material (1977, 1990) : Arm ave
95mm High Pressure Dilatometer
BH_STW_012A Test 2
7.70 Metres
10 Aug 21
RESULTS:
Gi : 9.3MPa
Pf : 609.6kPa
Po : 152.5kPa
Tf : 456.0kPa
Po + Tf : 608.5kPa
Origin : 2.859mm
Total pressure (kPa)
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
Radial Displacement (mm)
3
4
5
6
7
8
Shear stress at yield : Arm ave
Total pressure (kPa)
1,100
1,000
900
800
700
600
-3
-2
Ln[shear strain]

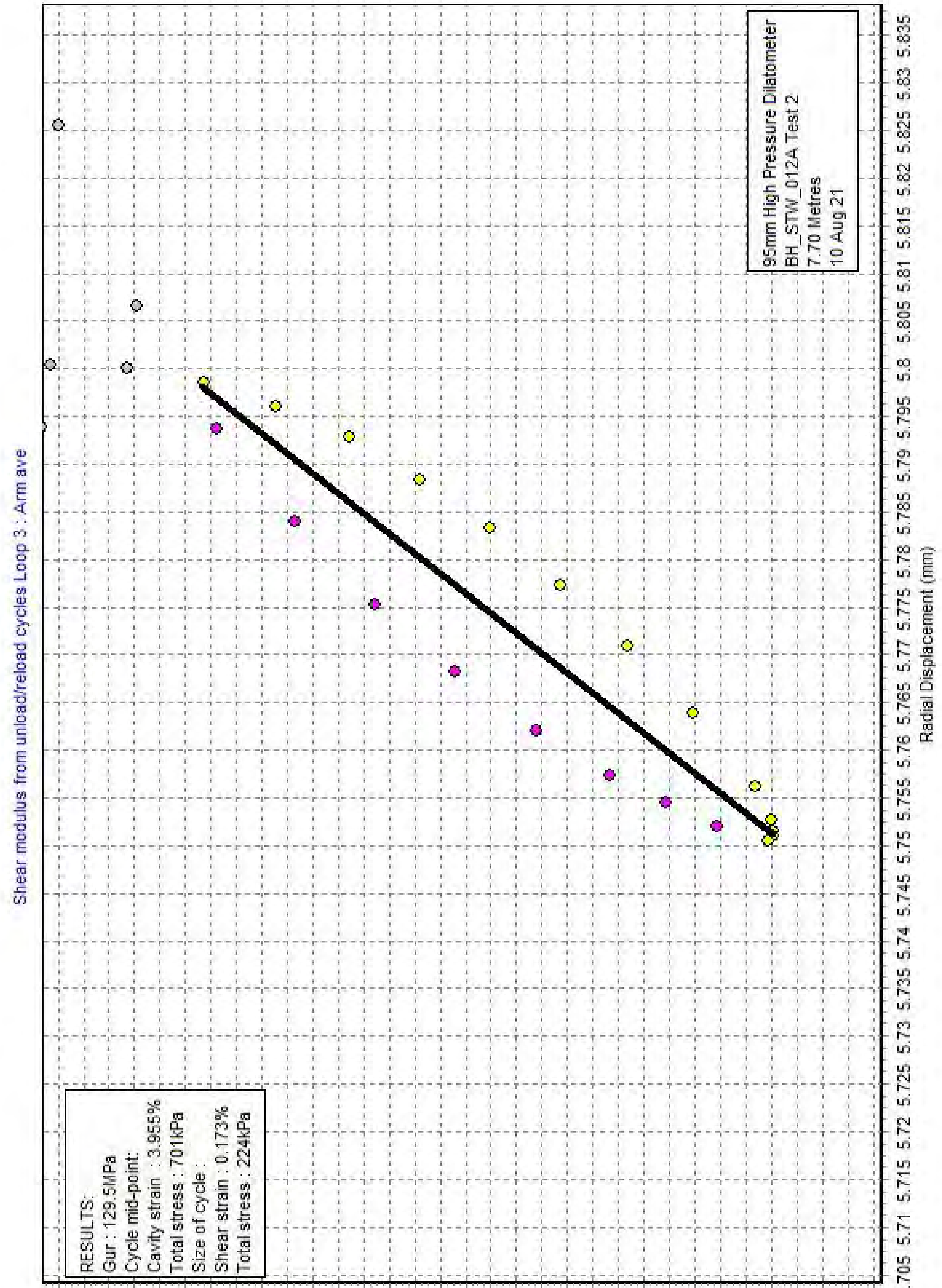

Hughes et al (1977) : Arm ave
95mm High Pressure Dilatometer
BH_STW_012A Test 2
7.70 Metres
10 Aug 21
RESULTS:
Ambient water pressure : 39.0 kPa
Residual friction angle : 27.0°
Gradient : 0.322
Friction angle : 27.7°
Dilation angle : 0.8°
Ln[hoop strain]
-3
-4
-5
-6
-7
-8
-9
Ln[Effective stress]
7
6.95
6.9
6.85
6.8
6.75
6.7
6.65
6.6
6.55
6.5
6.45
6.4
6.35
6.3
6.25
6.2
6.15
6.1
6.05

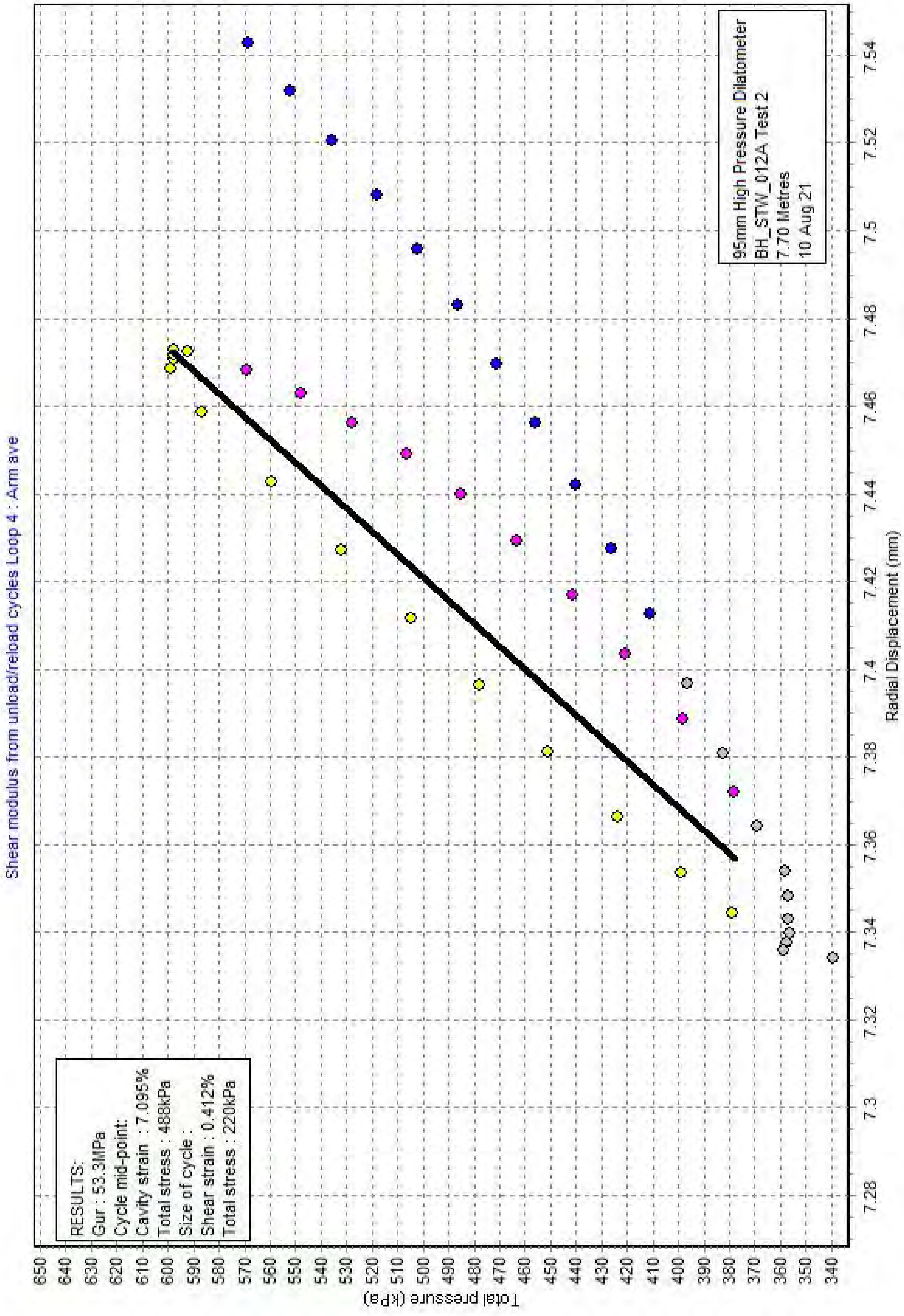


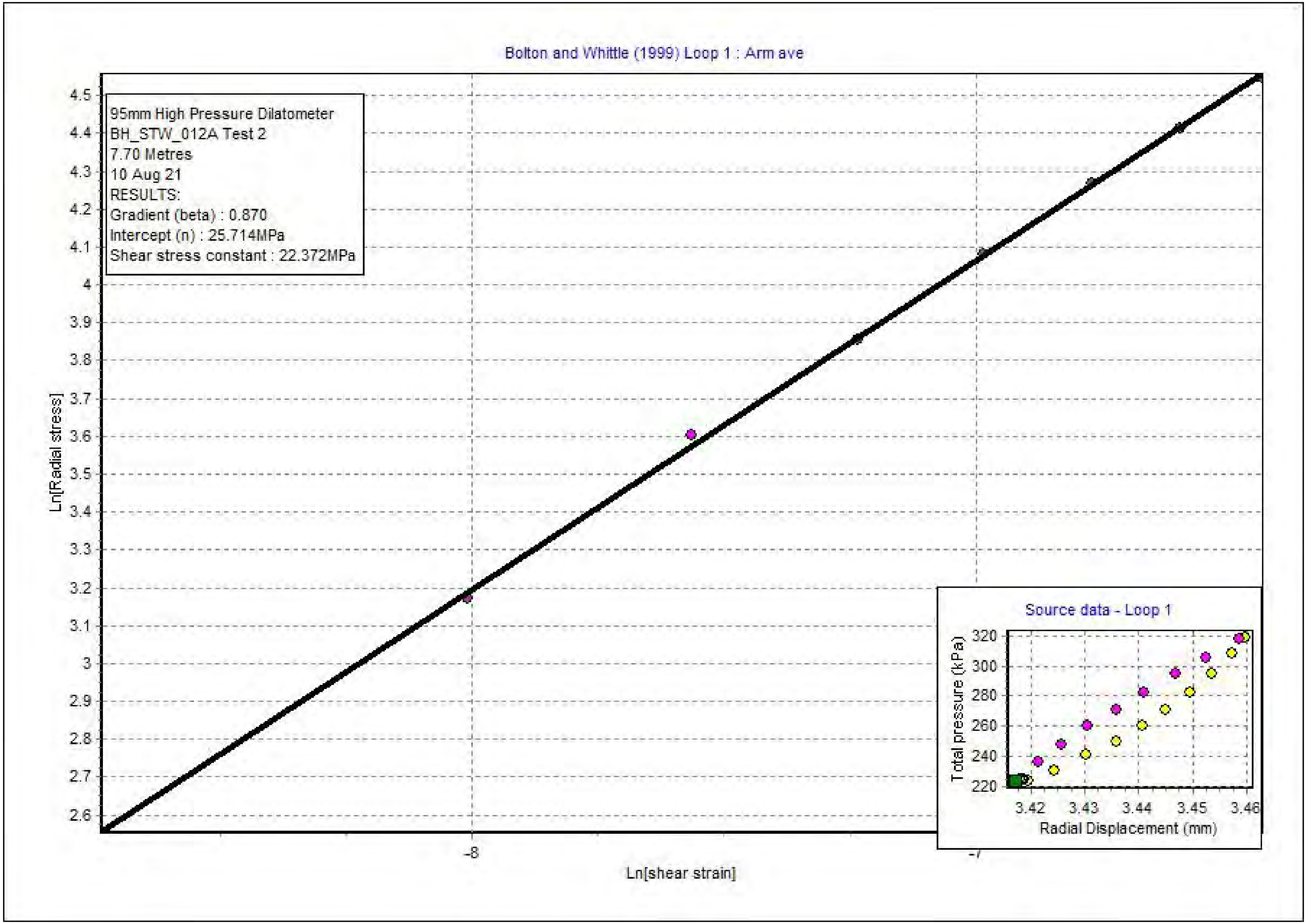
95mm High Pressure Dilatometer
BH_STW_012A Test 2
7.70 Metres
10 Aug 21
RESULTS:
Ambient water pressure : 39.0 kPa
Residual friction angle : 27.0°
Gradient : -1.652
Friction angle : 26.8°
Dilation angle : -0.2°

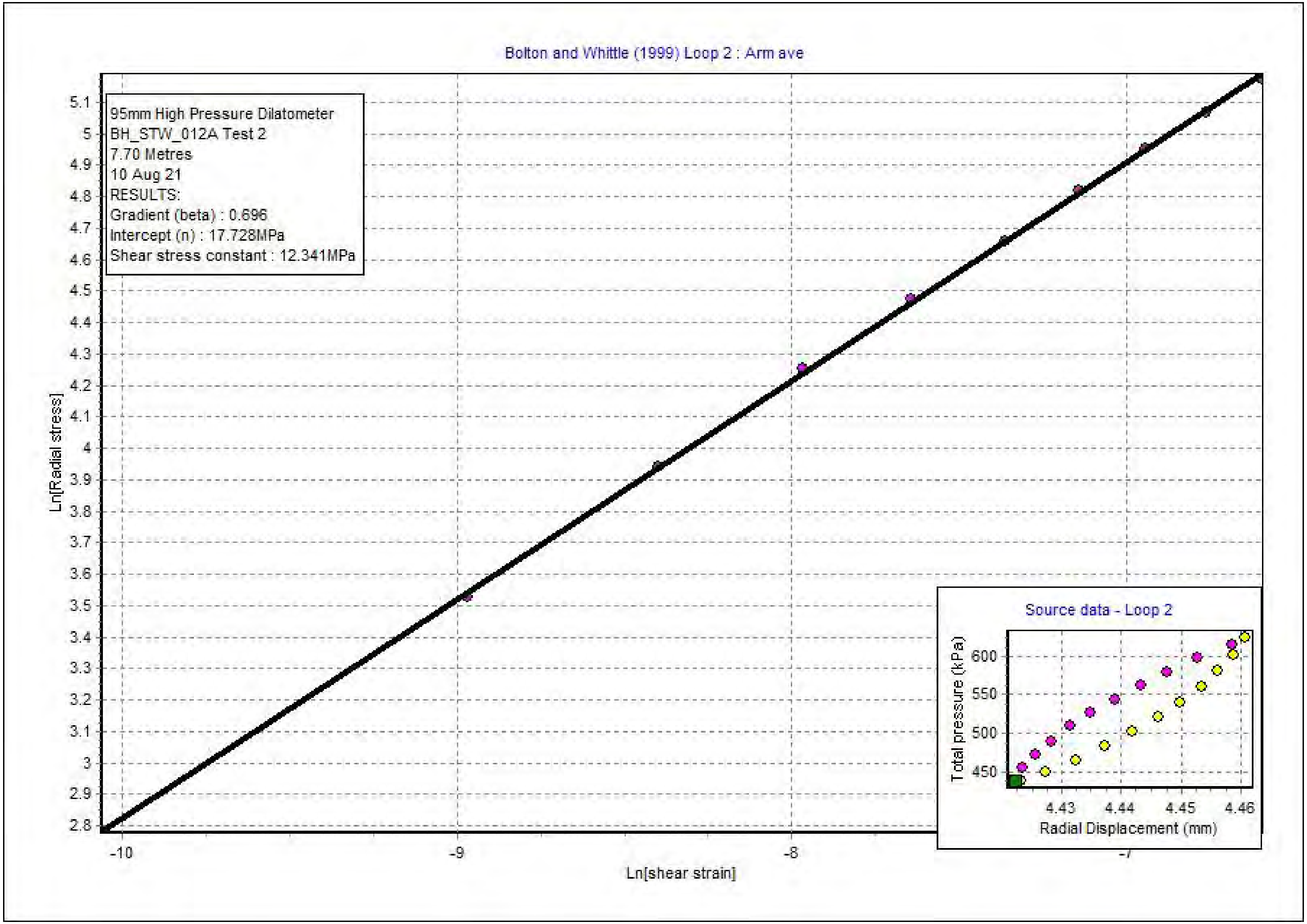

Shear modulus from unload/reload cycles Loop 1 : Arm ave
95mm High Pressure Dilatometer
BH_STW_012A Test 2
7.70 Metres
10 Aug 21
RESULTS:
Gur : 59.2MPa
Cycle mid-point:
Cavity strain : -0.519%
Total stress : 271kPa
Size of cycle :
Shear strain : 0.163%
Total stress : 97kPa
Radial Displacement (mm)
3.4
3.405
3.41
3.415
3.42
3.425
3.43
3.435
3.44
3.445
3.45
3.455
3.46
3.465
3.47
3.475
3.48
3.485
3.49
3.495
Total pressure (kPa)
345
340
335
330
325
320
315
310
305
300
295
290
285
280
275
270
265
260
255
250
245
240
235
230
225
220
215

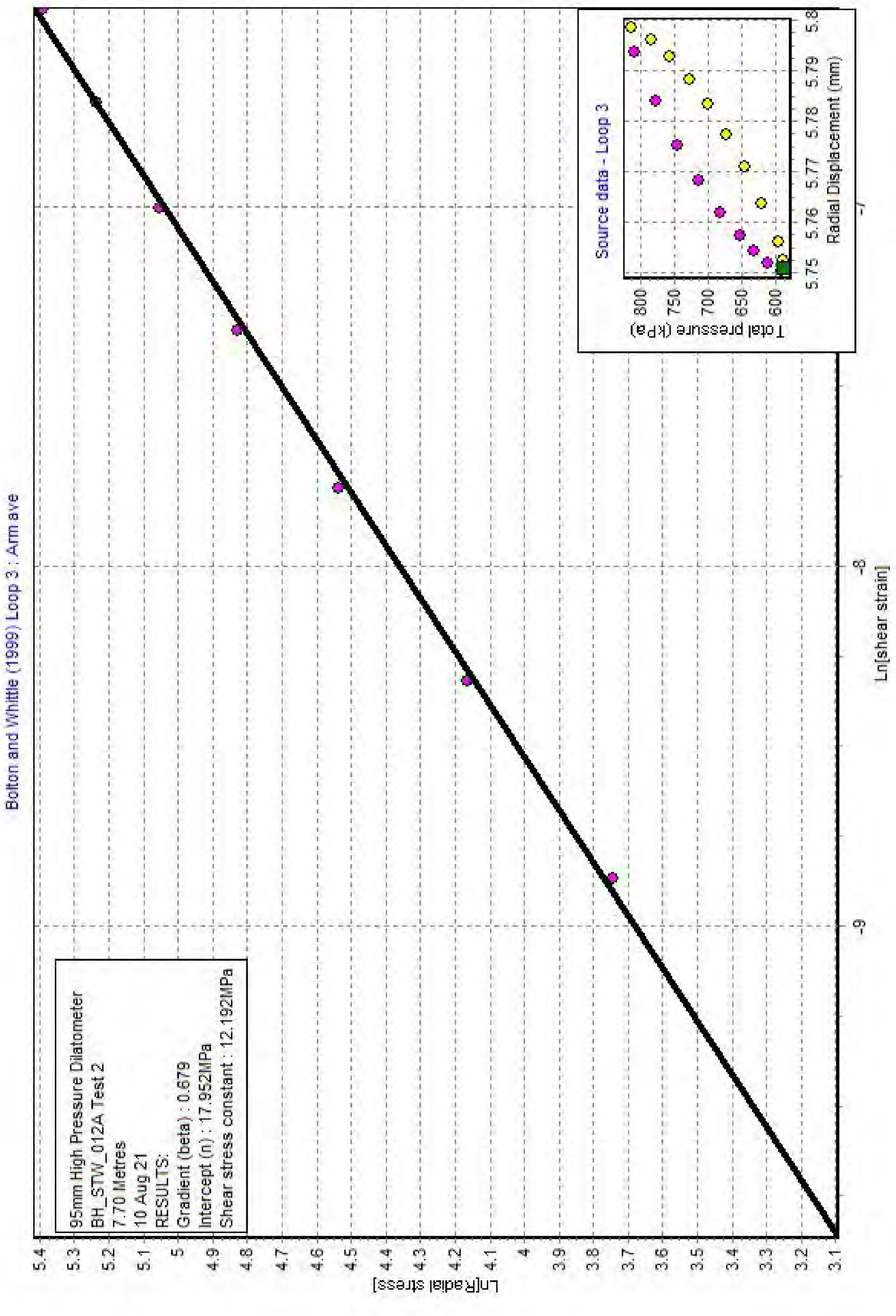

Shear modulus from unload/reload cycles Loop 2 : Arm ave
RESULTS:
Gur : 126.5MPa
Cycle mid-point:
Cavity strain : 1.401%
Total stress : 531kPa
Size of cycle :
Shear strain : 0.147%
Total stress : 186kPa
95mm High Pressure Dilatometer
BH_STW_012A Test 2
7.70 Metres
10 Aug 21
Total pressure (kPa)
660
650
640
630
620
610
600
590
580
570
560
550
540
530
520
510
500
490
480
470
460
450
440
430
420
410
Radial Displacement (mm)
4.39
4.395
4.4
4.405
4.41
4.415
4.42
4.425
4.43
4.435
4.44
4.445
4.45
4.455
4.46
4.465
4.47
4.475
4.48
4.485

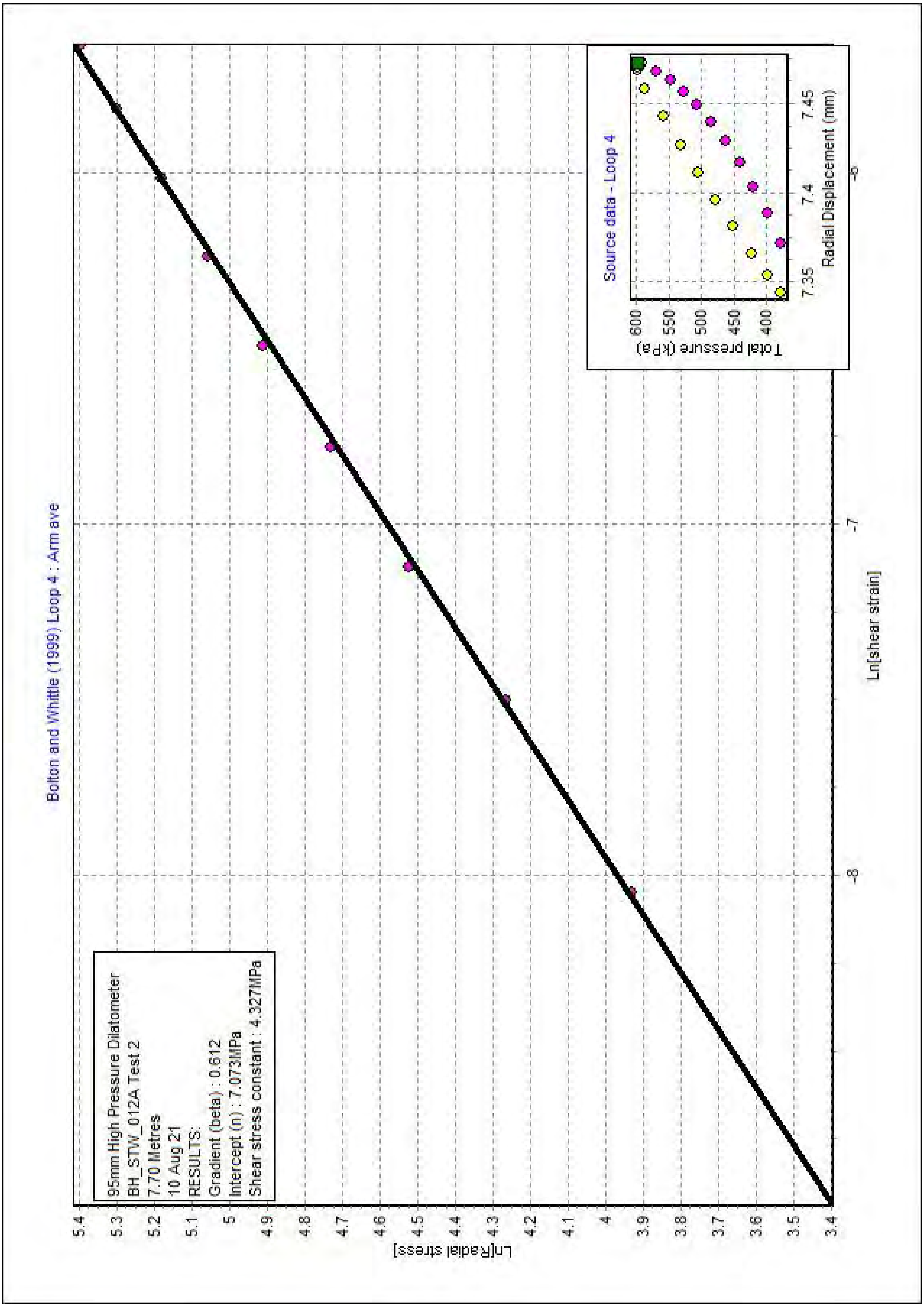

Shear modulus from unload/reload cycles Loop 3 : Arm ave
95mm High Pressure Dilatometer
BH_STW_012A Test 2
7.70 Metres
10 Aug 21
RESULTS:
Gur : 129.5MPa
Cycle mid-point:
Cavity strain : 3.955%
Total stress : 701kPa
Size of cycle :
Shear strain : 0.173%
Total stress : 224kPa
Radial Displacement (mm)
5.705
5.71
5.715
5.72
5.725
5.73
5.735
5.74
5.745
5.75
5.755
5.76
5.765
5.77
5.775
5.78
5.785
5.79
5.795
5.8
5.805
5.81
5.815
5.82
5.825
5.83
5.835
Total pressure (kPa)
870
860
850
840
830
820
810
800
790
780
770
760
750
740
730
720
710
700
690
680
670
660
650
640
630
620
610
600
590
580
570
560
550


Shear modulus from unload/reload cycles Loop 4 : Arm ave
95mm High Pressure Dilatometer
BH_STW_012A Test 2
7.70 Metres
10 Aug 21
RESULTS:
Gur : 53.3MPa
Cycle mid-point:
Cavity strain : 7.095%
Total stress : 488kPa
Size of cycle :
Shear strain : 0.412%
Total stress : 220kPa
Radial Displacement (mm)
7.28
7.3
7.32
7.34
7.36
7.38
7.4
7.42
7.44
7.46
7.48
7.5
7.52
7.54
Total pressure (kPa)
650
640
630
620
610
600
590
580
570
560
550
540
530
520
510
500
490
480
470
460
450
440
430
420
410
400
390
380
370
360
350
340

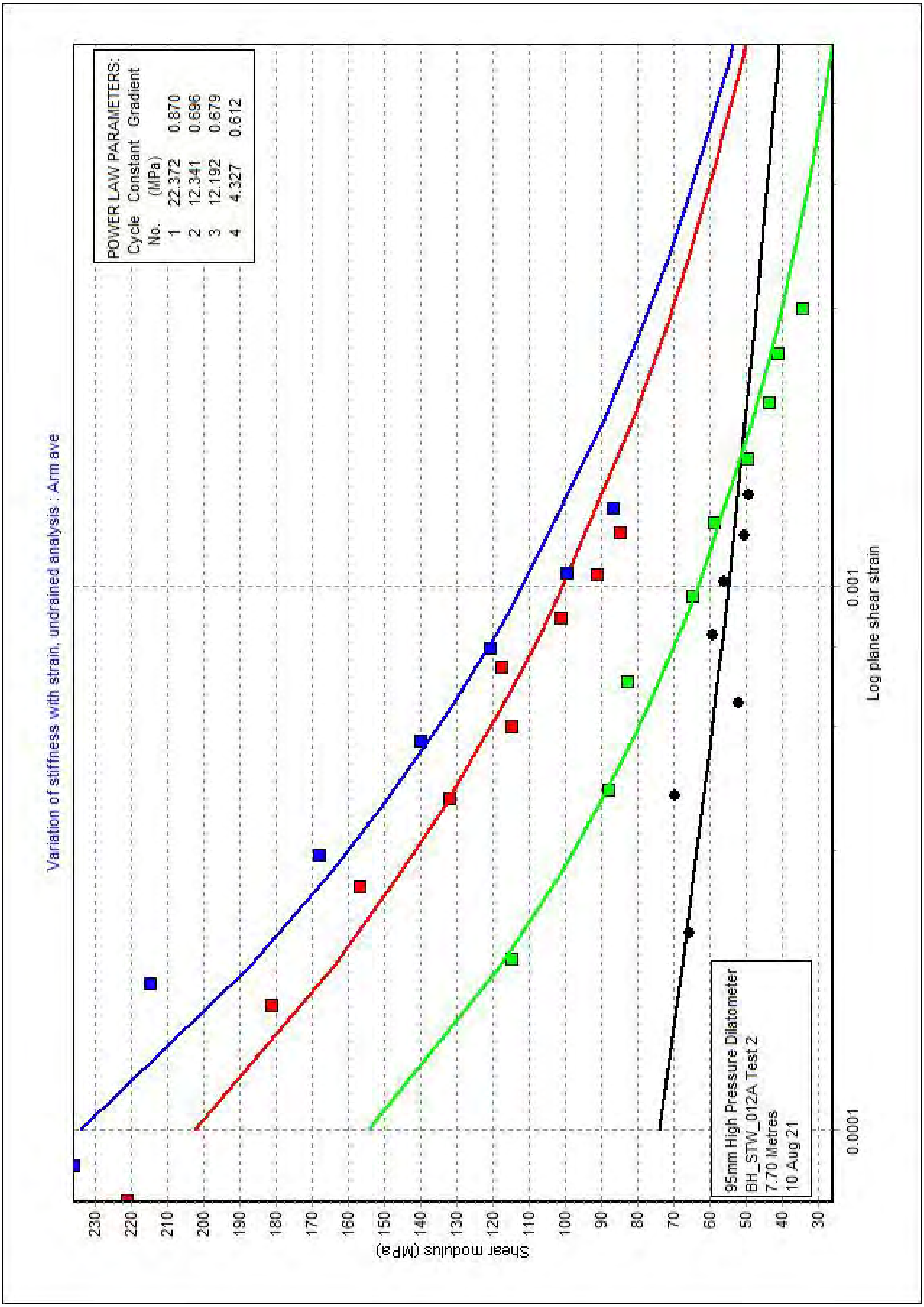

Bolton and Whittle (1999) Loop 1 : Arm ave
95mm High Pressure Dilatometer
BH_STW_012A Test 2
7.70 Metres
10 Aug 21
RESULTS:
Gradient (beta) : 0.870
Intercept (n) : 25.714MPa
Shear stress constant : 22.372MPa
Ln[Radial stress]
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
2.7
2.6
-8
-7
Ln[shear strain]
Source data - Loop 1
Total pressure (kPa)
320
300
280
260
240
220
3.42
3.43
3.44
3.45
3.46
Radial Displacement (mm)

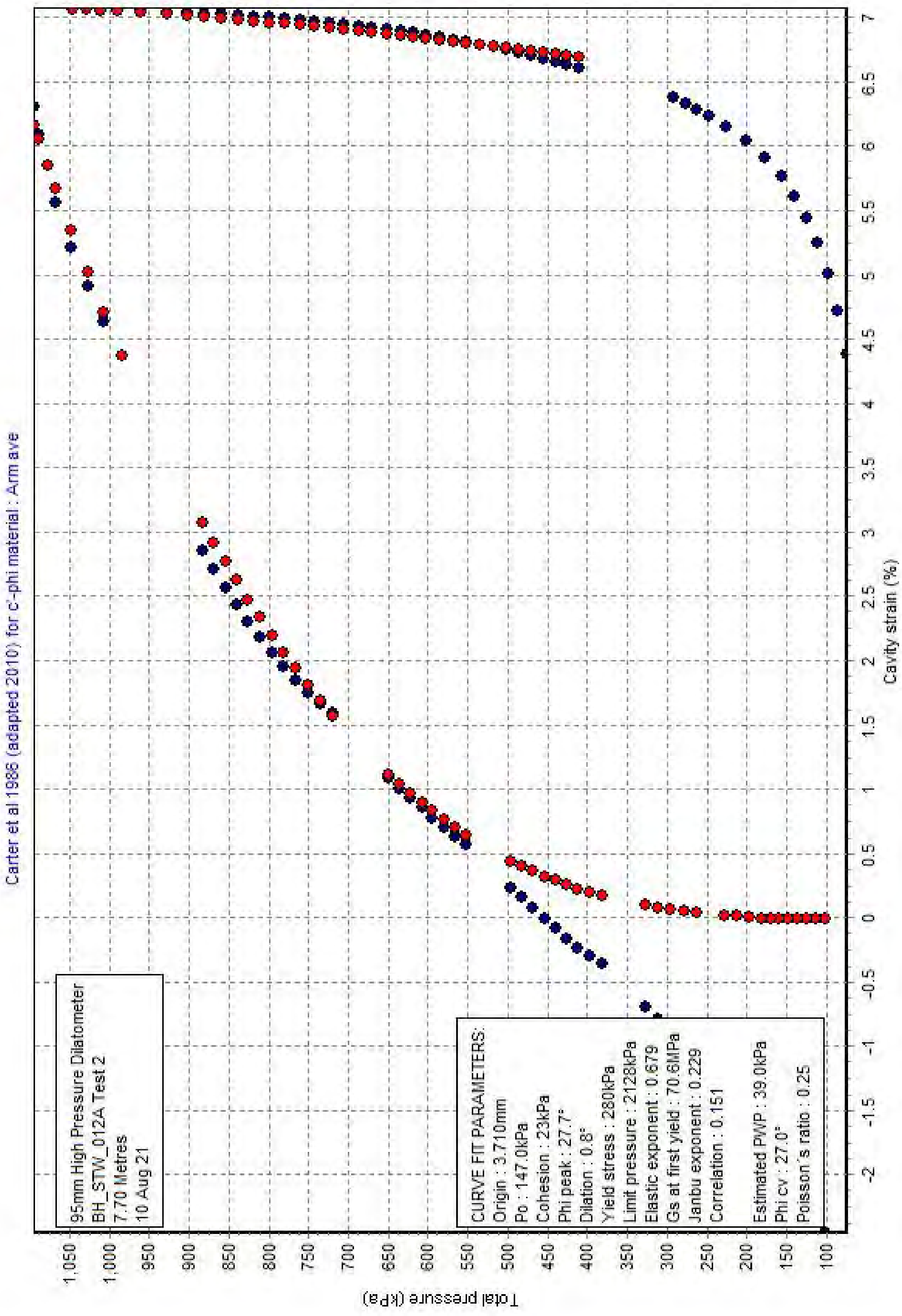

Bolton and Whittle (1999) Loop 2 : Arm ave
95mm High Pressure Dilatometer
BH_STW_012A Test 2
7.70 Metres
10 Aug 21
RESULTS:
Gradient (beta) : 0.696
Intercept (n) : 17.728MPa
Shear stress constant : 12.341MPa
Ln[Radial stress]
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
-10
-9
-8
-7
Ln[shear strain]
Source data - Loop 2
Total pressure (kPa)
600
550
500
450
4.43
4.44
4.45
4.46
Radial Displacement (mm)

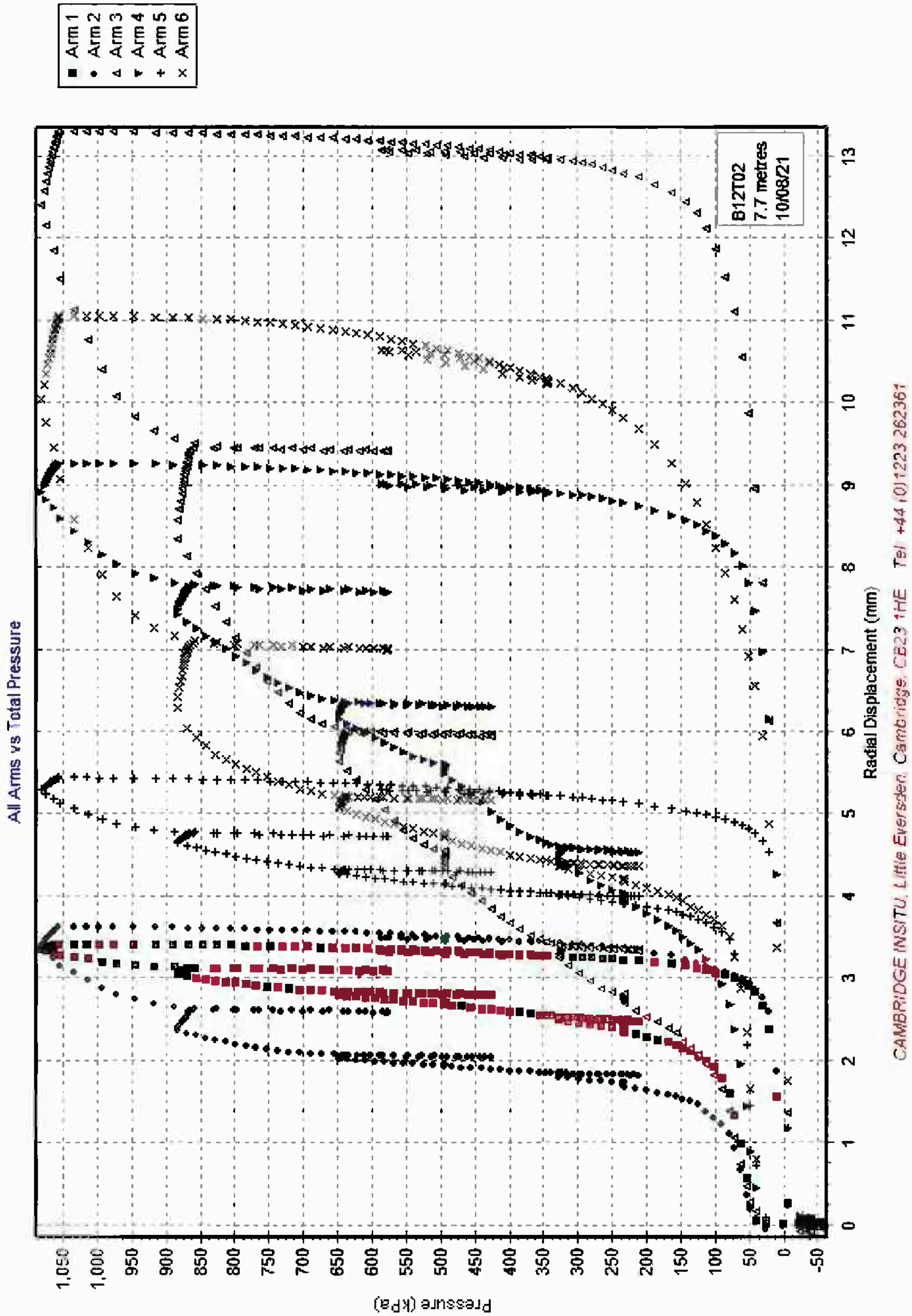

Bolton and Whittle (1999) Loop 3 : Arm ave
Ln[Radial stress]
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
Ln[shear strain]
-9
-8
-7
95mm High Pressure Dilatometer
BH_STW_012A Test 2
7.70 Metres
10 Aug 21
RESULTS:
Gradient (beta) : 0.679
Intercept (n) : 17.952MPa
Shear stress constant : 12.192MPa
Source data - Loop 3
Total pressure (kPa)
800
750
700
650
600
Radial Displacement (mm)
5.75
5.76
5.77
5.78
5.79
5.8



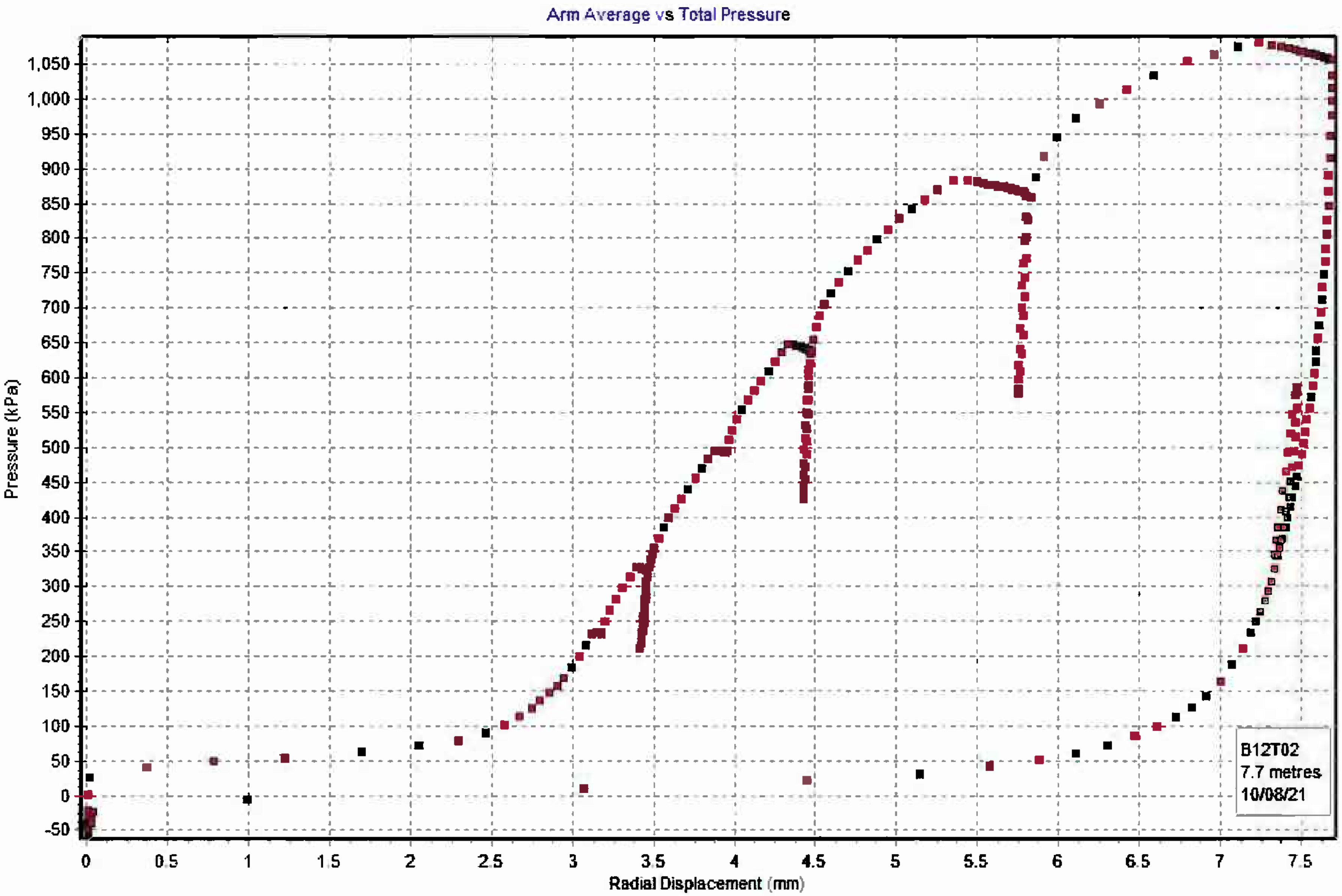
95mm High Pressure Dilatometer
BH_STW_012A Test 2
7.70 Metres
10 Aug 21
RESULTS:
Gradient (beta) : 0.612
Intercept (n) : 7.073MPa
Shear stress constant : 4.327MPa


Variation of stiffness with strain, undrained analysis : Arm ave
POWER LAW PARAMETERS:
Cycle Constant Gradient
No. (MPa)
1 22.372 0.870
2 12.341 0.696
3 12.192 0.679
4 4.327 0.612
95mm High Pressure Dilatometer
BH_STW_012A Test 2
7.70 Metres
10 Aug 21
Shear modulus (MPa)
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
Log plane shear strain
0.0001
0.001


Carter et al 1986 (adapted 2010) for c'-phi material : Arm ave
95mm High Pressure Dilatometer
BH_STW_012A Test 2
7.70 Metres
10 Aug 21
CURVE FIT PARAMETERS:
Origin : 3.710mm
Po : 147.0kPa
Cohesion : 23kPa
Phi peak : 27.7°
Dilation : 0.8°
Yield stress : 280kPa
Limit pressure : 2128kPa
Elastic exponent : 0.679
Gs at first yield : 70.6MPa
Janbu exponent : 0.229
Correlation : 0.151
Estimated PWP : 39.0kPa
Phi cv : 27.0°
Poisson's ratio : 0.25
Total pressure (kPa)
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
Cavity strain (%)
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7


All Arms vs Total Pressure
Arm 1
Arm 2
Arm 3
Arm 4
Arm 5
Arm 6
B12T02
7.7 metres
10/08/21
Pressure (kPa)
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
-50
Radial Displacement (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel +44 (0)1223 262361

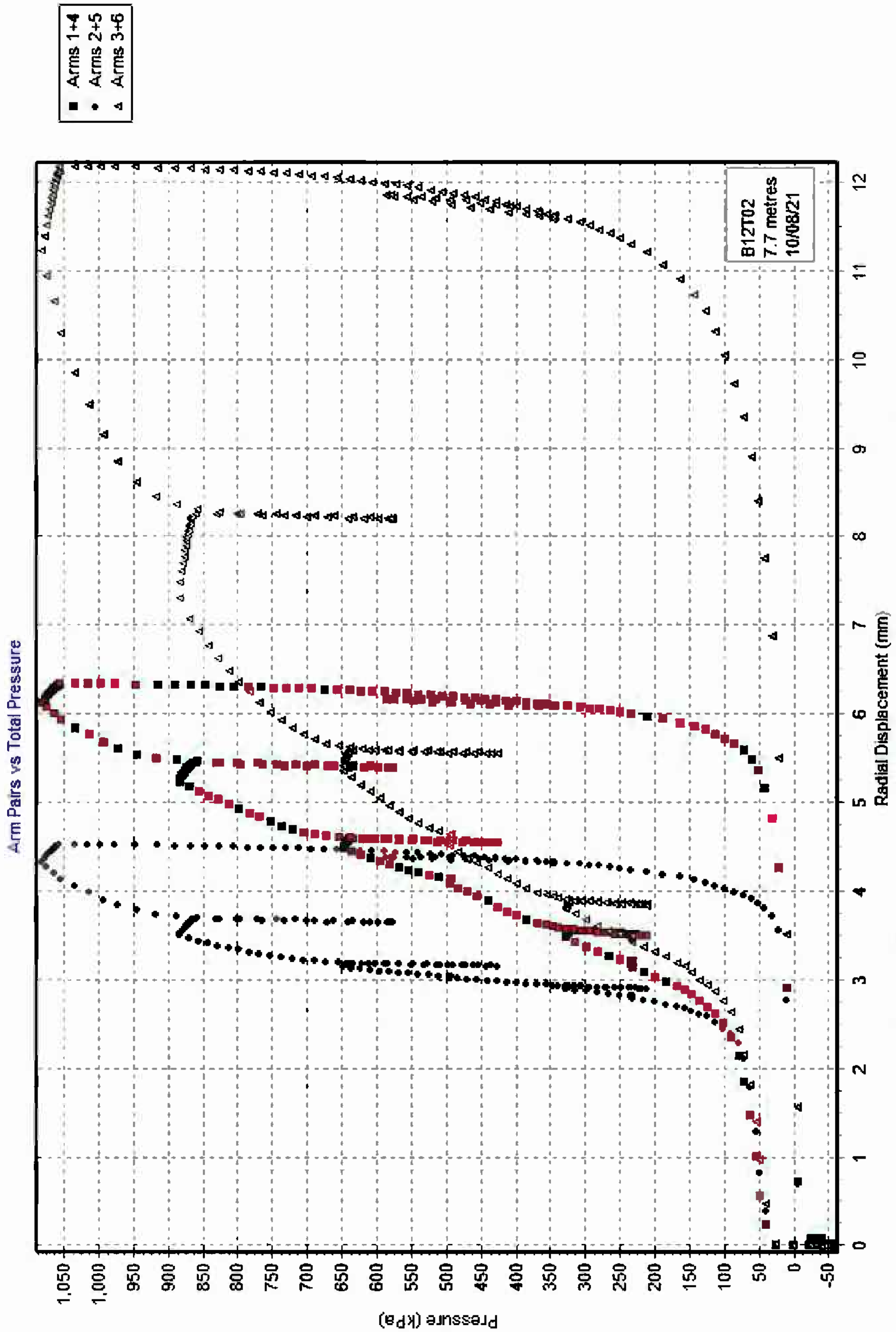
CIR1506/21



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel +44 (0)1223 262361

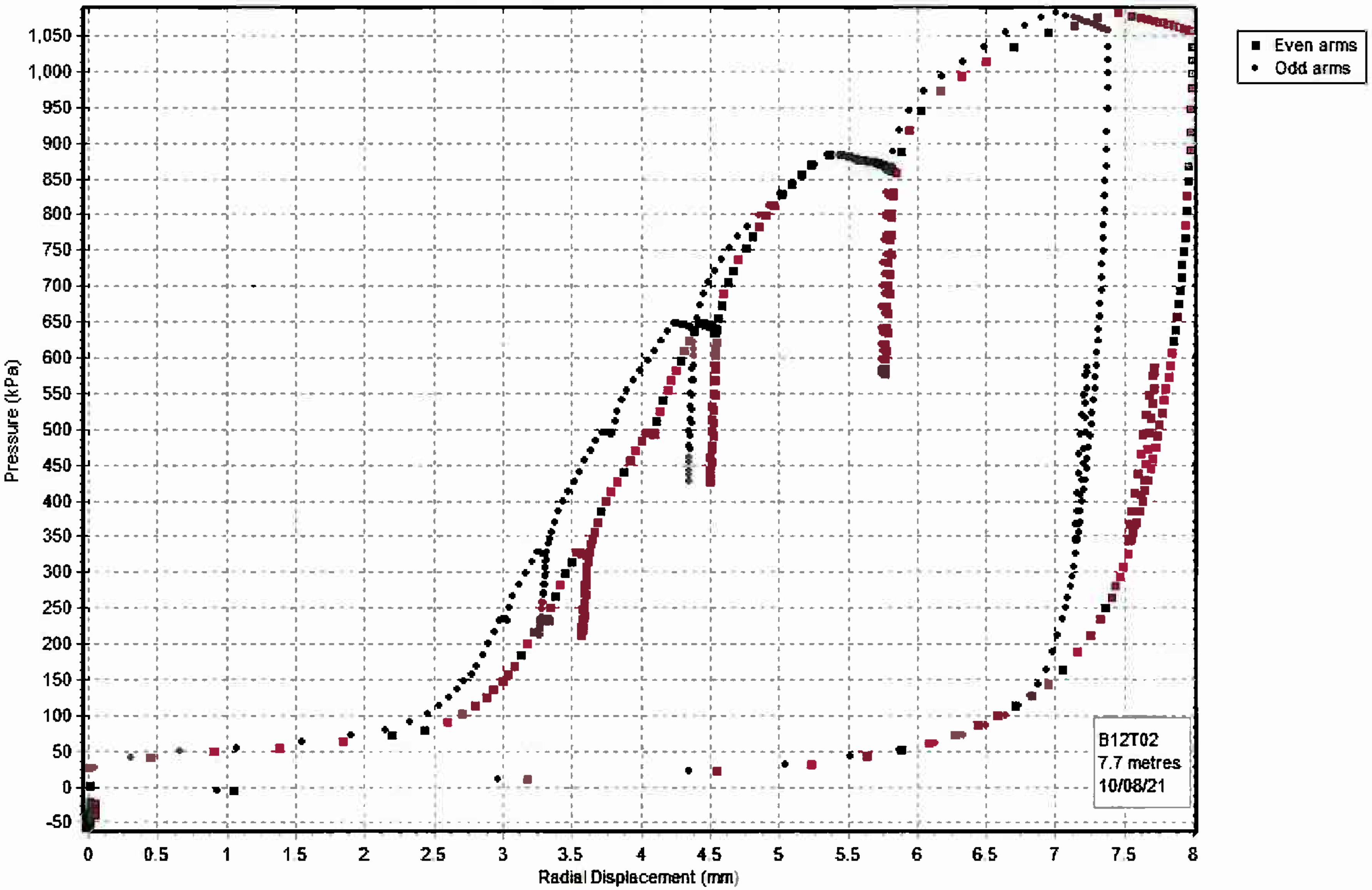
Cambridge WWTPR

Pressuremeter Testing



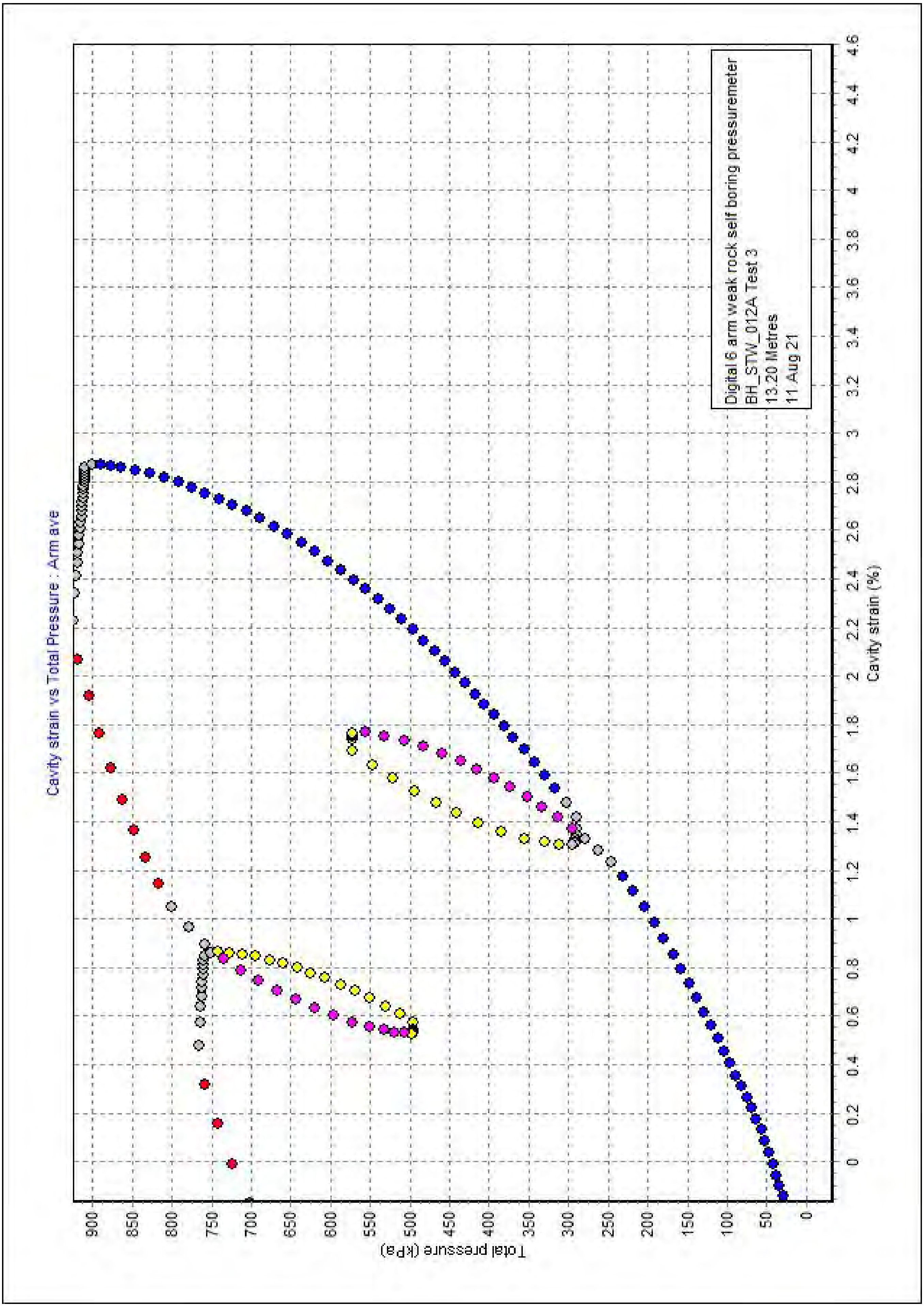
CAMBRIDGE INSITU, Little Eversden, Cambridge CB23 1HE Tel +44 (0)1223 262361

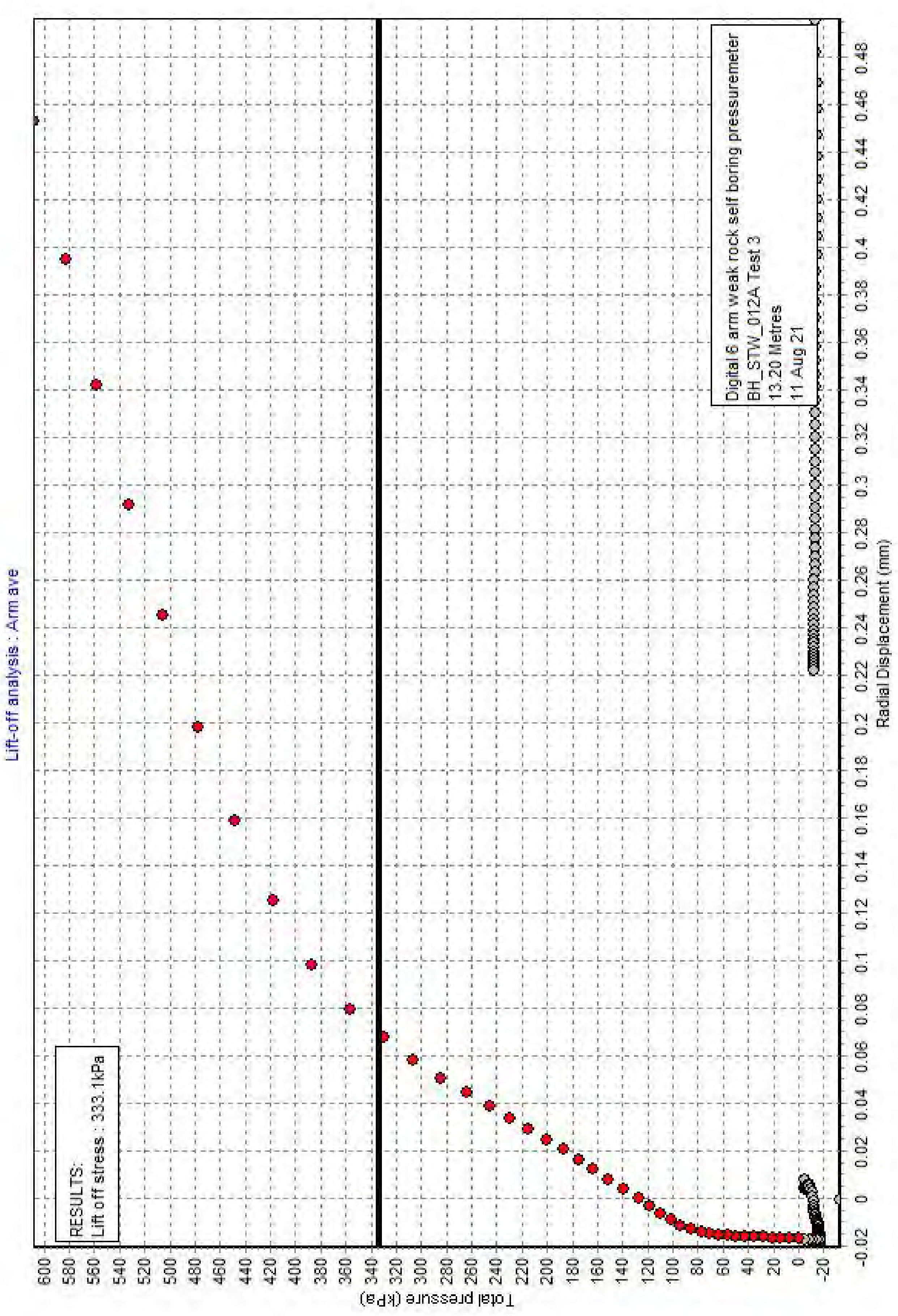
Odd and Even Arms vs Total Pressure

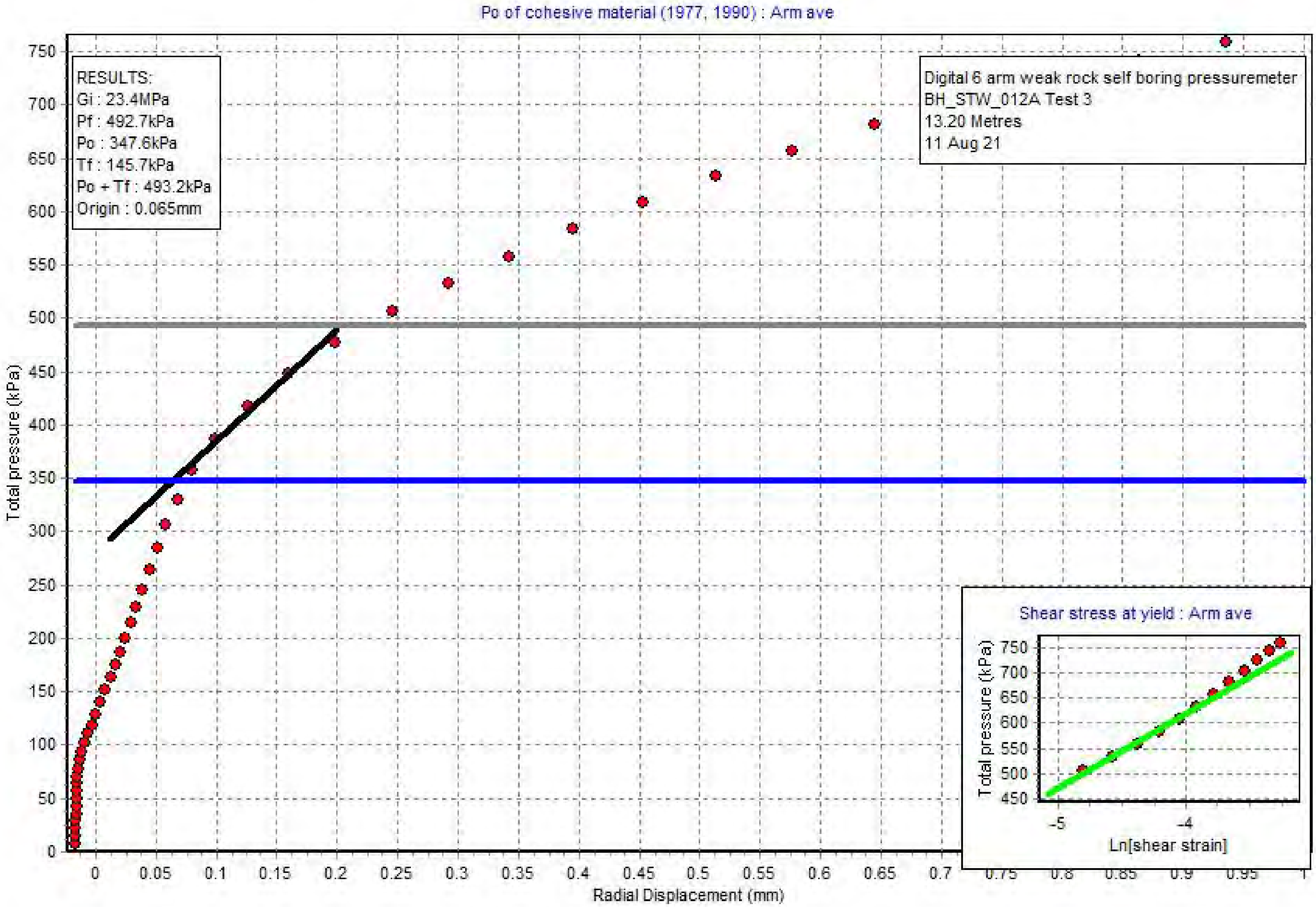


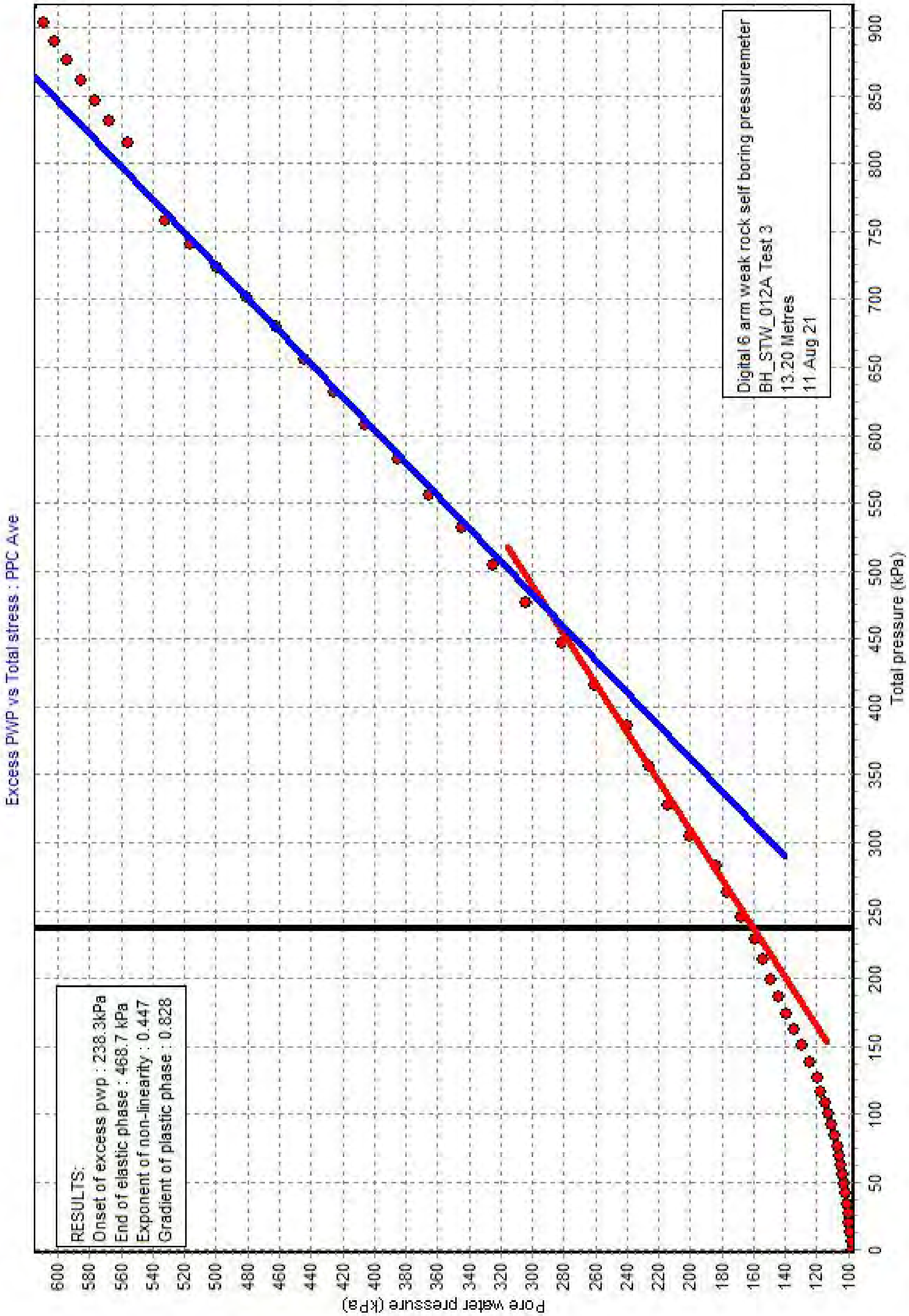
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361

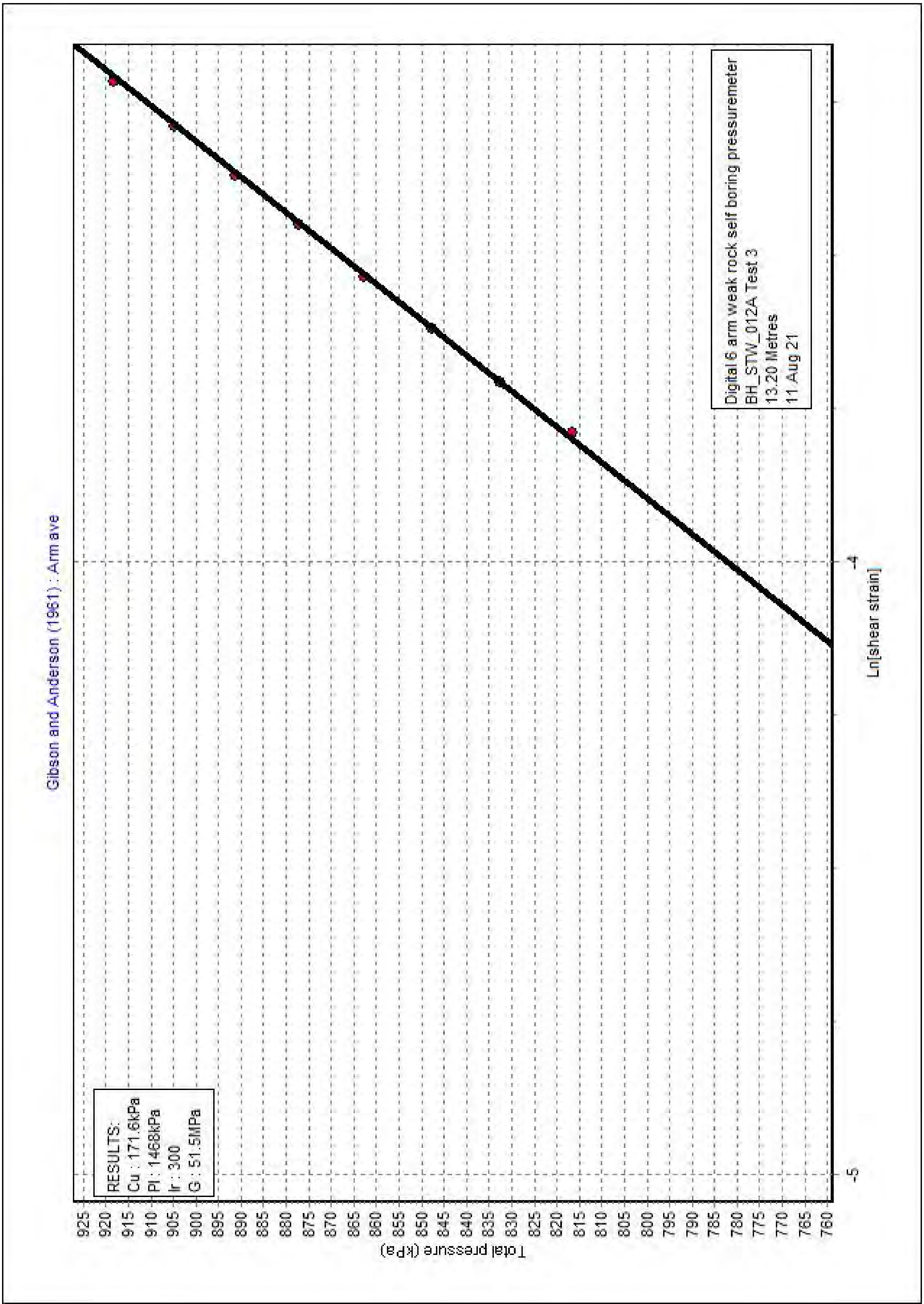
```
BH_STW_012A Test 3 - SUMMARY OF RESULTS
[File made with WinSitu ]

[DETAILS OF TEST]
Project        :   TE8364
Site           :   Cambridge Waste Water Treatment Plant Relocation Project
Borehole       :   BH_STW_012A
Test name      :   BH_STW_012A Test 3
Test date      :   11 Aug 21
Test depth     :   13.20 Metres
Water table    :   3.75 Metres
Ambient PWP    :   93.0 kPa
Material       :   Gault Clay
Probe          :   Digital 6 arm weak rock self boring pressuremeter
Diameter       :   88.1 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out
The file includes results from a curve fitting analysis

Analysed by SP/RW on 11 Aug 21

Remarks:  Arm 2 moves more than twice as much as any other arm and forces
an early end to the test. Appears to be significantly disturbed.

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm)                   :   "Arm ave=0.79"
Po from Marsland & Randolph (kPa)    :   "Arm ave=347.6"
Po from Lift off (kPa)               :   "Arm ave=333.1"
PWP versus Total Stress (kPa)        :   "PPC Ave=238.3"
Best estimate of Po (kPa)            :   "Arm ave=318.0"

[UNDRAINED STRENGTH PARAMETERS]
Gibson & Anderson 1961 - Cu (kPa)    :   "Arm ave=171.6"
Limit pressure (kPa)                 :   "Arm ave=1468"
Jefferies 1988 - Cu (kPa)            :   "Arm ave=173.0"
Undrained yield stress (kPa)         :   "Arm ave=492.7"
PWP derived yield stress (kPa)       :   "PPC Ave=468.7"

[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=23.4"
Axis       Loop   Value    Mean Strain  Mean Pc  dE      dPc
           No     (MPa)    (%)          (kPa)    (%)     (kPa)
Arm ave    1      37.5     0.708        621      0.666   251
Arm ave    2      33.6     1.542        439      0.793   267

[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]
Axis       Loop   Intercept  Alpha      Gradient
           No     (MPa)      (MPa)
Arm ave    1      5.995      3.770      0.629
Arm ave    2      5.574      3.446      0.618

Non-linear exponent from PWP response :   "PPC Ave=0.447"

[PARAMETERS USED FOR UNDRAINED CURVE MODELLING]
{Axis is  Arm ave}
Strain Origin (mm)                   :   0.79
Po (kPa)                             :   318
Cu (kPa)                             :   171.6
Limit pressure (kPa)                 :   1468
Non-linear exponent                  :   0.618
Calculated alpha (MPa)               :   3.979
G at yield (MPa)                     :   27.8
```

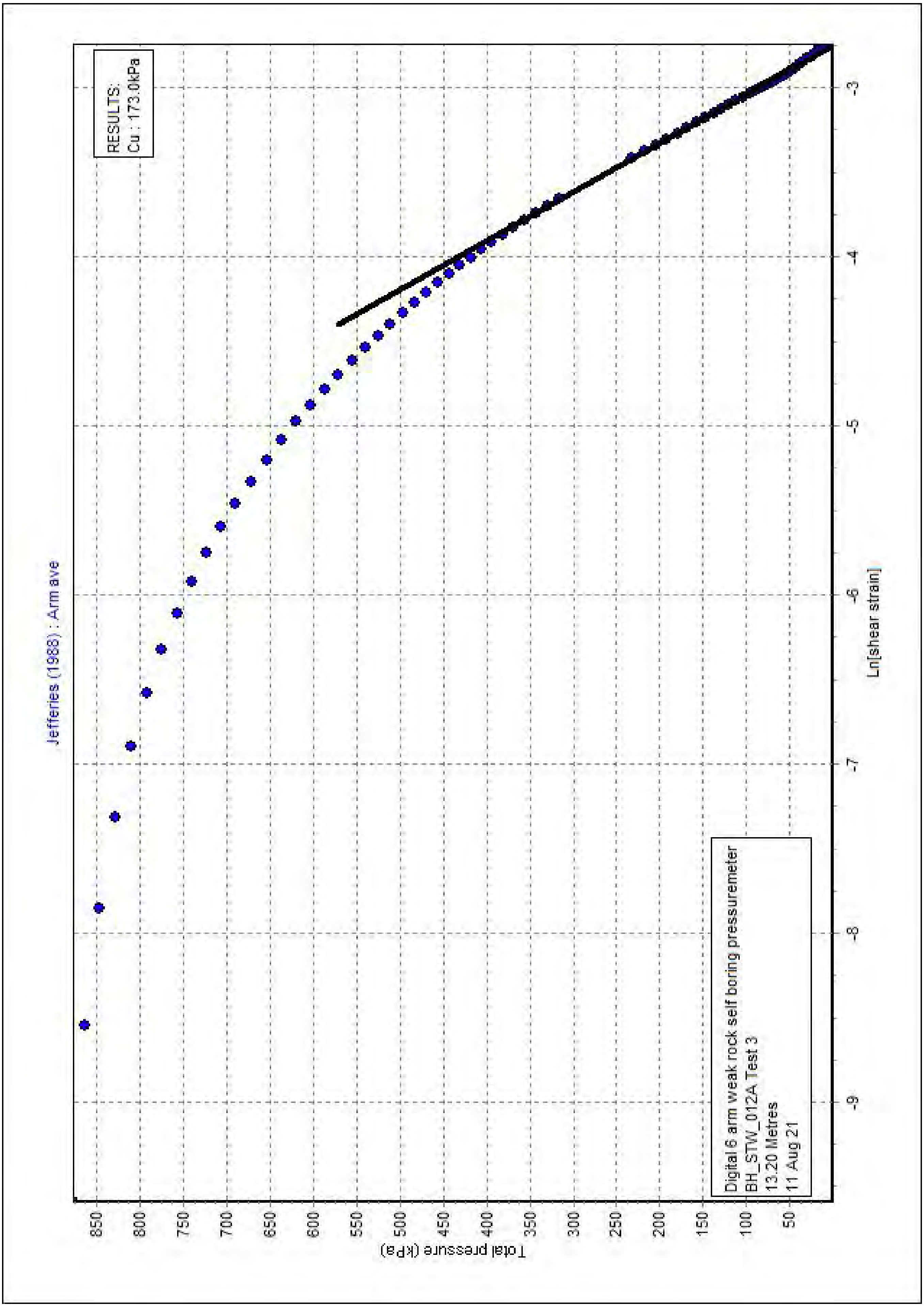

Cavity strain vs Total Pressure : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 3
13.20 Metres
11 Aug 21
Cavity strain (%)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
3.6
3.8
4
4.2
4.4
4.6
Total pressure (kPa)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900

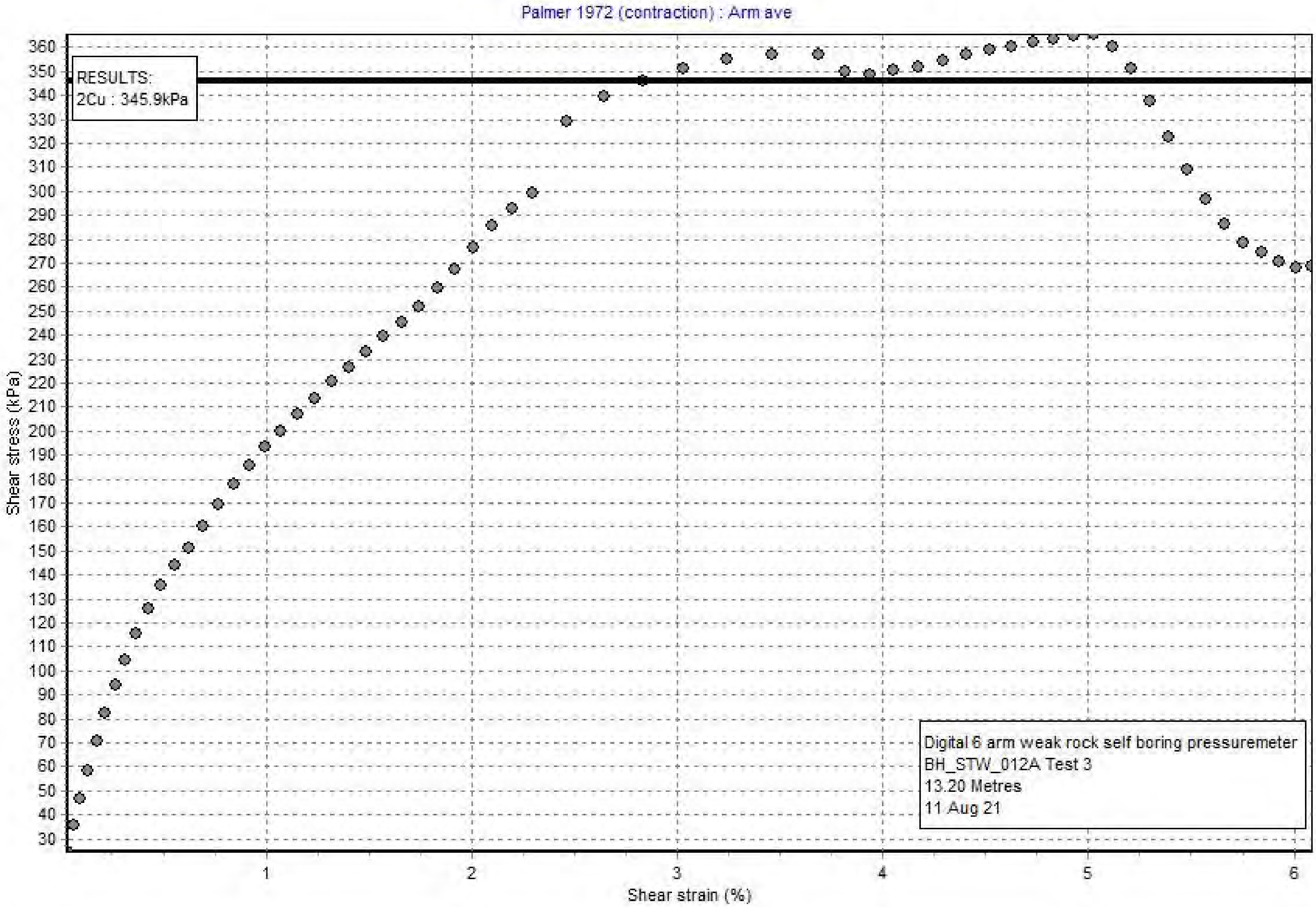

Lift-off analysis : Arm ave
RESULTS:
Lift off stress : 333.1kPa
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 3
13.20 Metres
11 Aug 21
Total pressure (kPa)
600
580
560
540
520
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
-20
Radial Displacement (mm)
-0.02
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
0.26
0.28
0.3
0.32
0.34
0.36
0.38
0.4
0.42
0.44
0.46
0.48

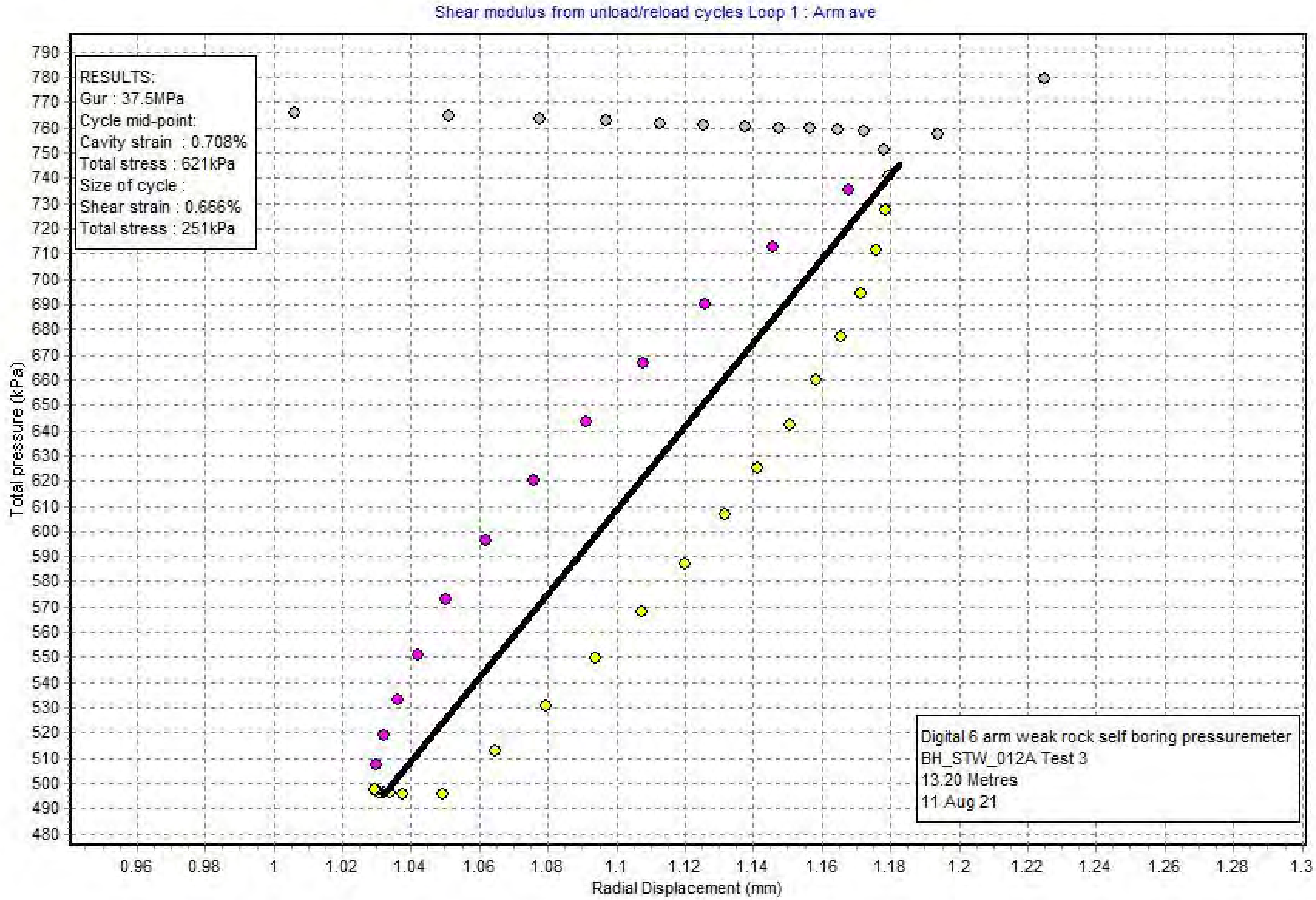

Po of cohesive material (1977, 1990) : Arm ave
RESULTS:
Gi : 23.4MPa
Pf : 492.7kPa
Po : 347.6kPa
Tf : 145.7kPa
Po + Tf : 493.2kPa
Origin : 0.065mm
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 3
13.20 Metres
11 Aug 21
Total pressure (kPa)
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Radial Displacement (mm)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0.75
0.8
0.85
0.9
0.95
1
Shear stress at yield : Arm ave
Total pressure (kPa)
750
700
650
600
550
500
450
-5
-4
Ln[shear strain]

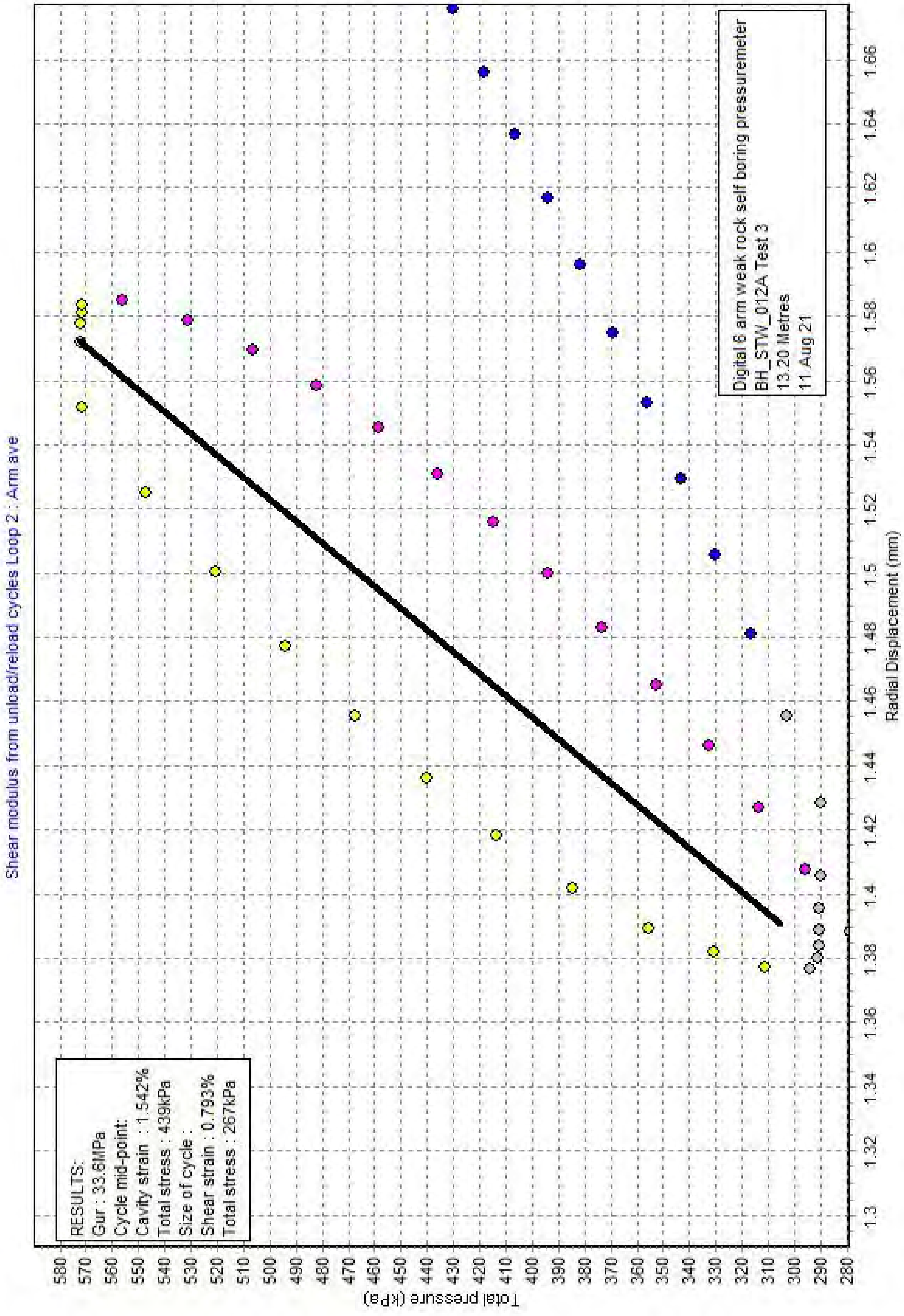

Excess PWP vs Total stress : PPC Ave
RESULTS:
Onset of excess pwp : 238.3kPa
End of elastic phase : 468.7 kPa
Exponent of non-linearity : 0.447
Gradient of plastic phase : 0.828
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 3
13.20 Metres
11 Aug 21
Total pressure (kPa)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
Pore water pressure (kPa)
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600


Gibson and Anderson (1961) : Arm ave
RESULTS:
Cu : 171.6kPa
Pl : 1468kPa
Ir : 300
G : 51.5MPa
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 3
13.20 Metres
11 Aug 21
Total pressure (kPa)
925
920
915
910
905
900
895
890
885
880
875
870
865
860
855
850
845
840
835
830
825
820
815
810
805
800
795
790
785
780
775
770
765
760
Ln[shear strain]
-5
-4


Jefferies (1988) : Arm ave
RESULTS:
Cu : 173.0kPa
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 3
13.20 Metres
11 Aug 21
Total pressure (kPa)
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
Ln[shear strain]
-3
-4
-5
-6
-7
-8
-9

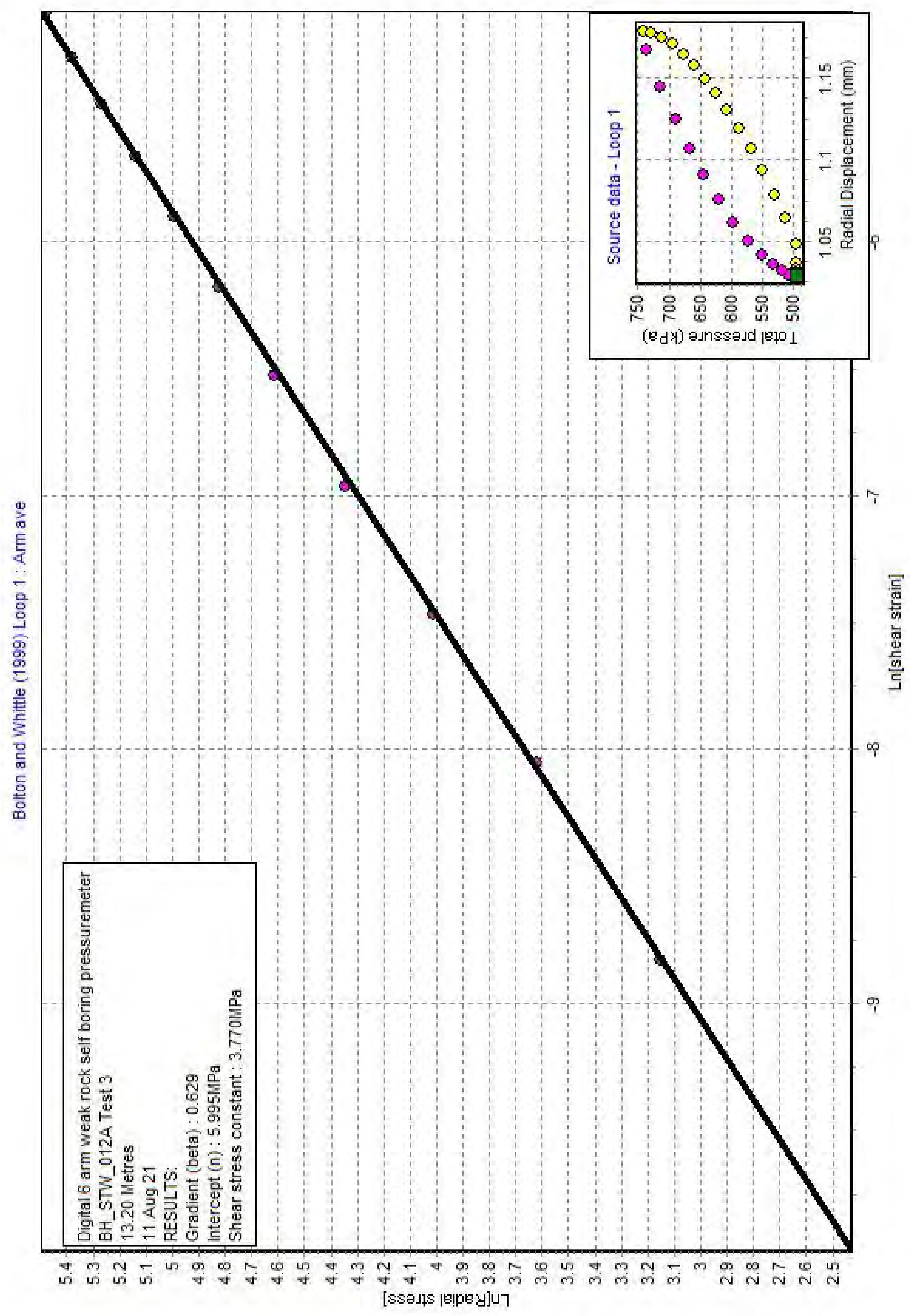

Palmer 1972 (contraction) : Arm ave
RESULTS:
2Cu : 345.9kPa
Shear stress (kPa)
360
350
340
330
320
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
Shear strain (%)
1
2
3
4
5
6
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 3
13.20 Metres
11 Aug 21

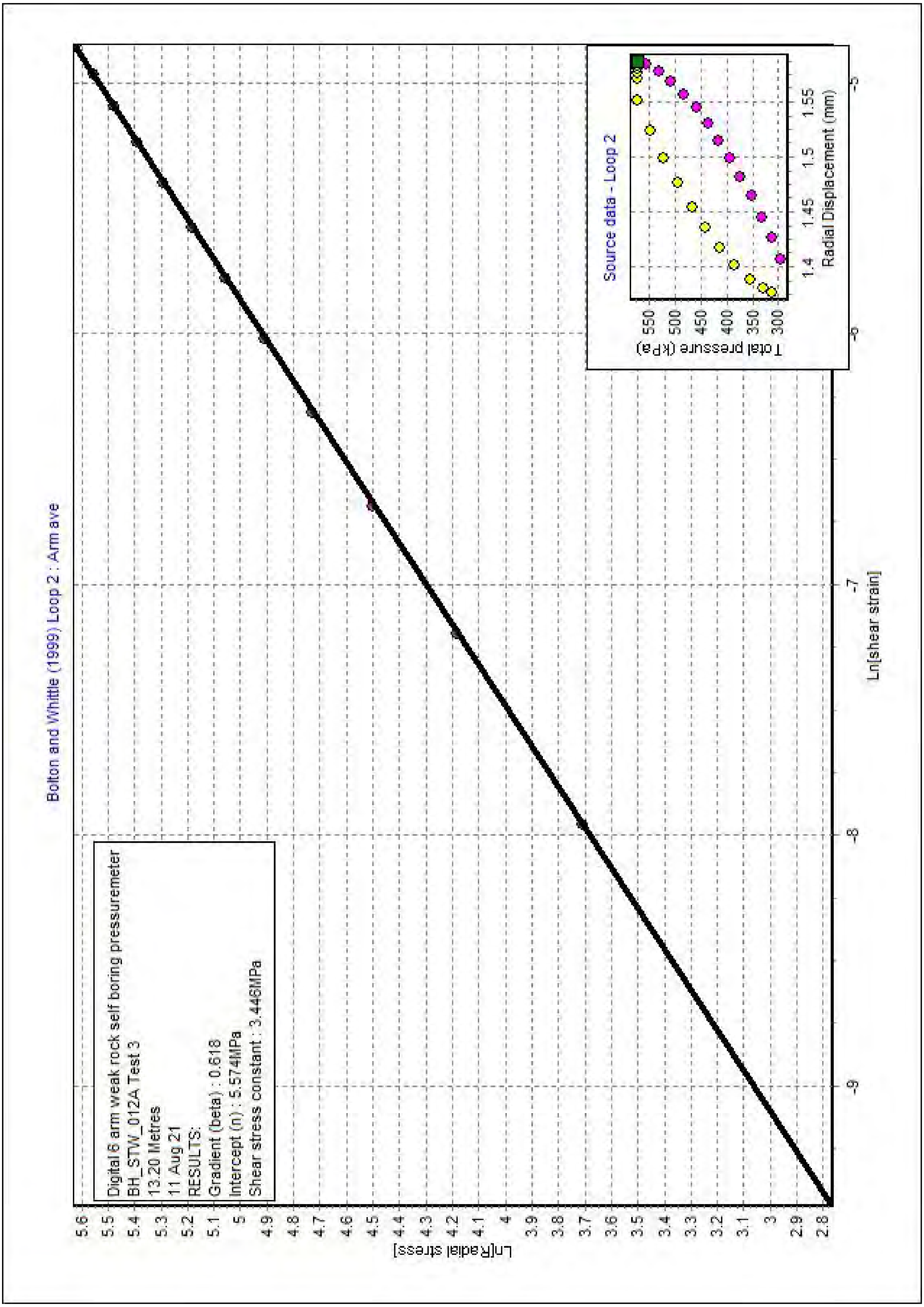

Shear modulus from unload/reload cycles Loop 1 : Arm ave
RESULTS:
Gur : 37.5MPa
Cycle mid-point:
Cavity strain : 0.708%
Total stress : 621kPa
Size of cycle :
Shear strain : 0.666%
Total stress : 251kPa
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 3
13.20 Metres
11 Aug 21
Total pressure (kPa)
790
780
770
760
750
740
730
720
710
700
690
680
670
660
650
640
630
620
610
600
590
580
570
560
550
540
530
520
510
500
490
480
Radial Displacement (mm)
0.96
0.98
1
1.02
1.04
1.06
1.08
1.1
1.12
1.14
1.16
1.18
1.2
1.22
1.24
1.26
1.28
1.3

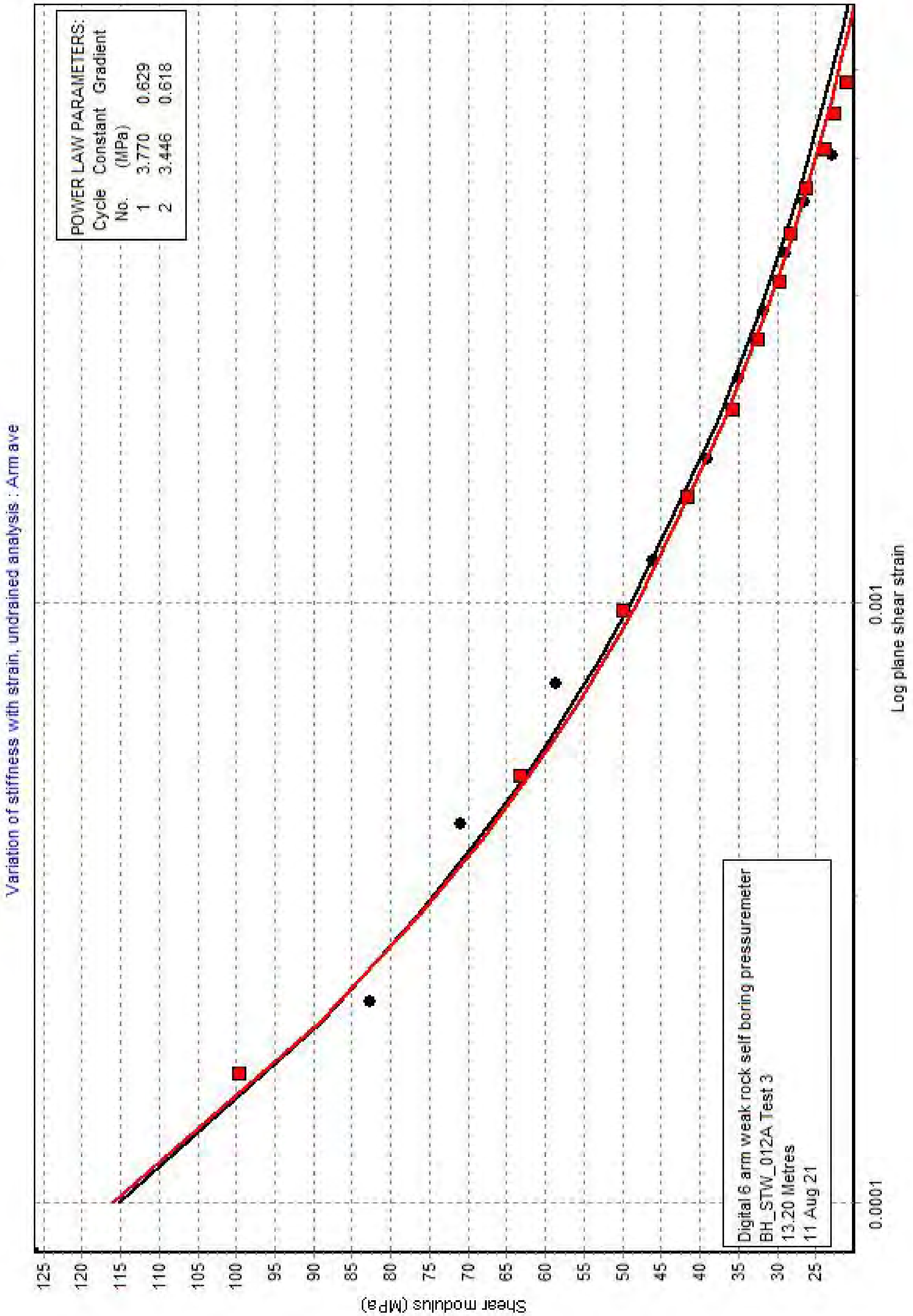


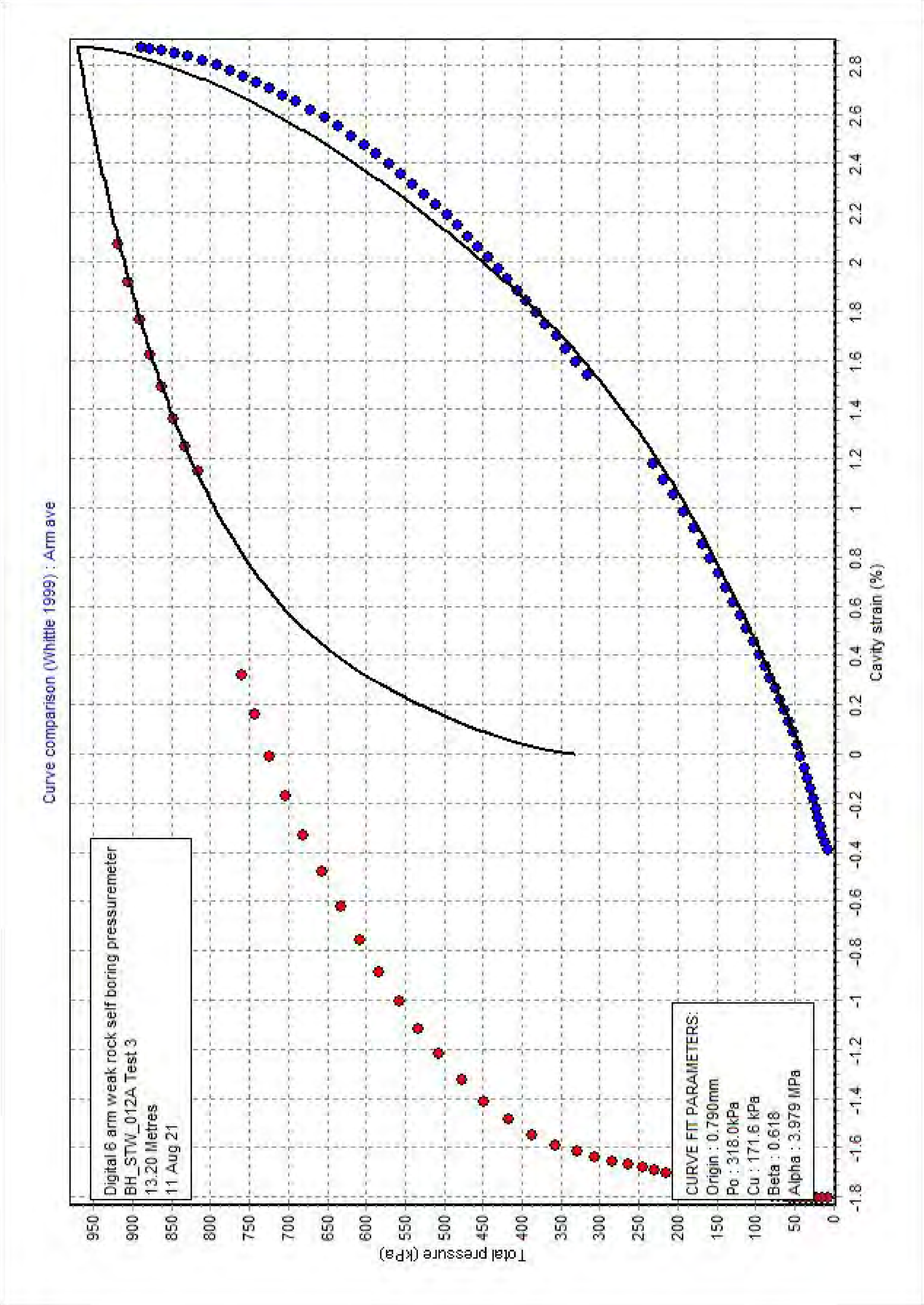
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 3
13.20 Metres
11 Aug 21

RESULTS:
Gur : 33.6MPa
Cycle mid-point:
Cavity strain : 1.542%
Total stress : 439kPa
Size of cycle :
Shear strain : 0.793%
Total stress : 267kPa


Bolton and Whittle (1999) Loop 1 : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 3
13.20 Metres
11 Aug 21
RESULTS:
Gradient (beta) : 0.629
Intercept (n) : 5.995MPa
Shear stress constant : 3.770MPa
Ln[Radial stress]
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
2.7
2.6
2.5
Ln[shear strain]
-9
-8
-7
-6
Source data - Loop 1
Total pressure (kPa)
750
700
650
600
550
500
Radial Displacement (mm)
1.05
1.1
1.15

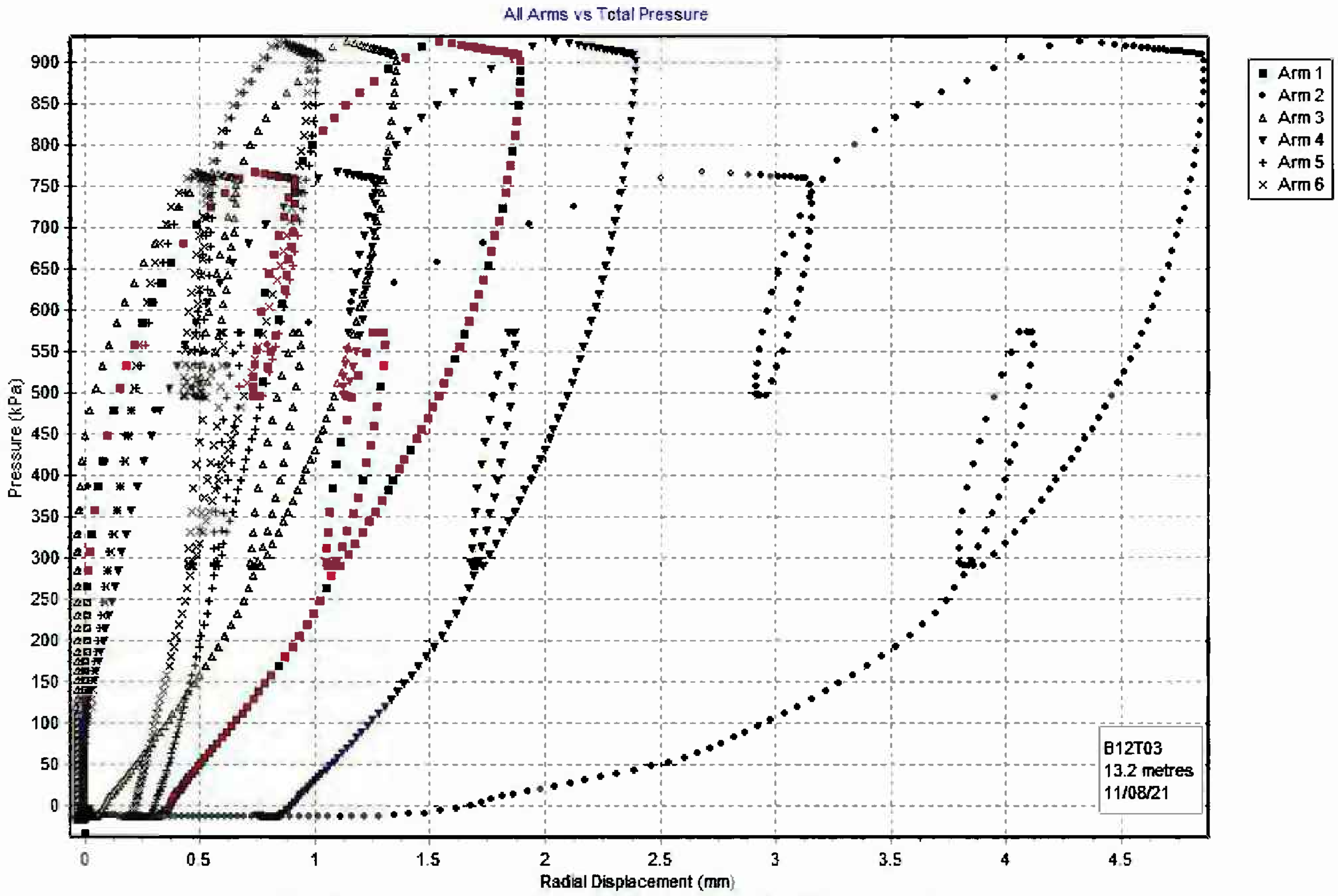

Bolton and Whittle (1999) Loop 2 : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 3
13.20 Metres
11 Aug 21
RESULTS:
Gradient (beta) : 0.618
Intercept (n) : 5.574MPa
Shear stress constant : 3.446MPa
Ln[Radial stress]
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
-9
-8
-7
-6
-5
Ln[shear strain]
Source data - Loop 2
Total pressure (kPa)
550
500
450
400
350
300
1.4
1.45
1.5
1.55
Radial Displacement (mm)


Variation of stiffness with strain, undrained analysis : Arm ave
POWER LAW PARAMETERS:
Cycle No. | Constant (MPa) | Gradient
1 | 3.770 | 0.629
2 | 3.446 | 0.618
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 3
13.20 Metres
11 Aug 21
Shear modulus (MPa)
125
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
Log plane shear strain
0.0001
0.001


Curve comparison (Whittle 1999) : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_012A Test 3
13.20 Metres
11 Aug 21
CURVE FIT PARAMETERS:
Origin : 0.790mm
Po : 318.0kPa
Cu : 171.6 kPa
Beta : 0.618
Alpha : 3.979 MPa
Total pressure (kPa)
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Cavity strain (%)
-1.8
-1.6
-1.4
-1.2
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8

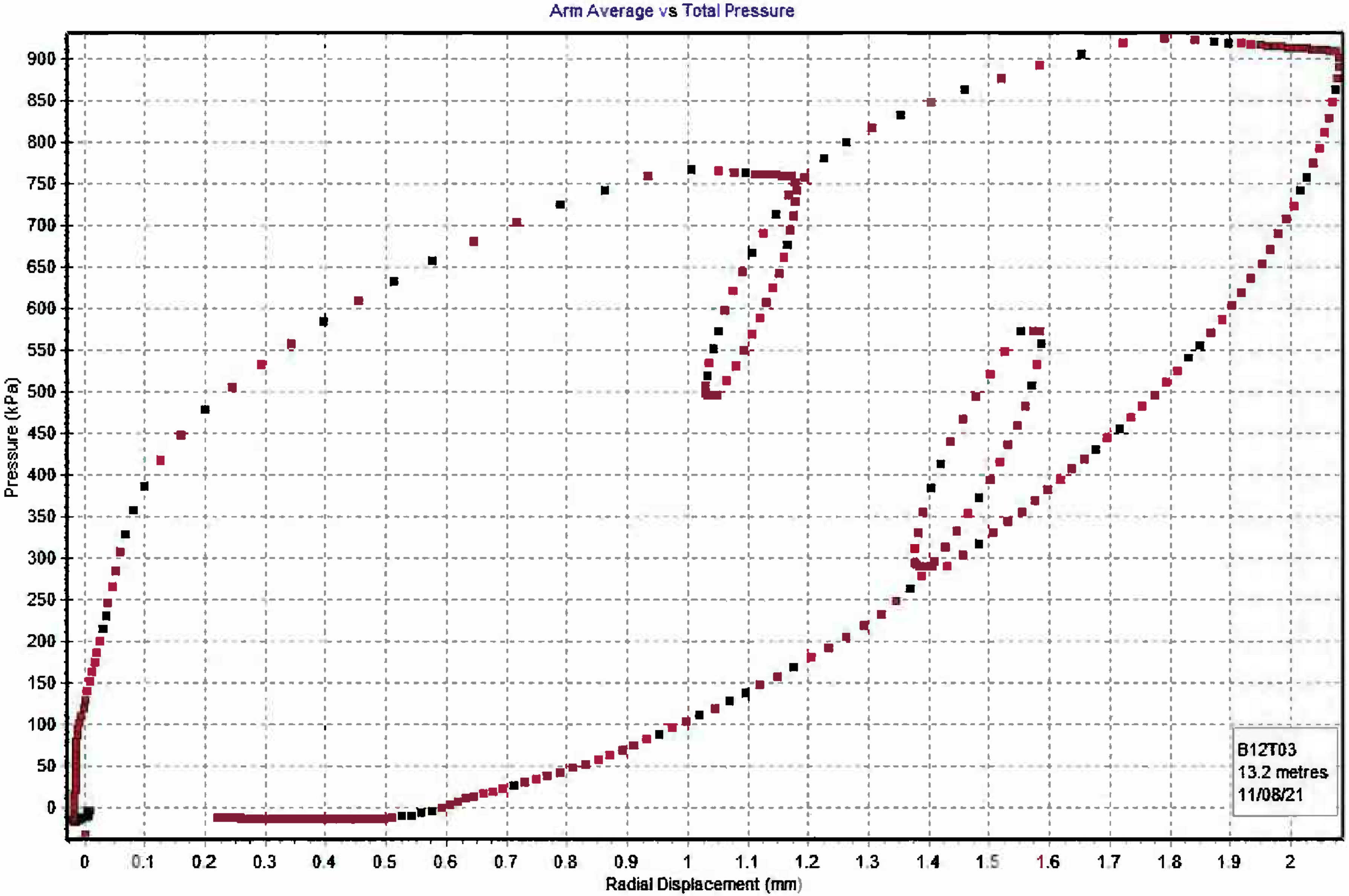
CIR1506/21

Cambridge WWTPR

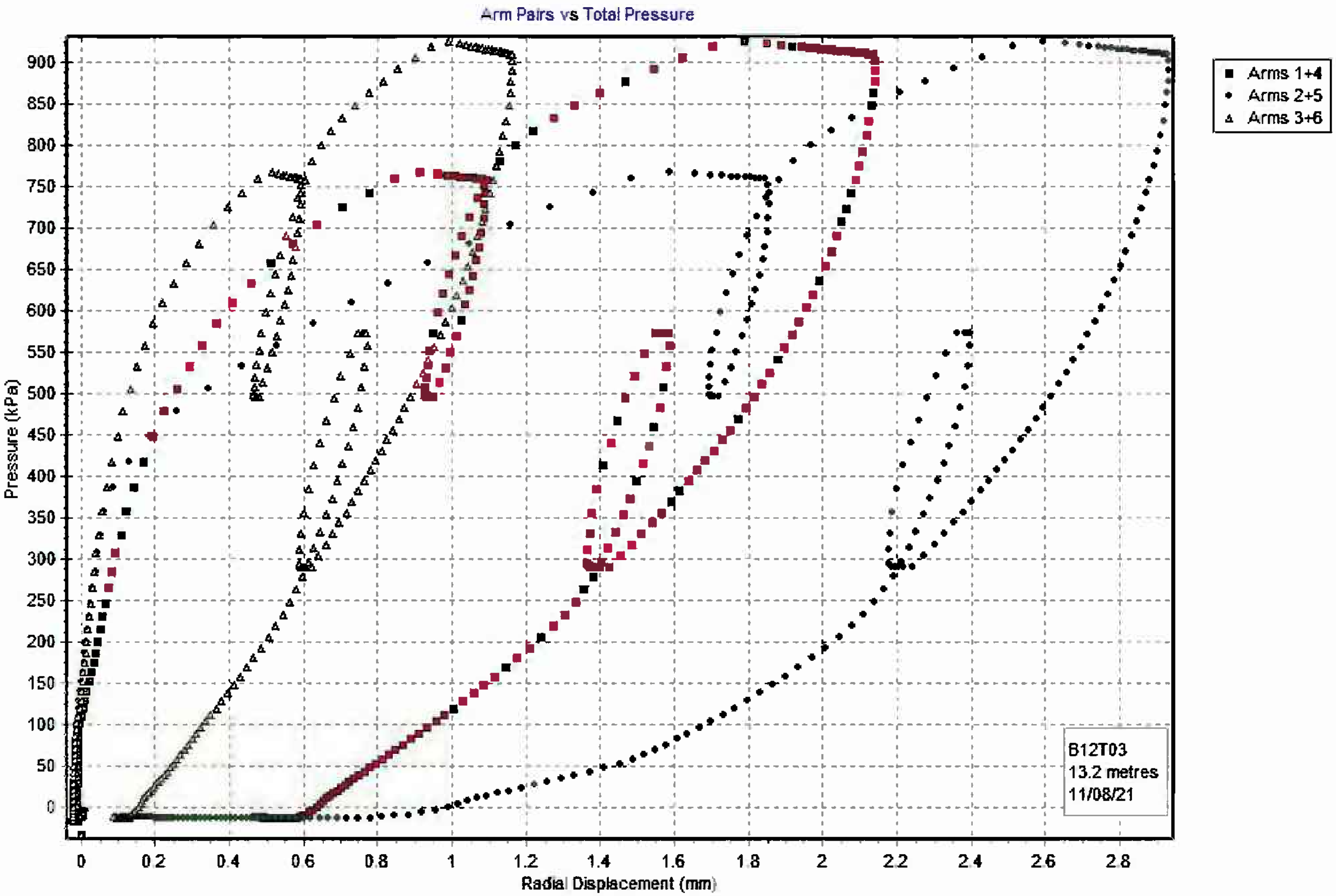


CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361

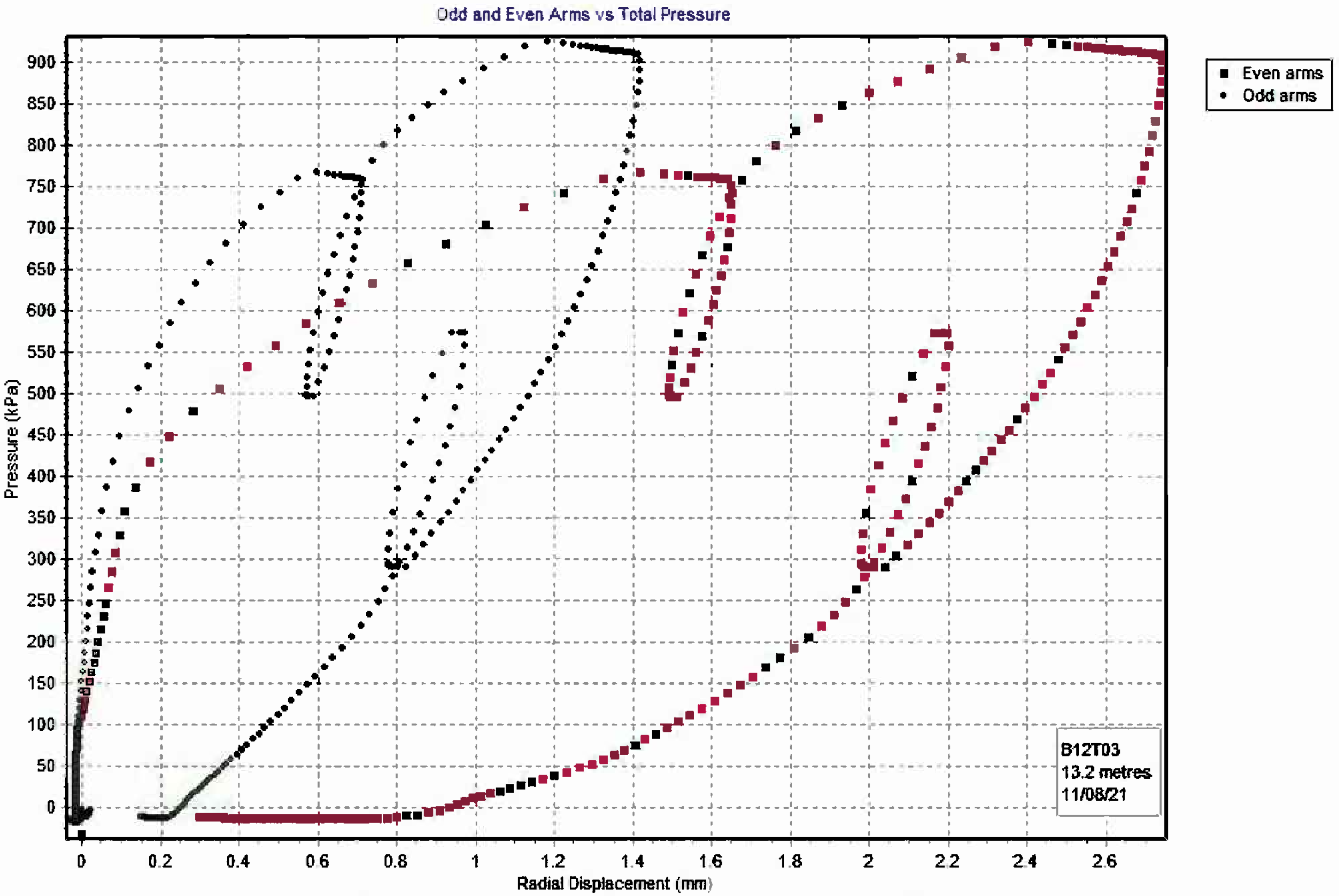
Pressuremeter Testing



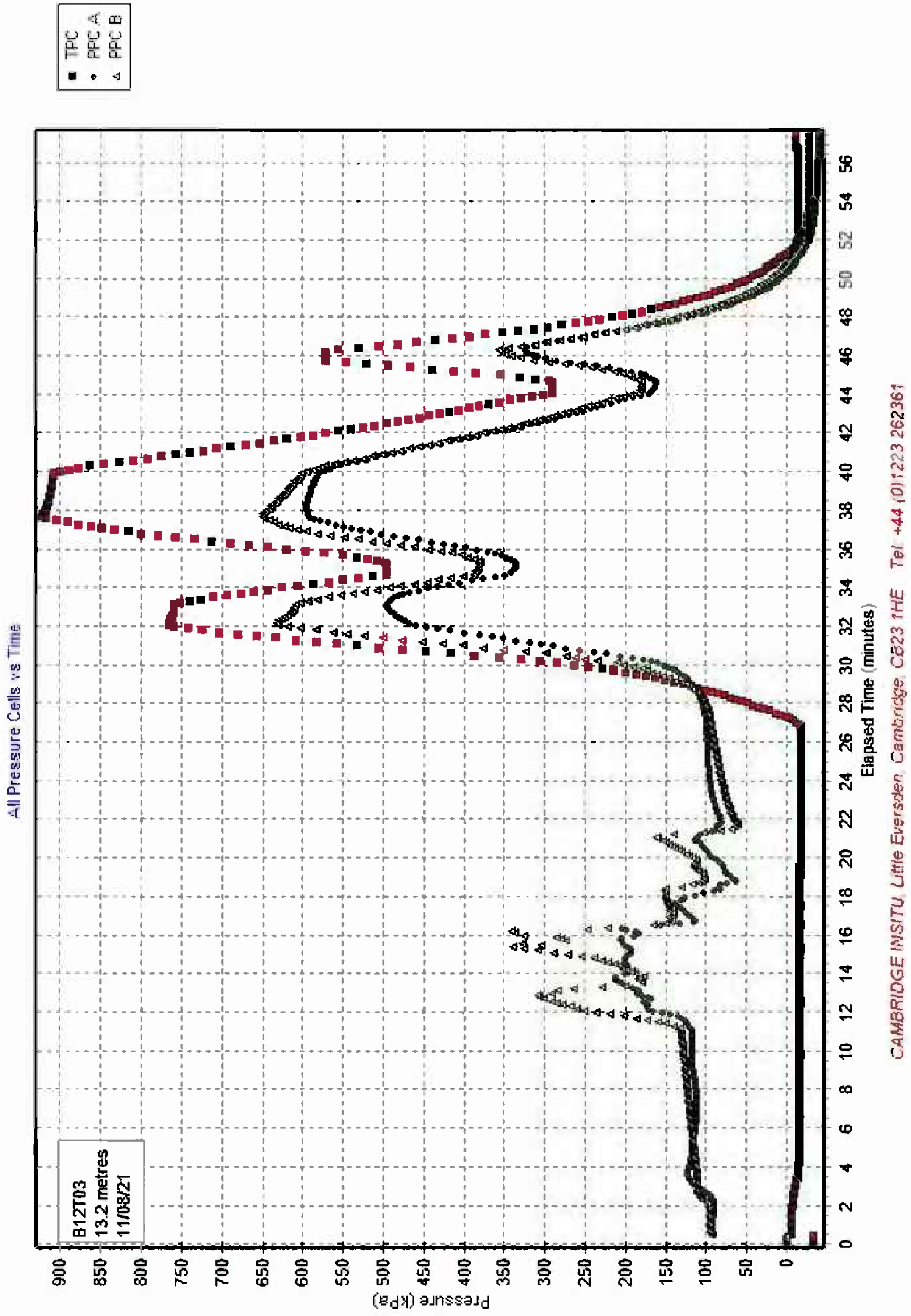
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361

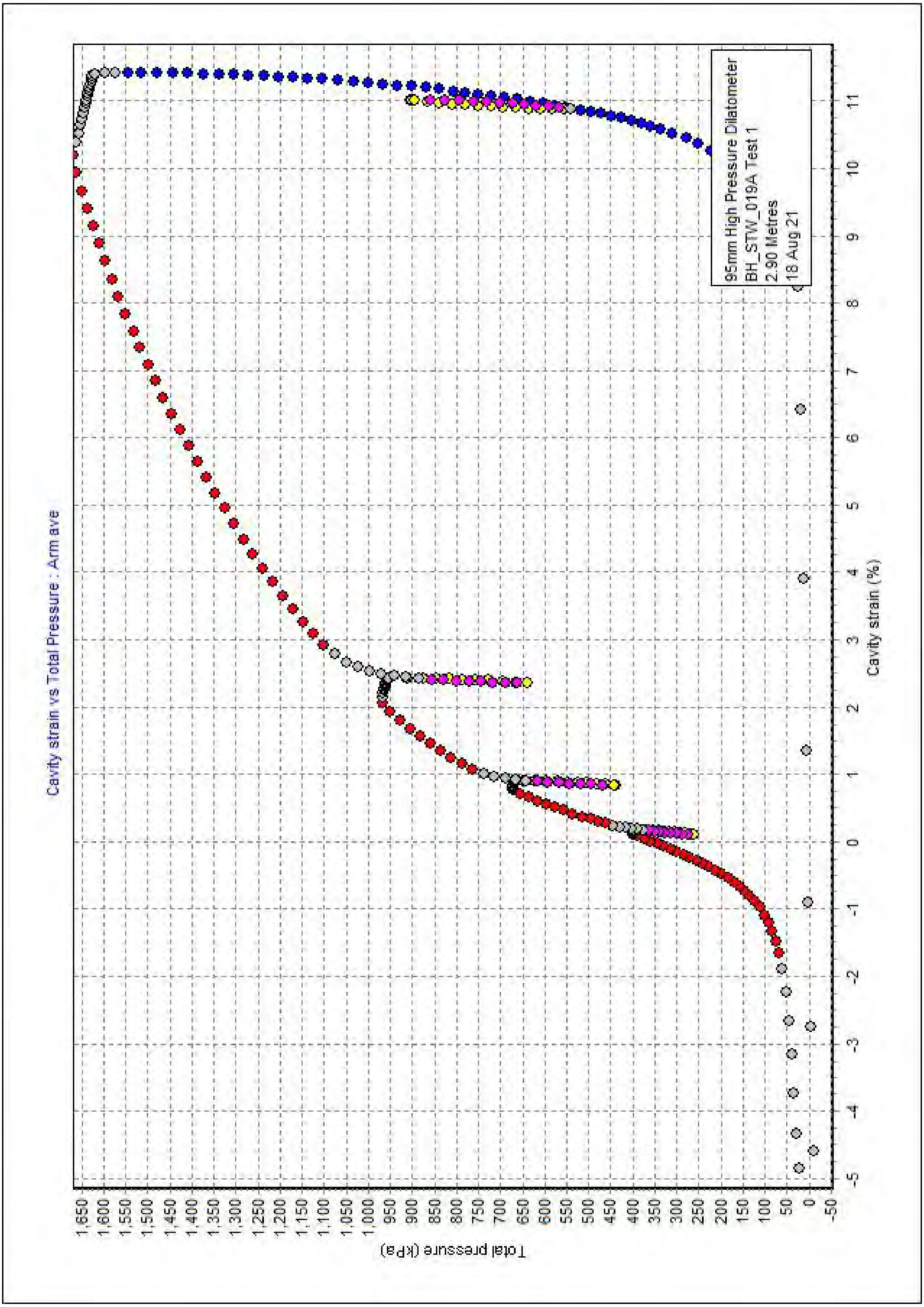


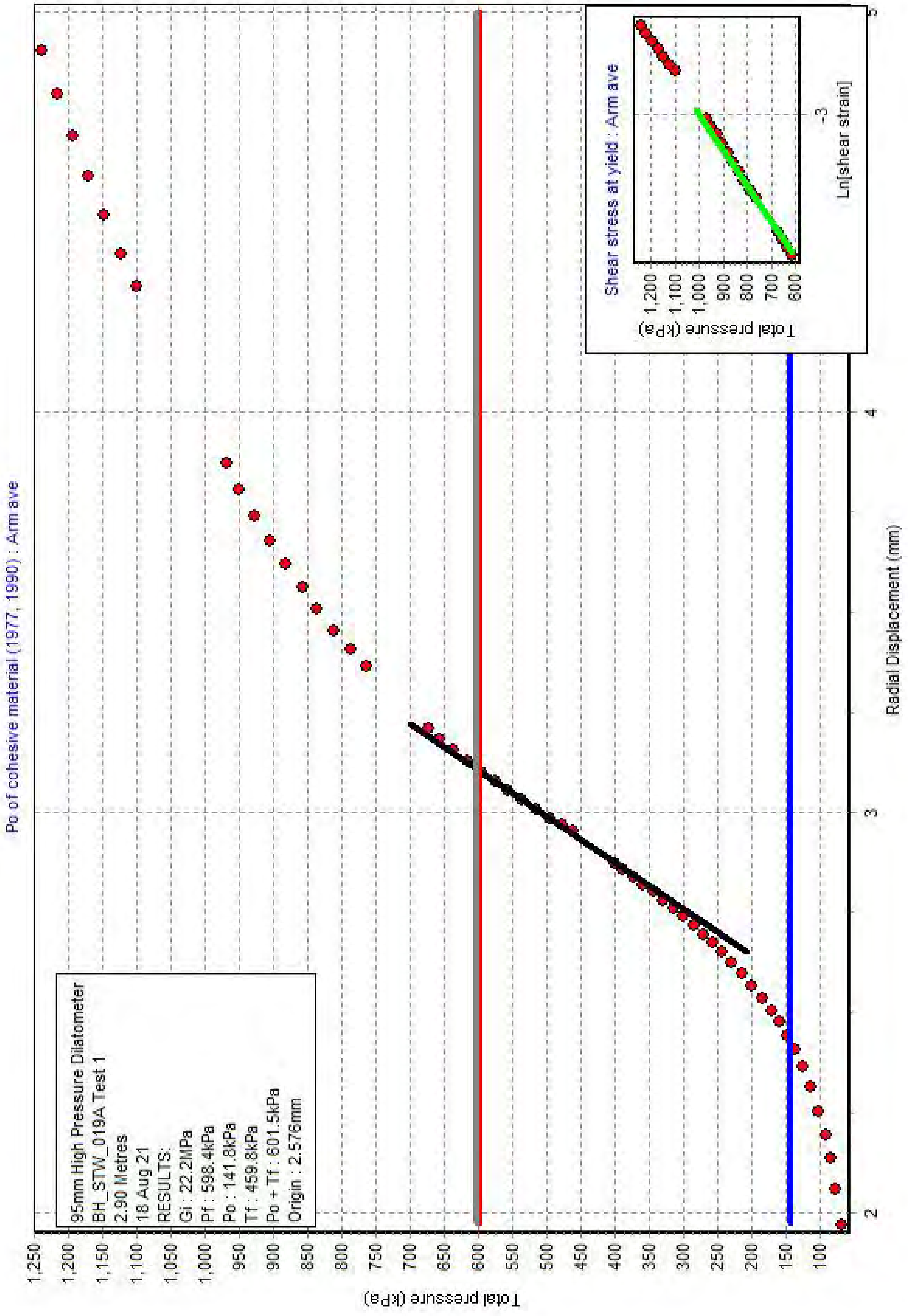
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel +44 (0)1223 262361

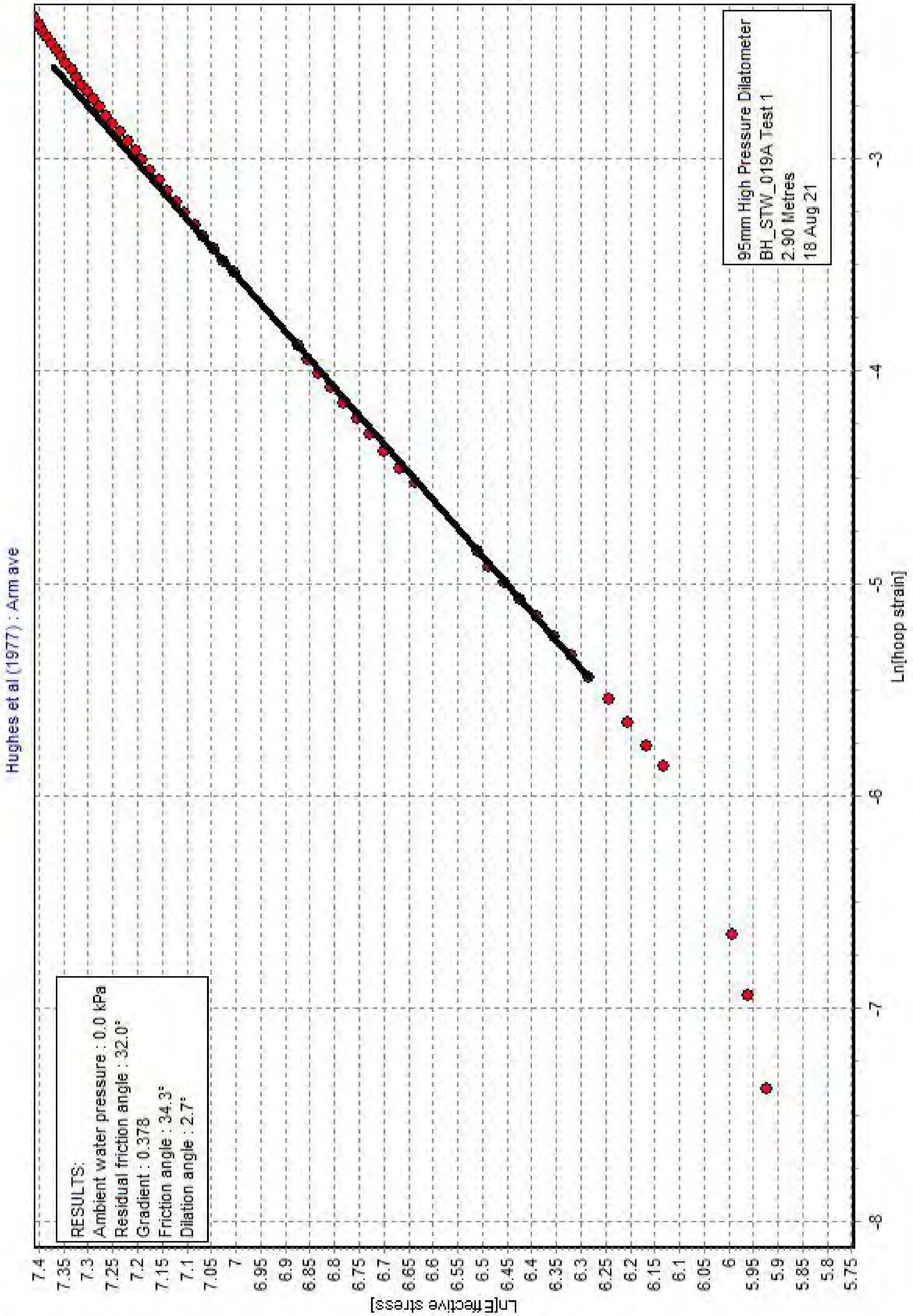

All Pressure Cells vs Time
■ TPC
◆ PPC A
△ PPC B
B12T03
13.2 metres
11/08/21
Pressure (kPa)
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Elapsed Time (minutes)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
54
56
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel +44 (0)1223 262361

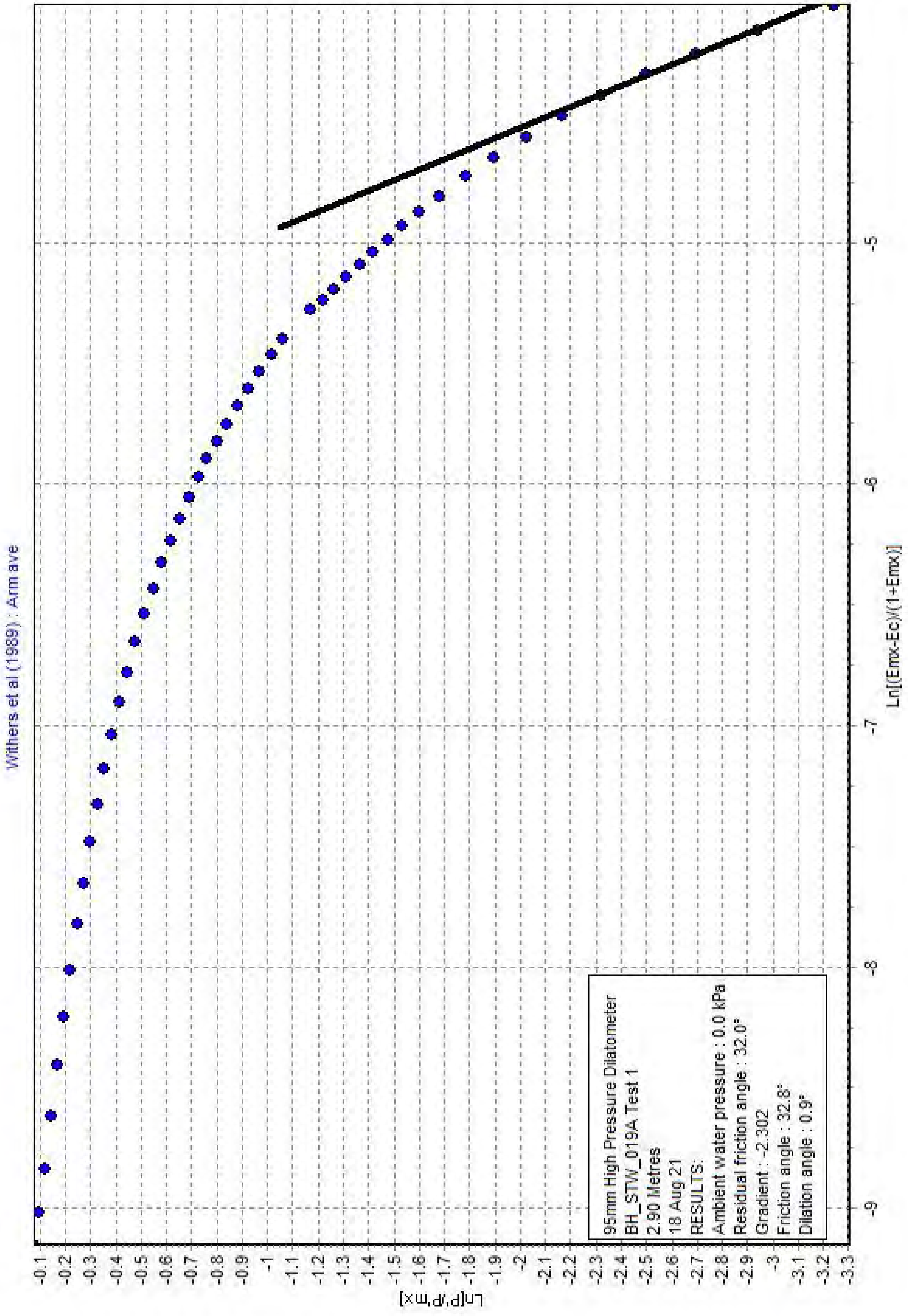
```
BH_STW_019A Test 1 - SUMMARY OF RESULTS
[File made with WinSitu ]

[DETAILS OF TEST]
Project        :   TE8364
Site           :   Cambridge Waste Water Treatment Plant Relocation Project
Borehole       :   BH_STW_019A
Test name      :   BH_STW_019A Test 1
Test date      :   18 Aug 21
Test depth     :   2.90 Metres
Water table    :   3.75 Metres
Ambient PWP    :   0.0 kPa
Material       :   Structureless Chalk
Probe          :   95mm High Pressure Dilatometer
Diameter       :   97.0 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out
The file includes results from a curve fitting analysis

Analysed by ES/RW on 19 Aug 21

Remarks:

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm)                    :   "Arm ave=2.81"
Po from Marsland & Randolph (kPa)     :   "Arm ave=141.8"
Best estimate of Po (kPa)             :   "Arm ave=91.0"

[UNDRAINED STRENGTH PARAMETERS]
Undrained yield stress (kPa)          :   "Arm ave=598.4"

[DRAINED ANALYSIS OF SANDS]
[Hughes et al 1977]
Constant volume friction angle (°)    :   32.0
Angle of internal friction (°)        :   "Arm ave=34.3"
Dilation angle (°)                    :   "Arm ave=2.7"
Gradient of log-log plot              :   "Arm ave=0.378"

[Withers et al 1989]
Angle of internal friction (°)        :   "Arm ave=32.8"
Dilation angle (°)                    :   "Arm ave=0.9"
Gradient of log-log plot              :   "Arm ave=-2.302"

[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=22.2"
Axis       Loop   Value    Mean Strain  Mean Pc  dE      dPc
           No     (MPa)    (%)          (kPa)    (%)     (kPa)
Arm ave    1      82.2     0.155        316      0.132   109
Arm ave    2      145.9    0.888        531      0.124   181
Arm ave    3      172.1    2.408        757      0.136   233
Arm ave    4      144.7    10.970       730      0.238   345

[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]
Axis       Loop   Intercept  Alpha      Gradient
           No     (MPa)      (MPa)
Arm ave    1      14.554     10.666     0.733
Arm ave    2      16.174     10.706     0.662
Arm ave    3      15.237     9.431      0.619
Arm ave    4      10.814     6.017      0.556


[PARAMETERS USED FOR DRAINED CURVE MODELLING]
{Axis is  Arm ave}
Strain Origin (mm)                    :   2.81
Po (kPa)                              :   91
Cohesion (kPa)                        :   20
Angle of peak friction (deg)          :   34.3
Angle of peak dilation (deg)          :   2.7
Total yield stress (kPa)              :   259
```

```
BH_STW_019A Test 1 - SUMMARY OF RESULTS
Total limit stress (kPa)            :   3213
G at first yield (MPa)              :   96.7
Non-linear exponent                 :   0.619
Janbu exponent                      :   0.146
Correlation                         :   0.549

Ambient pore water pressure (kPa)   :   0
Residual friction angle (deg)       :   32.0
Poisson's ratio                     :   0.25
```

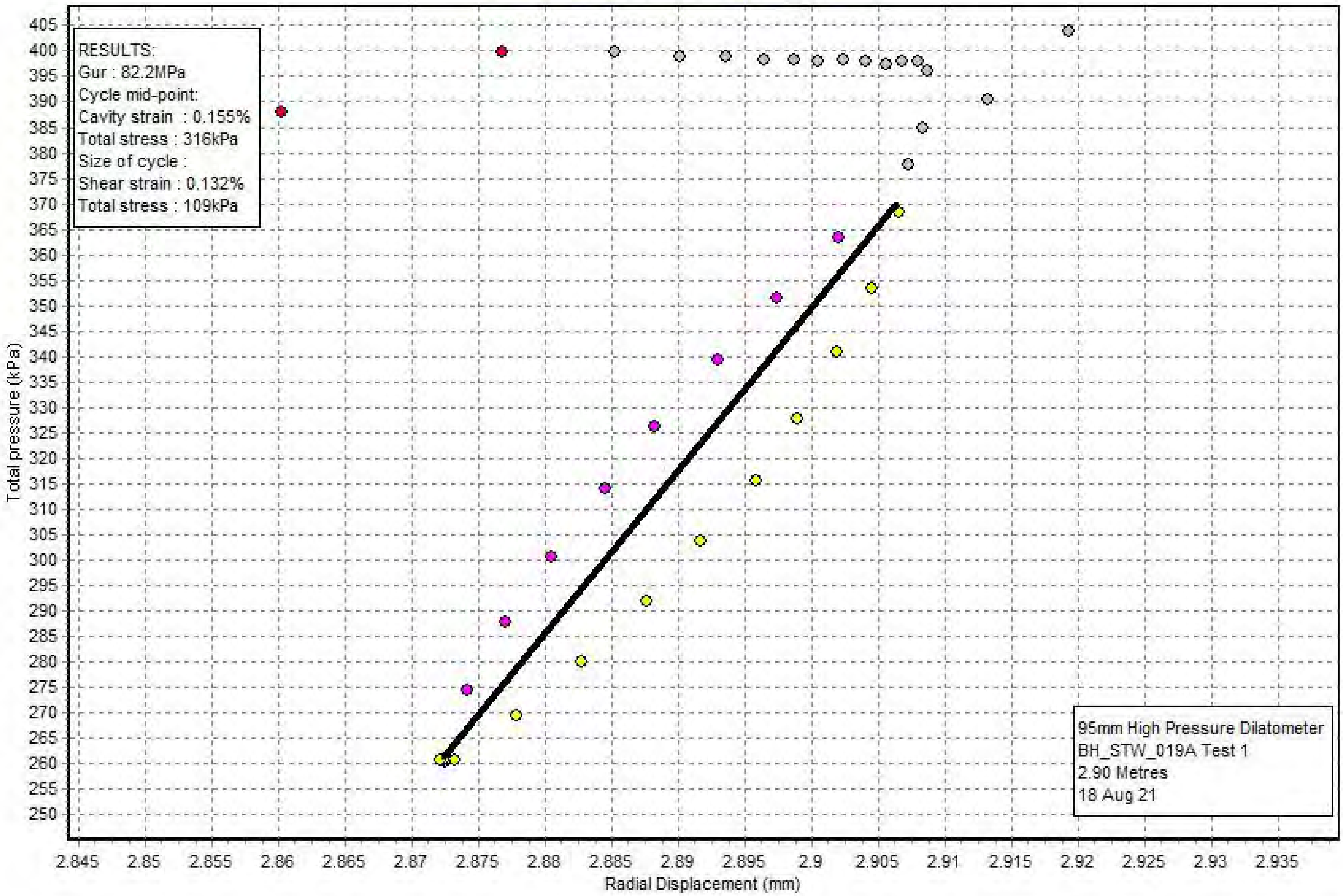

Cavity strain vs Total Pressure : Arm ave
95mm High Pressure Dilatometer
BH_STW_019A Test 1
2.90 Metres
18 Aug 21
Cavity strain (%)
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
7
8
9
10
11
Total pressure (kPa)
-50
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1,000
1,050
1,100
1,150
1,200
1,250
1,300
1,350
1,400
1,450
1,500
1,550
1,600
1,650


Po of cohesive material (1977, 1990) : Arm ave
95mm High Pressure Dilatometer
BH_STW_019A Test 1
2.90 Metres
18 Aug 21
RESULTS:
Gi : 22.2MPa
Pf : 598.4kPa
Po : 141.8kPa
Tf : 459.8kPa
Po + Tf : 601.5kPa
Origin : 2.576mm
Total pressure (kPa)
1,250
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
Radial Displacement (mm)
2
3
4
5
Shear stress at yield : Arm ave
Total pressure (kPa)
1,200
1,100
1,000
900
800
700
600
Ln[shear strain]
-3


Hughes et al (1977) : Arm ave
95mm High Pressure Dilatometer
BH_STW_019A Test 1
2.90 Metres
18 Aug 21
RESULTS:
Ambient water pressure : 0.0 kPa
Residual friction angle : 32.0°
Gradient : 0.378
Friction angle : 34.3°
Dilation angle : 2.7°
Ln[hoop strain]
-3
-4
-5
-6
-7
-8
Ln[Effective stress]
7.4
7.35
7.3
7.25
7.2
7.15
7.1
7.05
7
6.95
6.9
6.85
6.8
6.75
6.7
6.65
6.6
6.55
6.5
6.45
6.4
6.35
6.3
6.25
6.2
6.15
6.1
6.05
6
5.95
5.9
5.85
5.8
5.75

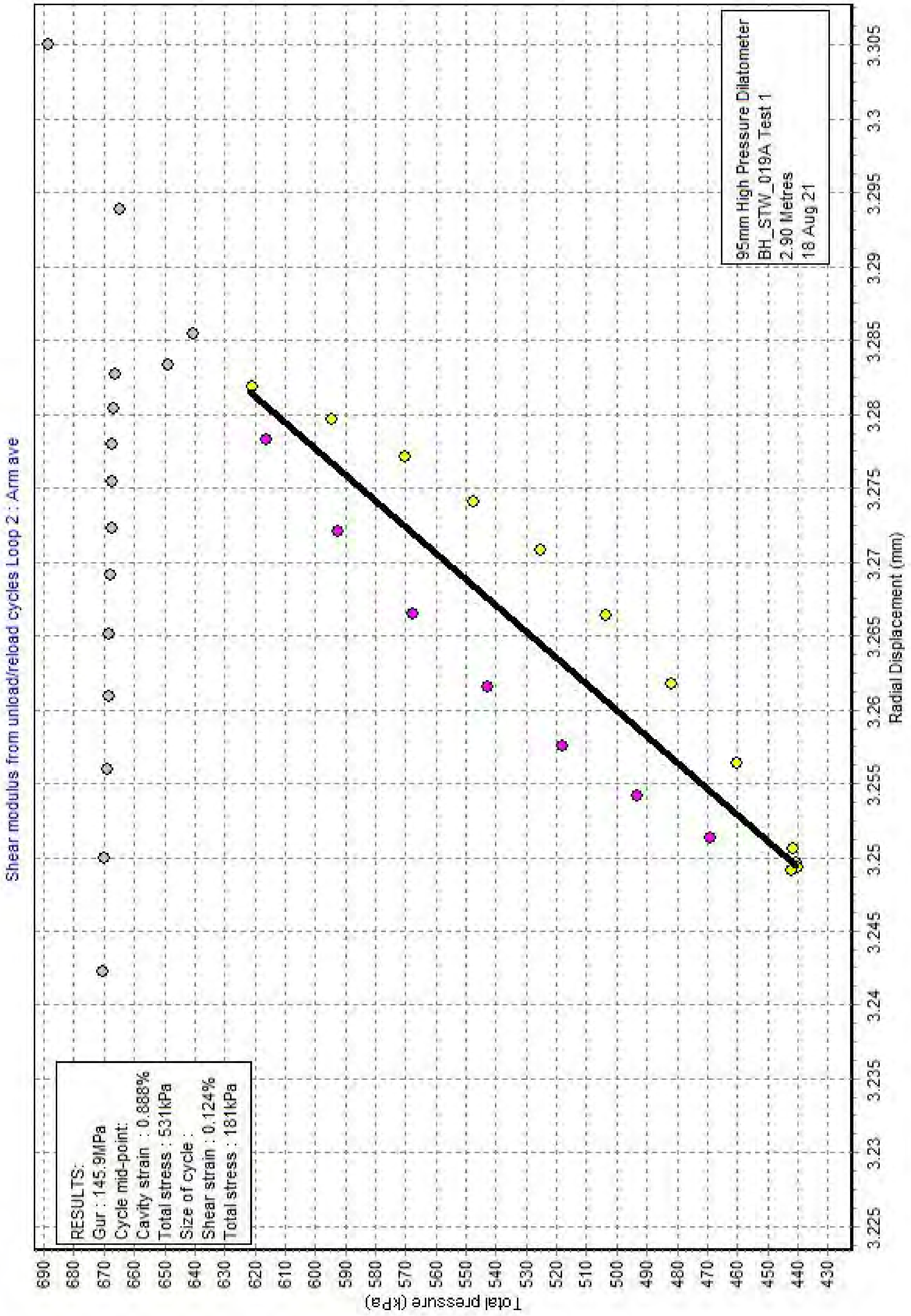

Withers et al (1989) : Arm ave
95mm High Pressure Dilatometer
BH_STW_019A Test 1
2.90 Metres
18 Aug 21
RESULTS:
Ambient water pressure : 0.0 kPa
Residual friction angle : 32.0°
Gradient : -2.302
Friction angle : 32.8°
Dilation angle : 0.9°
Ln[(Emx-Ec)/(1+Emx)]
-5
-6
-7
-8
-9
Ln[P'/P'mx]
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1
-1.1
-1.2
-1.3
-1.4
-1.5
-1.6
-1.7
-1.8
-1.9
-2
-2.1
-2.2
-2.3
-2.4
-2.5
-2.6
-2.7
-2.8
-2.9
-3
-3.1
-3.2
-3.3

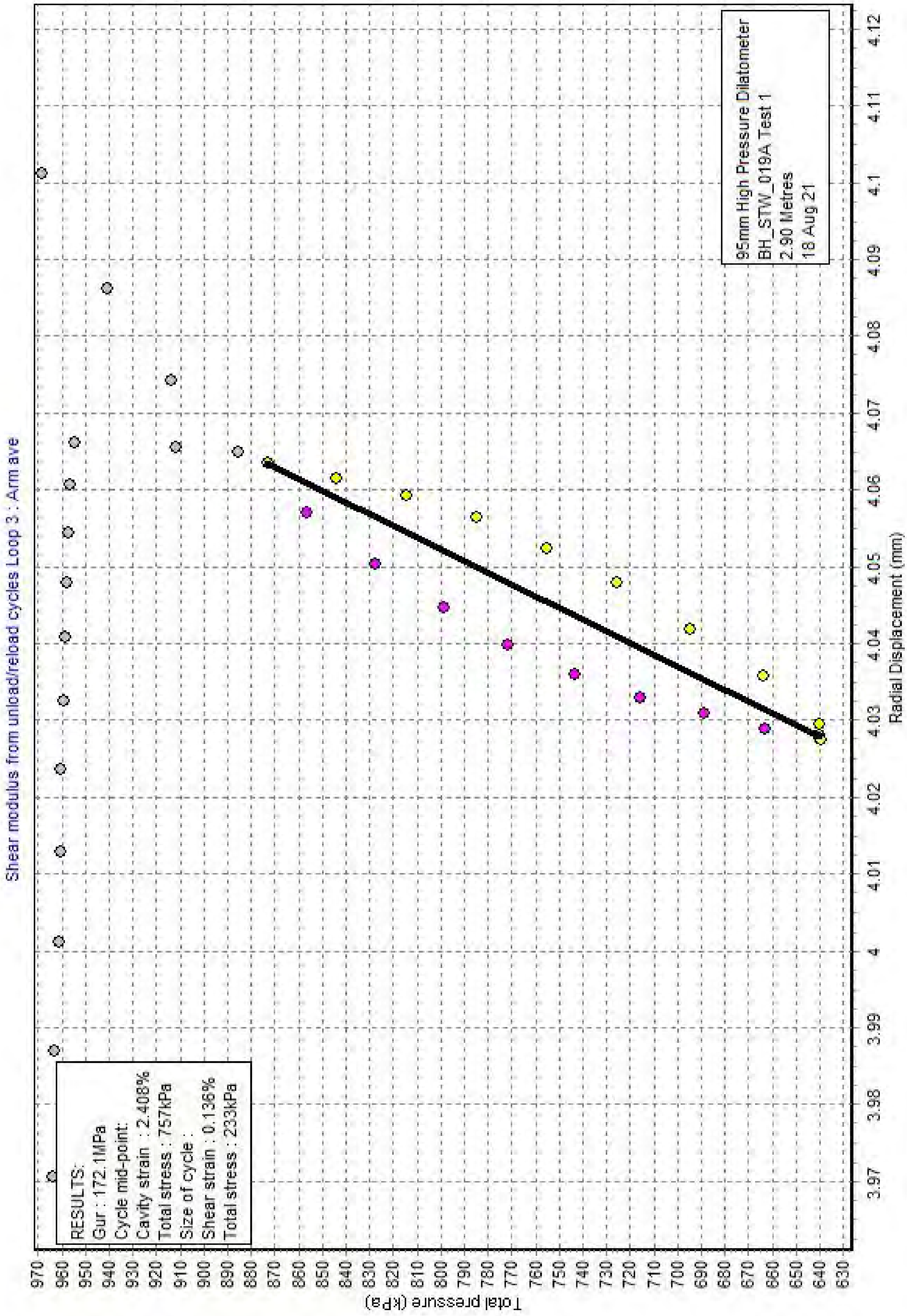
Shear modulus from unload/reload cycles Loop 1 : Arm ave

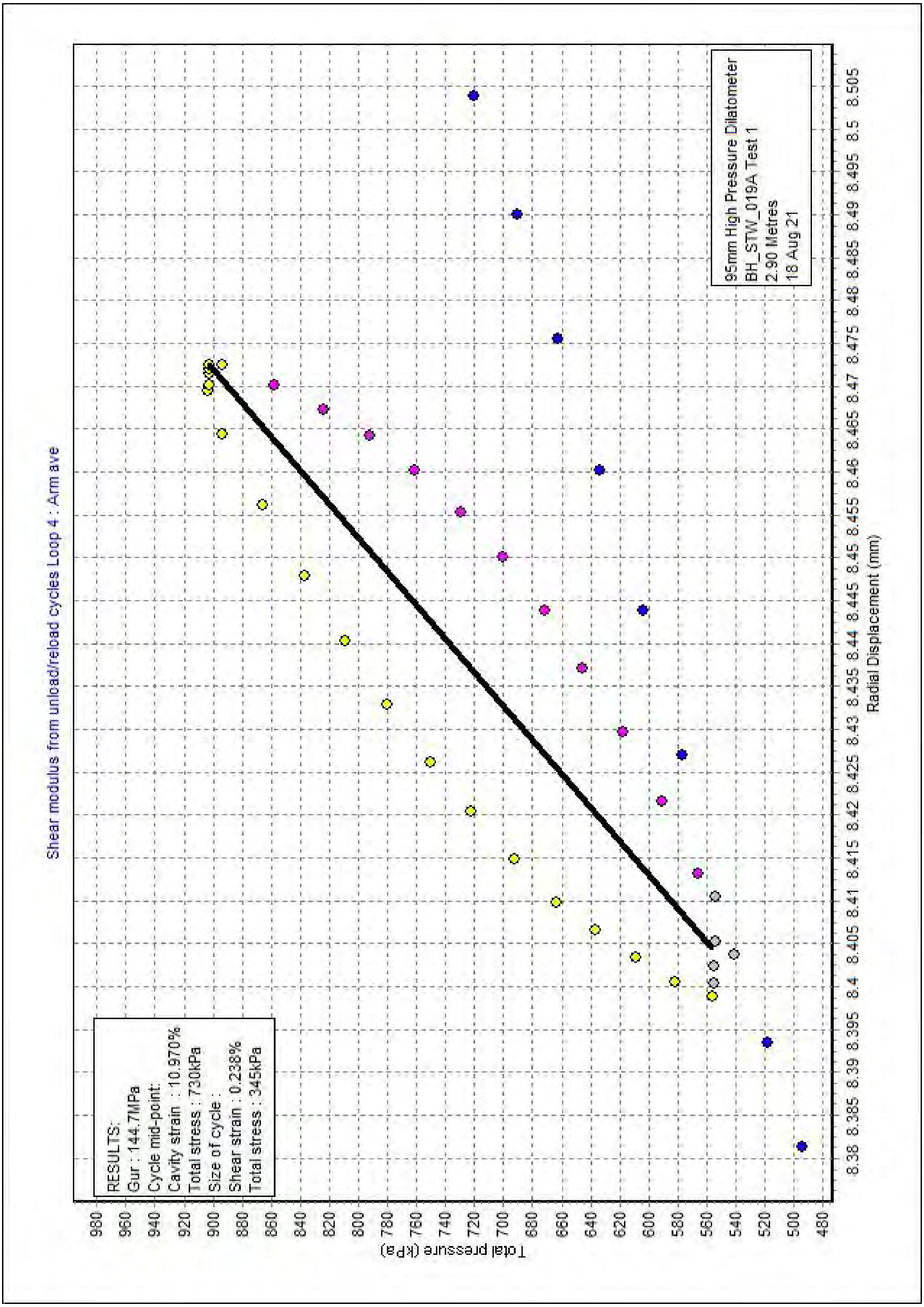


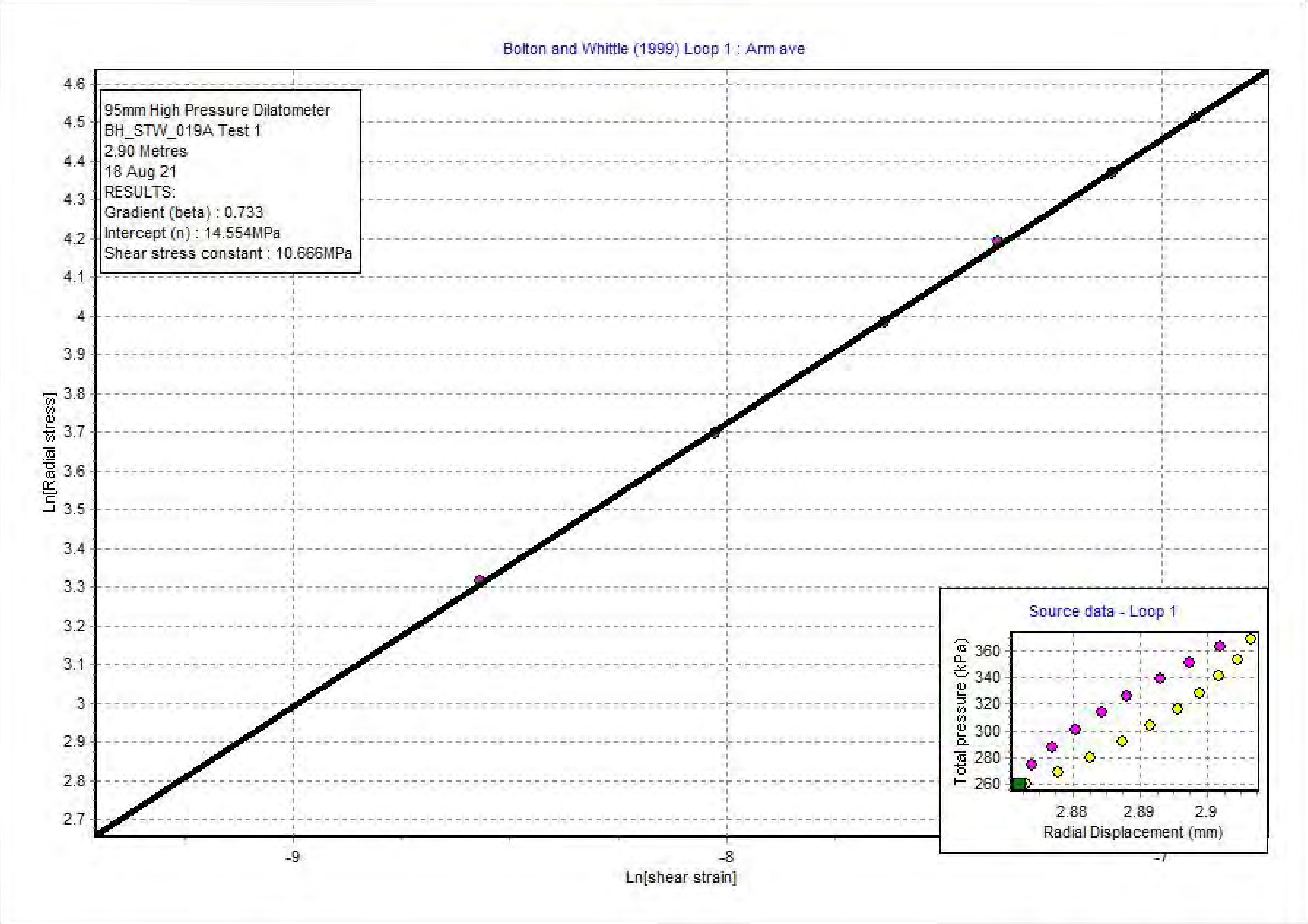
RESULTS:
Gur : 82.2MPa
Cycle mid-point:
Cavity strain : 0.155%
Total stress : 316kPa
Size of cycle :
Shear strain : 0.132%
Total stress : 109kPa

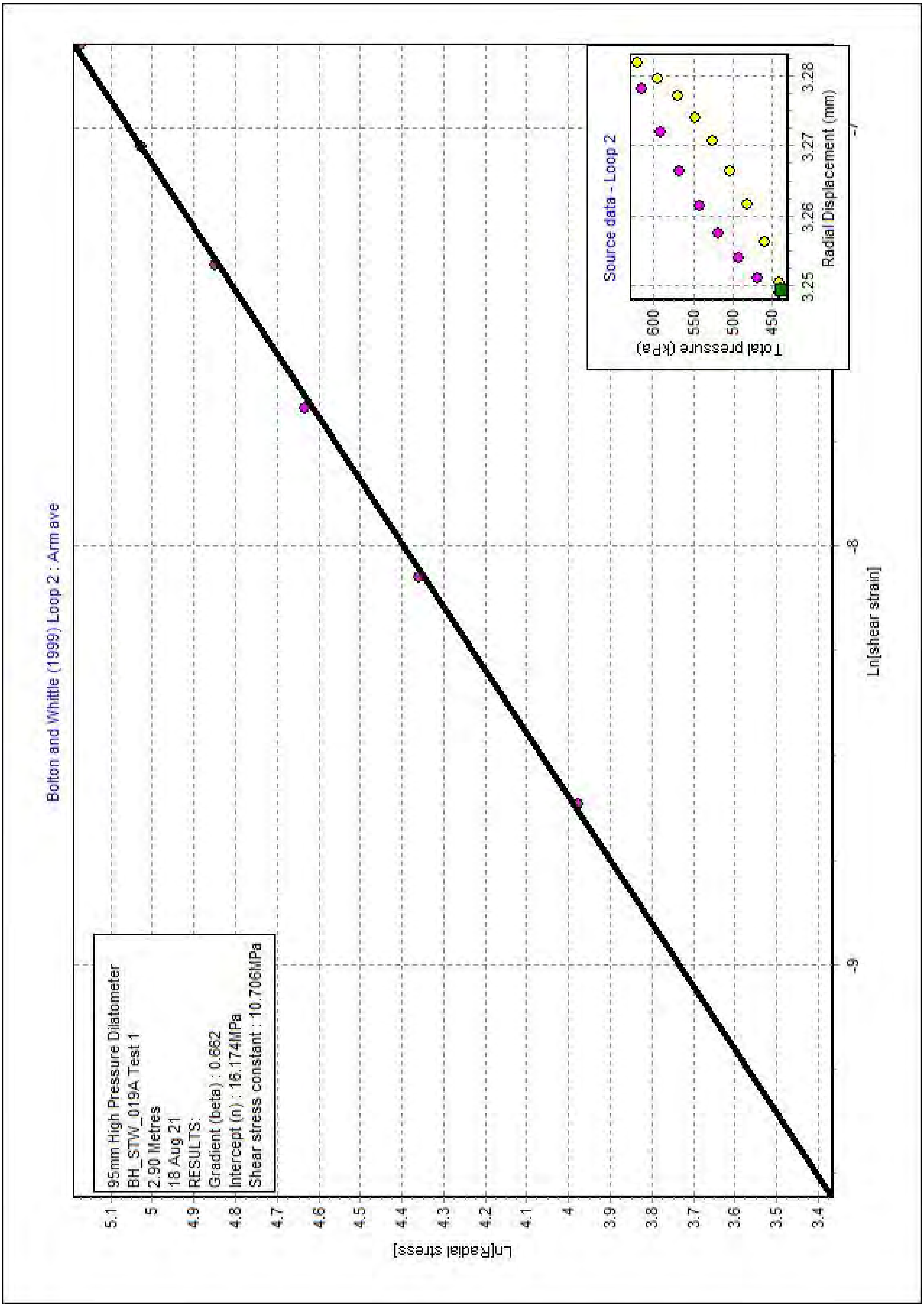
95mm High Pressure Dilatometer
BH_STW_019A Test 1
2.90 Metres
18 Aug 21


Shear modulus from unload/reload cycles Loop 2 : Arm ave
RESULTS:
Gur : 145.9MPa
Cycle mid-point:
Cavity strain : 0.888%
Total stress : 531kPa
Size of cycle :
Shear strain : 0.124%
Total stress : 181kPa
95mm High Pressure Dilatometer
BH_STW_019A Test 1
2.90 Metres
18 Aug 21
Radial Displacement (mm)
3.225
3.23
3.235
3.24
3.245
3.25
3.255
3.26
3.265
3.27
3.275
3.28
3.285
3.29
3.295
3.3
3.305
Total pressure (kPa)
690
680
670
660
650
640
630
620
610
600
590
580
570
560
550
540
530
520
510
500
490
480
470
460
450
440
430


Shear modulus from unload/reload cycles Loop 3 : Arm ave
RESULTS:
Gur : 172.1MPa
Cycle mid-point:
Cavity strain : 2.408%
Total stress : 757kPa
Size of cycle :
Shear strain : 0.136%
Total stress : 233kPa
95mm High Pressure Dilatometer
BH_STW_019A Test 1
2.90 Metres
18 Aug 21
Total pressure (kPa)
970
960
950
940
930
920
910
900
890
880
870
860
850
840
830
820
810
800
790
780
770
760
750
740
730
720
710
700
690
680
670
660
650
640
630
Radial Displacement (mm)
3.97
3.98
3.99
4
4.01
4.02
4.03
4.04
4.05
4.06
4.07
4.08
4.09
4.1
4.11
4.12

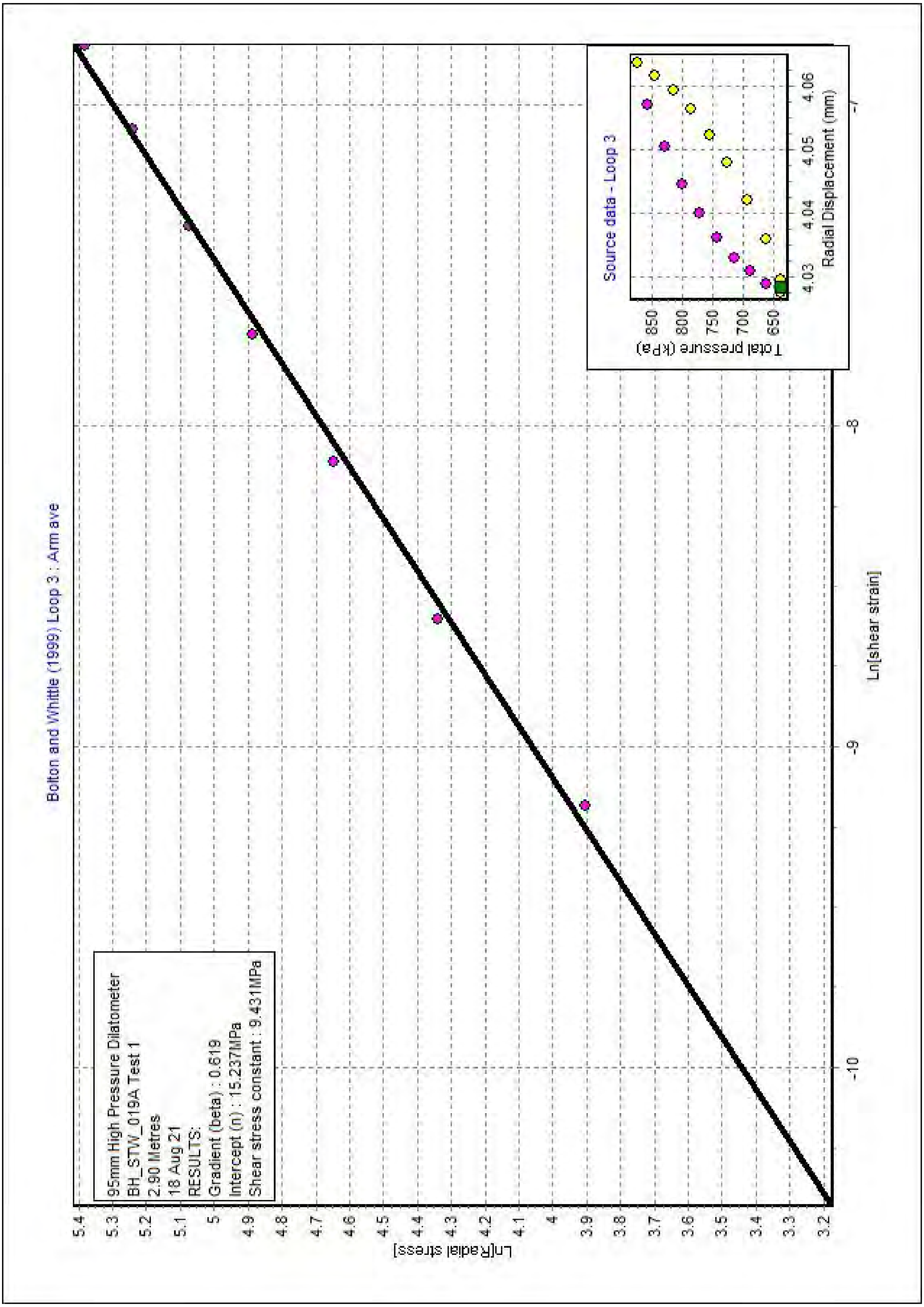

Shear modulus from unload/reload cycles Loop 4 : Arm ave
RESULTS:
Gur : 144.7MPa
Cycle mid-point:
Cavity strain : 10.970%
Total stress : 730kPa
Size of cycle :
Shear strain : 0.238%
Total stress : 345kPa
95mm High Pressure Dilatometer
BH_STW_019A Test 1
2.90 Metres
18 Aug 21
Total pressure (kPa)
980 960 940 920 900 880 860 840 820 800 780 760 740 720 700 680 660 640 620 600 580 560 540 520 500 480
Radial Displacement (mm)
8.38 8.385 8.39 8.395 8.4 8.405 8.41 8.415 8.42 8.425 8.43 8.435 8.44 8.445 8.45 8.455 8.46 8.465 8.47 8.475 8.48 8.485 8.49 8.495 8.5 8.505


Bolton and Whittle (1999) Loop 1 : Arm ave
95mm High Pressure Dilatometer
BH_STW_019A Test 1
2.90 Metres
18 Aug 21
RESULTS:
Gradient (beta) : 0.733
Intercept (n) : 14.554MPa
Shear stress constant : 10.666MPa
Ln[Radial stress]
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
2.7
Ln[shear strain]
-9
-8
-7
Source data - Loop 1
Total pressure (kPa)
360
340
320
300
280
260
Radial Displacement (mm)
2.88
2.89
2.9

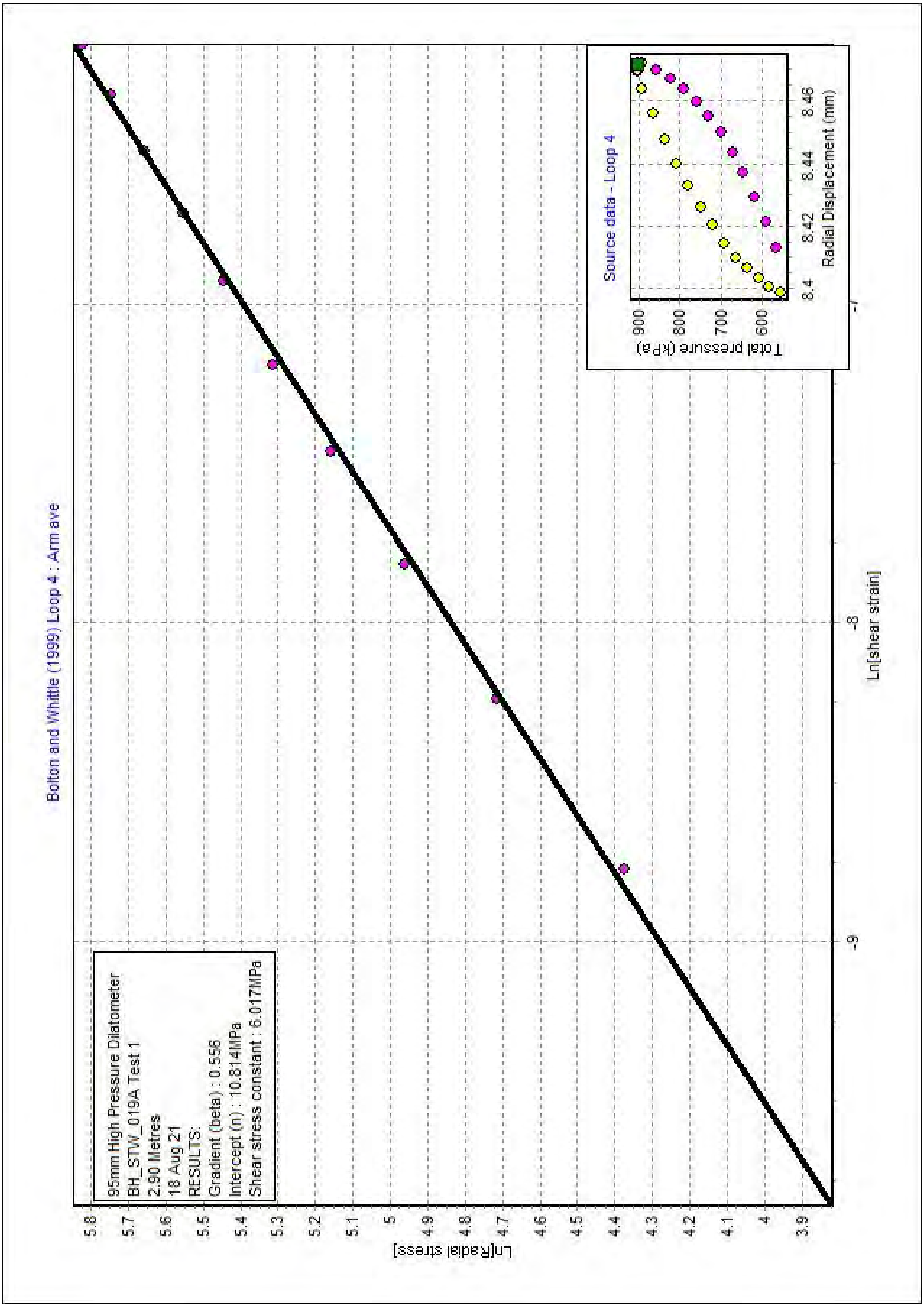


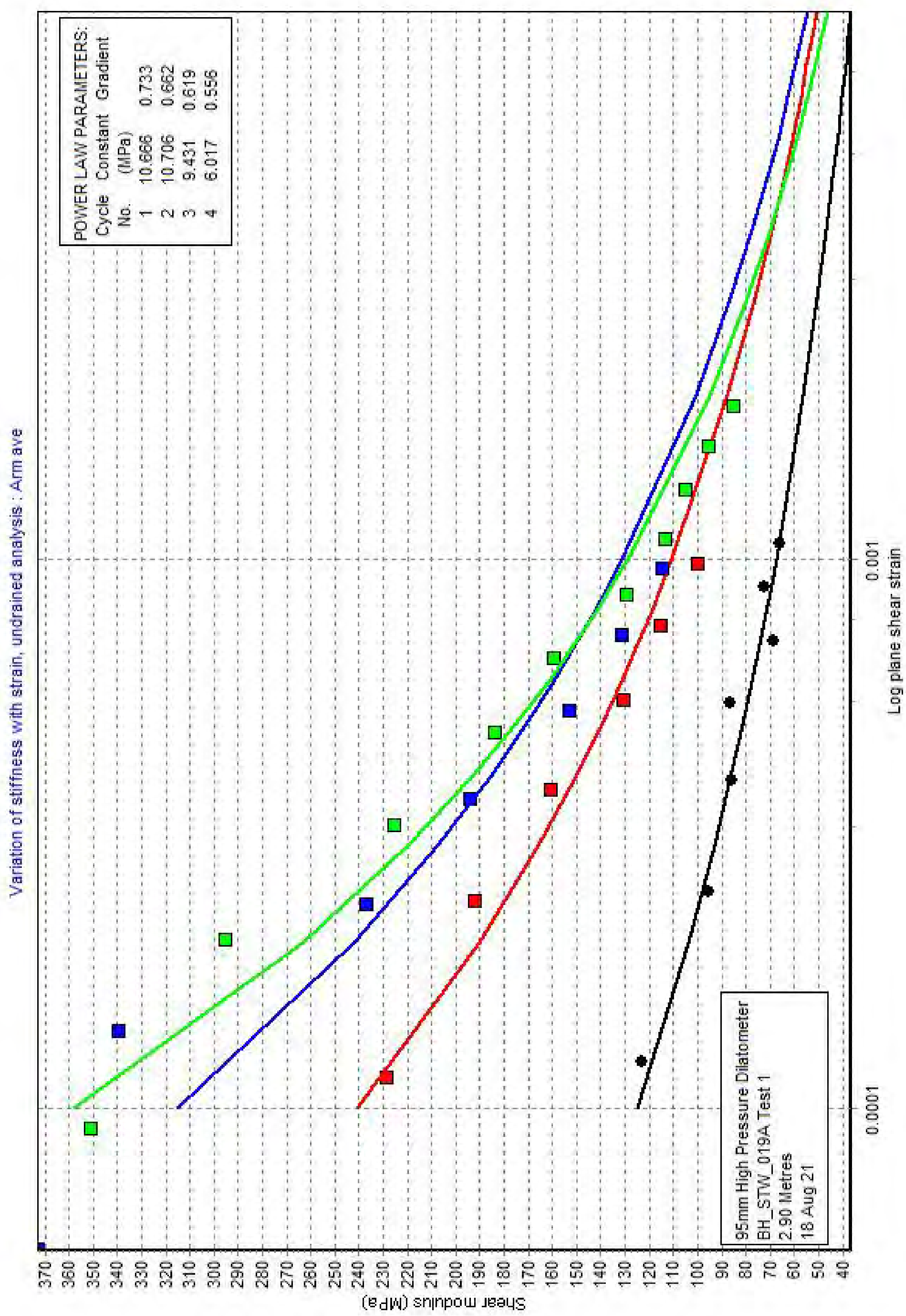
Bolton and Whittle (1999) Loop 2 : Arm ave

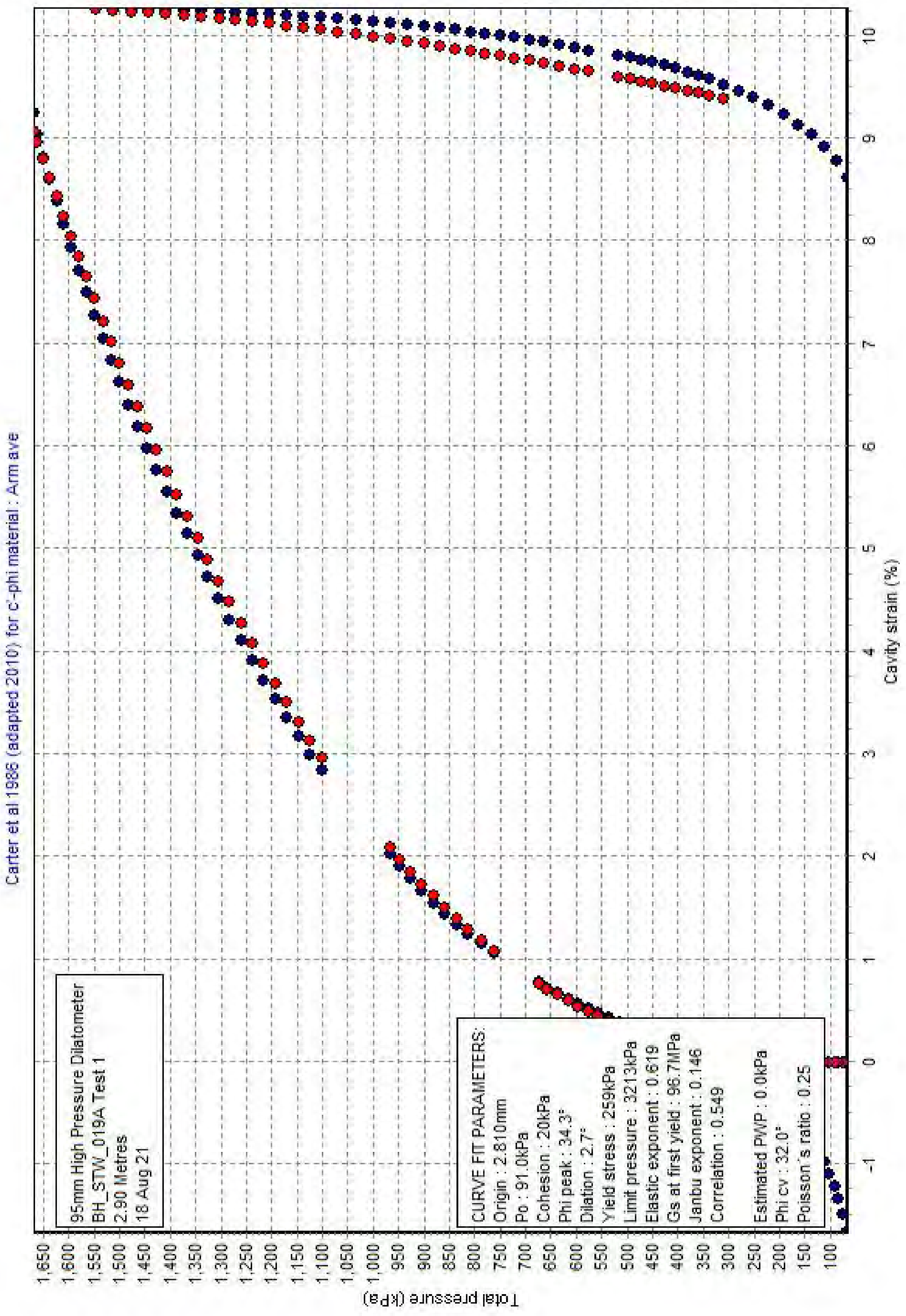
95mm High Pressure Dilatometer
BH_STW_019A Test 1
2.90 Metres
18 Aug 21
RESULTS:
Gradient (beta) : 0.662
Intercept (n) : 16.174MPa
Shear stress constant : 10.706MPa

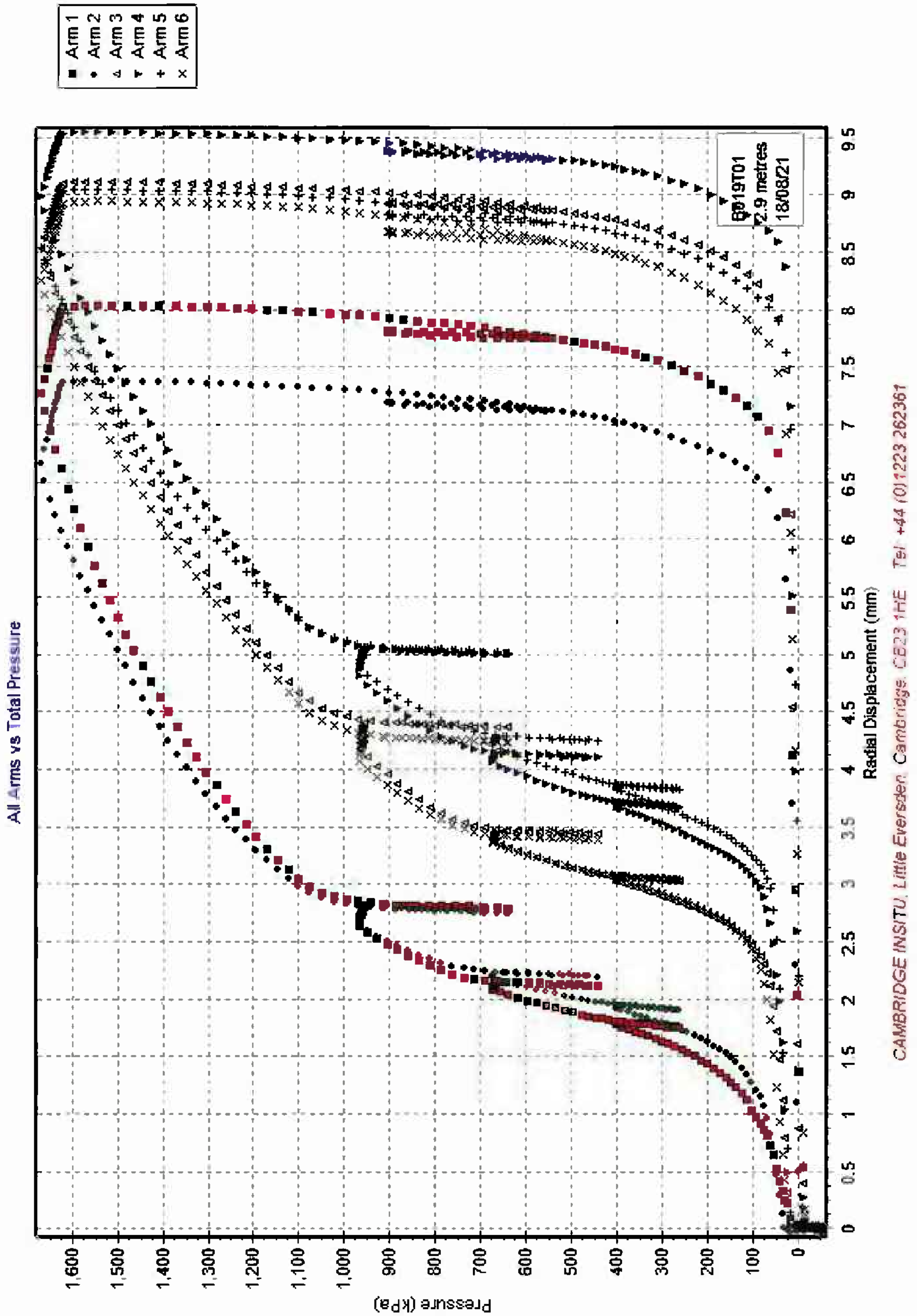


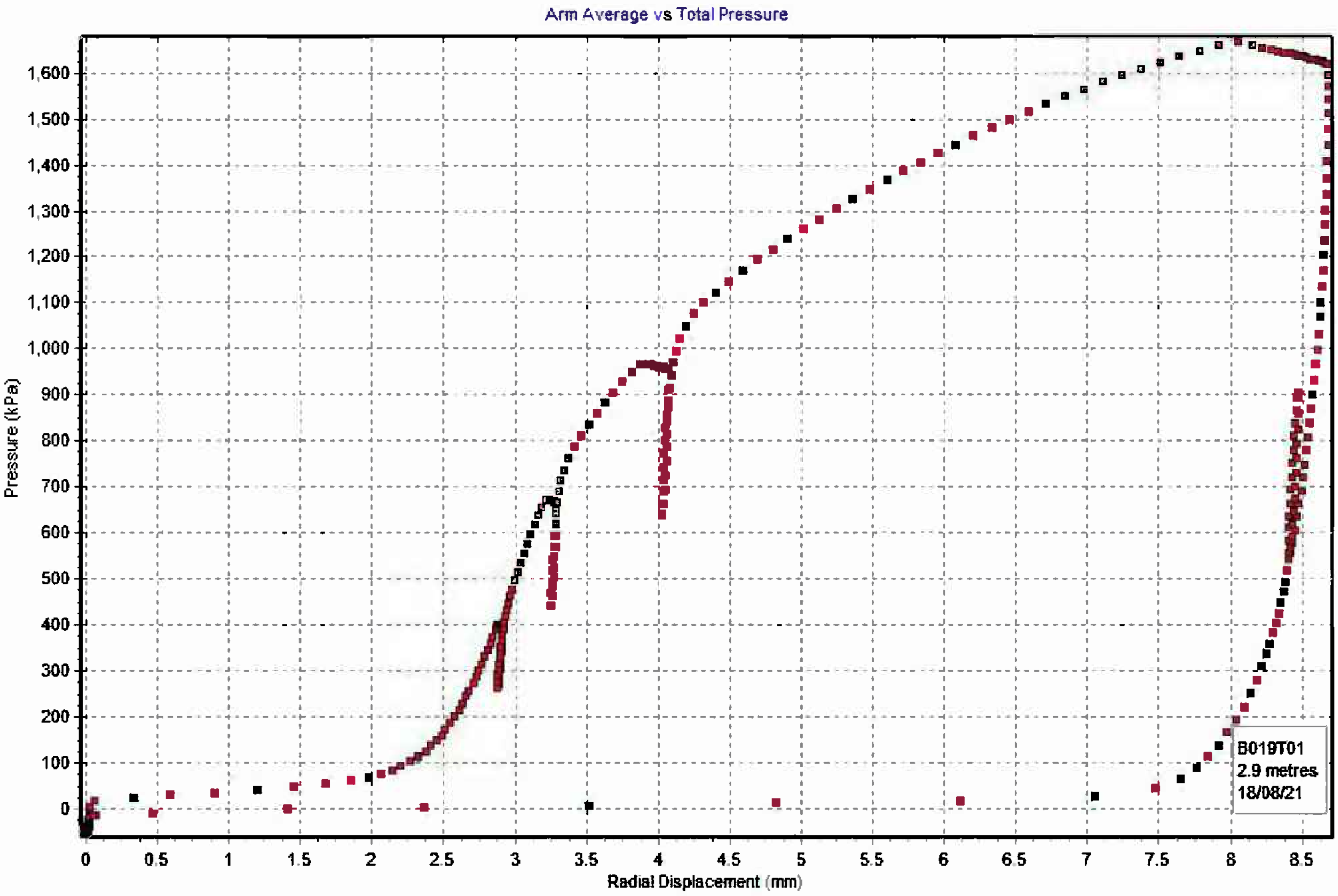
95mm High Pressure Dilatometer
BH_STW_019A Test 1
2.90 Metres
18 Aug 21
RESULTS:
Gradient (beta) : 0.619
Intercept (n) : 15.237MPa
Shear stress constant : 9.431MPa


Bolton and Whittle (1999) Loop 4 : Arm ave
95mm High Pressure Dilatometer
BH_STW_019A Test 1
2.90 Metres
18 Aug 21
RESULTS:
Gradient (beta) : 0.556
Intercept (n) : 10.814MPa
Shear stress constant : 6.017MPa
Ln[Radial stress]
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
Ln[shear strain]
-9
-8
-7
Source data - Loop 4
Total pressure (kPa)
900
800
700
600
Radial Displacement (mm)
8.4
8.42
8.44
8.46


Variation of stiffness with strain, undrained analysis : Arm ave
POWER LAW PARAMETERS:
Cycle Constant Gradient
No. (MPa)
1 10.666 0.733
2 10.706 0.662
3 9.431 0.619
4 6.017 0.556
95mm High Pressure Dilatometer
BH_STW_019A Test 1
2.90 Metres
18 Aug 21
Shear modulus (MPa)
370
360
350
340
330
320
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
Log plane shear strain
0.0001
0.001


Carter et al 1986 (adapted 2010) for c'-phi material : Arm ave
95mm High Pressure Dilatometer
BH_STW_019A Test 1
2.90 Metres
18 Aug 21
CURVE FIT PARAMETERS:
Origin : 2.810mm
Po : 91.0kPa
Cohesion : 20kPa
Phi peak : 34.3°
Dilation : 2.7°
Yield stress : 259kPa
Limit pressure : 3213kPa
Elastic exponent : 0.619
Gs at first yield : 96.7MPa
Janbu exponent : 0.146
Correlation : 0.549
Estimated PWP : 0.0kPa
Phi cv : 32.0°
Poisson's ratio : 0.25
Total pressure (kPa)
1,650
1,600
1,550
1,500
1,450
1,400
1,350
1,300
1,250
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
Cavity strain (%)
-1
0
1
2
3
4
5
6
7
8
9
10


All Arms vs Total Pressure
Arm 1
Arm 2
Arm 3
Arm 4
Arm 5
Arm 6
BH19T01
12.9 metres
18/08/21
Pressure (kPa)
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
0
Radial Displacement (mm)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361

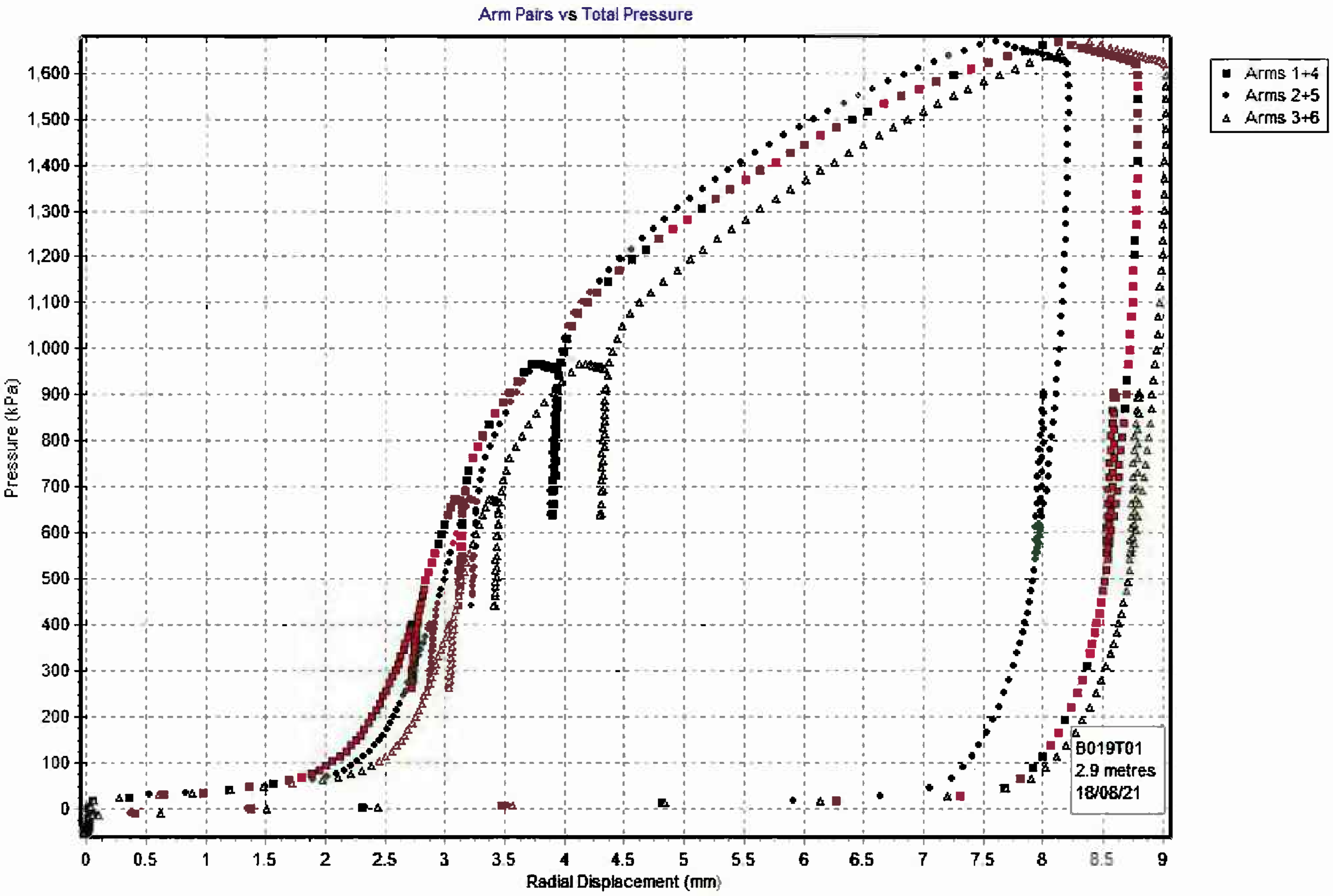


CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel +44 (0)1223 262361

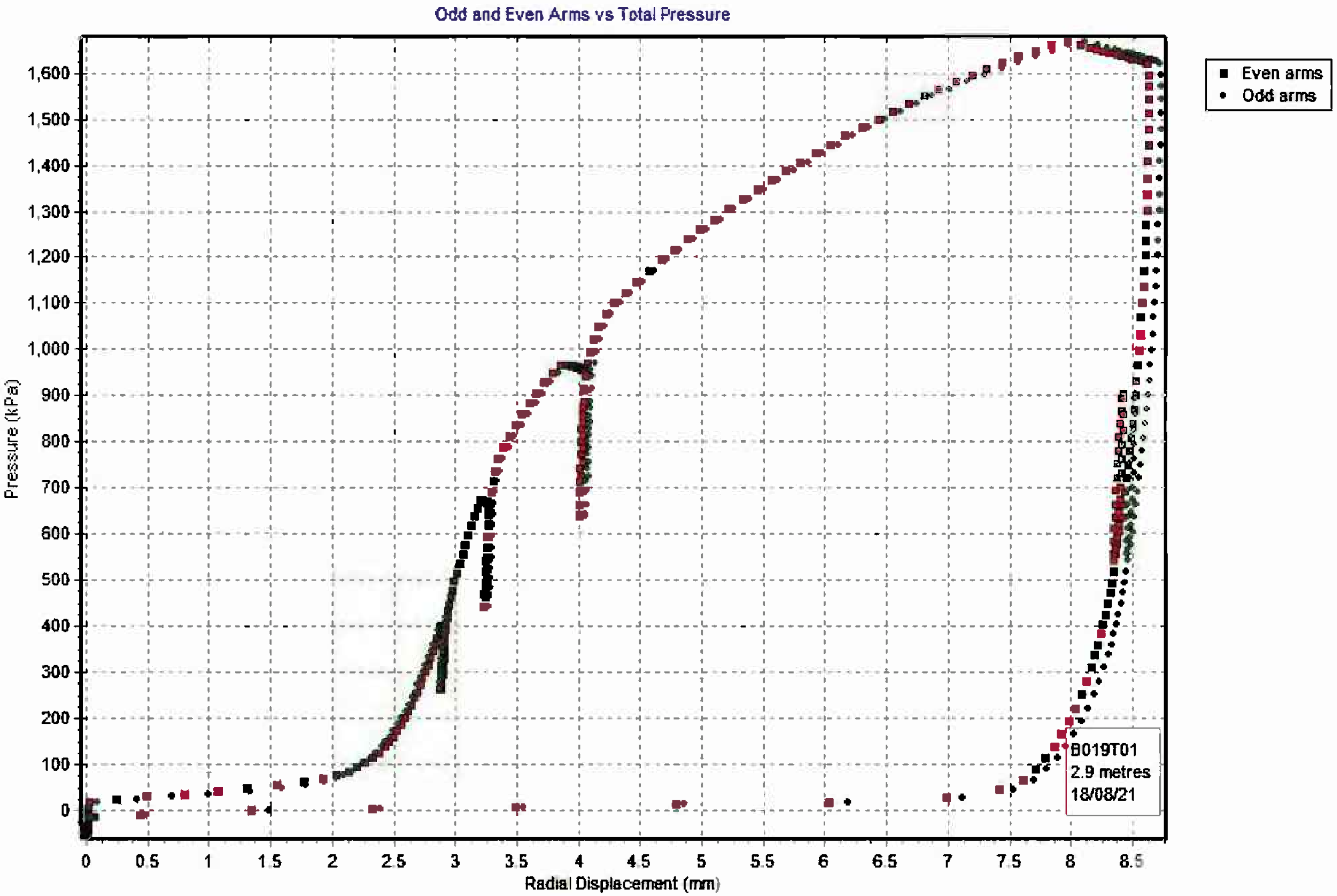
CIR1506/21

Cambridge WWTPR

Pressuremeter Testing



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel: +44 (0)1223 262361



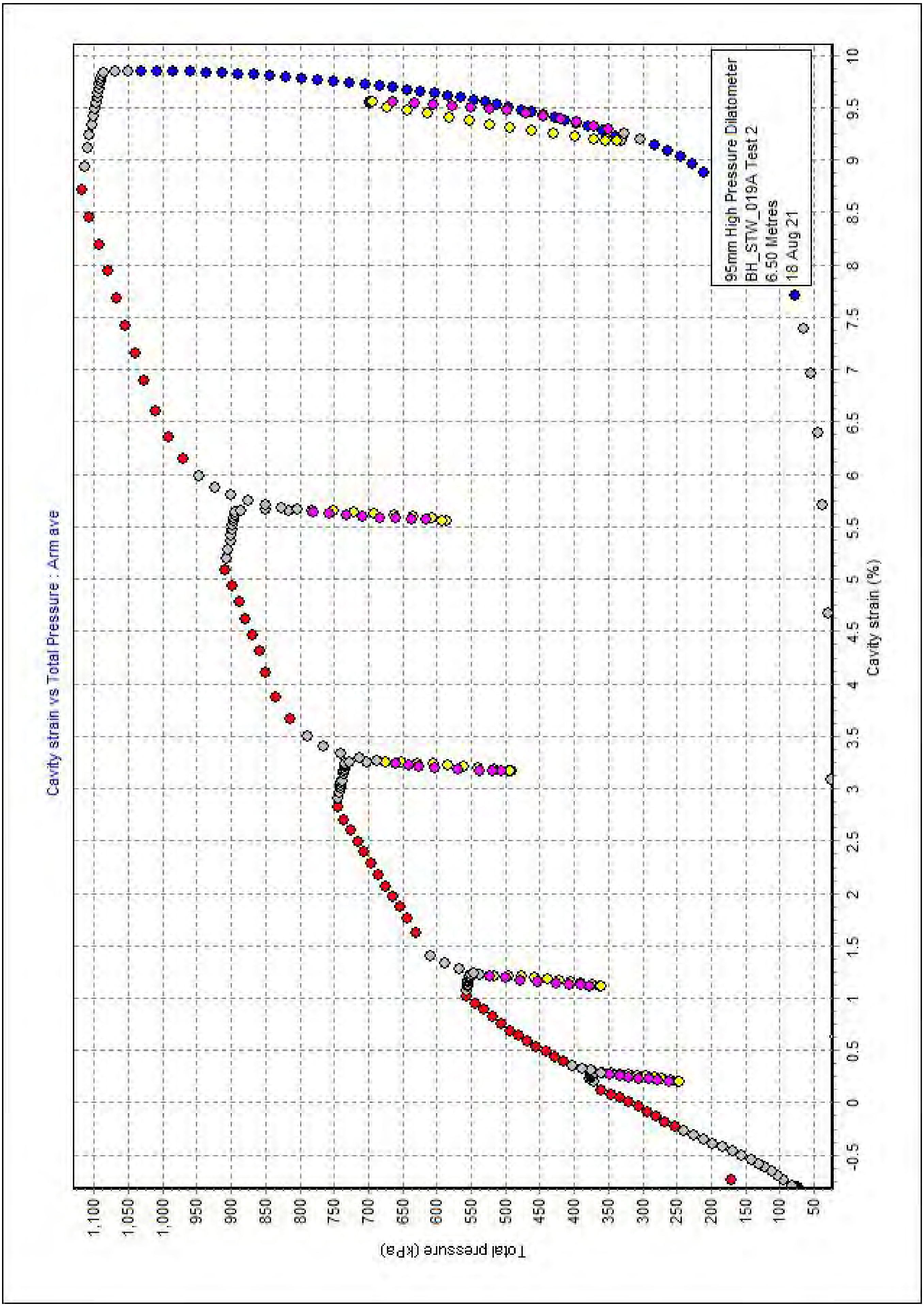
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361

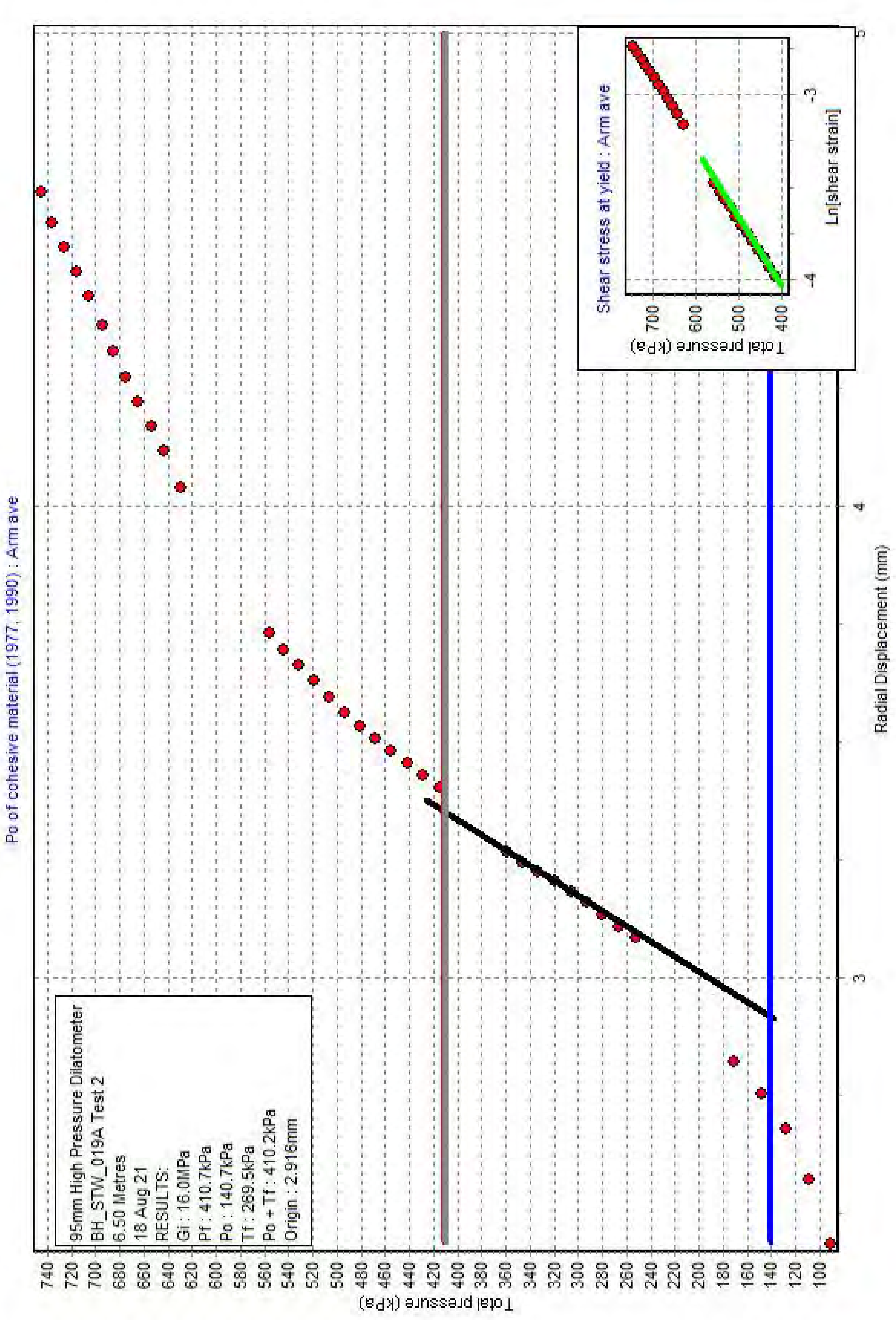
```
BH_STW_019A Test 2 - SUMMARY OF RESULTS
[File made with WinSitu ]

[DETAILS OF TEST]
Project         :   TE8364
Site            :   Cambridge Waste Water Treatment Plant Relocation Project
Borehole        :   BH_STW_019A
Test name       :   BH_STW_019A Test 2
Test date       :   18 Aug 21
Test depth      :   6.50 Metres
Water table     :   2.4 Metres
Ambient PWP     :   27.0 kPa
Material        :   Structureless Chalk
Probe           :   95mm High Pressure Dilatometer
Diameter        :   97.0 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out
The file includes results from a curve fitting analysis

Analysed by ES/RW on 19 Aug 21

Remarks:

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm)                  :   "Arm ave=3.20"
Po from Marsland & Randolph (kPa)   :   "Arm ave=140.7"
Best estimate of Po (kPa)           :   "Arm ave=113.0"

[UNDRAINED STRENGTH PARAMETERS]
Undrained yield stress (kPa)        :   "Arm ave=410.7"

[DRAINED ANALYSIS OF SANDS]
[Hughes et al 1977]
Constant volume friction angle (°)  :   28.0
Angle of internal friction (°)      :   "Arm ave=29.6"
Dilation angle (°)                  :   "Arm ave=1.8"
Gradient of log-log plot            :   "Arm ave=0.341"

[Withers et al 1989]
Angle of internal friction (°)      :   "Arm ave=27.7"
Dilation angle (°)                  :   "Arm ave=-0.4"
Gradient of log-log plot            :   "Arm ave=-1.751"

[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=16.0"
Axis        Loop   Value    Mean Strain  Mean Pc  dE      dPc
            No     (MPa)    (%)          (kPa)    (%)     (kPa)
Arm ave     1      62.7     0.252        297      0.160   101
Arm ave     2      80.6     1.176        442      0.196   158
Arm ave     3      106.1    3.218        584      0.172   183
Arm ave     4      110.9    5.615        686      0.179   198
Arm ave     5      58.9     9.400        514      0.612   361

[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]
Axis        Loop   Intercept  Alpha      Gradient
            No     (MPa)      (MPa)
Arm ave     1      11.144     8.079      0.725
Arm ave     2      10.138     6.691      0.660
Arm ave     3      20.454     14.739     0.721
Arm ave     4      13.856     9.148      0.660
Arm ave     5      5.751      3.003      0.522


[PARAMETERS USED FOR DRAINED CURVE MODELLING]
{Axis is  Arm ave}
Strain Origin (mm)                  :   3.20
Po (kPa)                            :   113
Cohesion (kPa)                      :   46
Angle of peak friction (deg)        :   29.6
```

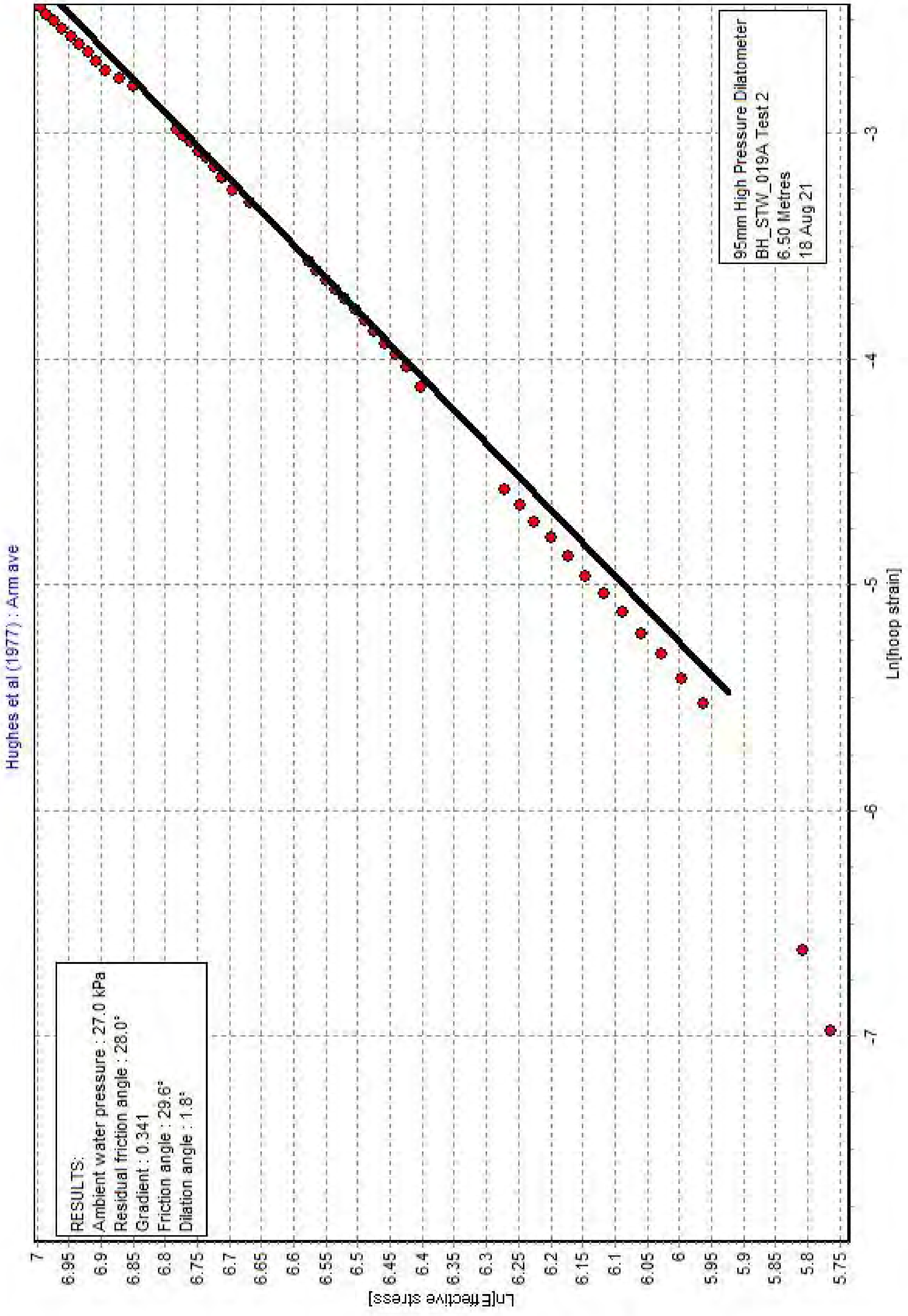
BH_STW_019A Test 2 - SUMMARY OF RESULTS

Angle of peak dilation (deg) : 1.8
Total yield stress (kPa) : 281
Total limit stress (kPa) : 2085
G at first yield (MPa) : 38.3
Non-linear exponent : 0.660
Janbu exponent : 0.295
Correlation : 0.309

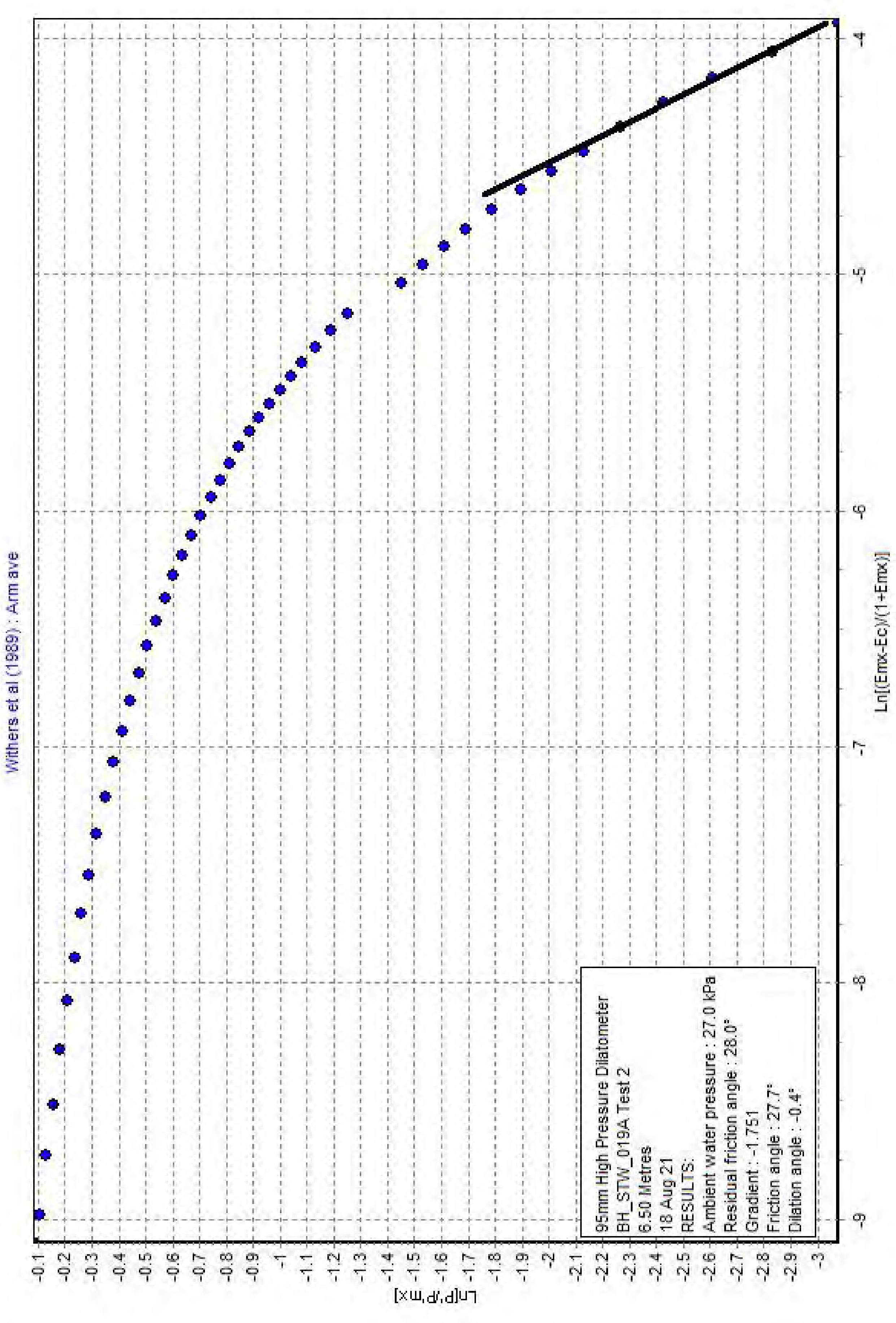
Ambient pore water pressure (kPa) : 27
Residual friction angle (deg) : 28.0
Poisson's ratio : 0.25

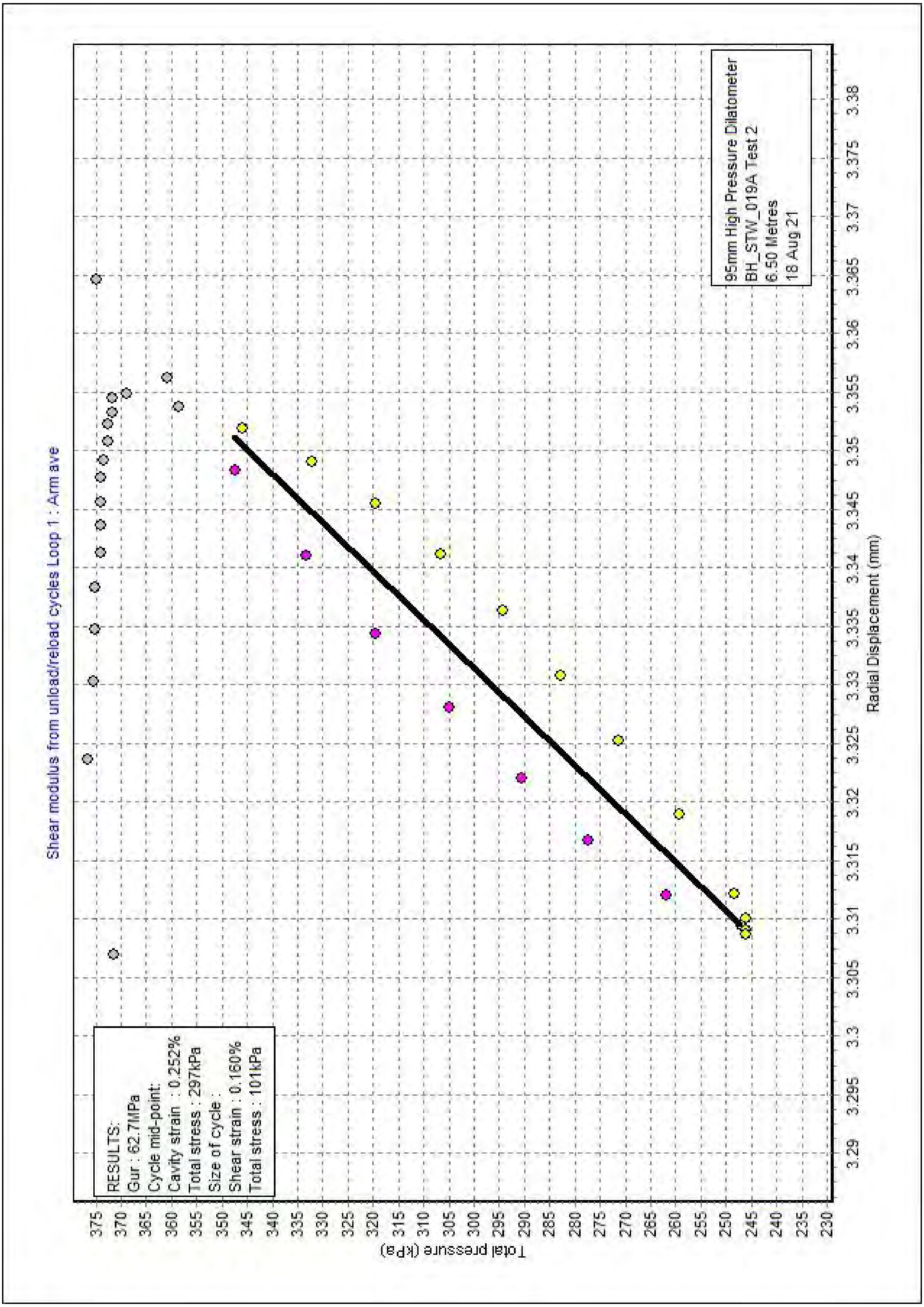

Cavity strain vs Total Pressure : Arm ave
95mm High Pressure Dilatometer
BH_STW_019A Test 2
6.50 Metres
18 Aug 21
Total pressure (kPa)
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
Cavity strain (%)
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10


Po of cohesive material (1977, 1990) : Arm ave
95mm High Pressure Dilatometer
BH_STW_019A Test 2
6.50 Metres
18 Aug 21
RESULTS:
Gi : 16.0MPa
Pf : 410.7kPa
Po : 140.7kPa
Tf : 269.5kPa
Po + Tf : 410.2kPa
Origin : 2.916mm
Total pressure (kPa)
740
720
700
680
660
640
620
600
580
560
540
520
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
Radial Displacement (mm)
3
4
5
Shear stress at yield : Arm ave
Total pressure (kPa)
700
600
500
400
Ln[shear strain]
-4
-3

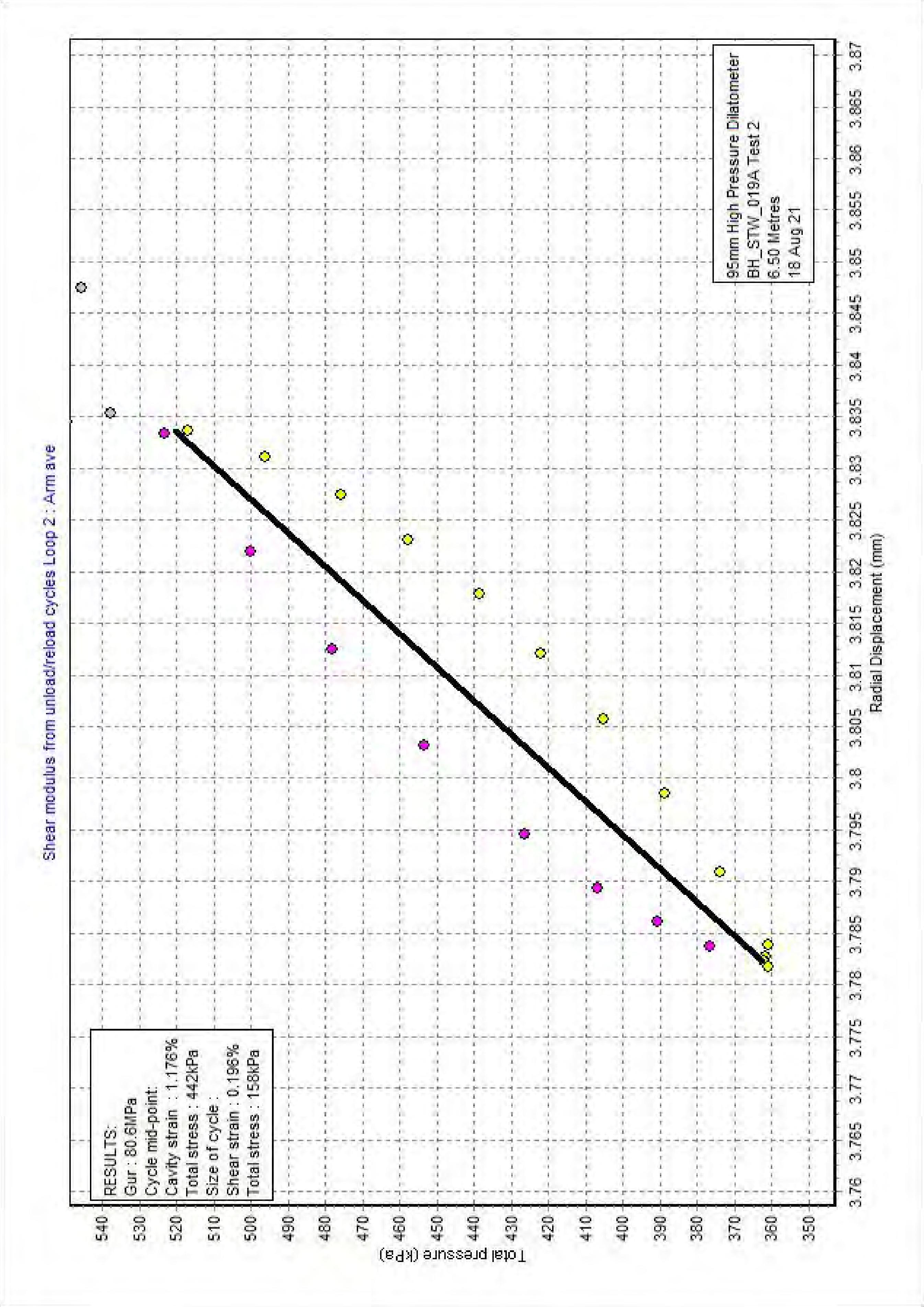


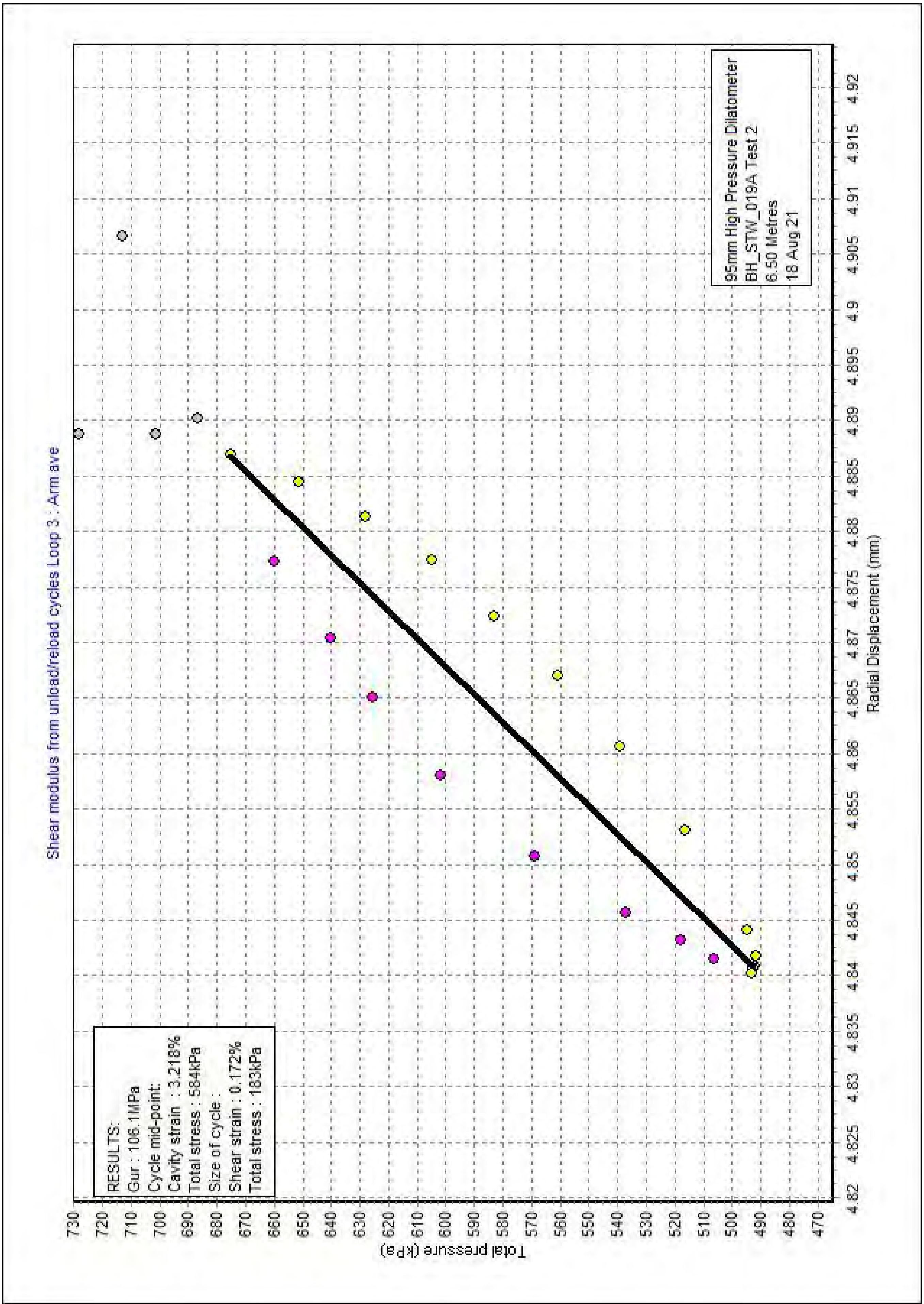
RESULTS:
Ambient water pressure : 27.0 kPa
Residual friction angle : 28.0°
Gradient : 0.341
Friction angle : 29.6°
Dilation angle : 1.8°

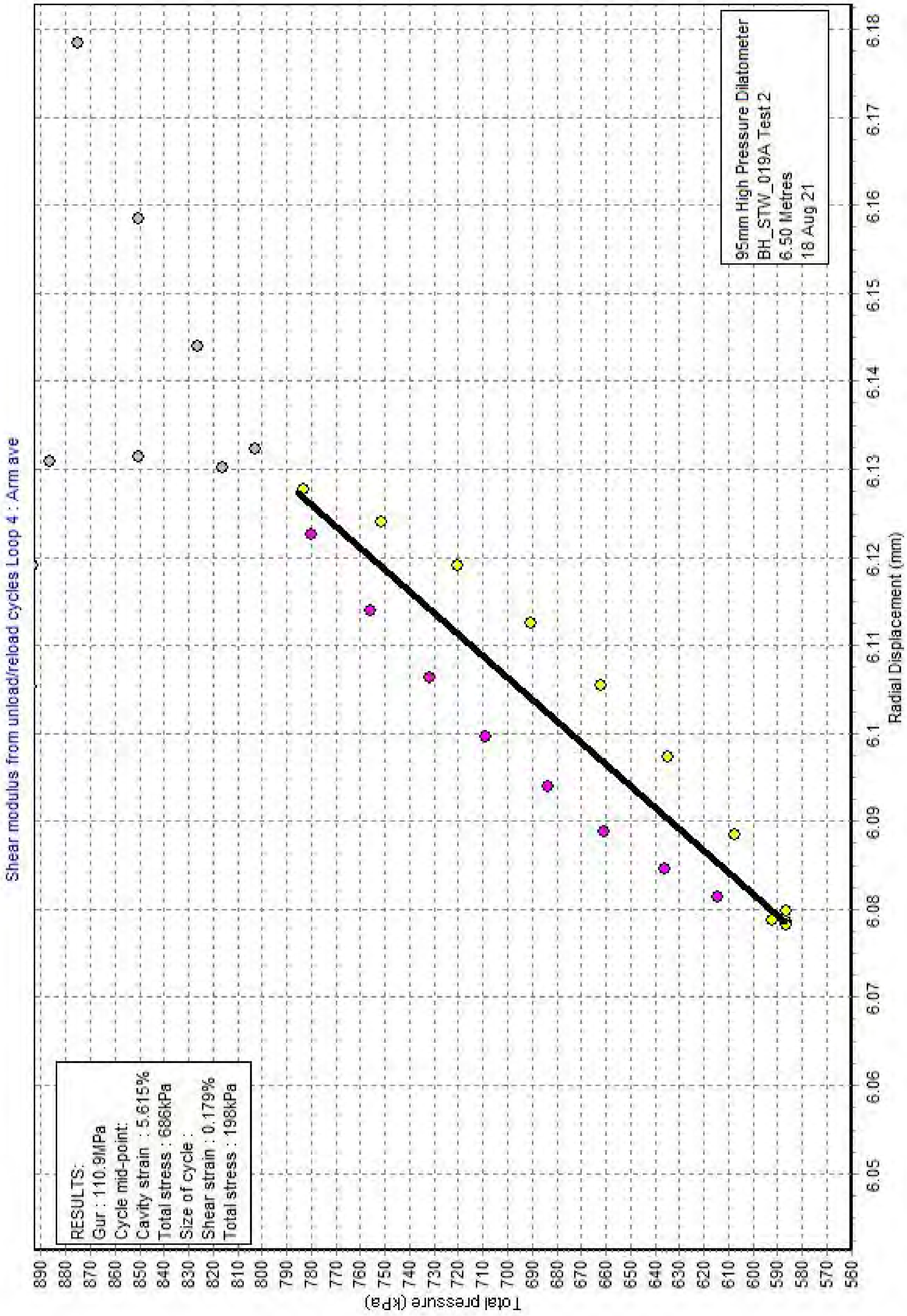

Withers et al (1989) : Arm ave
95mm High Pressure Dilatometer
BH_STW_019A Test 2
6.50 Metres
18 Aug 21
RESULTS:
Ambient water pressure : 27.0 kPa
Residual friction angle : 28.0°
Gradient : -1.751
Friction angle : 27.7°
Dilation angle : -0.4°
Ln[P'/P'mx]
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1
-1.1
-1.2
-1.3
-1.4
-1.5
-1.6
-1.7
-1.8
-1.9
-2
-2.1
-2.2
-2.3
-2.4
-2.5
-2.6
-2.7
-2.8
-2.9
-3
Ln[(Emx-Ec)/(1+Emx)]
-4
-5
-6
-7
-8
-9

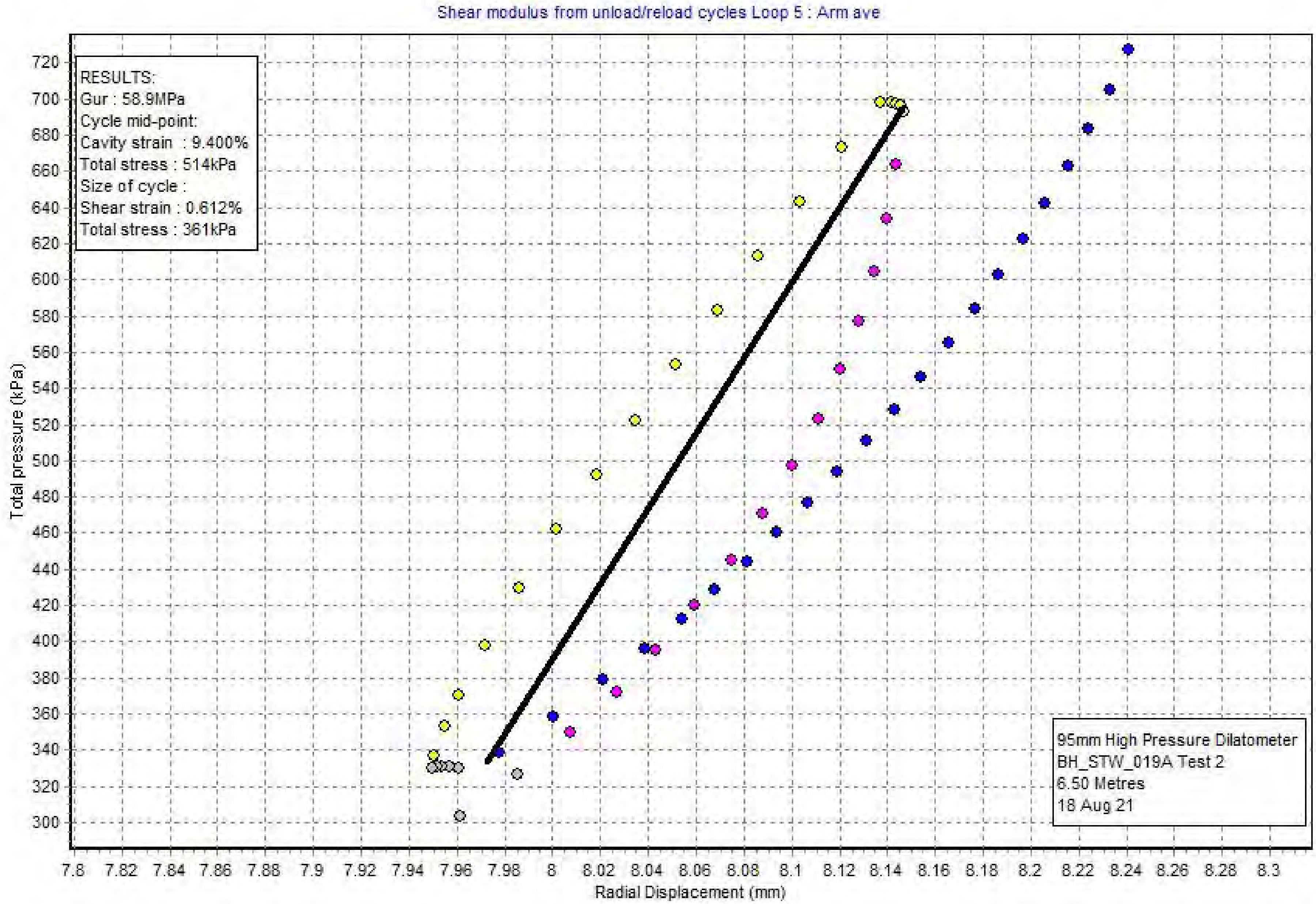


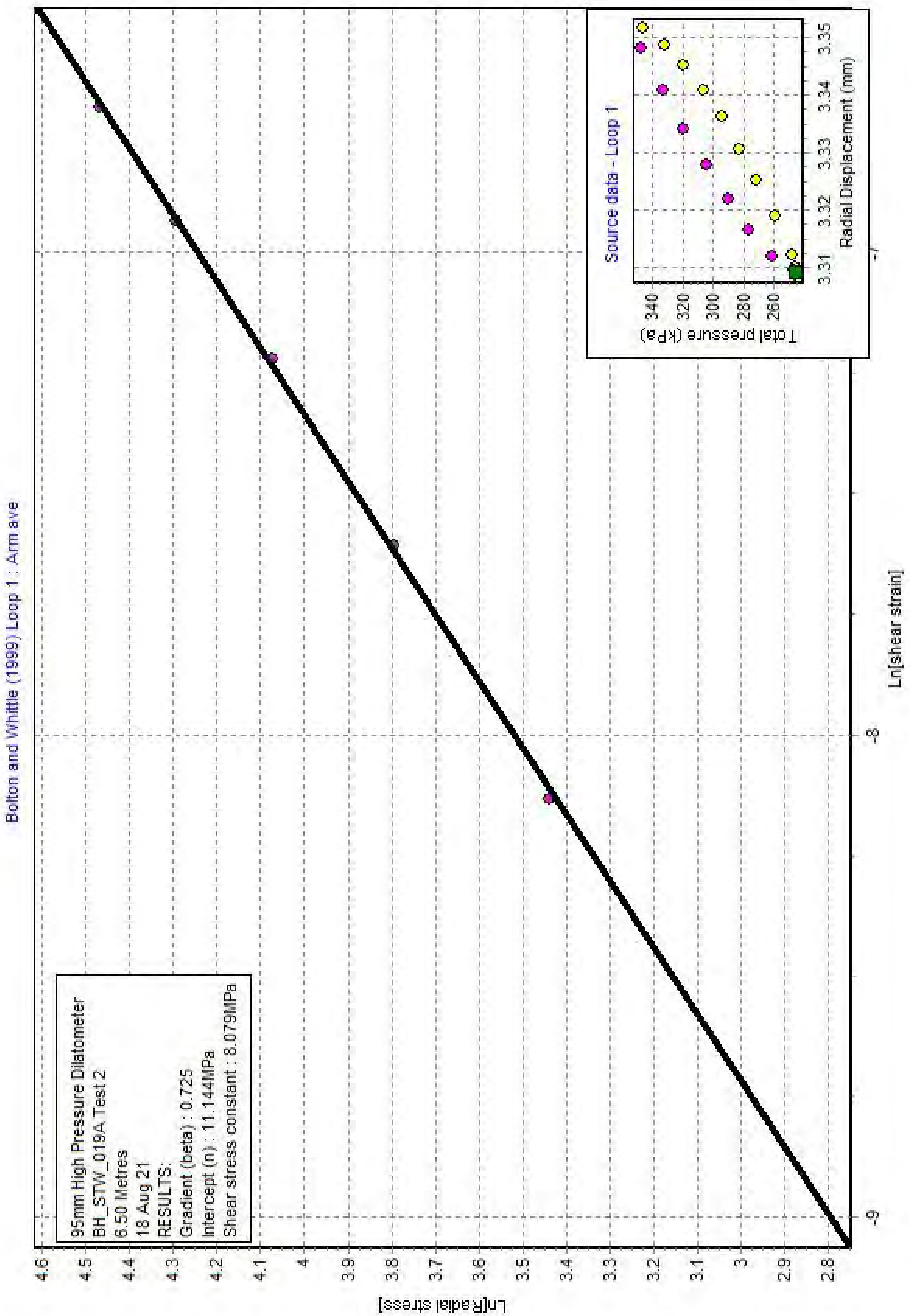
RESULTS:
Gur : 62.7MPa
Cycle mid-point:
Cavity strain : 0.252%
Total stress : 297kPa
Size of cycle :
Shear strain : 0.160%
Total stress : 101kPa

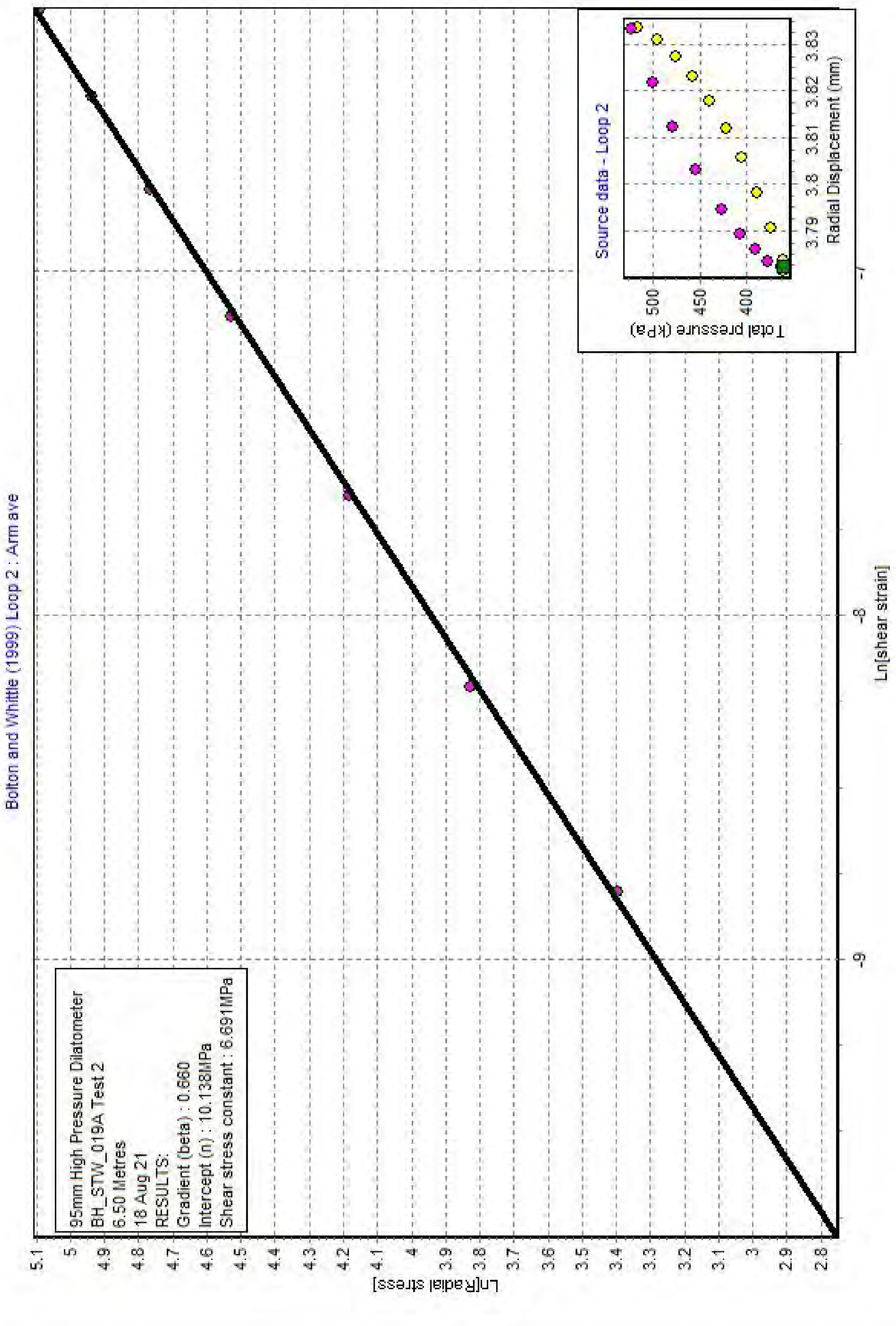

Shear modulus from unload/reload cycles Loop 2 : Arm ave
Total pressure (kPa)
350
360
370
380
390
400
410
420
430
440
450
460
470
480
490
500
510
520
530
540
Radial Displacement (mm)
3.76
3.765
3.77
3.775
3.78
3.785
3.79
3.795
3.8
3.805
3.81
3.815
3.82
3.825
3.83
3.835
3.84
3.845
3.85
3.855
3.86
3.865
3.87
95mm High Pressure Dilatometer
BH_STW_019A Test 2
6.50 Metres
18 Aug 21
RESULTS:
Gur : 80.6MPa
Cycle mid-point:
Cavity strain : 1.176%
Total stress : 442kPa
Size of cycle :
Shear strain : 0.196%
Total stress : 158kPa

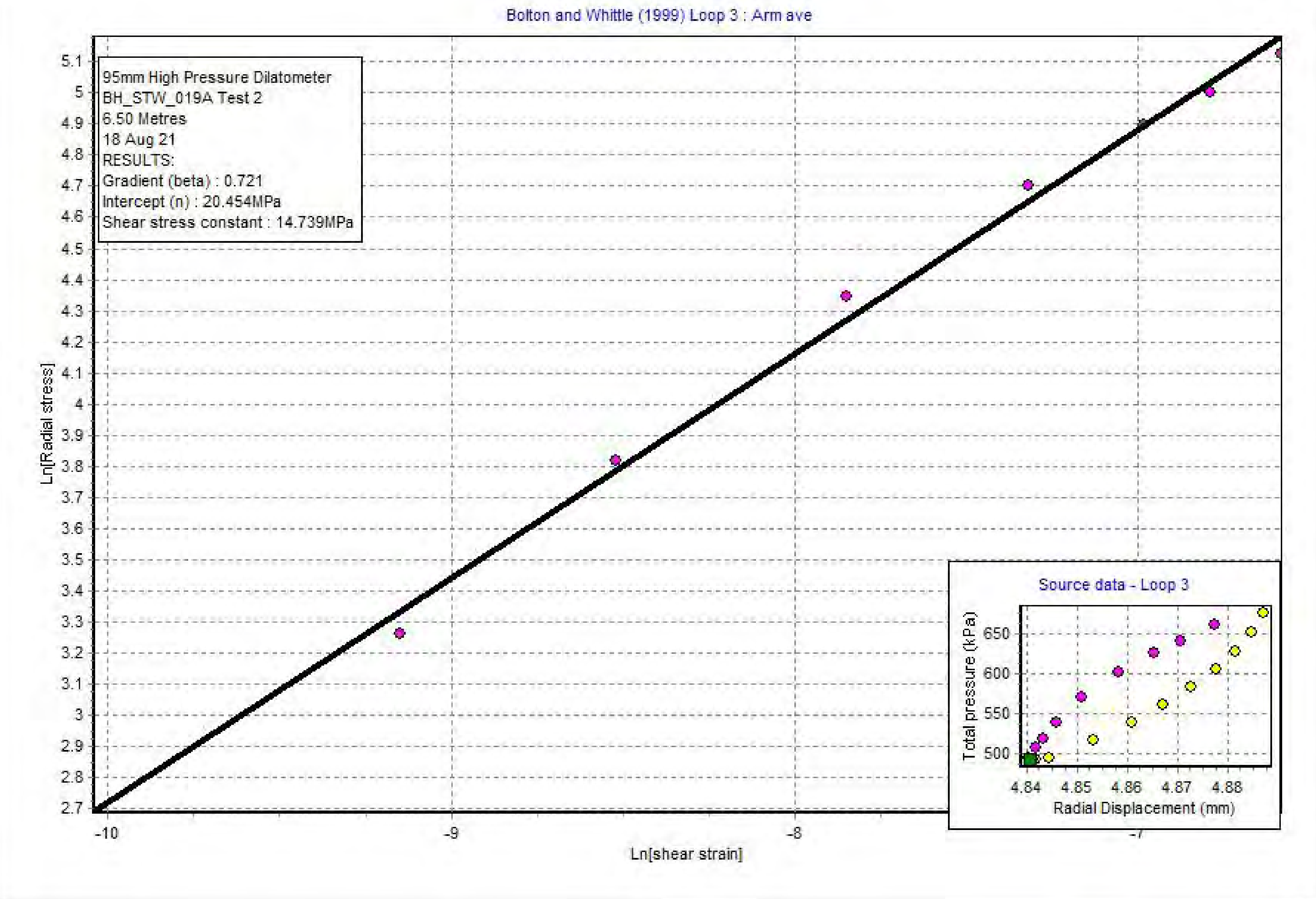

Shear modulus from unload/reload cycles Loop 3 : Arm ave
95mm High Pressure Dilatometer
BH_STW_019A Test 2
6.50 Metres
18 Aug 21
RESULTS:
Gur : 106.1MPa
Cycle mid-point:
Cavity strain : 3.218%
Total stress : 584kPa
Size of cycle :
Shear strain : 0.172%
Total stress : 183kPa
Total pressure (kPa)
730
720
710
700
690
680
670
660
650
640
630
620
610
600
590
580
570
560
550
540
530
520
510
500
490
480
470
Radial Displacement (mm)
4.82
4.825
4.83
4.835
4.84
4.845
4.85
4.855
4.86
4.865
4.87
4.875
4.88
4.885
4.89
4.895
4.9
4.905
4.91
4.915
4.92

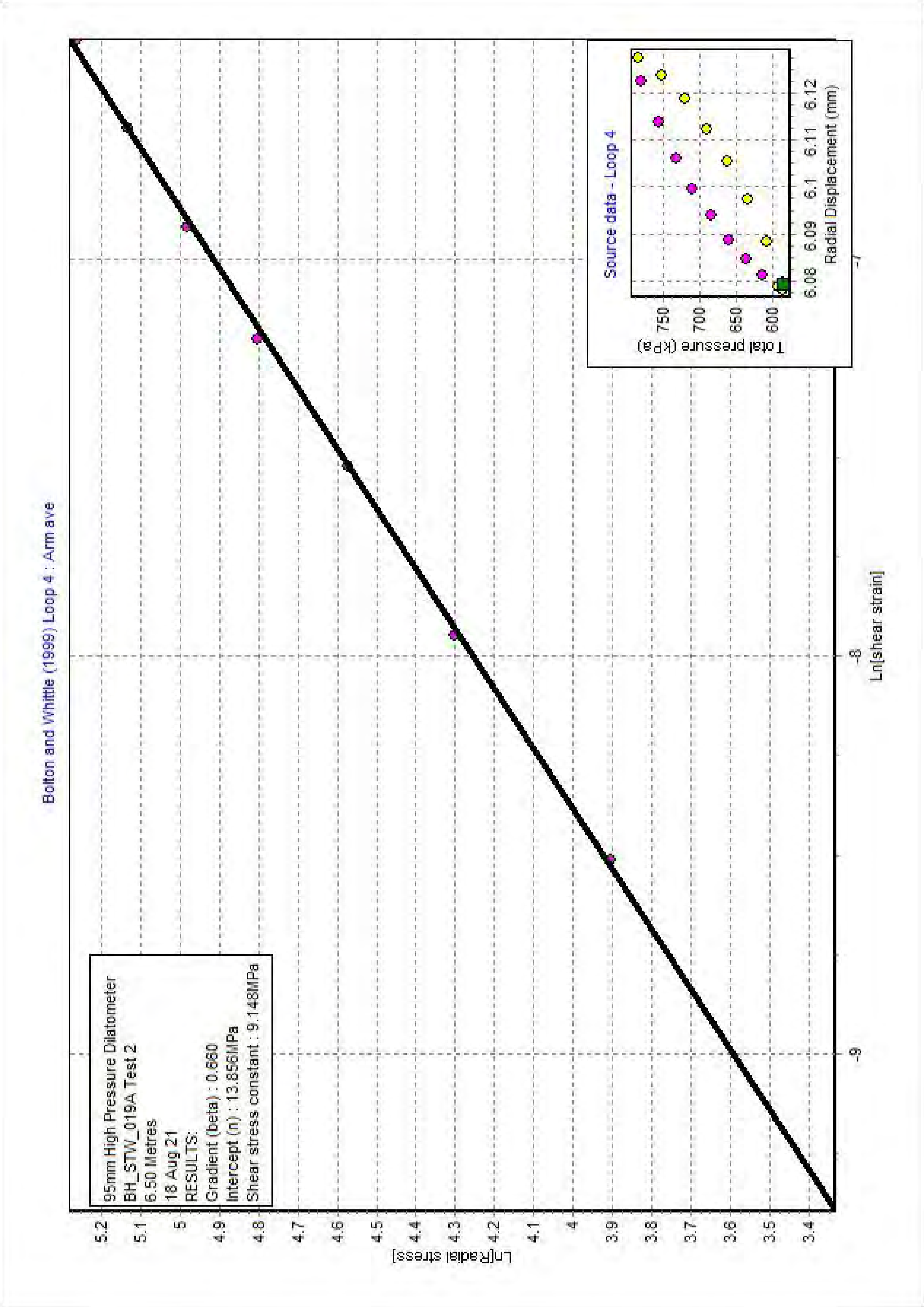

Shear modulus from unload/reload cycles Loop 4 : Arm ave
95mm High Pressure Dilatometer
BH_STW_019A Test 2
6.50 Metres
18 Aug 21
RESULTS:
Gur : 110.9MPa
Cycle mid-point:
Cavity strain : 5.615%
Total stress : 686kPa
Size of cycle :
Shear strain : 0.179%
Total stress : 198kPa
Radial Displacement (mm)
6.05
6.06
6.07
6.08
6.09
6.1
6.11
6.12
6.13
6.14
6.15
6.16
6.17
6.18
Total pressure (kPa)
890
880
870
860
850
840
830
820
810
800
790
780
770
760
750
740
730
720
710
700
690
680
670
660
650
640
630
620
610
600
590
580
570
560


Shear modulus from unload/reload cycles Loop 5 : Arm ave
RESULTS:
Gur : 58.9MPa
Cycle mid-point:
Cavity strain : 9.400%
Total stress : 514kPa
Size of cycle :
Shear strain : 0.612%
Total stress : 361kPa
95mm High Pressure Dilatometer
BH_STW_019A Test 2
6.50 Metres
18 Aug 21
Total pressure (kPa)
720
700
680
660
640
620
600
580
560
540
520
500
480
460
440
420
400
380
360
340
320
300
Radial Displacement (mm)
7.8
7.82
7.84
7.86
7.88
7.9
7.92
7.94
7.96
7.98
8
8.02
8.04
8.06
8.08
8.1
8.12
8.14
8.16
8.18
8.2
8.22
8.24
8.26
8.28
8.3


Bolton and Whittle (1999) Loop 1 : Arm ave
95mm High Pressure Dilatometer
BH_STW_019A Test 2
6.50 Metres
18 Aug 21
RESULTS:
Gradient (beta) : 0.725
Intercept (n) : 11.144MPa
Shear stress constant : 8.079MPa
Ln[Radial stress]
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
Ln[shear strain]
-9
-8
-7
Source data - Loop 1
Total pressure (kPa)
340
320
300
280
260
Radial Displacement (mm)
3.31
3.32
3.33
3.34
3.35

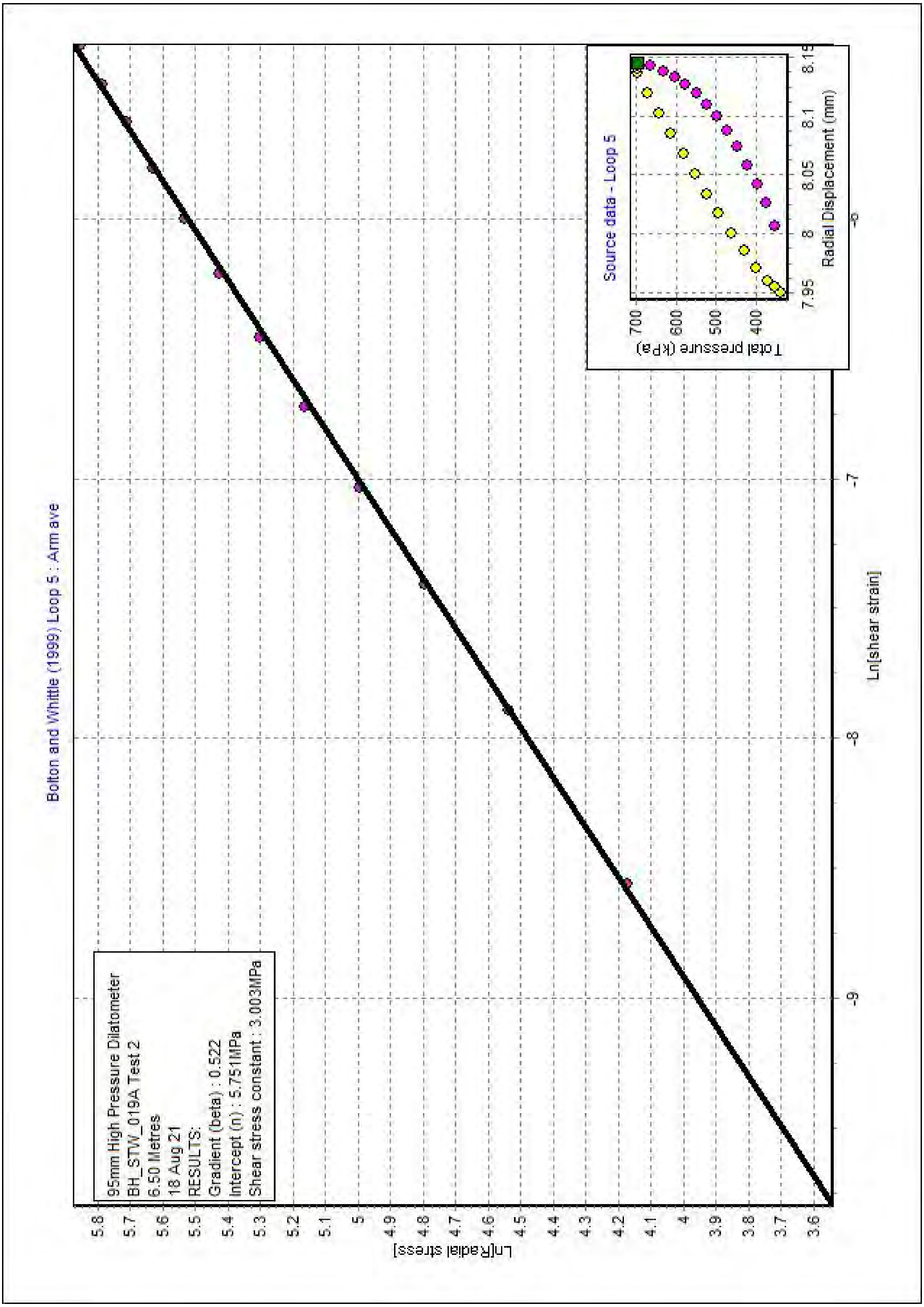

Bolton and Whittle (1999) Loop 2 : Arm ave
95mm High Pressure Dilatometer
BH_STW_019A Test 2
6.50 Metres
18 Aug 21
RESULTS:
Gradient (beta) : 0.660
Intercept (n) : 10.138MPa
Shear stress constant : 6.691MPa
Ln[Radial stress]
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
Ln[shear strain]
-9
-8
-7
Source data - Loop 2
Total pressure (kPa)
500
450
400
Radial Displacement (mm)
3.79
3.8
3.81
3.82
3.83

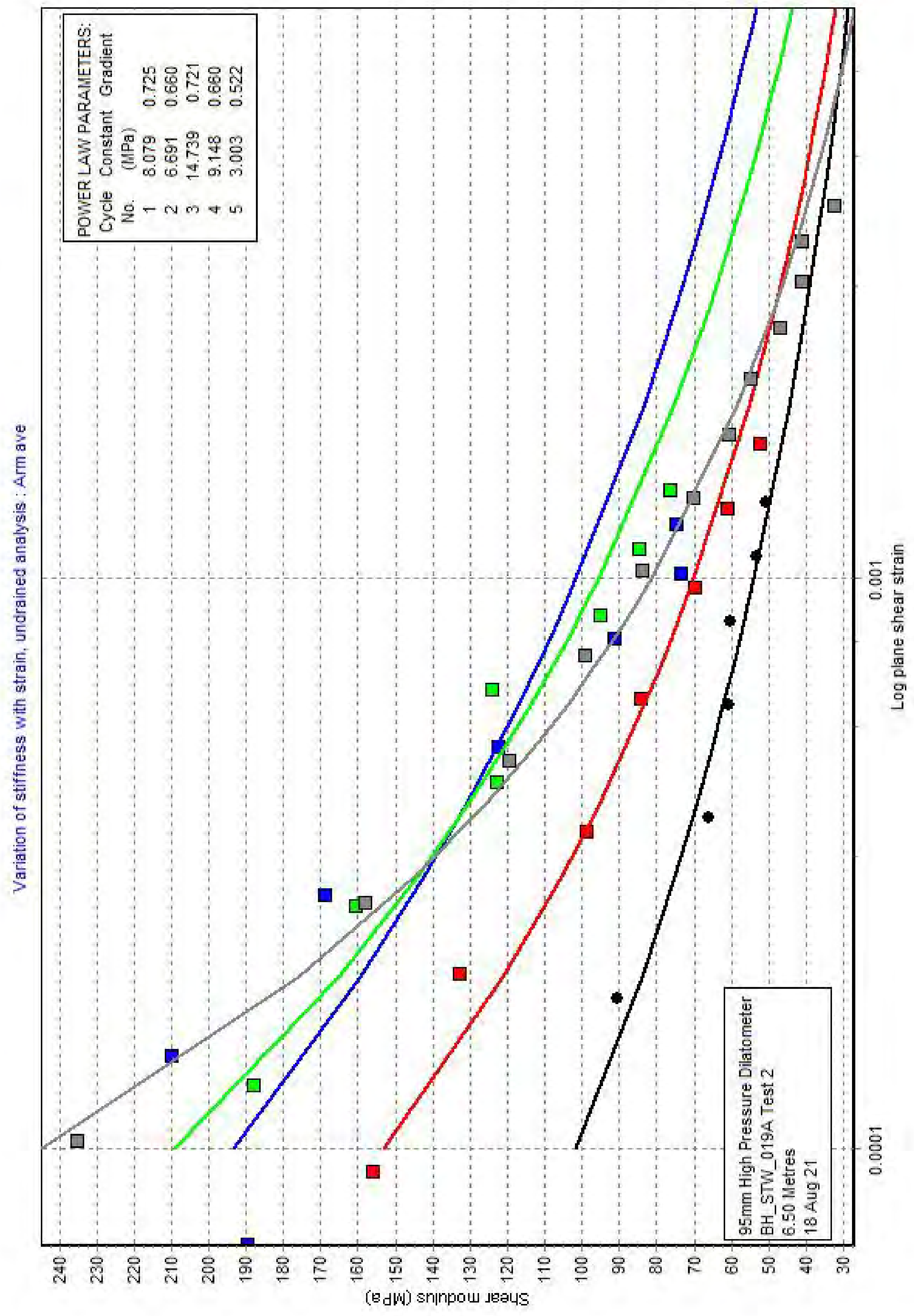

Bolton and Whittle (1999) Loop 3 : Arm ave
95mm High Pressure Dilatometer
BH_STW_019A Test 2
6.50 Metres
18 Aug 21
RESULTS:
Gradient (beta) : 0.721
Intercept (n) : 20.454MPa
Shear stress constant : 14.739MPa
Ln[Radial stress]
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
2.7
-10
-9
-8
-7
Ln[shear strain]
Source data - Loop 3
Total pressure (kPa)
650
600
550
500
4.84
4.85
4.86
4.87
4.88
Radial Displacement (mm)



Bolton and Whittle (1999) Loop 4 : Arm ave

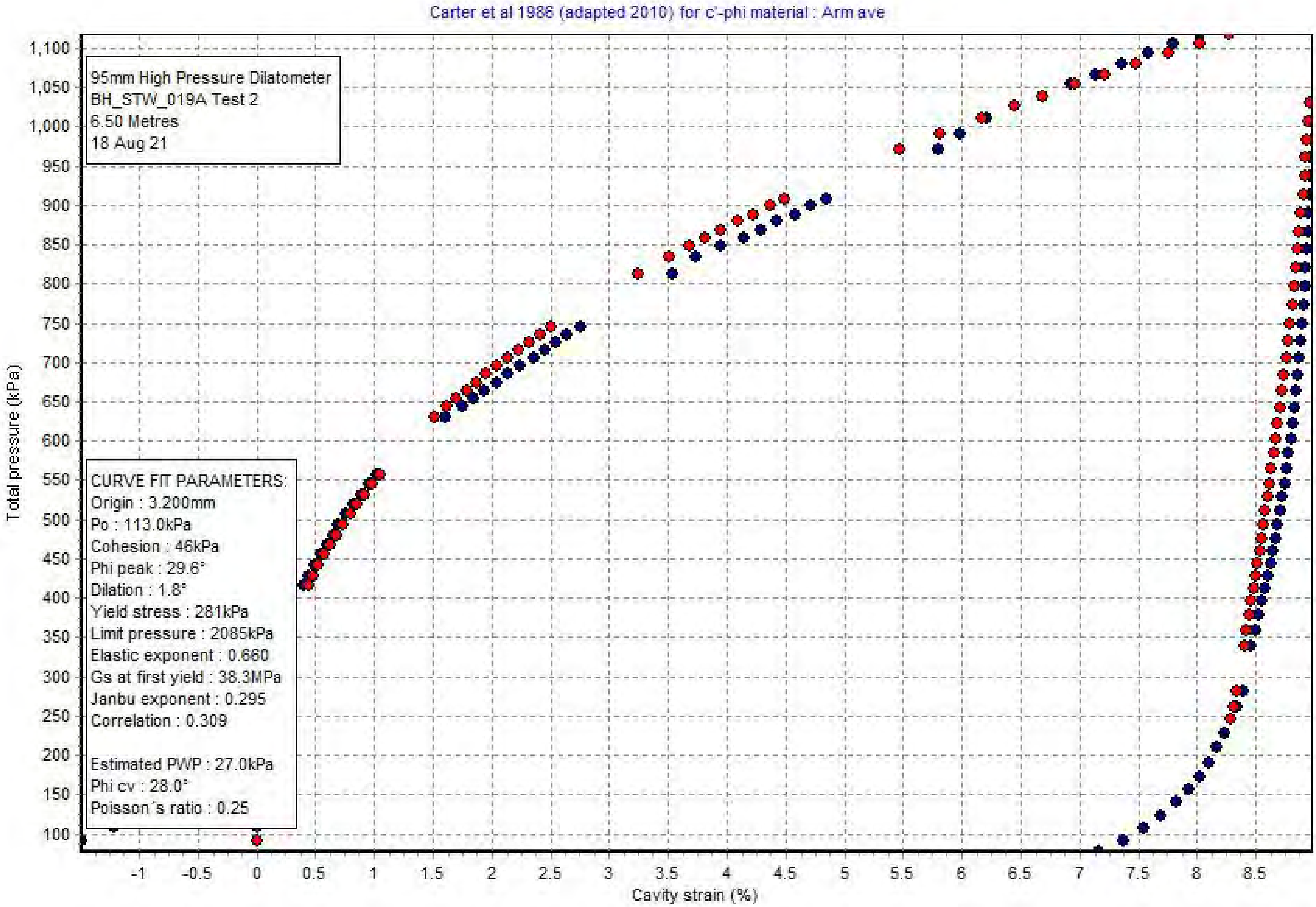
95mm High Pressure Dilatometer
BH_STW_019A Test 2
6.50 Metres
18 Aug 21
RESULTS:
Gradient (beta) : 0.660
Intercept (n) : 13.856MPa
Shear stress constant : 9.148MPa

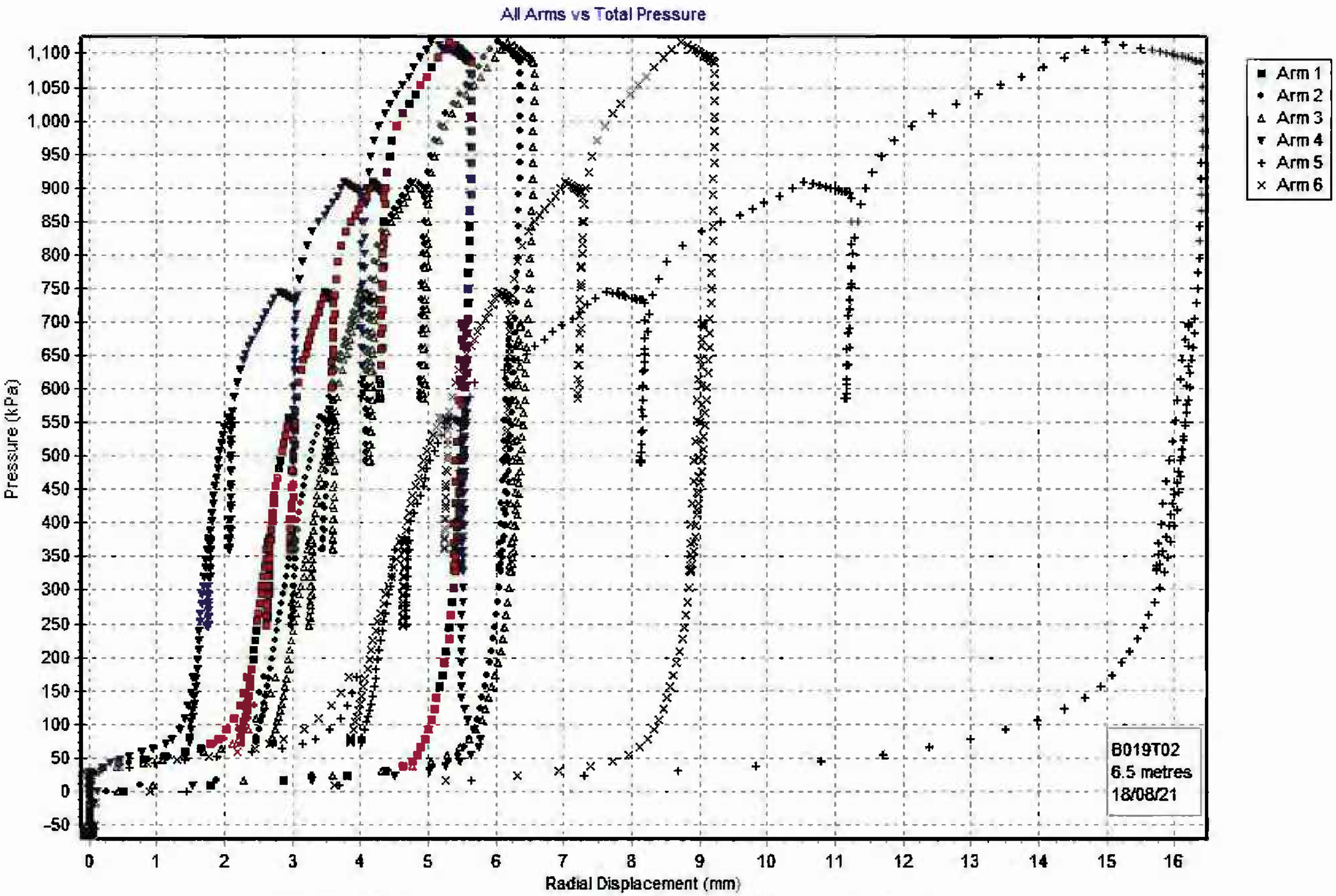

Bolton and Whittle (1999) Loop 5 : Arm ave
95mm High Pressure Dilatometer
BH_STW_019A Test 2
6.50 Metres
18 Aug 21
RESULTS:
Gradient (beta) : 0.522
Intercept (n) : 5.751MPa
Shear stress constant : 3.003MPa
Ln[Radial stress]
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
Ln[shear strain]
-9
-8
-7
-6
Source data - Loop 5
Total pressure (kPa)
700
600
500
400
Radial Displacement (mm)
7.95
8
8.05
8.1
8.15



POWER LAW PARAMETERS:

Cycle No.	Constant (MPa)	Gradient
1	8.079	0.725
2	6.691	0.660
3	14.739	0.721
4	9.148	0.660
5	3.003	0.522


Carter et al 1986 (adapted 2010) for c'-phi material : Arm ave
95mm High Pressure Dilatometer
BH_STW_019A Test 2
6.50 Metres
18 Aug 21
CURVE FIT PARAMETERS:
Origin : 3.200mm
Po : 113.0kPa
Cohesion : 46kPa
Phi peak : 29.6°
Dilation : 1.8°
Yield stress : 281kPa
Limit pressure : 2085kPa
Elastic exponent : 0.660
Gs at first yield : 38.3MPa
Janbu exponent : 0.295
Correlation : 0.309
Estimated PWP : 27.0kPa
Phi cv : 28.0°
Poisson´s ratio : 0.25
Total pressure (kPa)
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
-1
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
Cavity strain (%)



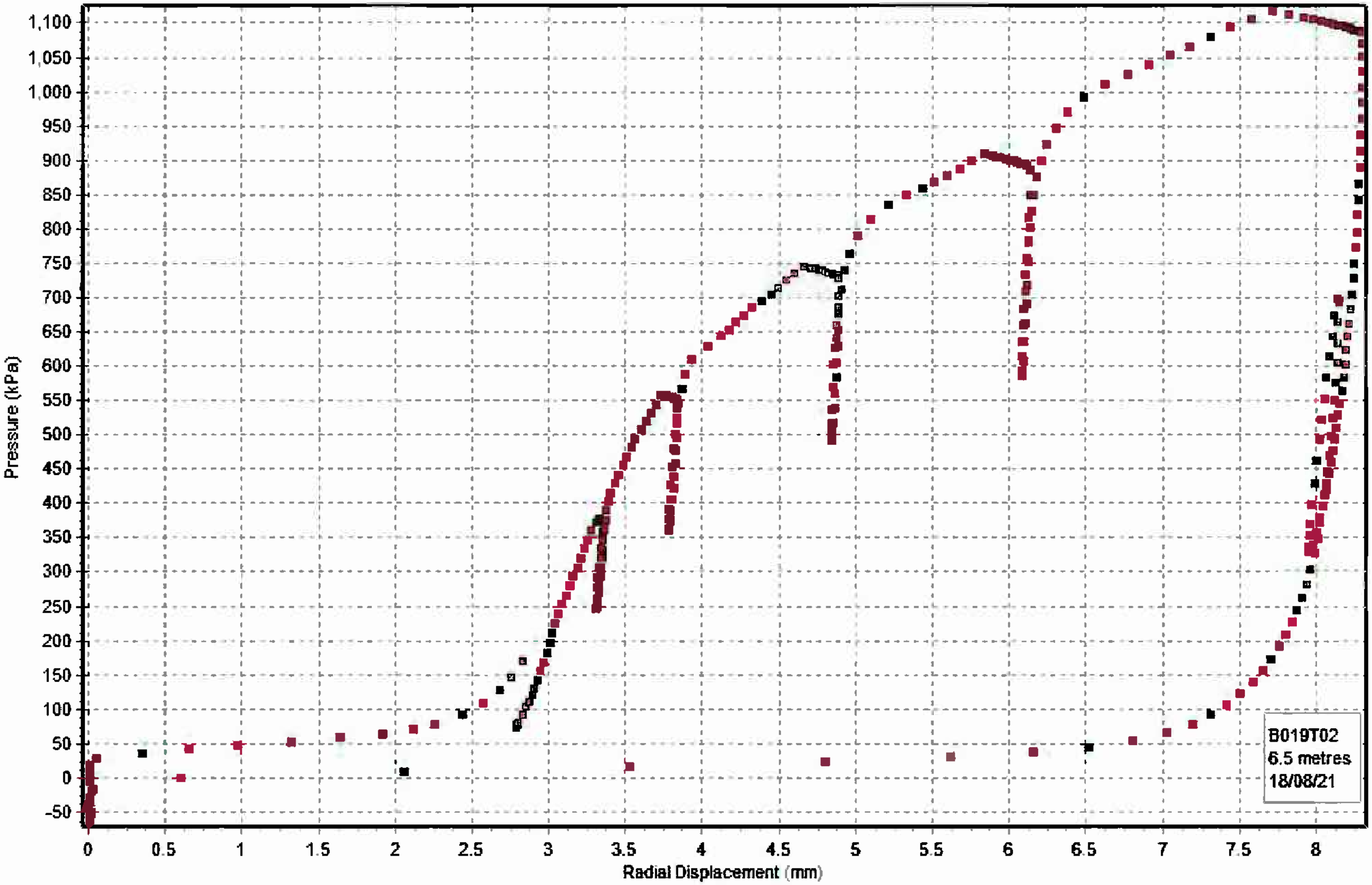
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel +44 (0)1223 262361

CIR1506/21

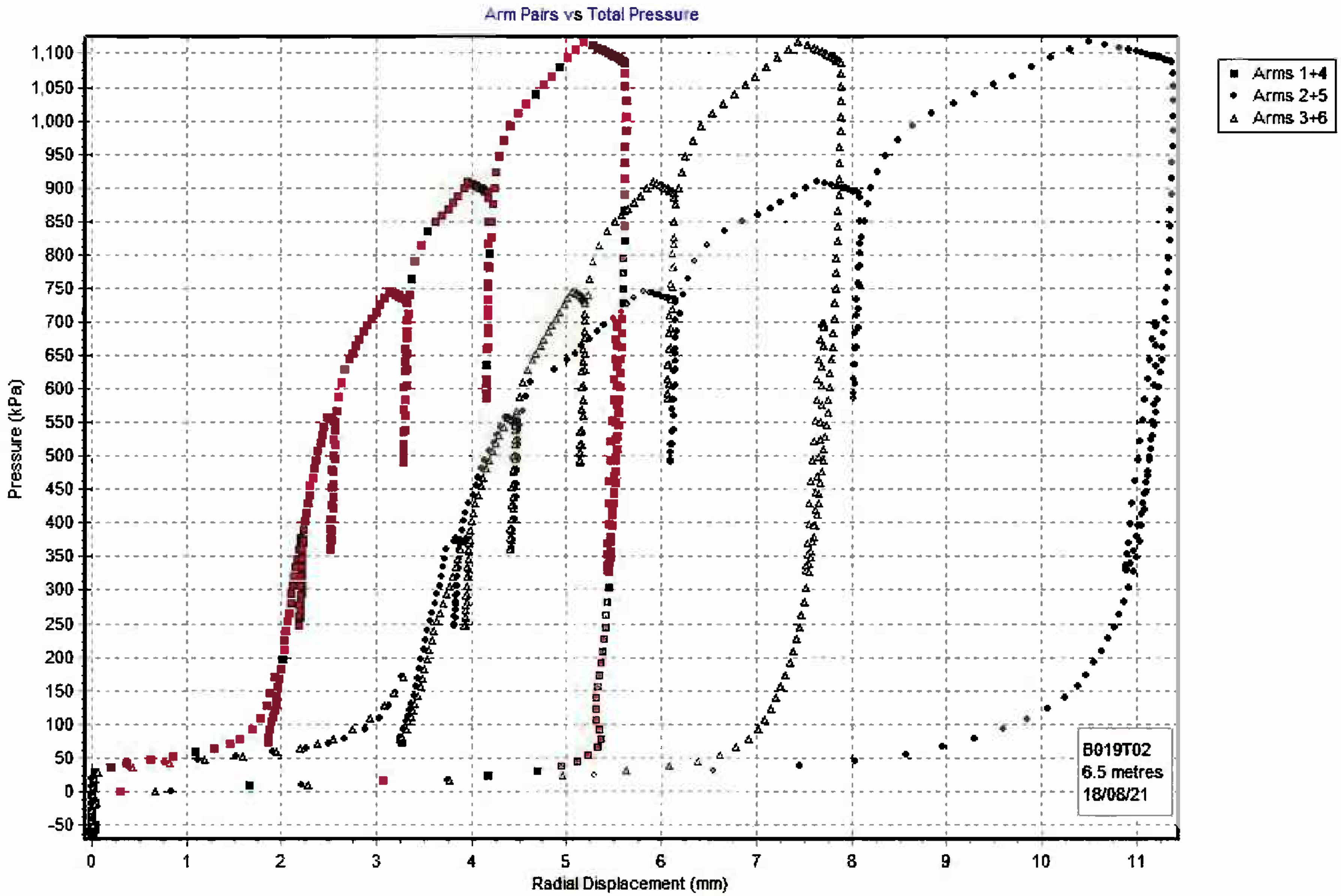
Cambridge WWTPR

Pressuremeter Testing

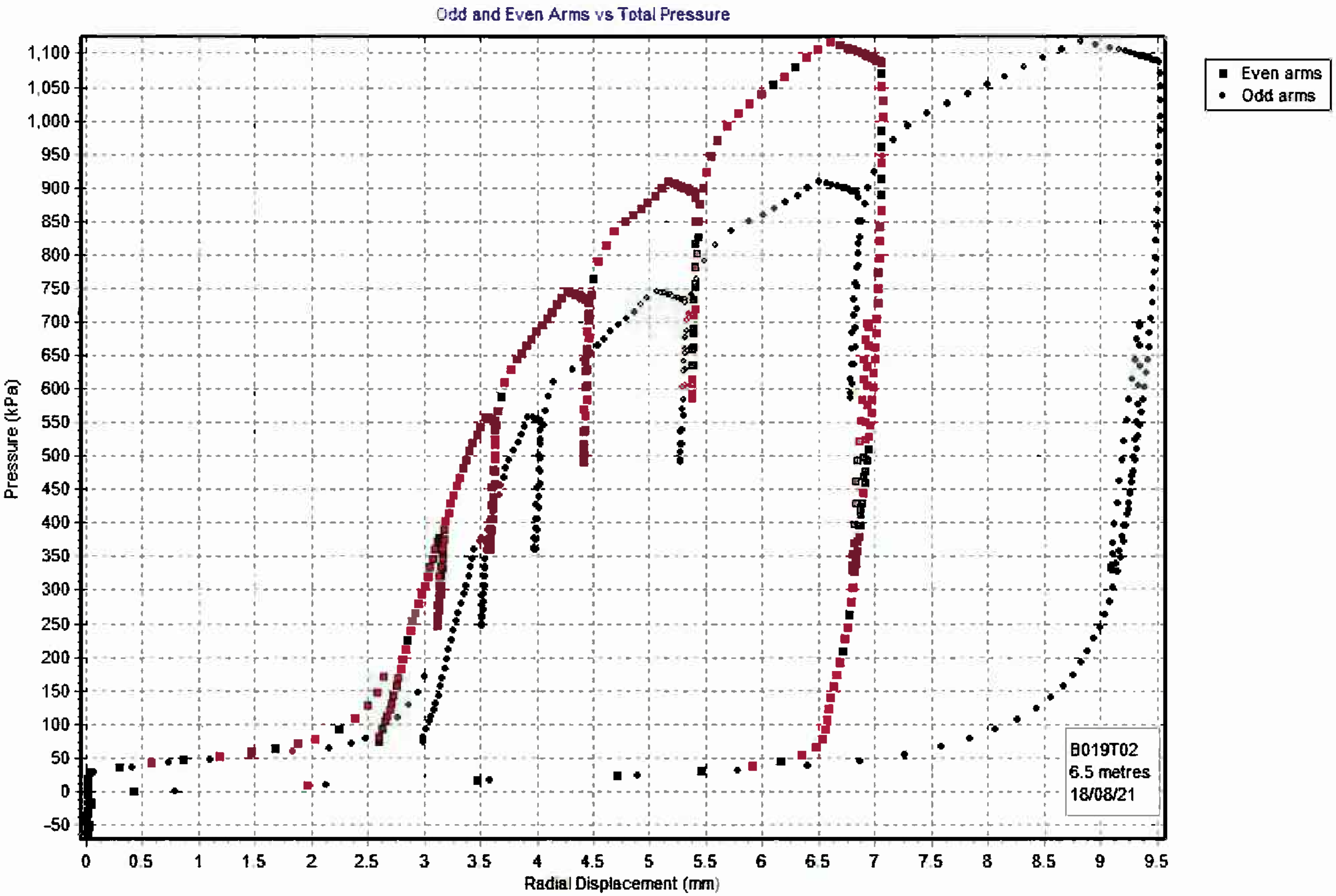
Arm Average vs Total Pressure



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel: +44 (0)1223 262361

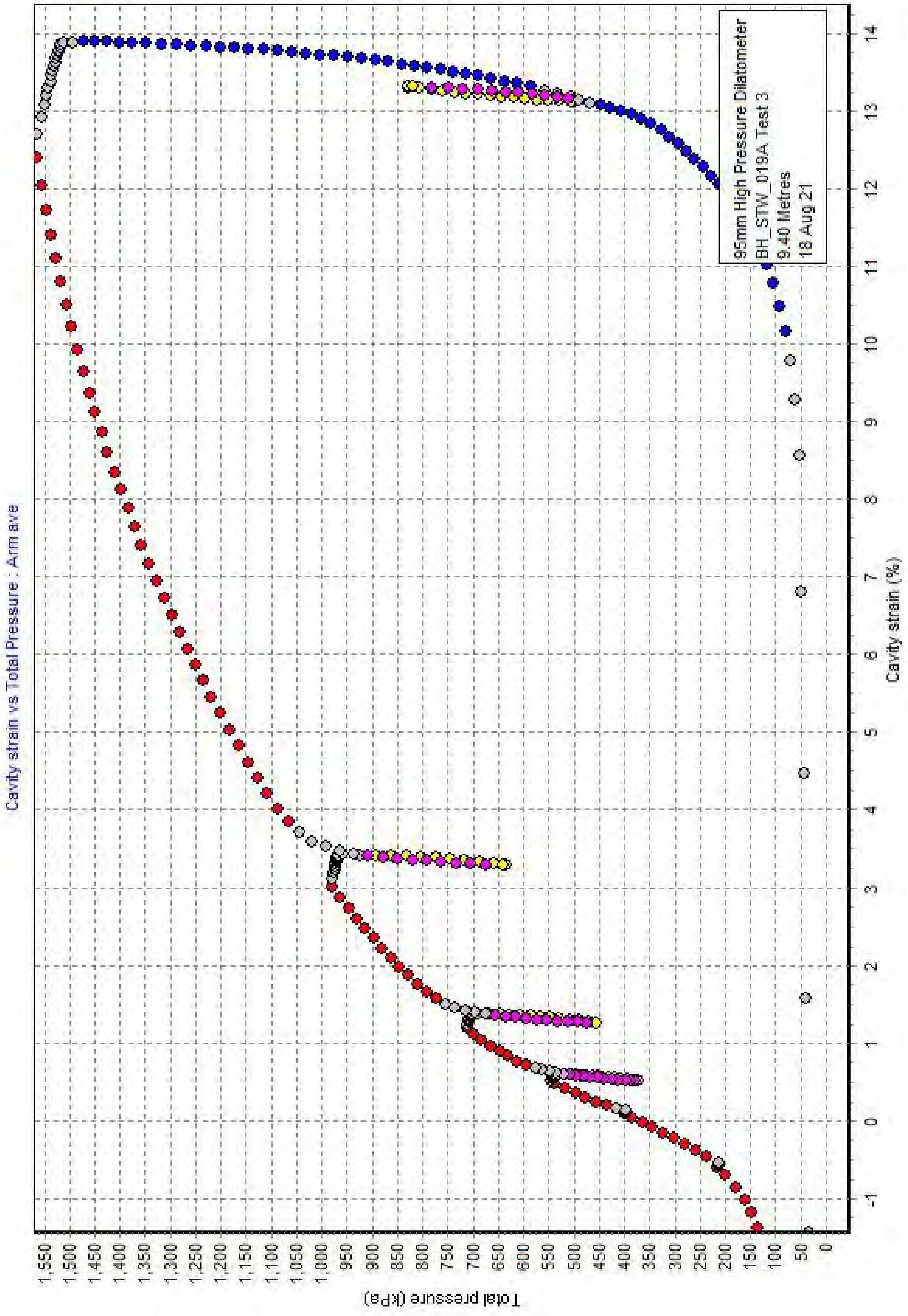


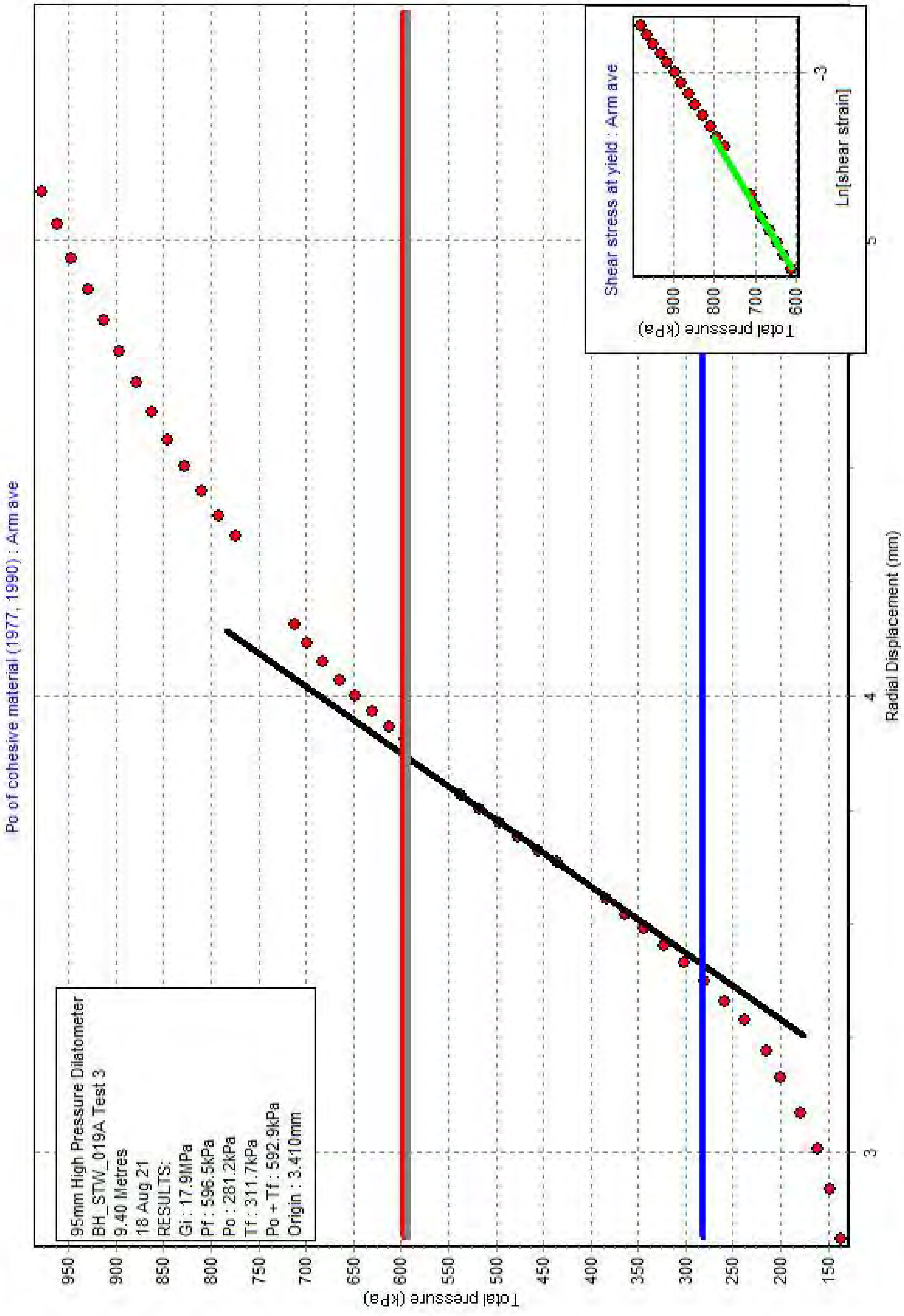
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361

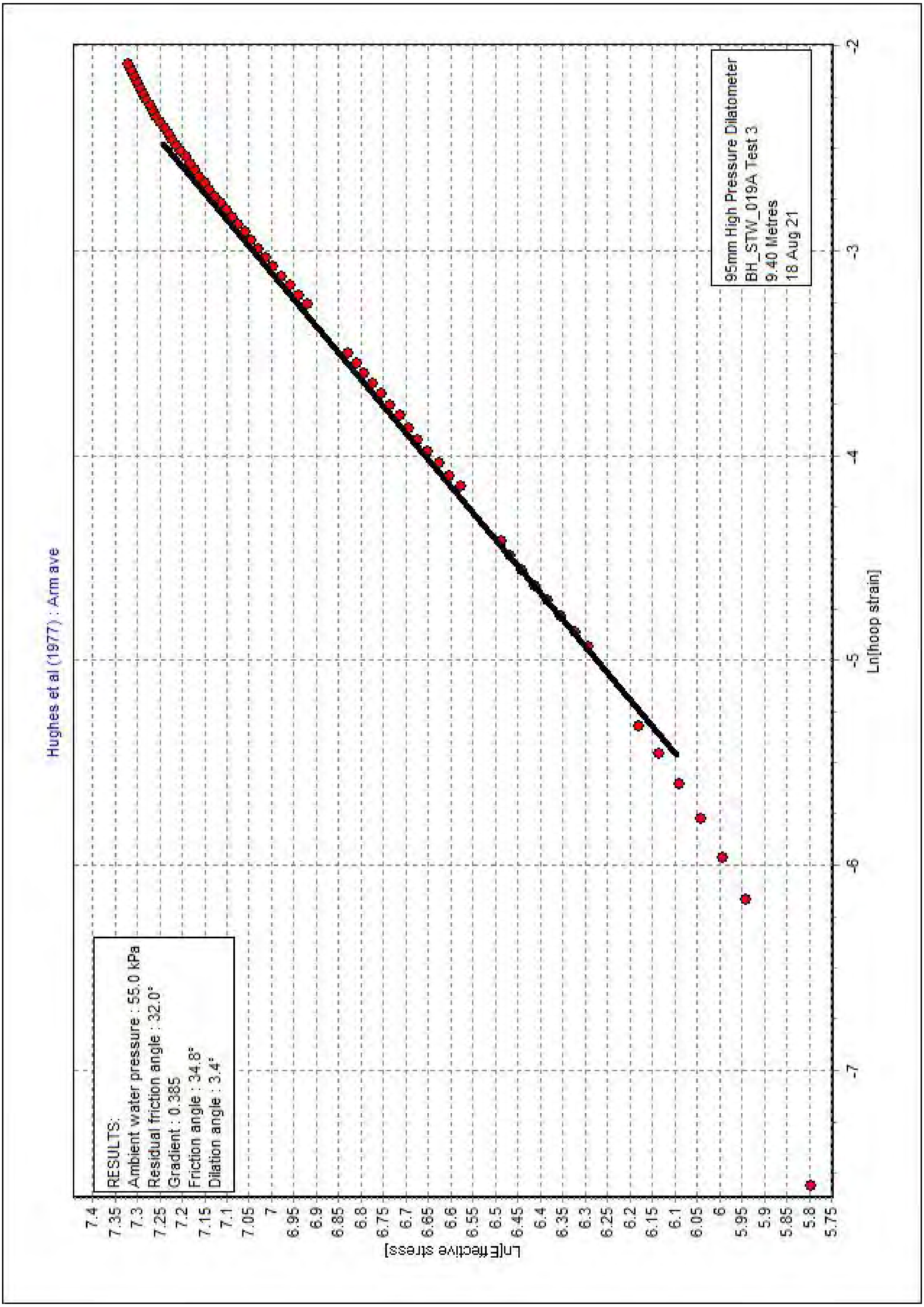
```
BH_STW_019A Test 3 - SUMMARY OF RESULTS
[File made with WinSitu ]

[DETAILS OF TEST]
Project        :   TE8364
Site           :   Cambridge Waste Water Treatment Plant Relocation Project
Borehole       :   BH_STW_019A
Test name      :   BH_STW_019A Test 3
Test date      :   18 Aug 21
Test depth     :   9.40 Metres
Water table    :   2.6 Metres
Ambient PWP    :   55.0 kPa
Material       :   Structureless Chalk
Probe          :   95mm High Pressure Dilatometer
Diameter       :   97.0 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out
The file includes results from a curve fitting analysis

Analysed by ES/RW on 19 Aug 21

Remarks:

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm)                  :   "Arm ave=3.53"
Po from Marsland & Randolph (kPa)   :   "Arm ave=281.2"
Best estimate of Po (kPa)           :   "Arm ave=166.0"

[UNDRAINED STRENGTH PARAMETERS]
Undrained yield stress (kPa)        :   "Arm ave=596.5"

[DRAINED ANALYSIS OF SANDS]
[Hughes et al 1977]
Constant volume friction angle (°)  :   32.0
Angle of internal friction (°)      :   "Arm ave=34.8"
Dilation angle (°)                  :   "Arm ave=3.4"
Gradient of log-log plot            :   "Arm ave=0.385"

[Withers et al 1989]
Angle of internal friction (°)      :   "Arm ave=34.7"
Dilation angle (°)                  :   "Arm ave=3.3"
Gradient of log-log plot            :   "Arm ave=-2.418"

[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=17.9"
Axis       Loop   Value    Mean Strain  Mean Pc  dE      dPc
           No     (MPa)    (%)          (kPa)    (%)     (kPa)
Arm ave    1      82.4     0.566        440      0.165   136
Arm ave    2      91.2     1.332        563      0.232   212
Arm ave    3      113.3    3.372        769      0.237   269
Arm ave    4      100.4    13.252       664      0.327   329

[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]
Axis       Loop   Intercept  Alpha      Gradient
           No     (MPa)      (MPa)
Arm ave    1      15.908     11.724     0.737
Arm ave    2      15.511     10.836     0.699
Arm ave    3      11.376     6.942      0.610
Arm ave    4      13.677     8.694      0.636


[PARAMETERS USED FOR DRAINED CURVE MODELLING]
{Axis is  Arm ave}
Strain Origin (mm)                  :   3.53
Po (kPa)                            :   166
Cohesion (kPa)                      :   14
Angle of peak friction (deg)        :   34.8
Angle of peak dilation (deg)        :   3.4
Total yield stress (kPa)            :   359
```

BH_STW_019A Test 3 - SUMMARY OF RESULTS

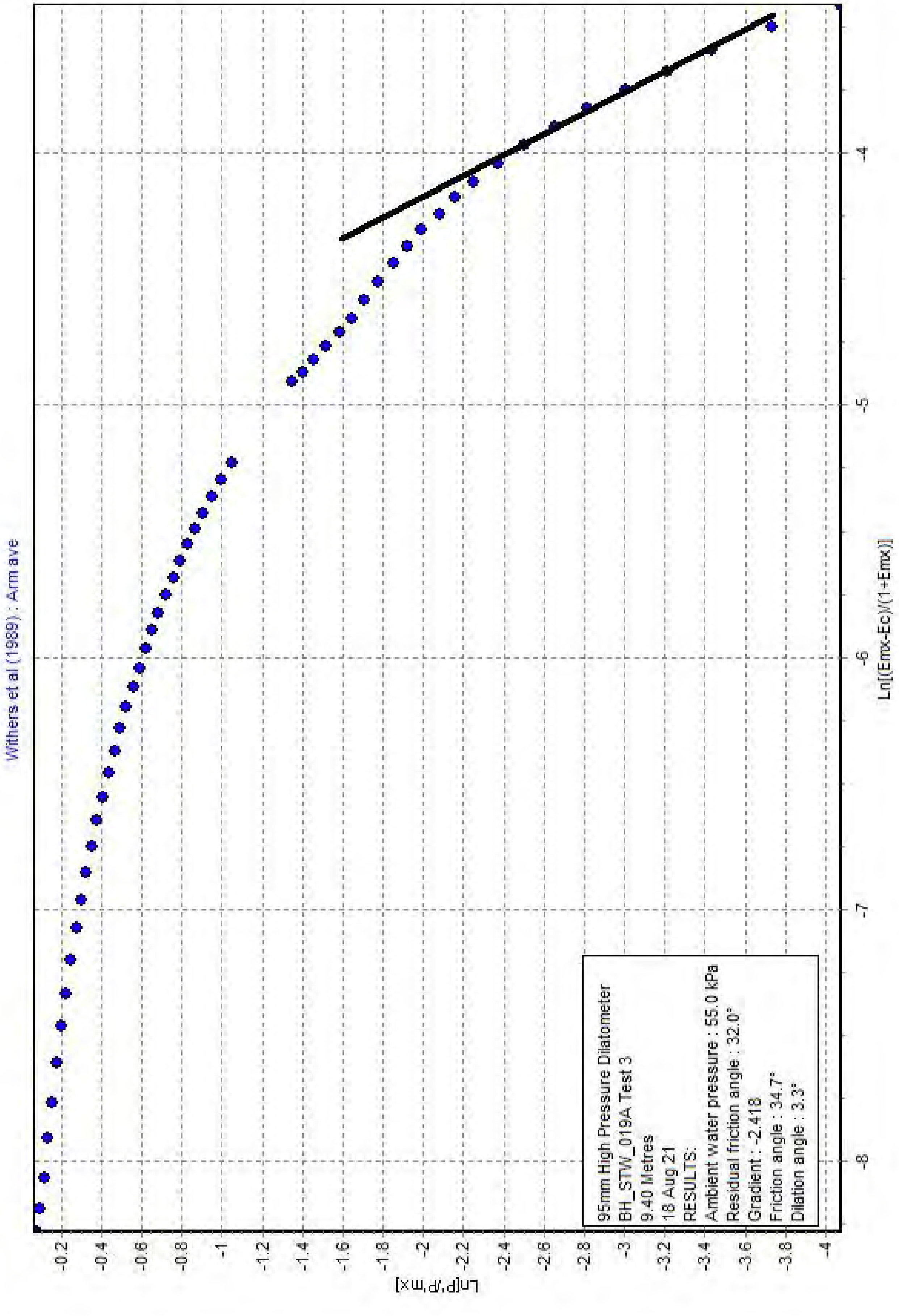
```
Total limit stress (kPa)            :   2785
G at first yield (MPa)              :   46.8
Non-linear exponent                 :   0.610
Janbu exponent                      :   0.257
Correlation                         :   0.918

Ambient pore water pressure (kPa)   :   55
Residual friction angle (deg)       :   32.0
Poisson's ratio                     :   0.25
```


Cavity strain vs Total Pressure : Arm ave
95mm High Pressure Dilatometer
BH_STW_019A Test 3
9.40 Metres
18 Aug 21
Cavity strain (%)
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Total pressure (kPa)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1,000
1,050
1,100
1,150
1,200
1,250
1,300
1,350
1,400
1,450
1,500
1,550

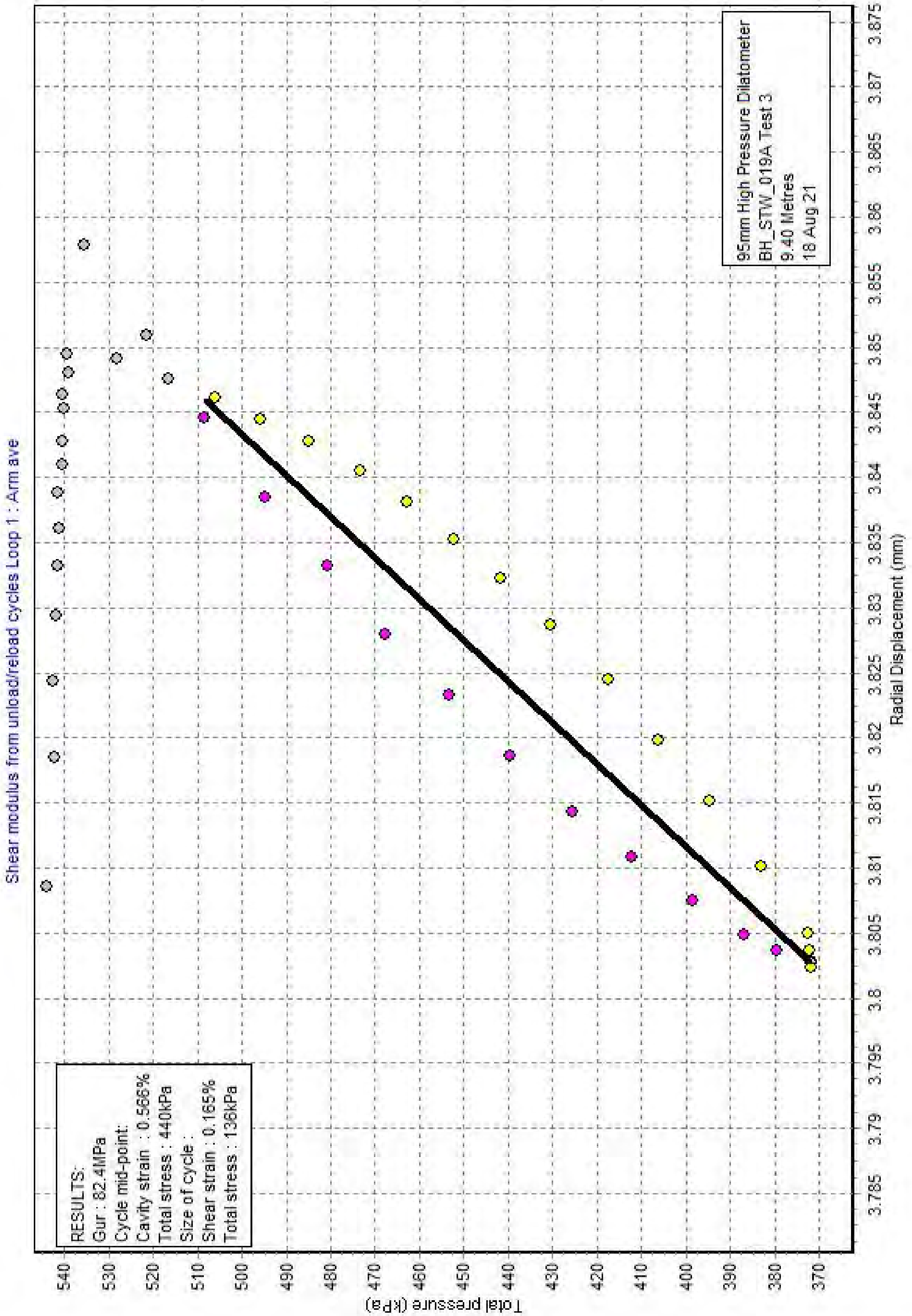

Po of cohesive material (1977, 1990) : Arm ave
95mm High Pressure Dilatometer
BH_STW_019A Test 3
9.40 Metres
18 Aug 21
RESULTS:
Gi : 17.9MPa
Pf : 596.5kPa
Po : 281.2kPa
Tf : 311.7kPa
Po + Tf : 592.9kPa
Origin : 3.410mm
Total pressure (kPa)
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
Radial Displacement (mm)
3
4
5
Shear stress at yield : Arm ave
Total pressure (kPa)
900
800
700
600
Ln[shear strain]
-3
-5

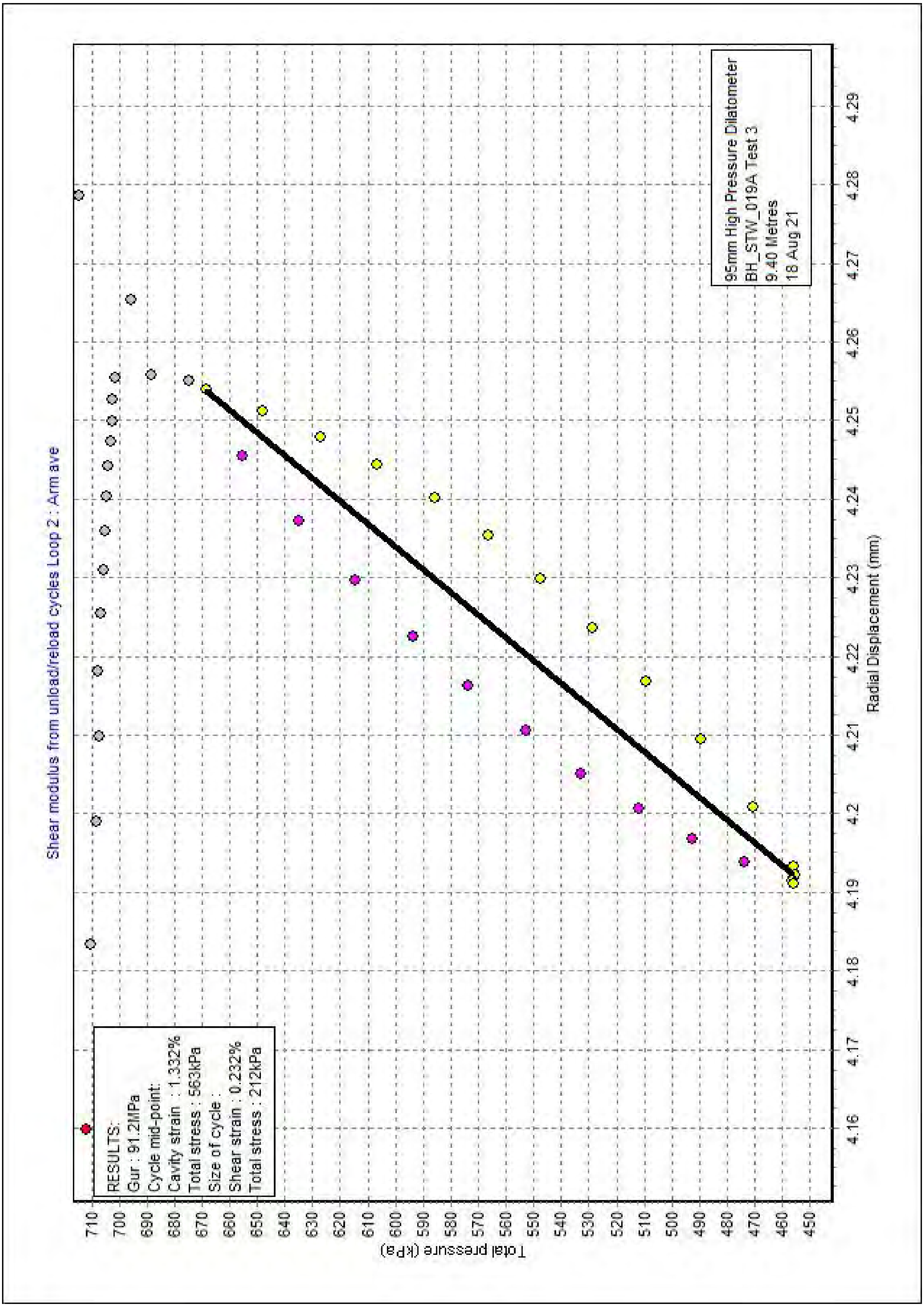


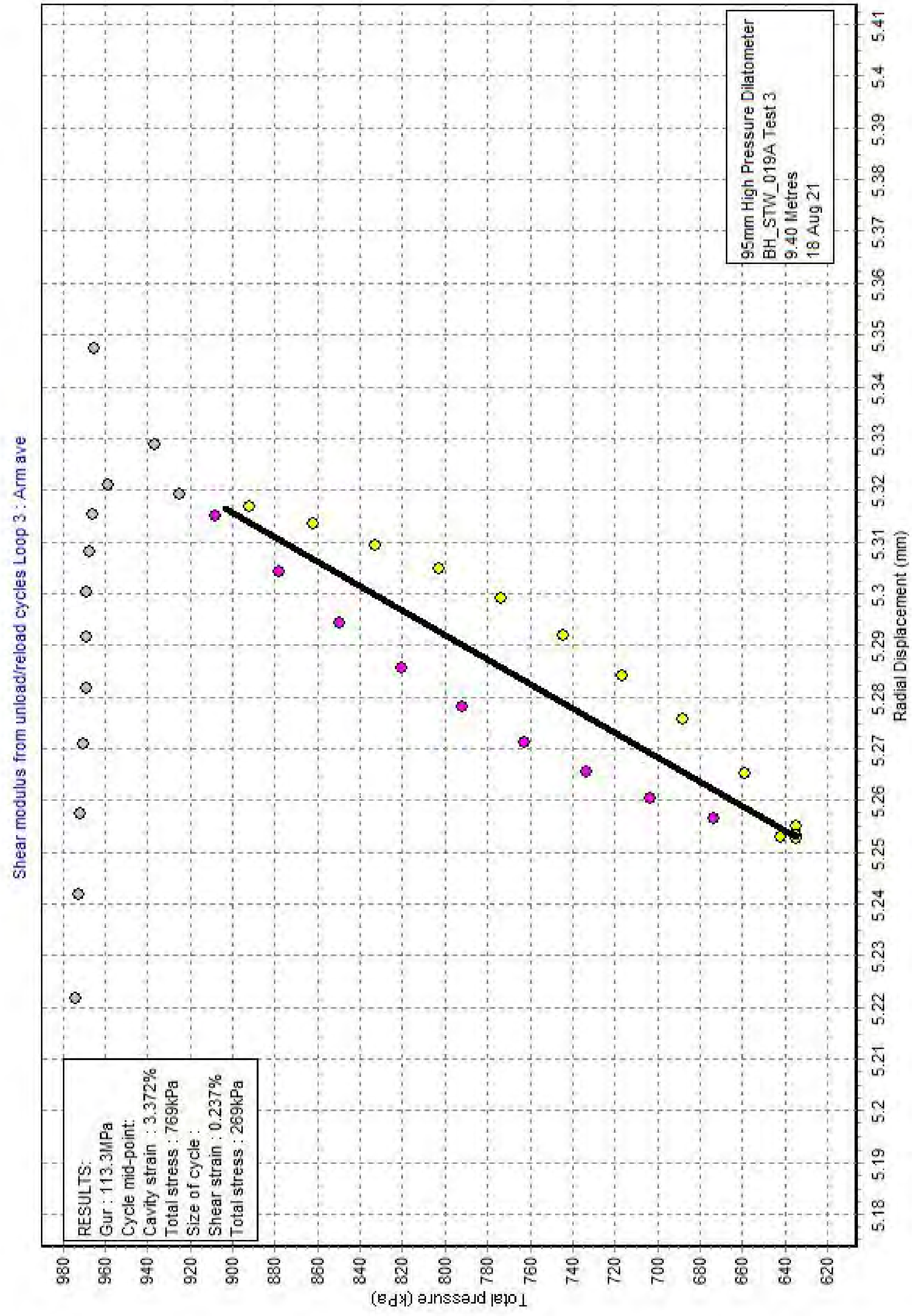
RESULTS:
Ambient water pressure : 55.0 kPa
Residual friction angle : 32.0°
Gradient : 0.385
Friction angle : 34.8°
Dilation angle : 3.4°



95mm High Pressure Dilatometer
BH_STW_019A Test 3
9.40 Metres
18 Aug 21
RESULTS:
Ambient water pressure : 55.0 kPa
Residual friction angle : 32.0°
Gradient : -2.418
Friction angle : 34.7°
Dilation angle : 3.3°

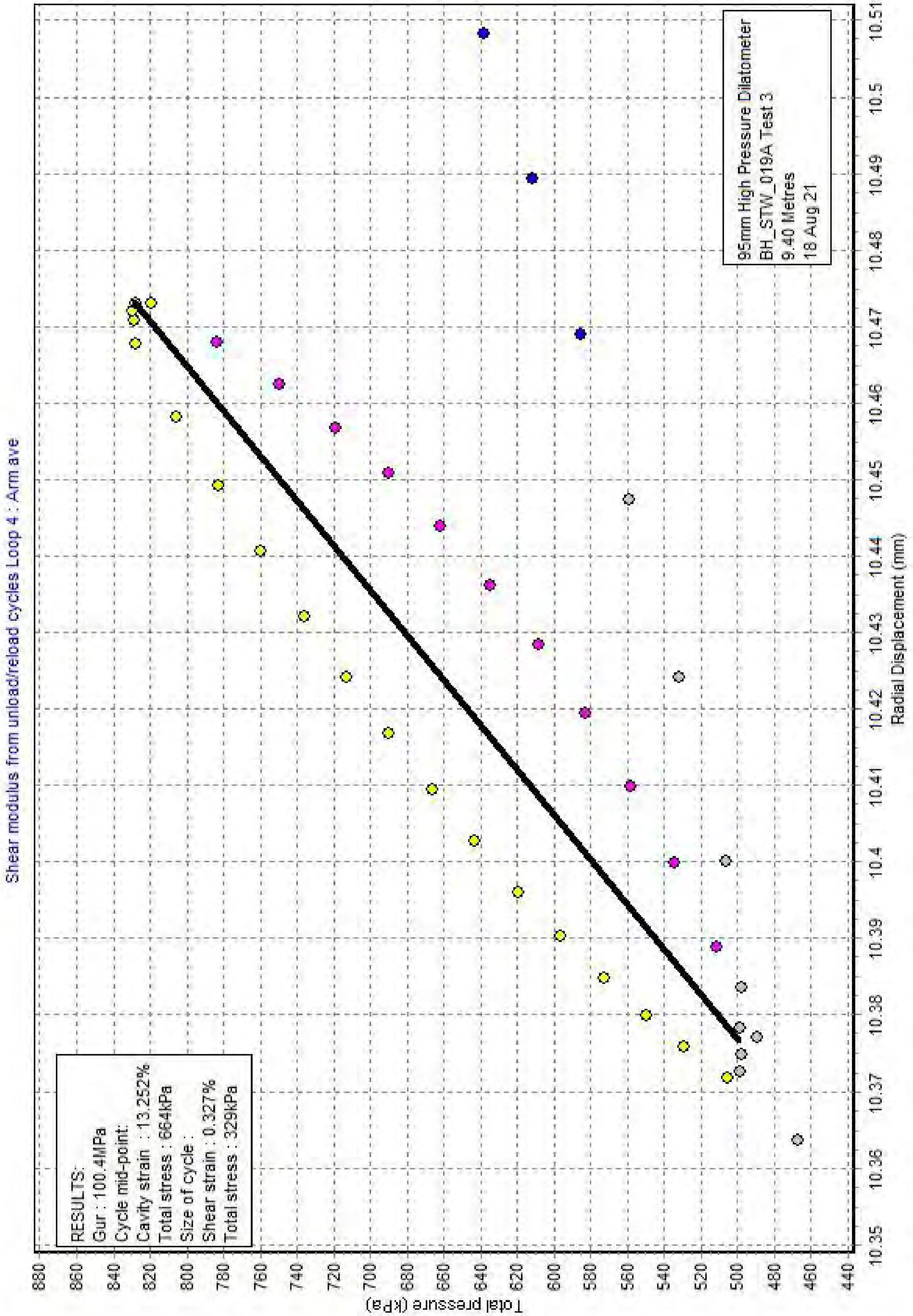

Shear modulus from unload/reload cycles Loop 1 : Arm ave
95mm High Pressure Dilatometer
BH_STW_019A Test 3
9.40 Metres
18 Aug 21
RESULTS:
Gur : 82.4MPa
Cycle mid-point:
Cavity strain : 0.566%
Total stress : 440kPa
Size of cycle :
Shear strain : 0.165%
Total stress : 136kPa
Total pressure (kPa)
540
530
520
510
500
490
480
470
460
450
440
430
420
410
400
390
380
370
Radial Displacement (mm)
3.785
3.79
3.795
3.8
3.805
3.81
3.815
3.82
3.825
3.83
3.835
3.84
3.845
3.85
3.855
3.86
3.865
3.87
3.875

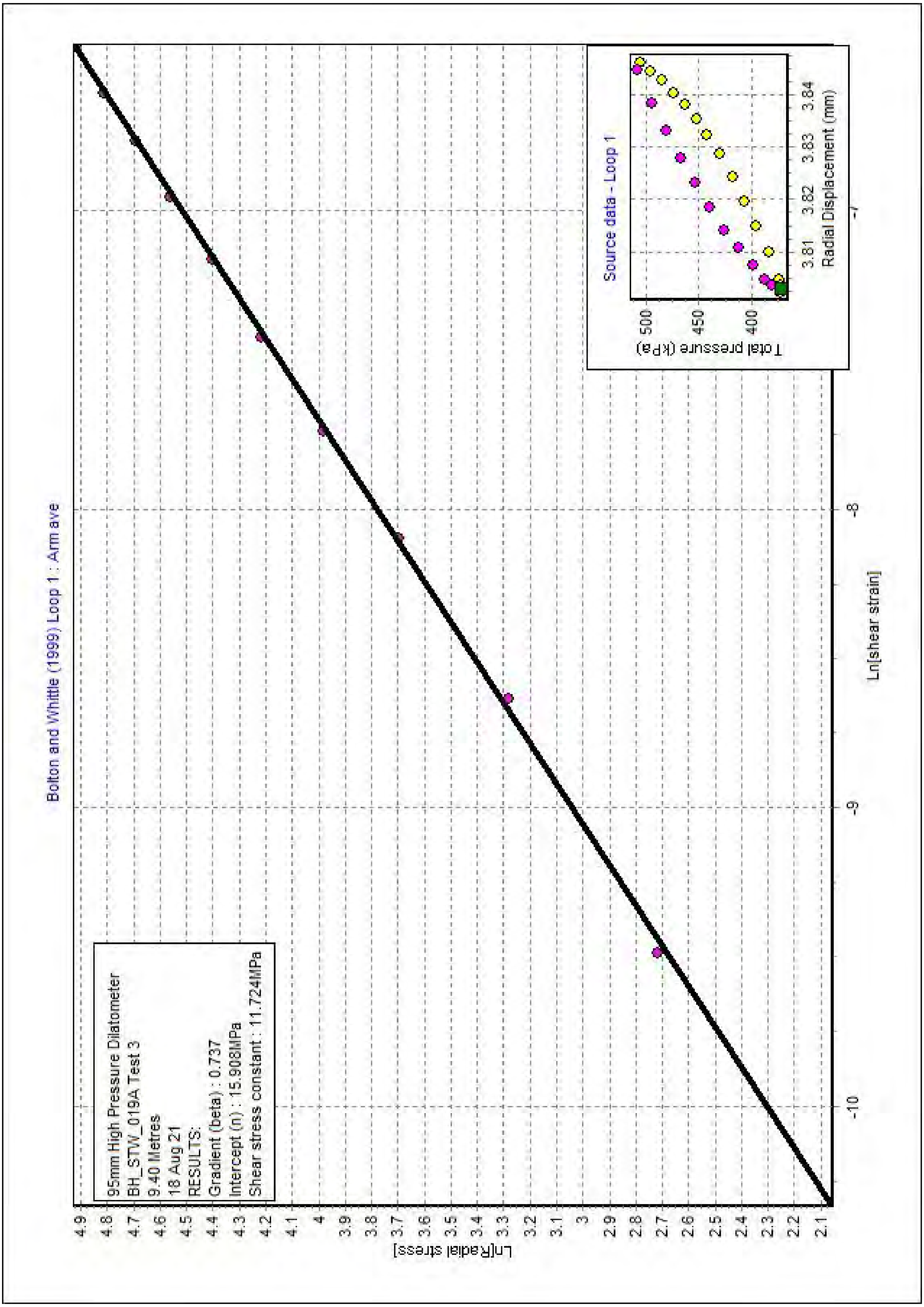

Shear modulus from unload/reload cycles Loop 2 : Arm ave
95mm High Pressure Dilatometer
BH_STW_019A Test 3
9.40 Metres
18 Aug 21
RESULTS:
Gur : 91.2MPa
Cycle mid-point:
Cavity strain : 1.332%
Total stress : 563kPa
Size of cycle :
Shear strain : 0.232%
Total stress : 212kPa
Radial Displacement (mm)
4.16
4.17
4.18
4.19
4.2
4.21
4.22
4.23
4.24
4.25
4.26
4.27
4.28
4.29
Total pressure (kPa)
450
460
470
480
490
500
510
520
530
540
550
560
570
580
590
600
610
620
630
640
650
660
670
680
690
700
710

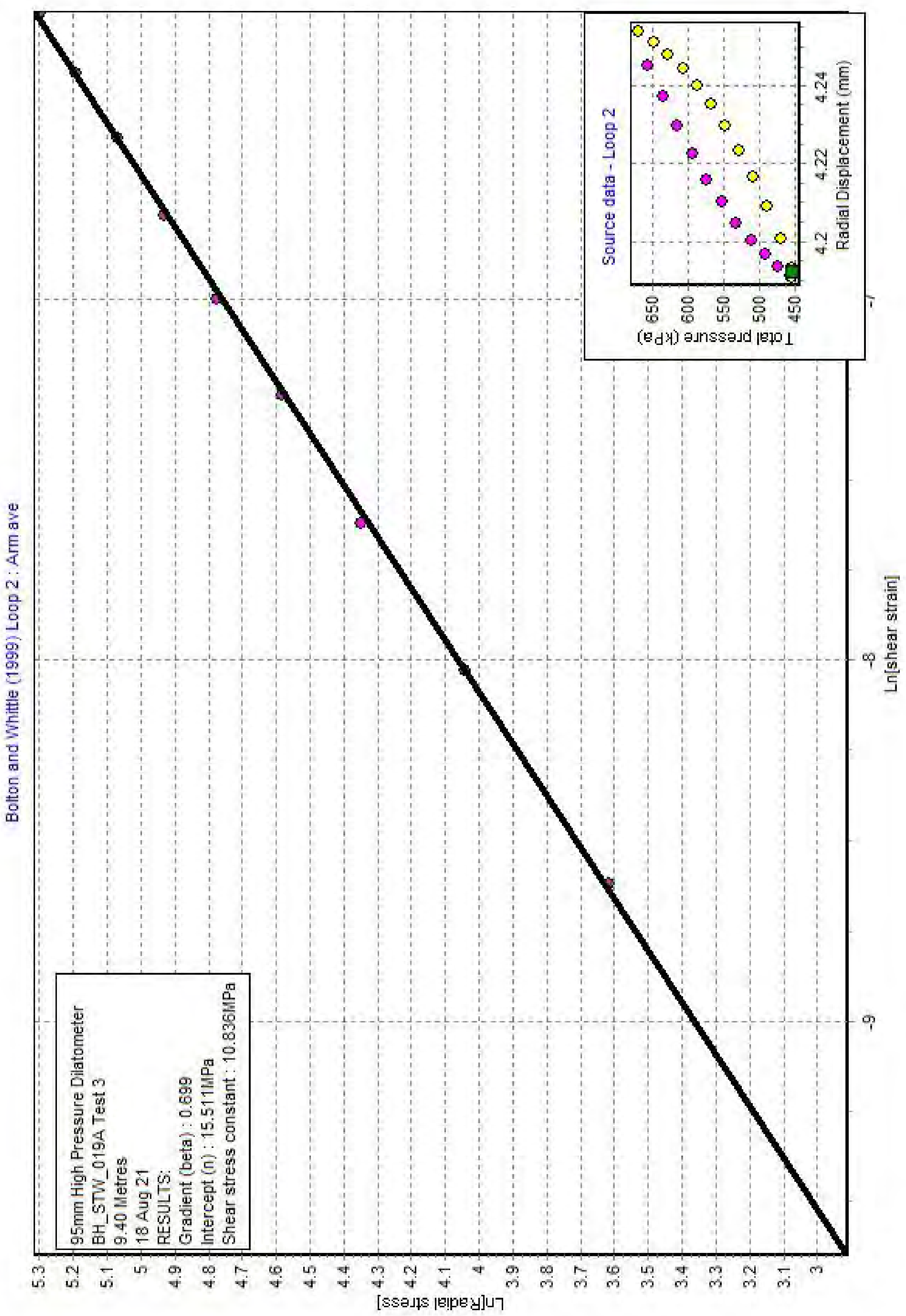


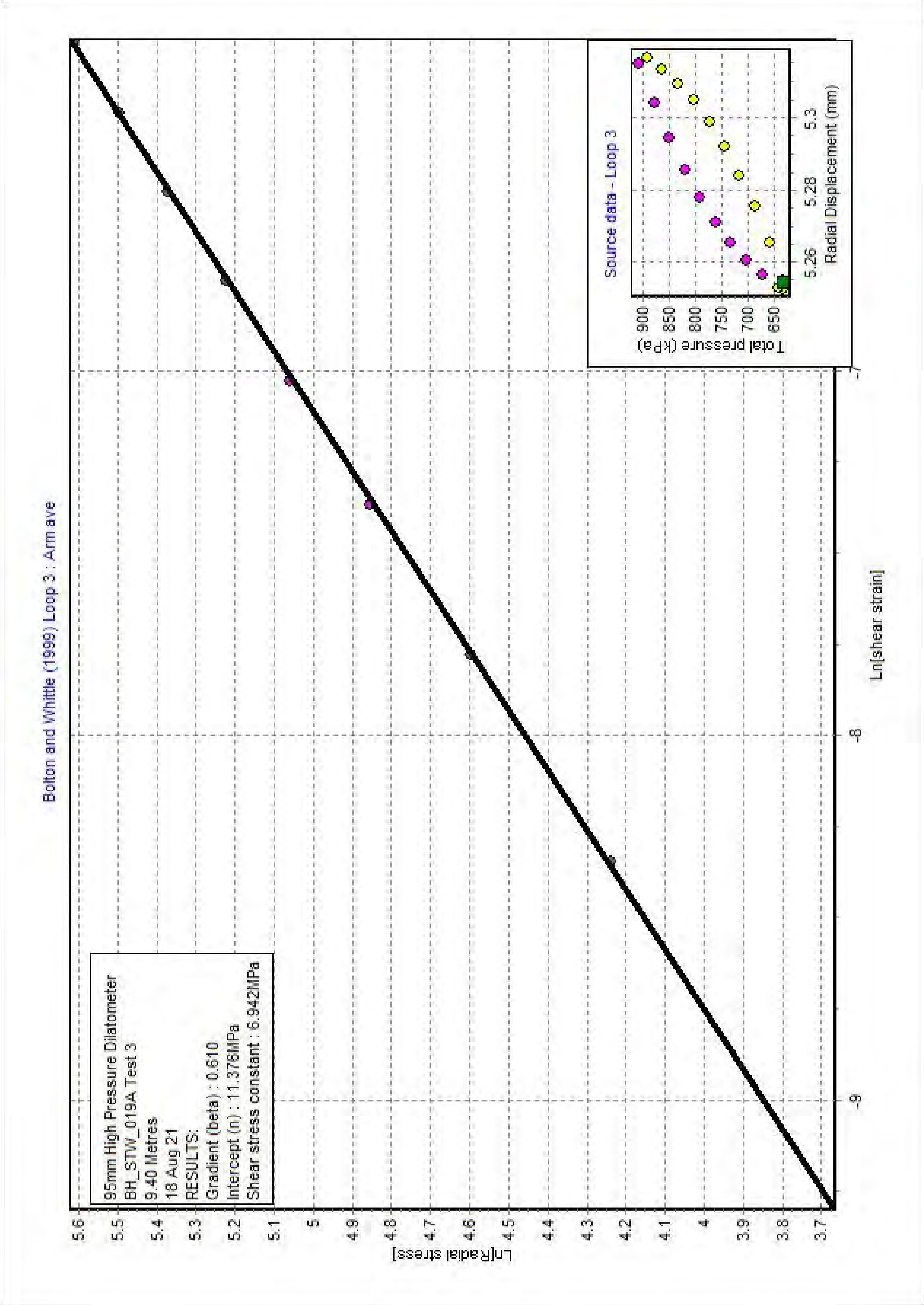
95mm High Pressure Dilatometer
BH_STW_019A Test 3
9.40 Metres
18 Aug 21

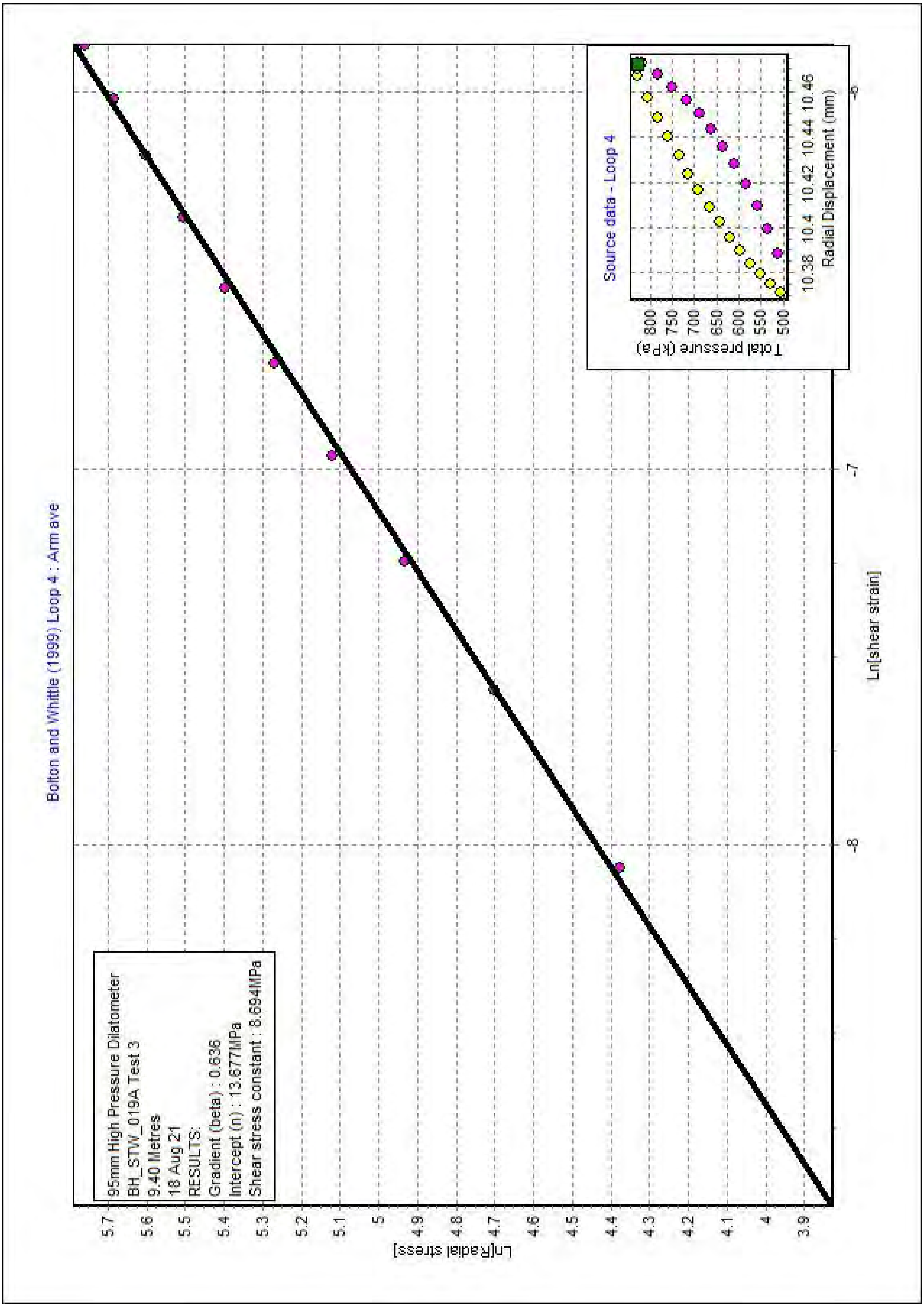
RESULTS:
Gur : 113.3MPa
Cycle mid-point:
Cavity strain : 3.372%
Total stress : 769kPa
Size of cycle :
Shear strain : 0.237%
Total stress : 269kPa

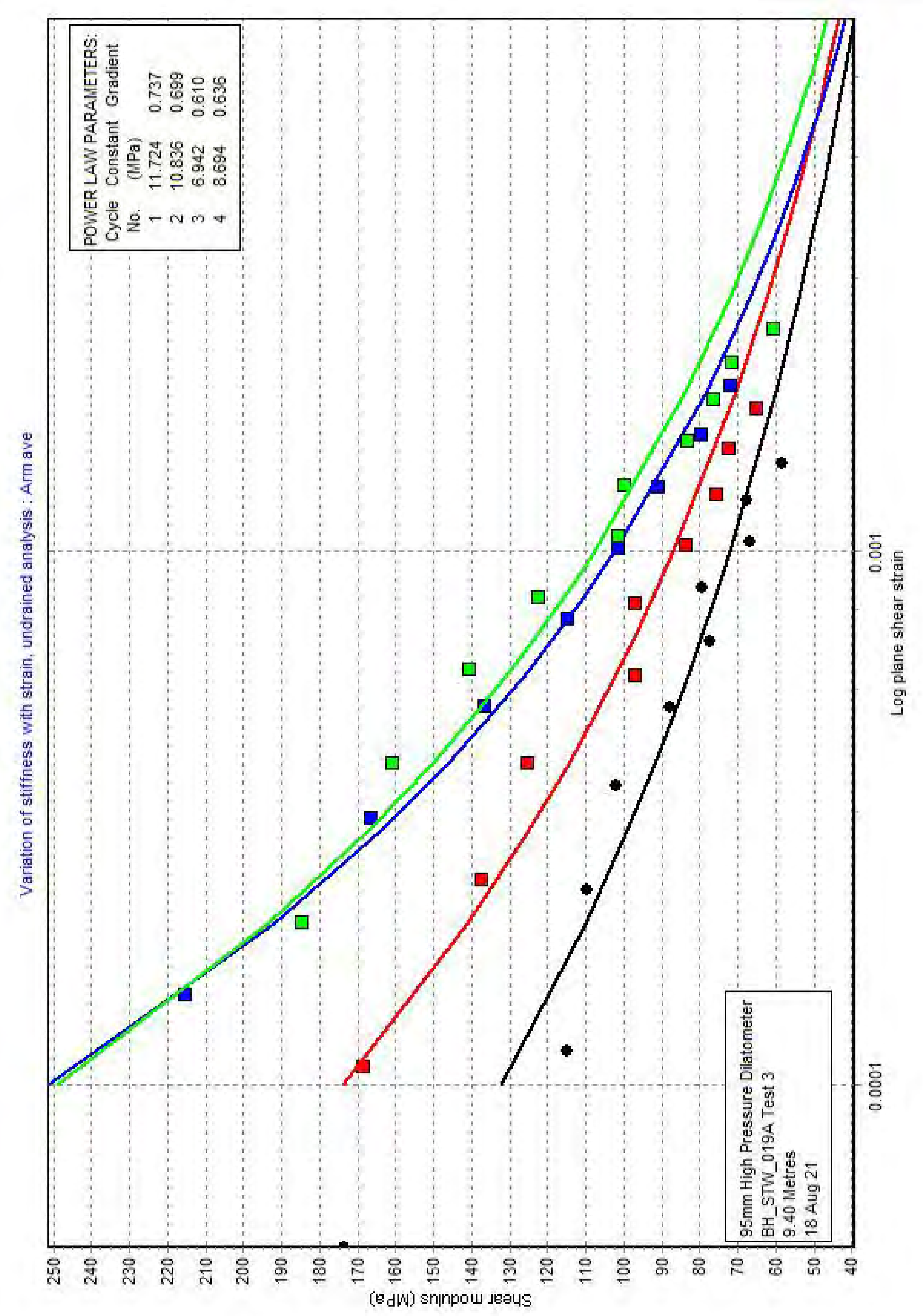

Shear modulus from unload/reload cycles Loop 4 : Arm ave
RESULTS:
Gur : 100.4MPa
Cycle mid-point:
Cavity strain : 13.252%
Total stress : 664kPa
Size of cycle :
Shear strain : 0.327%
Total stress : 329kPa
95mm High Pressure Dilatometer
BH_STW_019A Test 3
9.40 Metres
18 Aug 21
Total pressure (kPa)
880
860
840
820
800
780
760
740
720
700
680
660
640
620
600
580
560
540
520
500
480
460
440
Radial Displacement (mm)
10.35
10.36
10.37
10.38
10.39
10.4
10.41
10.42
10.43
10.44
10.45
10.46
10.47
10.48
10.49
10.5
10.51

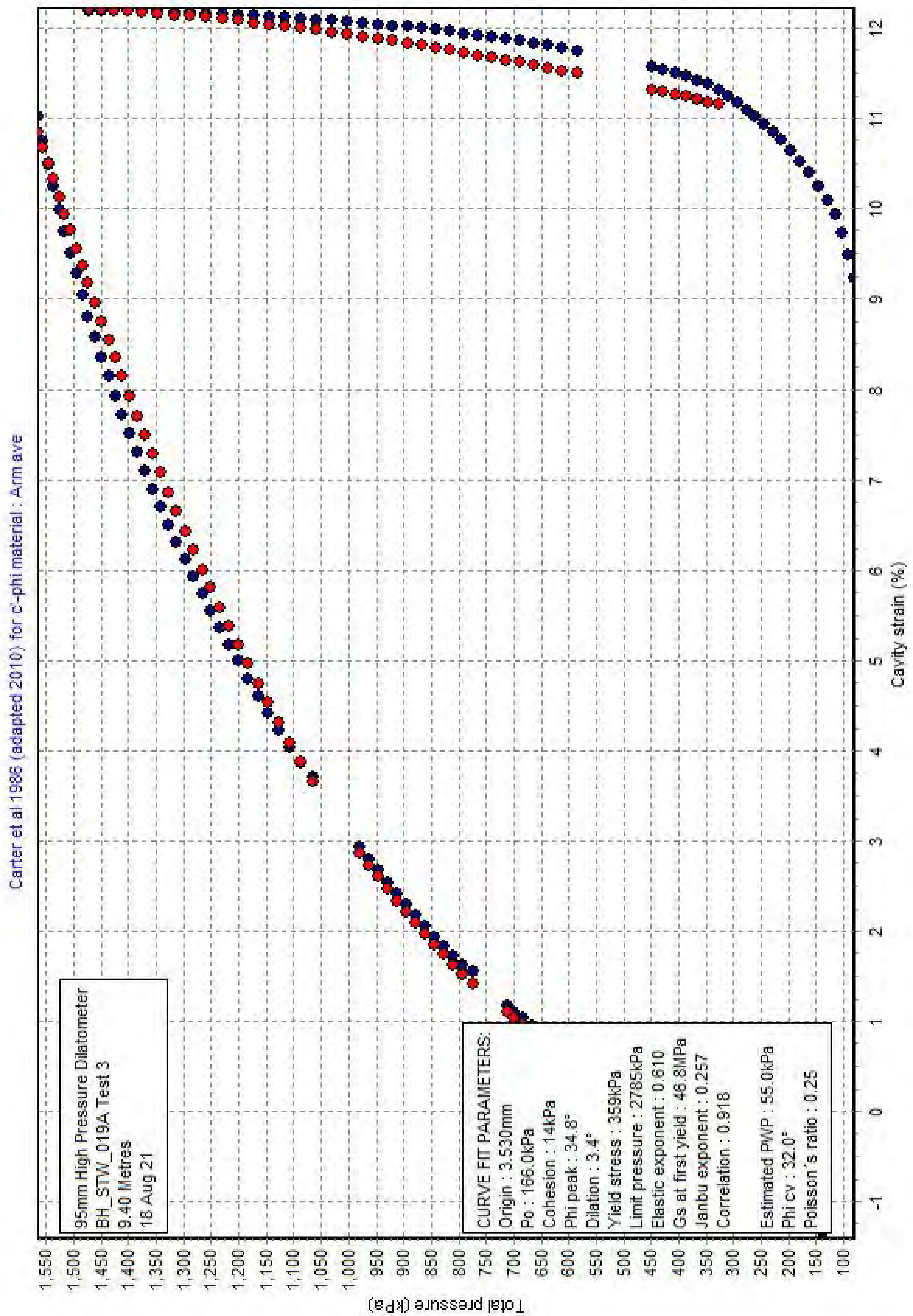

Bolton and Whittle (1999) Loop 1 : Arm ave
95mm High Pressure Dilatometer
BH_STW_019A Test 3
9.40 Metres
18 Aug 21
RESULTS:
Gradient (beta) : 0.737
Intercept (n) : 15.908MPa
Shear stress constant : 11.724MPa
Ln[Radial stress]
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
Ln[shear strain]
-10
-9
-8
-7
Source data - Loop 1
Total pressure (kPa)
500
450
400
Radial Displacement (mm)
3.81
3.82
3.83
3.84

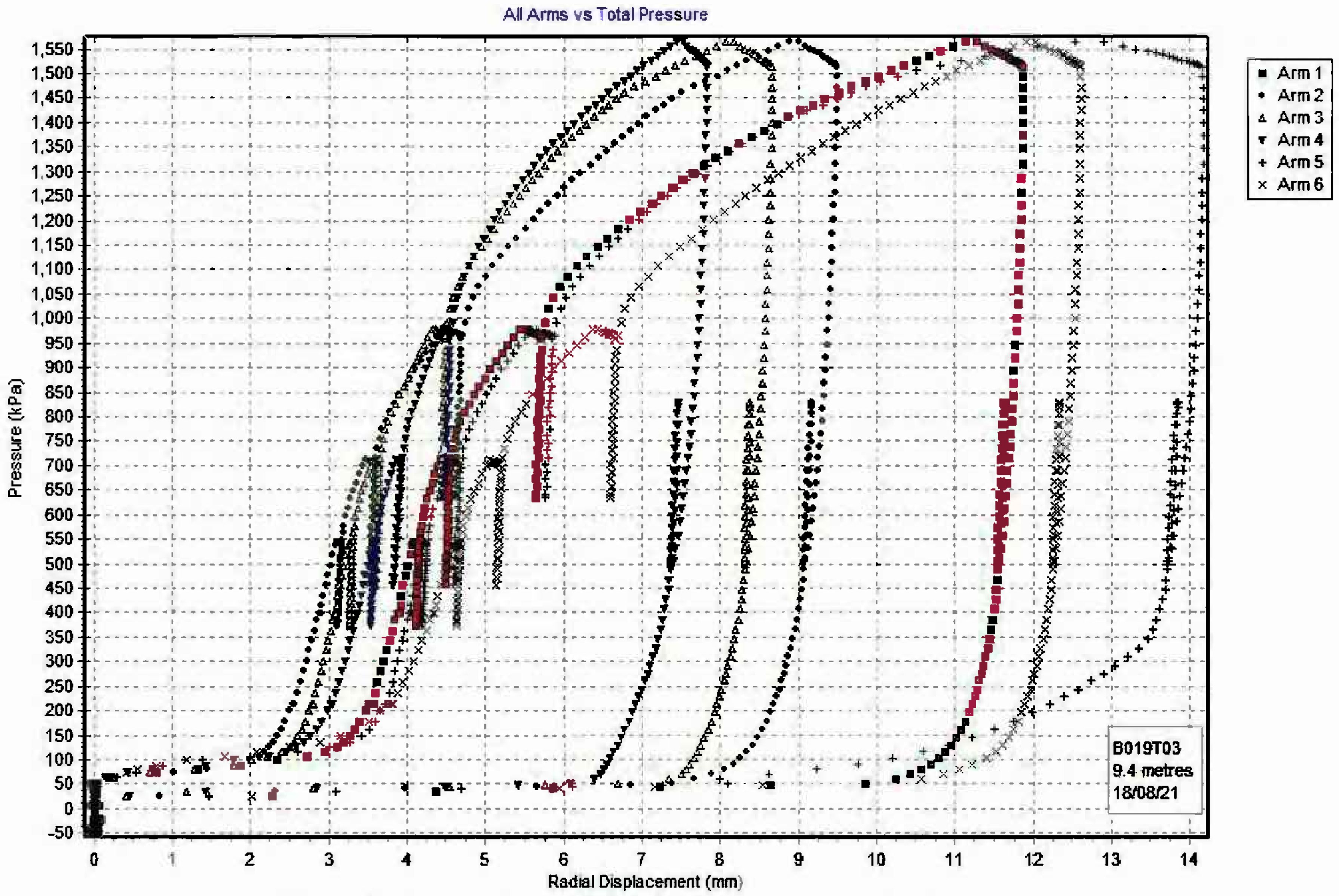

Bolton and Whittle (1999) Loop 2 : Arm ave
95mm High Pressure Dilatometer
BH_STW_019A Test 3
9.40 Metres
18 Aug 21
RESULTS:
Gradient (beta) : 0.699
Intercept (n) : 15.511MPa
Shear stress constant : 10.836MPa
Ln[Radial stress]
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
Ln[shear strain]
-9
-8
-7
Source data - Loop 2
Total pressure (kPa)
650
600
550
500
450
Radial Displacement (mm)
4.2
4.22
4.24


Bolton and Whittle (1999) Loop 3 : Arm ave
95mm High Pressure Dilatometer
BH_STW_019A Test 3
9.40 Metres
18 Aug 21
RESULTS:
Gradient (beta) : 0.610
Intercept (n) : 11.376MPa
Shear stress constant : 6.942MPa
Ln[Radial stress]
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
Ln[shear strain]
-9
-8
-7
Source data - Loop 3
Total pressure (kPa)
900
850
800
750
700
650
Radial Displacement (mm)
5.26
5.28
5.3

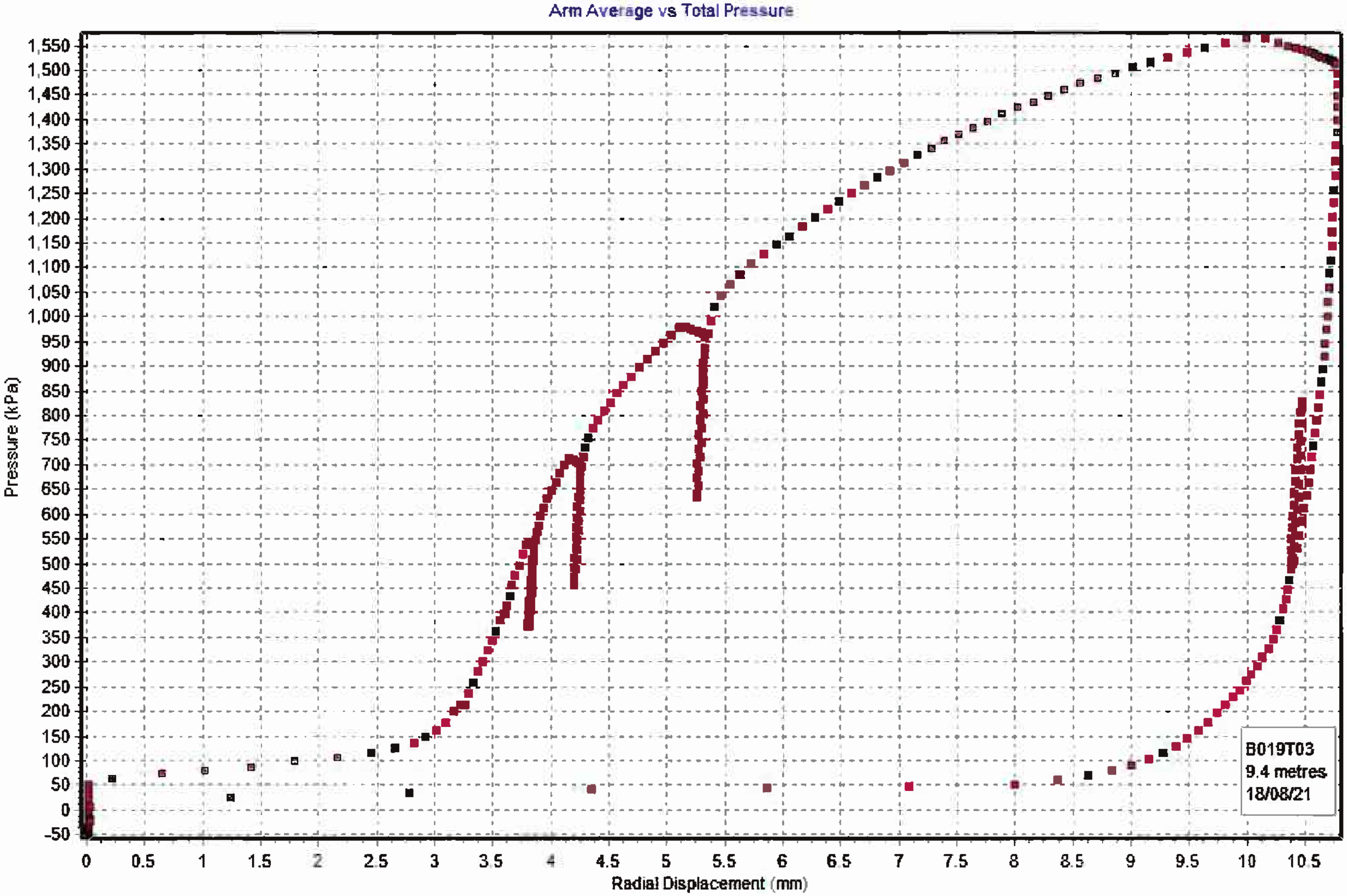

Bolton and Whittle (1999) Loop 4 : Arm ave
95mm High Pressure Dilatometer
BH_STW_019A Test 3
9.40 Metres
18 Aug 21
RESULTS:
Gradient (beta) : 0.636
Intercept (n) : 13.677MPa
Shear stress constant : 8.694MPa
Ln[Radial stress]
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
Ln[shear strain]
-8
-7
-6
Source data - Loop 4
Total pressure (kPa)
800
750
700
650
600
550
500
Radial Displacement (mm)
10.38
10.4
10.42
10.44
10.46


Variation of stiffness with strain, undrained analysis : Arm ave
POWER LAW PARAMETERS:
Cycle No. | Constant (MPa) | Gradient
1 | 11.724 | 0.737
2 | 10.836 | 0.699
3 | 6.942 | 0.610
4 | 8.694 | 0.636
95mm High Pressure Dilatometer
BH_STW_019A Test 3
9.40 Metres
18 Aug 21
Shear modulus (MPa)
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
Log plane shear strain
0.0001
0.001


Carter et al 1986 (adapted 2010) for c'-phi material : Arm ave
95mm High Pressure Dilatometer
BH_STW_019A Test 3
9.40 Metres
18 Aug 21
CURVE FIT PARAMETERS:
Origin : 3.530mm
Po : 166.0kPa
Cohesion : 14kPa
Phi peak : 34.8°
Dilation : 3.4°
Yield stress : 359kPa
Limit pressure : 2785kPa
Elastic exponent : 0.610
Gs at first yield : 46.8MPa
Janbu exponent : 0.257
Correlation : 0.918
Estimated PWP : 55.0kPa
Phi cv : 32.0°
Poisson's ratio : 0.25
Total pressure (kPa)
1,550
1,500
1,450
1,400
1,350
1,300
1,250
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
Cavity strain (%)
-1
0
1
2
3
4
5
6
7
8
9
10
11
12

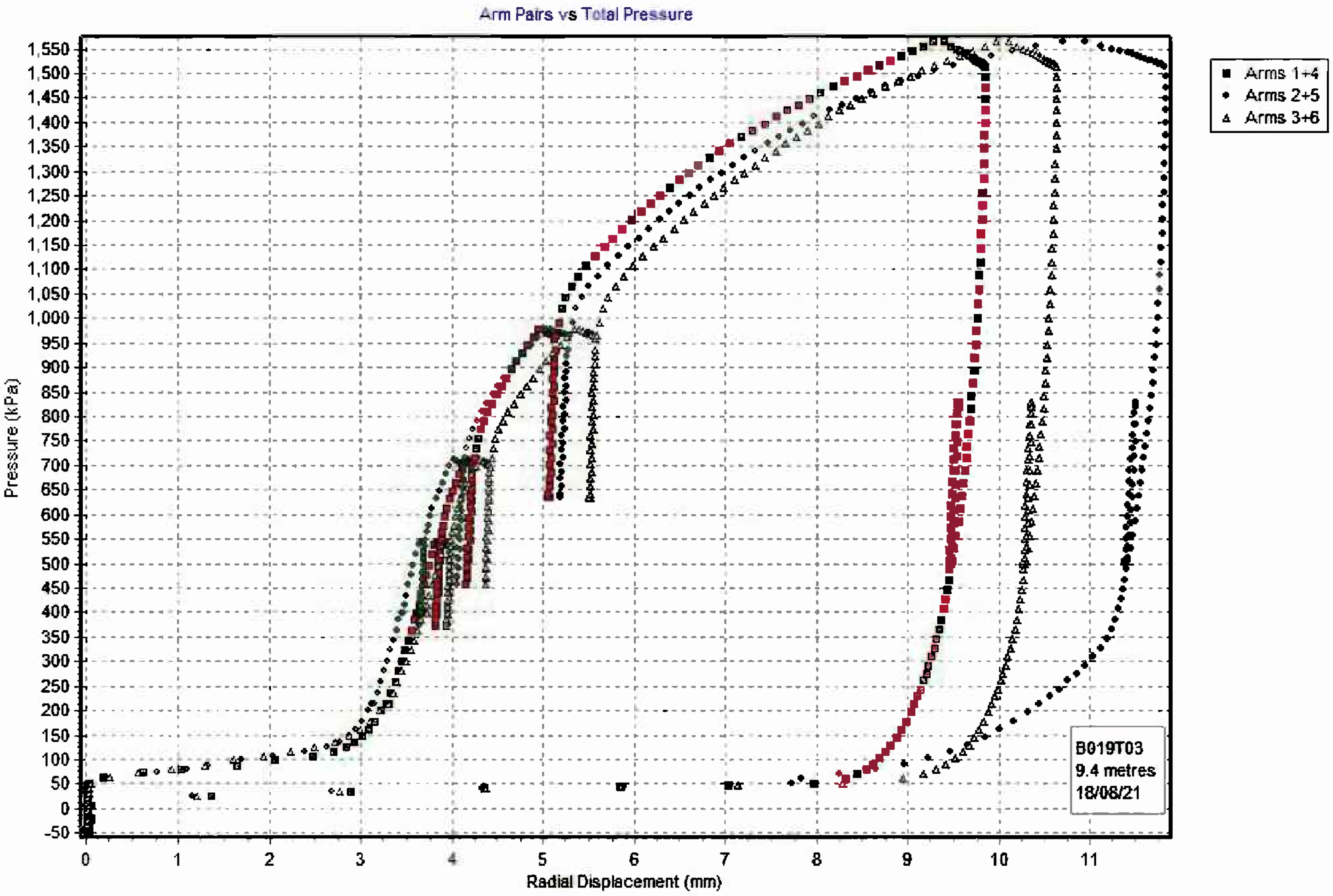


CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361

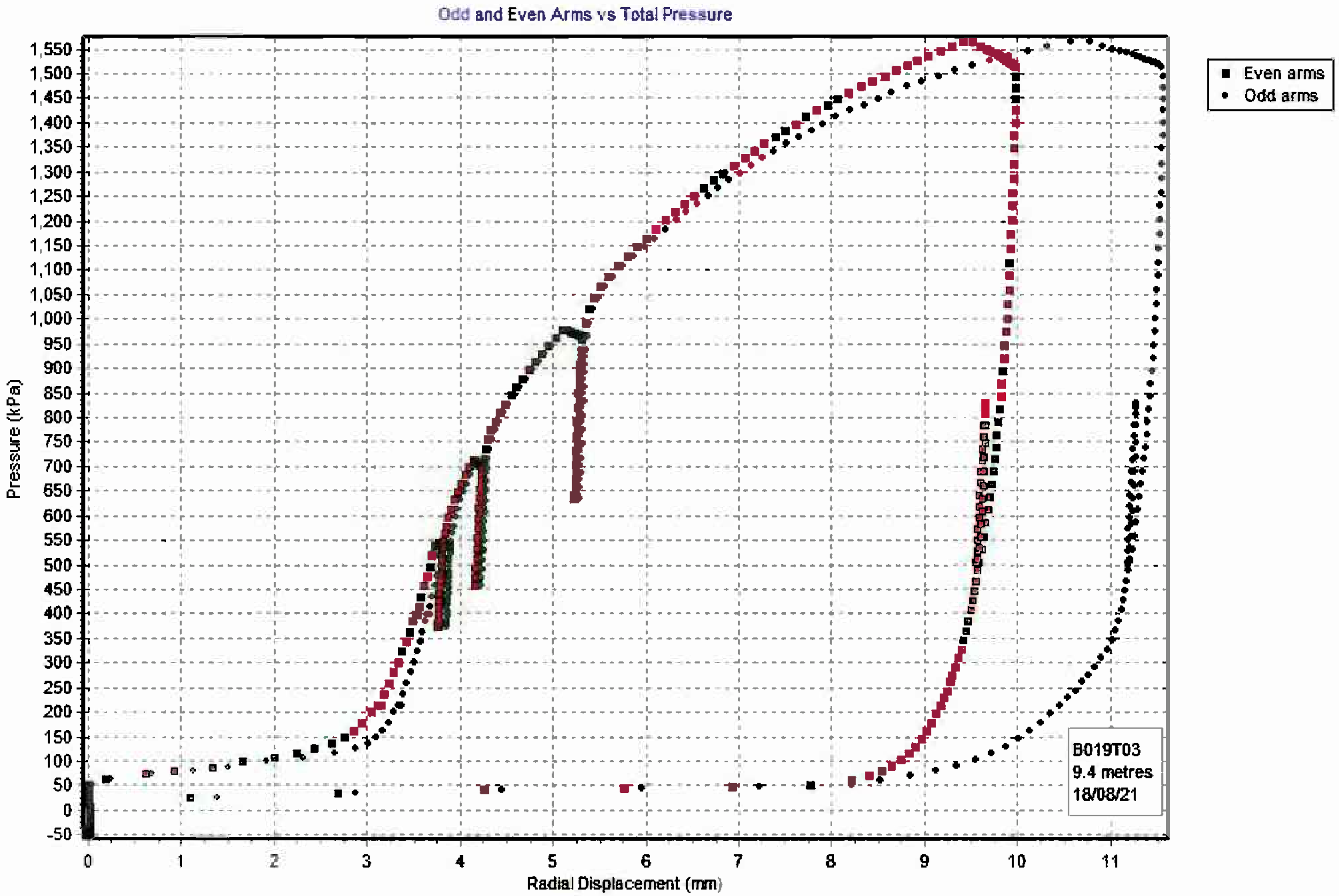


Arm Average vs Total Pressure

CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361



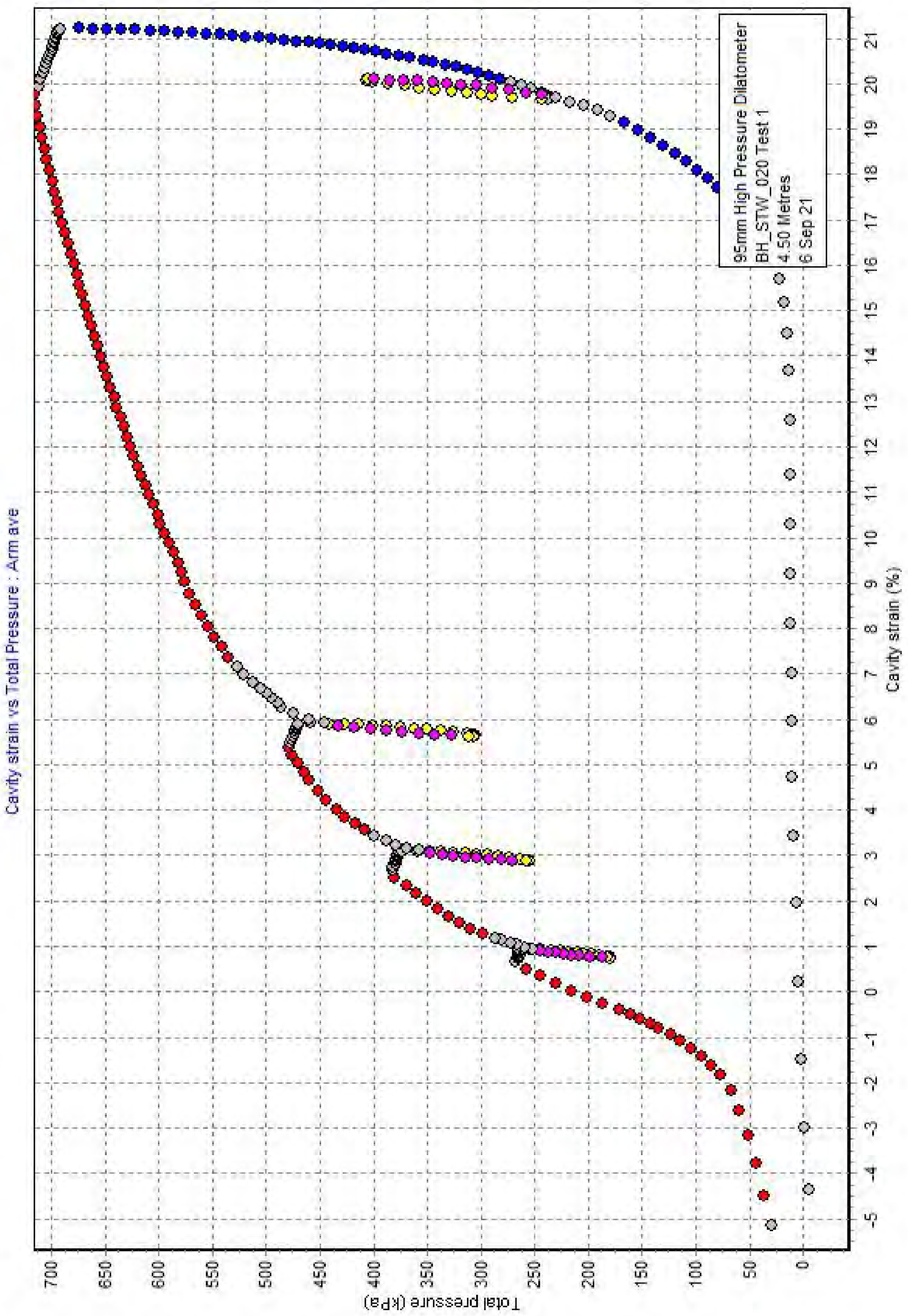
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361

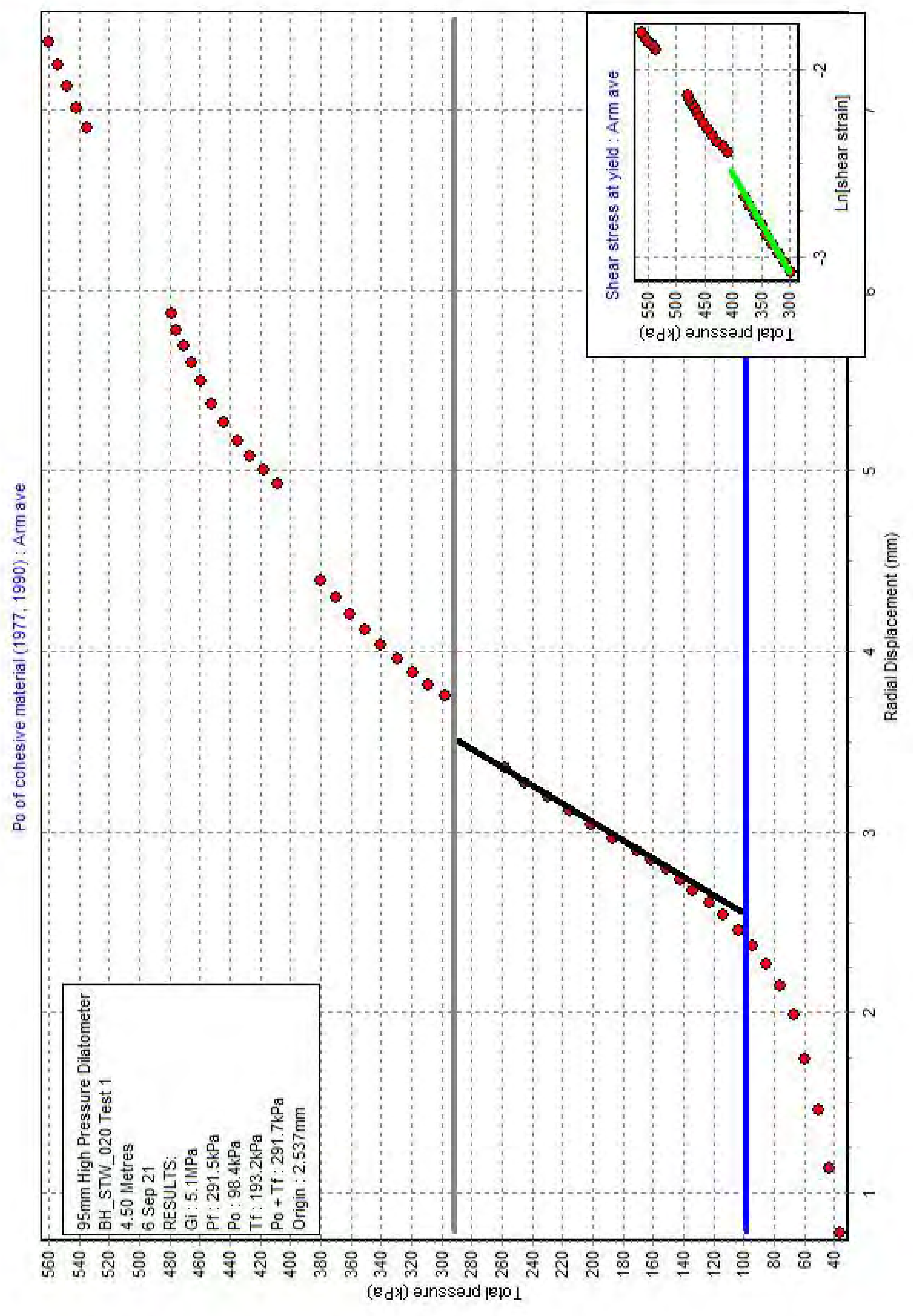
```
BH_STW_020 Test 1 - SUMMARY OF RESULTS
[File made with WinSitu ]

[DETAILS OF TEST]
Project        :   TE8364
Site           :   Cambridge Waste Water Treatment Plant Relocation Project
Borehole       :   BH_STW_020
Test name      :   BH_STW_020 Test 1
Test date      :   6 Sep 21
Test depth     :   4.50 Metres
Water table    :   3.75 Metres
Ambient PWP    :   0.0 kPa
Material       :   Structureless Chalk
Probe          :   95mm High Pressure Dilatometer
Diameter       :   97.0 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out
The file includes results from a curve fitting analysis

Analysed by ES/YB/RW on 6 Sep 21

Remarks:

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm)                  :   "Arm ave=3.09"
Po from Marsland & Randolph (kPa)   :   "Arm ave=98.4"
Best estimate of Po (kPa)           :   "Arm ave=98.0"

[UNDRAINED STRENGTH PARAMETERS]
Undrained yield stress (kPa)        :   "Arm ave=291.5"

[DRAINED ANALYSIS OF SANDS]
[Hughes et al 1977]
Constant volume friction angle (°)  :   32.0
Angle of internal friction (°)      :   "Arm ave=32.4"
Dilation angle (°)                  :   "Arm ave=0.5"
Gradient of log-log plot            :   "Arm ave=0.352"

[Withers et al 1989]
Angle of internal friction (°)      :   "Arm ave=33.2"
Dilation angle (°)                  :   "Arm ave=1.4"
Gradient of log-log plot            :   "Arm ave=-2.327"

[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=5.1"
Axis       Loop   Value    Mean Strain  Mean Pc  dE      dPc
           No     (MPa)    (%)          (kPa)    (%)     (kPa)
Arm ave    1      19.4     0.864        212      0.334   65
Arm ave    2      25.0     3.007        301      0.375   94
Arm ave    3      26.1     5.798        374      0.511   134
Arm ave    4      24.6     19.922       322      0.671   165

[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]
Axis       Loop   Intercept  Alpha      Gradient
           No     (MPa)      (MPa)
Arm ave    1      2.758      1.790      0.649
Arm ave    2      2.712      1.610      0.594
Arm ave    3      2.696      1.508      0.559
Arm ave    4      3.535      2.090      0.591


[PARAMETERS USED FOR DRAINED CURVE MODELLING]
{Axis is  Arm ave}
Strain Origin (mm)                  :   3.09
Po (kPa)                            :   98
Cohesion (kPa)                      :   10
Angle of peak friction (deg)        :   32.4
Angle of peak dilation (deg)        :   0.5
Total yield stress (kPa)            :   287
```

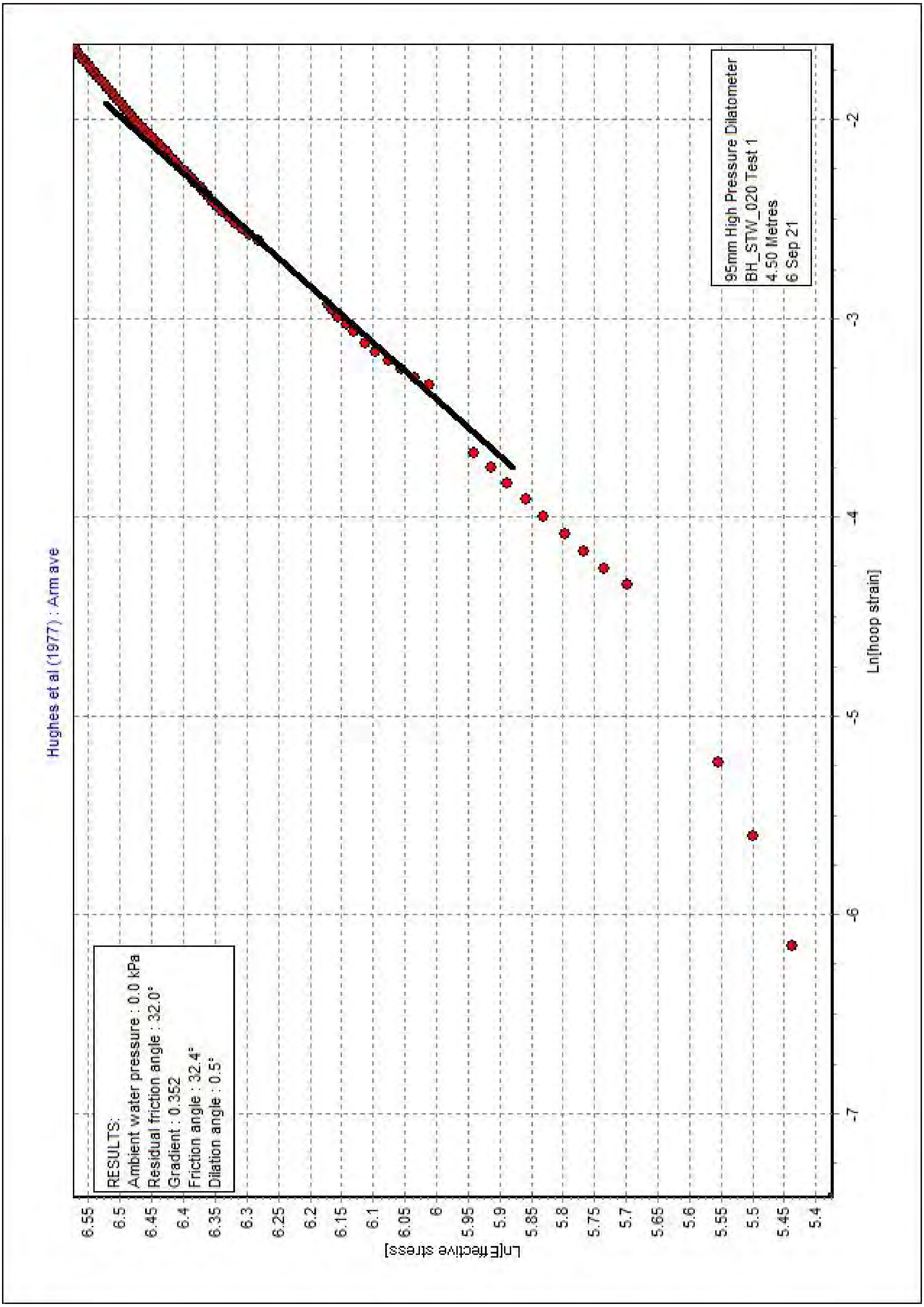
BH_STW_020 Test 1 - SUMMARY OF RESULTS

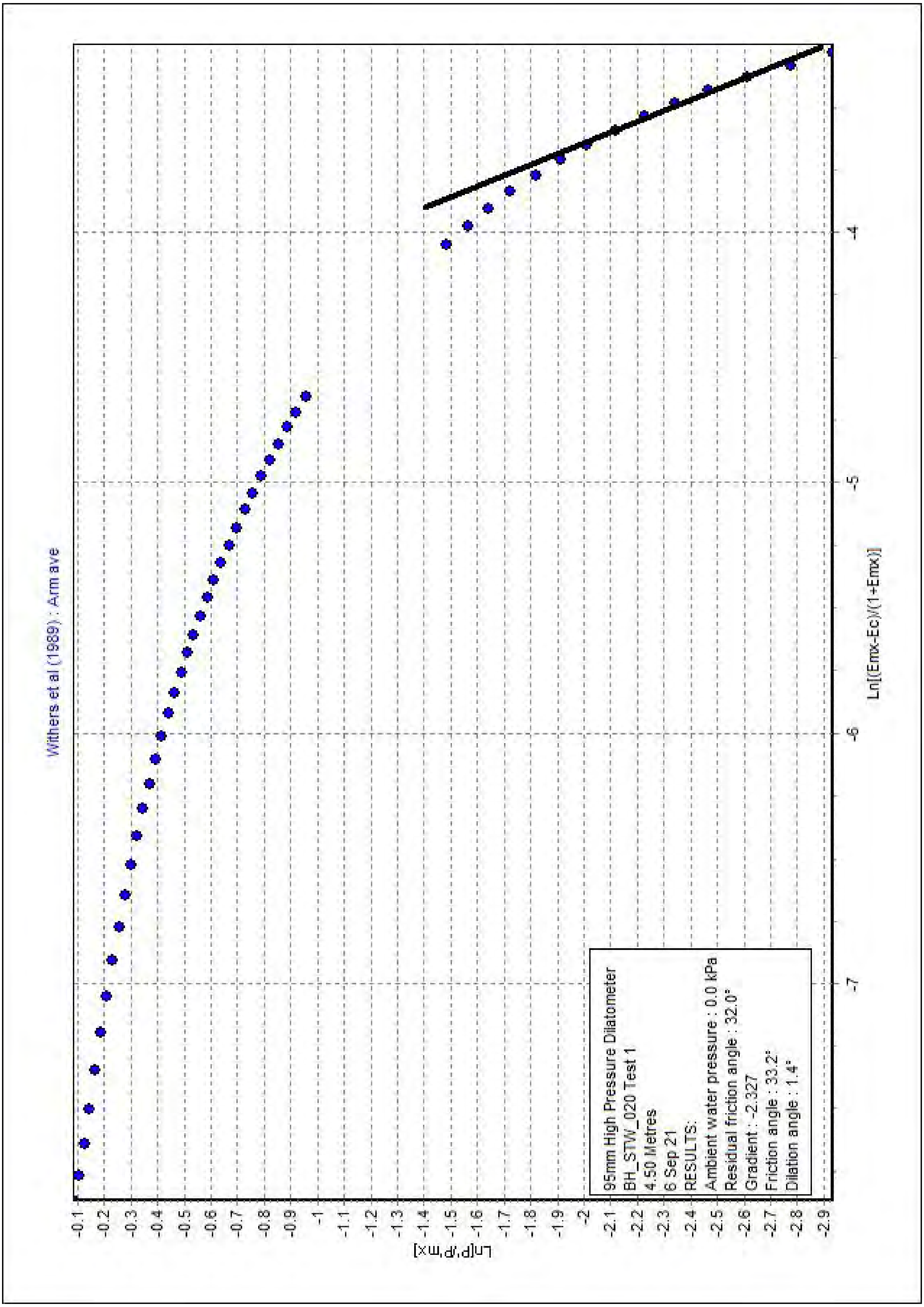
Total limit stress (kPa) : 1031
G at first yield (MPa) : 5.2
Non-linear exponent : 0.559
Janbu exponent : 0.418
Correlation : 0.991

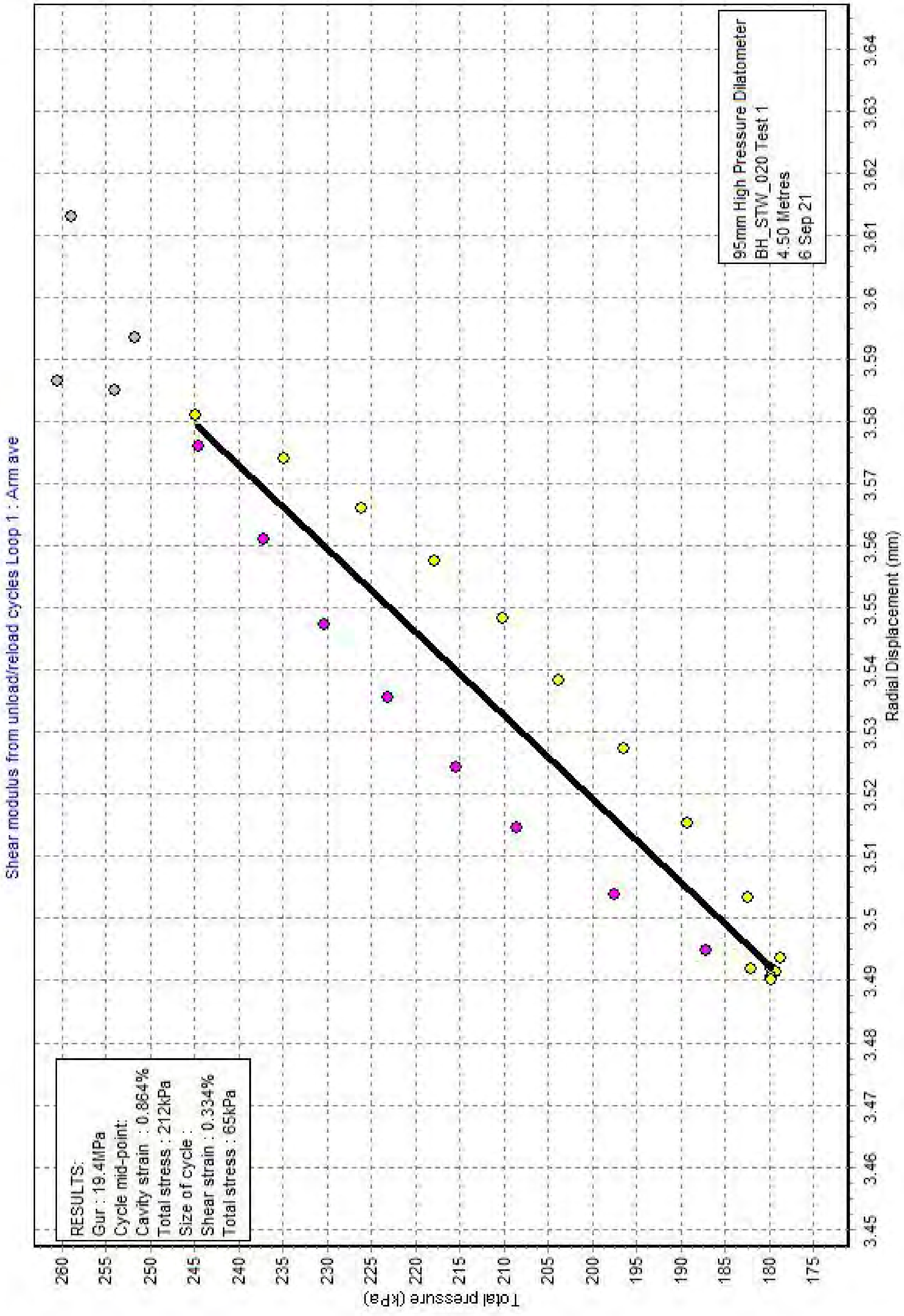
Ambient pore water pressure (kPa) : 0
Residual friction angle (deg) : 32.0
Poisson's ratio : 0.25

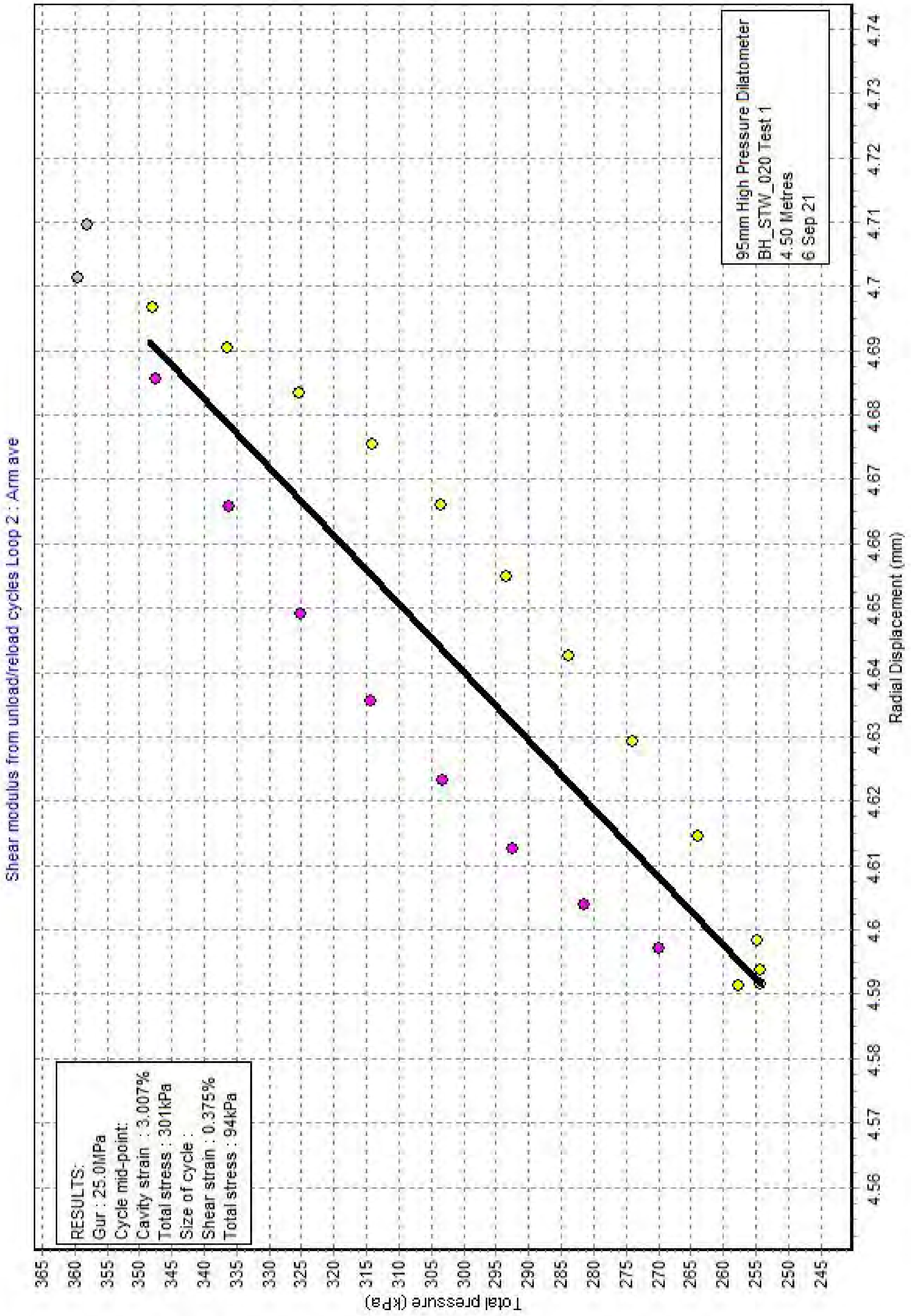

Cavity strain vs Total Pressure : Arm ave
95mm High Pressure Dilatometer
BH_STW_020 Test 1
4.50 Metres
6 Sep 21
Cavity strain (%)
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
Total pressure (kPa)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700

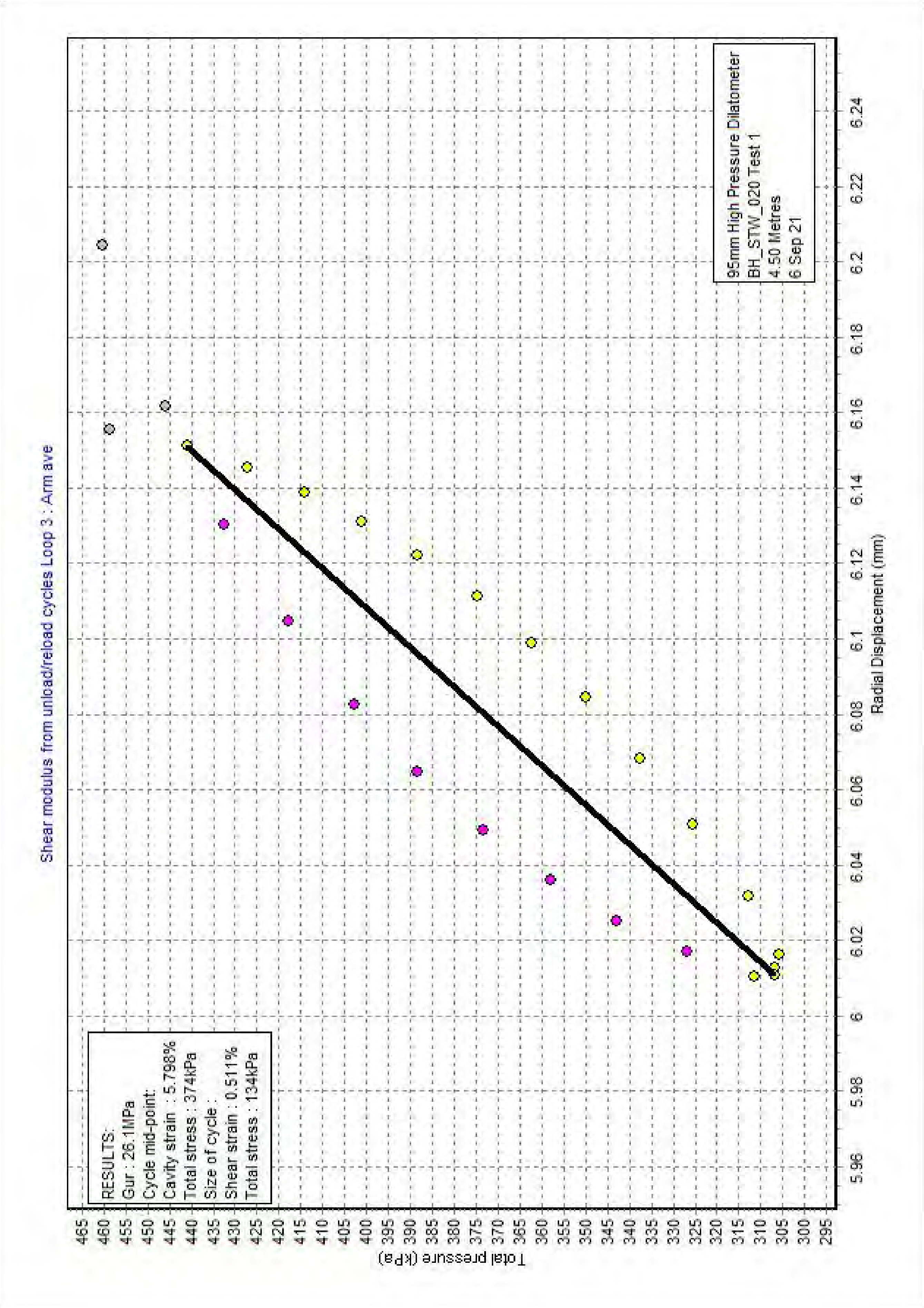

Po of cohesive material (1977, 1990) : Arm ave
95mm High Pressure Dilatometer
BH_STW_020 Test 1
4.50 Metres
6 Sep 21
RESULTS:
Gi : 5.1MPa
Pf : 291.5kPa
Po : 98.4kPa
Tf : 193.2kPa
Po + Tf : 291.7kPa
Origin : 2.537mm
Total pressure (kPa)
560
540
520
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
Radial Displacement (mm)
1
2
3
4
5
Shear stress at yield : Arm ave
Total pressure (kPa)
550
500
450
400
350
300
Ln[shear strain]
-3
-2

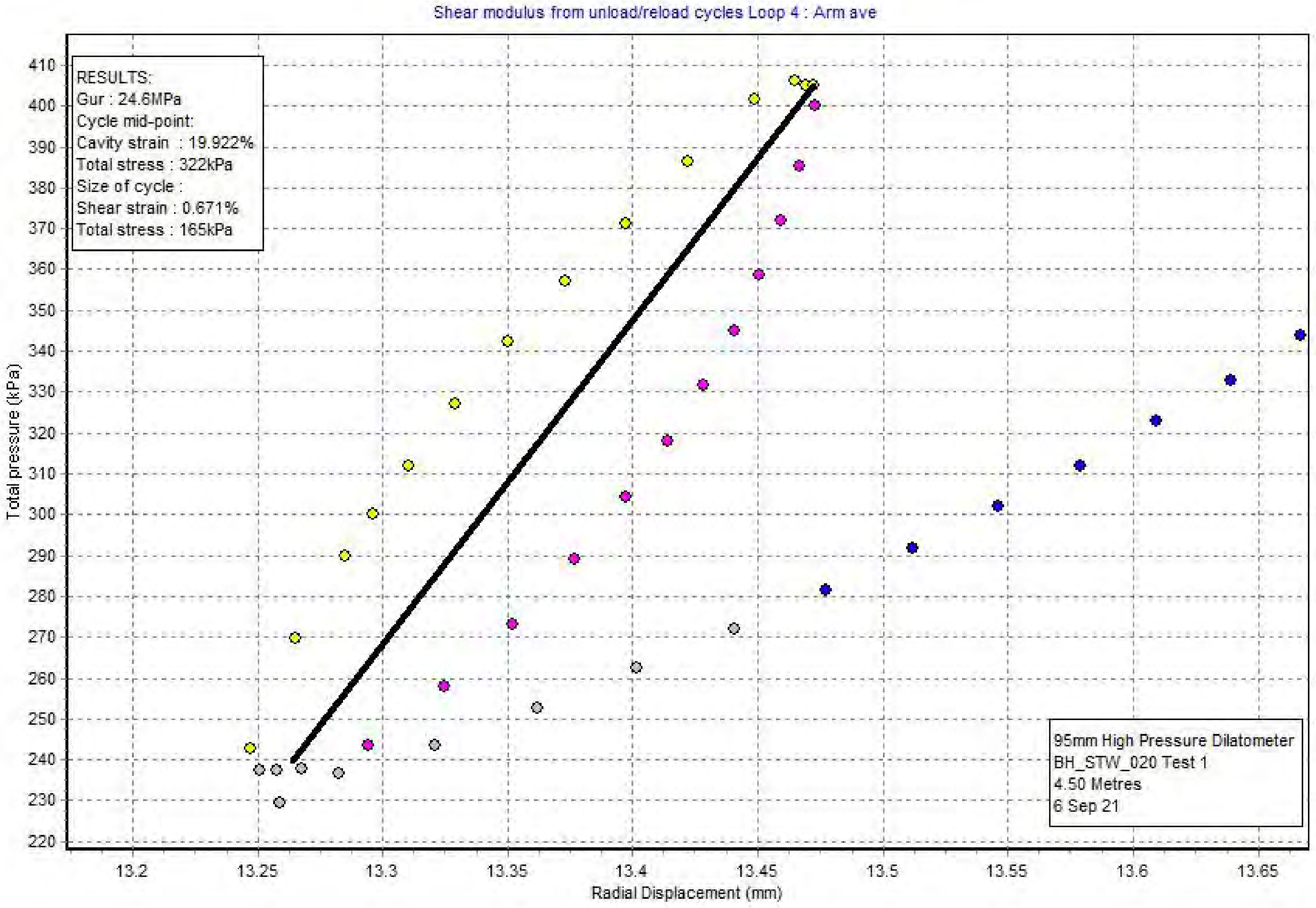

Hughes et al (1977) : Arm ave
95mm High Pressure Dilatometer
BH_STW_020 Test 1
4.50 Metres
6 Sep 21
RESULTS:
Ambient water pressure : 0.0 kPa
Residual friction angle : 32.0°
Gradient : 0.352
Friction angle : 32.4°
Dilation angle : 0.5°
Ln[hoop strain]
-2
-3
-4
-5
-6
-7
Ln[Effective stress]
6.55
6.5
6.45
6.4
6.35
6.3
6.25
6.2
6.15
6.1
6.05
6
5.95
5.9
5.85
5.8
5.75
5.7
5.65
5.6
5.55
5.5
5.45
5.4

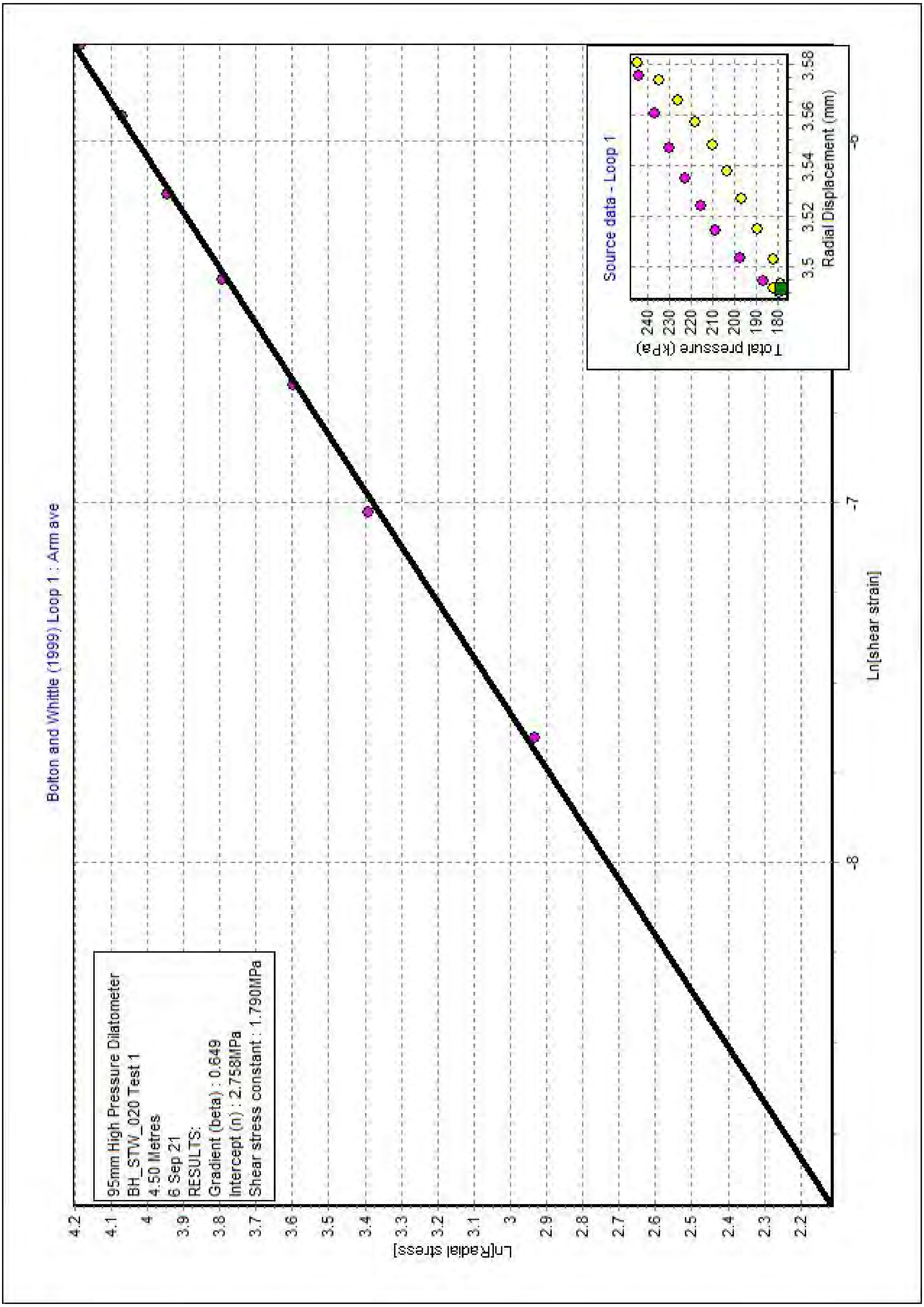

Withers et al (1989) : Arm ave
95mm High Pressure Dilatometer
BH_STW_020 Test 1
4.50 Metres
6 Sep 21
RESULTS:
Ambient water pressure : 0.0 kPa
Residual friction angle : 32.0°
Gradient : -2.327
Friction angle : 33.2°
Dilation angle : 1.4°
Ln[(Emx-Ec)/(1+Emx)]
-4
-5
-6
-7
Ln[P'/P'mx]
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1
-1.1
-1.2
-1.3
-1.4
-1.5
-1.6
-1.7
-1.8
-1.9
-2
-2.1
-2.2
-2.3
-2.4
-2.5
-2.6
-2.7
-2.8
-2.9

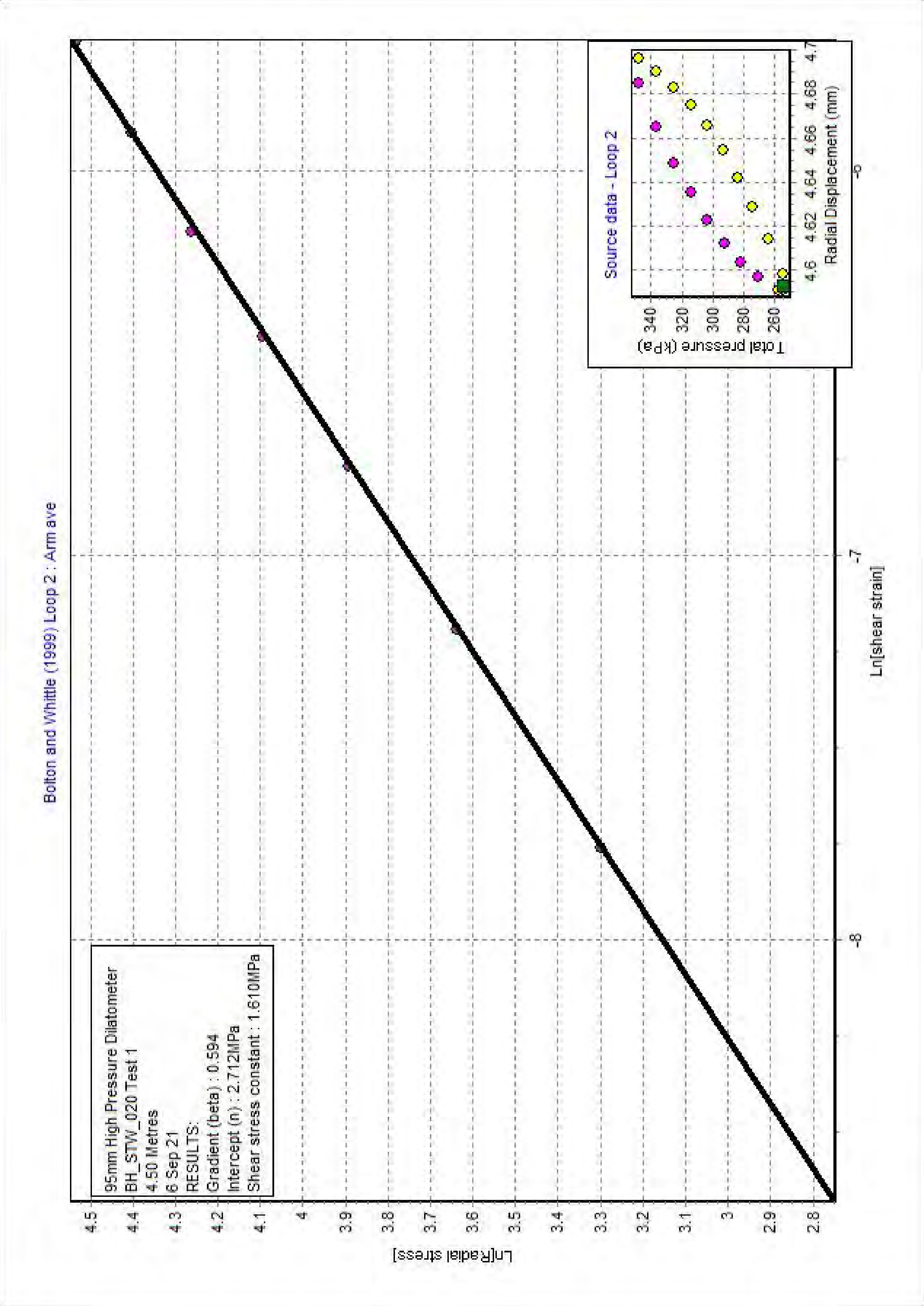

Shear modulus from unload/reload cycles Loop 1 : Arm ave
95mm High Pressure Dilatometer
BH_STW_020 Test 1
4.50 Metres
6 Sep 21
RESULTS:
Gur : 19.4MPa
Cycle mid-point:
Cavity strain : 0.864%
Total stress : 212kPa
Size of cycle :
Shear strain : 0.334%
Total stress : 65kPa
Radial Displacement (mm)
3.45
3.46
3.47
3.48
3.49
3.5
3.51
3.52
3.53
3.54
3.55
3.56
3.57
3.58
3.59
3.6
3.61
3.62
3.63
3.64
Total pressure (kPa)
260
255
250
245
240
235
230
225
220
215
210
205
200
195
190
185
180
175

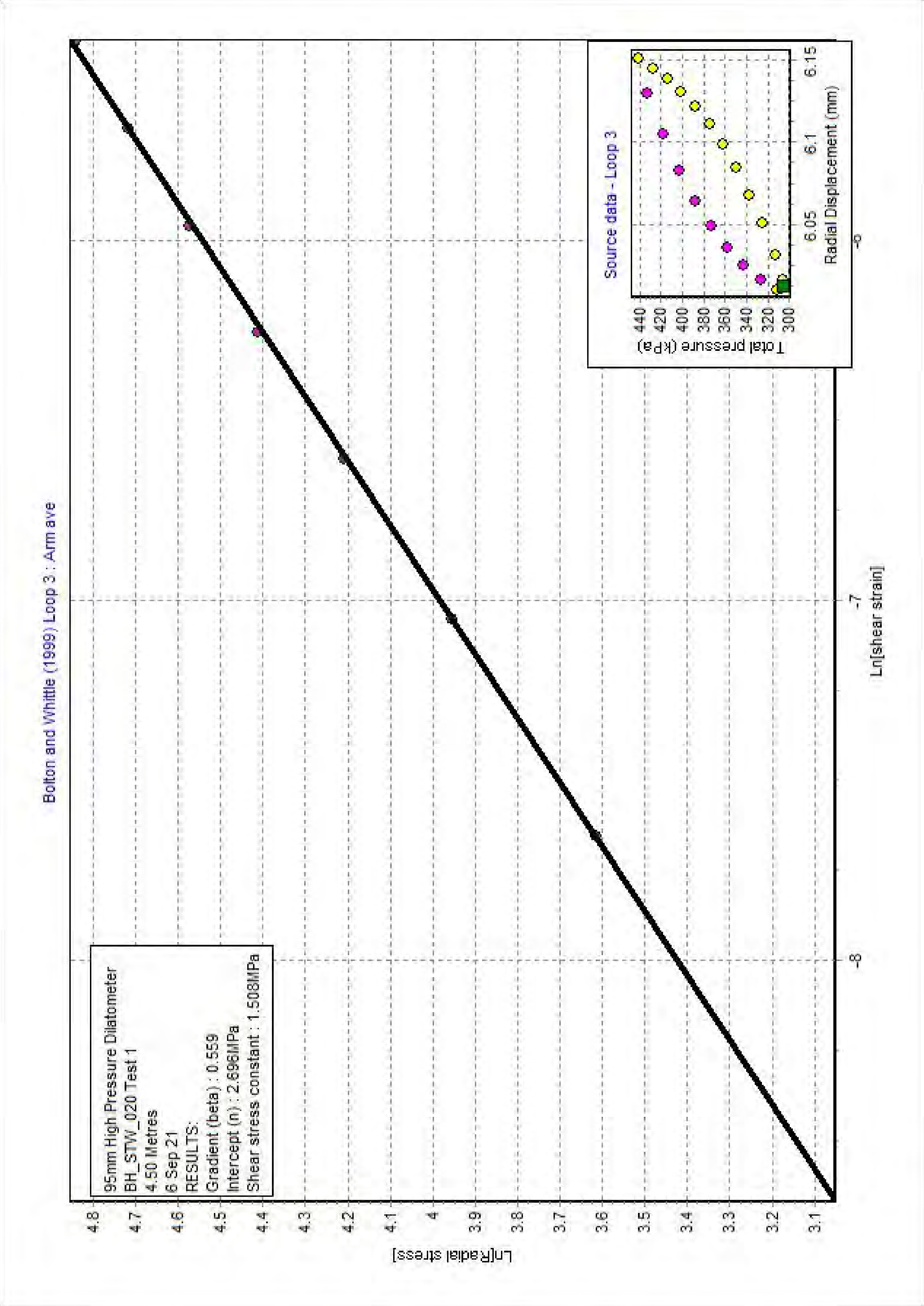

Shear modulus from unload/reload cycles Loop 2 : Arm ave
95mm High Pressure Dilatometer
BH_STW_020 Test 1
4.50 Metres
6 Sep 21
RESULTS:
Gur : 25.0MPa
Cycle mid-point:
Cavity strain : 3.007%
Total stress : 301kPa
Size of cycle :
Shear strain : 0.375%
Total stress : 94kPa
Radial Displacement (mm)
4.56
4.57
4.58
4.59
4.6
4.61
4.62
4.63
4.64
4.65
4.66
4.67
4.68
4.69
4.7
4.71
4.72
4.73
4.74
Total pressure (kPa)
365
360
355
350
345
340
335
330
325
320
315
310
305
300
295
290
285
280
275
270
265
260
255
250
245

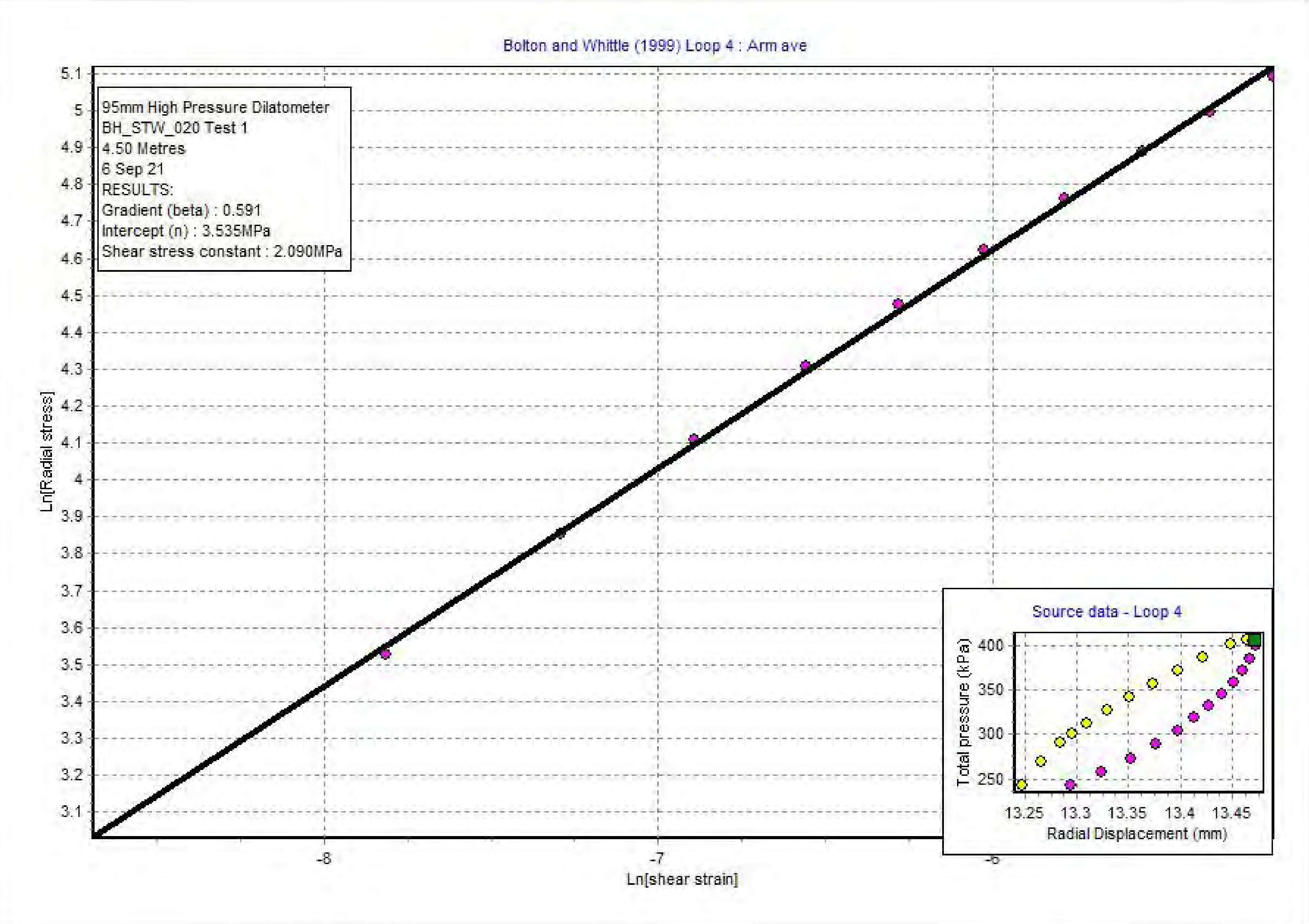

Shear modulus from unload/reload cycles Loop 3 : Arm ave
RESULTS:
Gur : 26.1MPa
Cycle mid-point:
Cavity strain : 5.798%
Total stress : 374kPa
Size of cycle :
Shear strain : 0.511%
Total stress : 134kPa
95mm High Pressure Dilatometer
BH_STW_020 Test 1
4.50 Metres
6 Sep 21
Total pressure (kPa)
465
460
455
450
445
440
435
430
425
420
415
410
405
400
395
390
385
380
375
370
365
360
355
350
345
340
335
330
325
320
315
310
305
300
295
Radial Displacement (mm)
5.96
5.98
6
6.02
6.04
6.06
6.08
6.1
6.12
6.14
6.16
6.18
6.2
6.22
6.24


Shear modulus from unload/reload cycles Loop 4 : Arm ave
RESULTS:
Gur : 24.6MPa
Cycle mid-point:
Cavity strain : 19.922%
Total stress : 322kPa
Size of cycle :
Shear strain : 0.671%
Total stress : 165kPa
95mm High Pressure Dilatometer
BH_STW_020 Test 1
4.50 Metres
6 Sep 21
Total pressure (kPa)
410
400
390
380
370
360
350
340
330
320
310
300
290
280
270
260
250
240
230
220
Radial Displacement (mm)
13.2
13.25
13.3
13.35
13.4
13.45
13.5
13.55
13.6
13.65

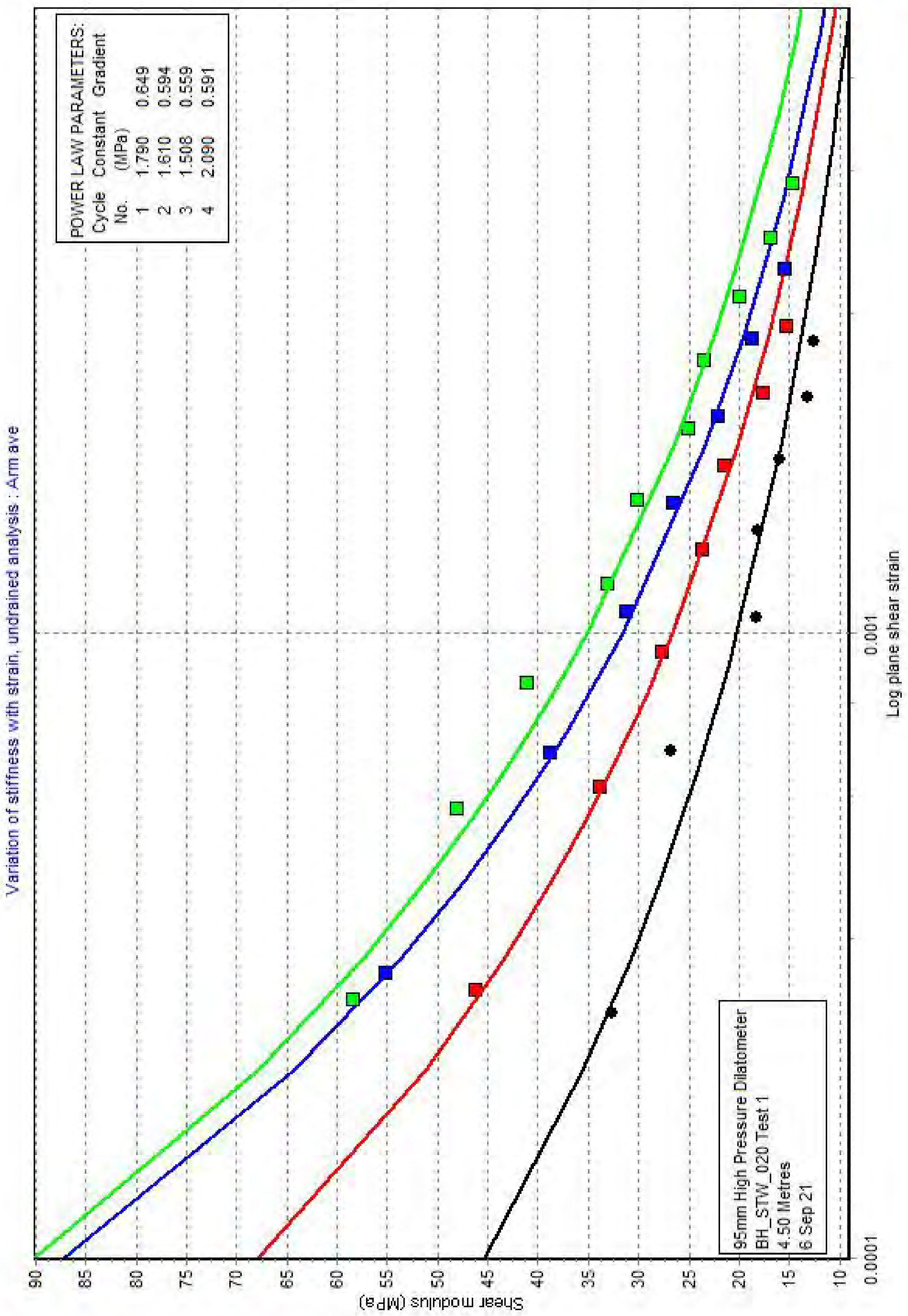

Bolton and Whittle (1999) Loop 1 : Arm ave
95mm High Pressure Dilatometer
BH_STW_020 Test 1
4.50 Metres
6 Sep 21
RESULTS:
Gradient (beta) : 0.649
Intercept (n) : 2.758MPa
Shear stress constant : 1.790MPa
Ln[Radial stress]
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
Ln[shear strain]
-8
-7
-6
Source data - Loop 1
Total pressure (kPa)
240
230
220
210
200
190
180
Radial Displacement (mm)
3.5
3.52
3.54
3.56
3.58

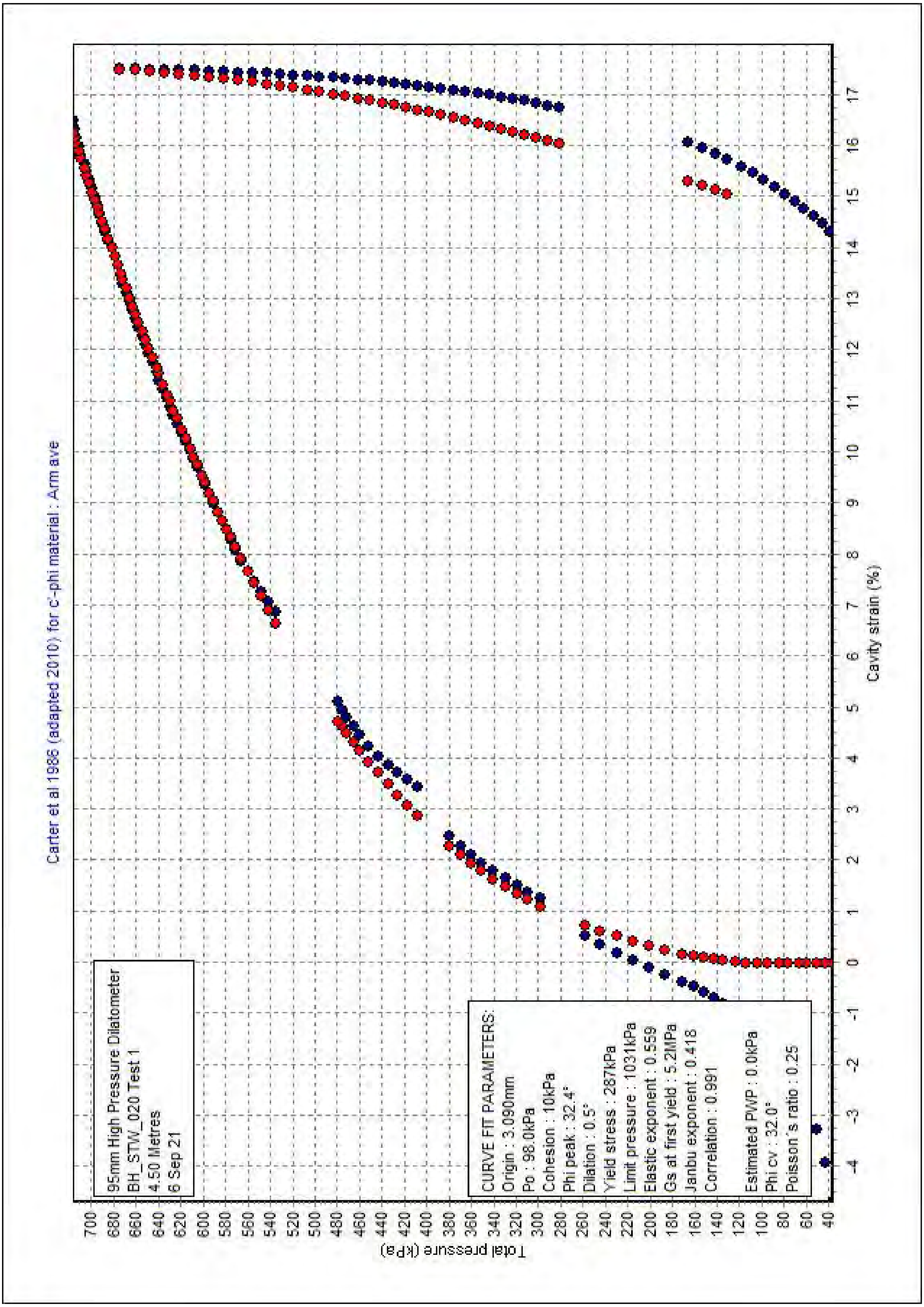

Bolton and Whittle (1999) Loop 2 : Arm ave
95mm High Pressure Dilatometer
BH_STW_020 Test 1
4.50 Metres
6 Sep 21
RESULTS:
Gradient (beta) : 0.594
Intercept (n) : 2.712MPa
Shear stress constant : 1.610MPa
Ln[Radial stress]
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
Ln[shear strain]
-8
-7
-6
Source data - Loop 2
Total pressure (kPa)
340
320
300
280
260
Radial Displacement (mm)
4.6
4.62
4.64
4.66
4.68
4.7


Bolton and Whittle (1999) Loop 3 : Arm ave
95mm High Pressure Dilatometer
BH_STW_020 Test 1
4.50 Metres
6 Sep 21
RESULTS:
Gradient (beta) : 0.559
Intercept (n) : 2.696MPa
Shear stress constant : 1.508MPa
Ln[Radial stress]
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
Ln[shear strain]
-8
-7
-6
Source data - Loop 3
Total pressure (kPa)
440
420
400
380
360
340
320
300
Radial Displacement (mm)
6.05
6.1
6.15



95mm High Pressure Dilatometer
BH_STW_020 Test 1
4.50 Metres
6 Sep 21
RESULTS:
Gradient (beta) : 0.591
Intercept (n) : 3.535MPa
Shear stress constant : 2.090MPa

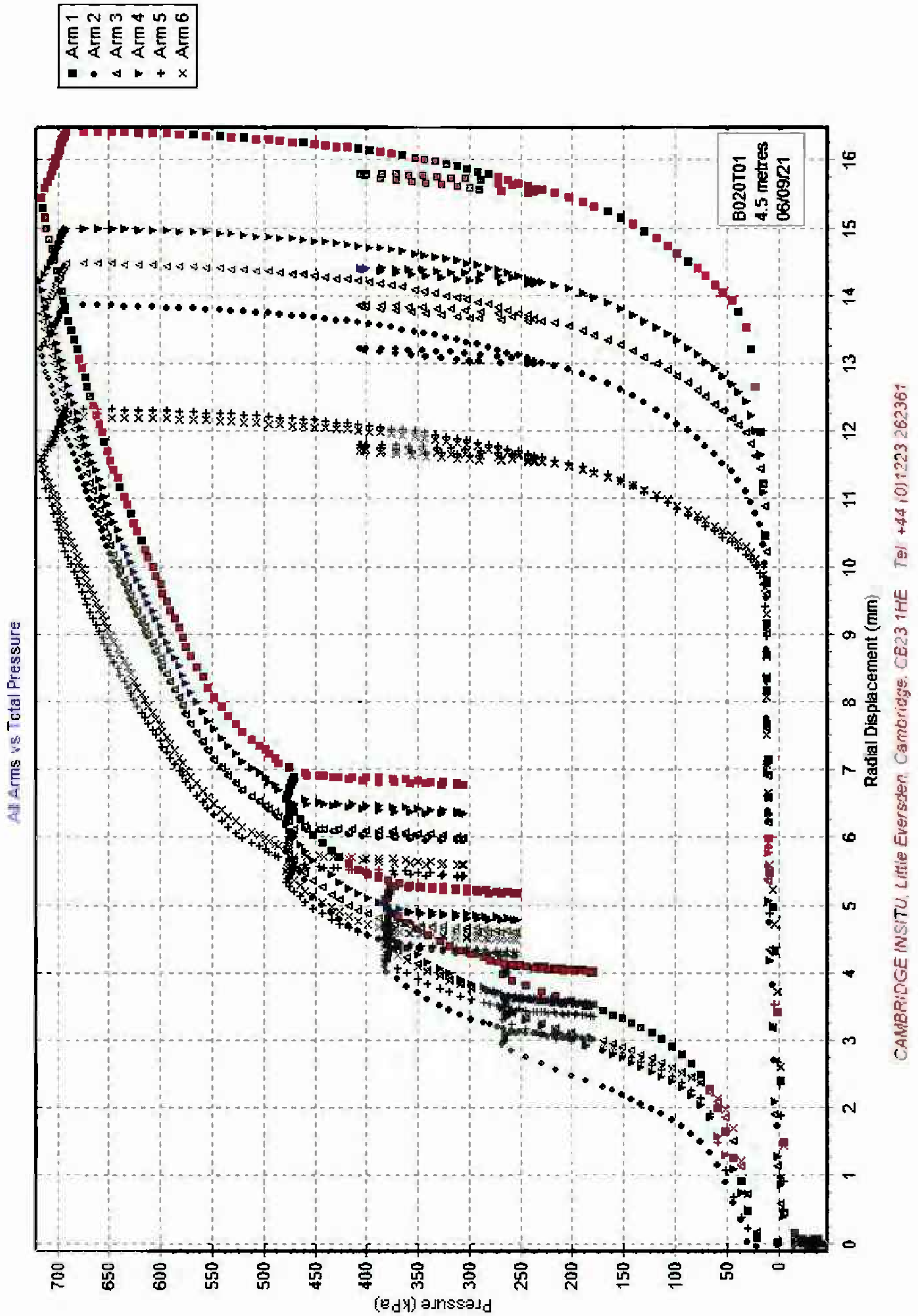

Variation of stiffness with strain, undrained analysis : Arm ave
POWER LAW PARAMETERS:
Cycle Constant Gradient
No. (MPa)
1 1.790 0.649
2 1.610 0.594
3 1.508 0.559
4 2.090 0.591
95mm High Pressure Dilatometer
BH_STW_020 Test 1
4.50 Metres
6 Sep 21
Shear modulus (MPa)
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
Log plane shear strain
0.0001
0.001



95mm High Pressure Dilatometer
BH_STW_020 Test 1
4.50 Metres
6 Sep 21

CURVE FIT PARAMETERS:
Origin : 3.090mm
Po : 98.0kPa
Cohesion : 10kPa
Phi peak : 32.4°
Dilation : 0.5°
Yield stress : 287kPa
Limit pressure : 1031kPa
Elastic exponent : 0.559
Gs at first yield : 5.2MPa
Janbu exponent : 0.418
Correlation : 0.991

Estimated PWP : 0.0kPa
Phi cv : 32.0°
Poisson's ratio : 0.25

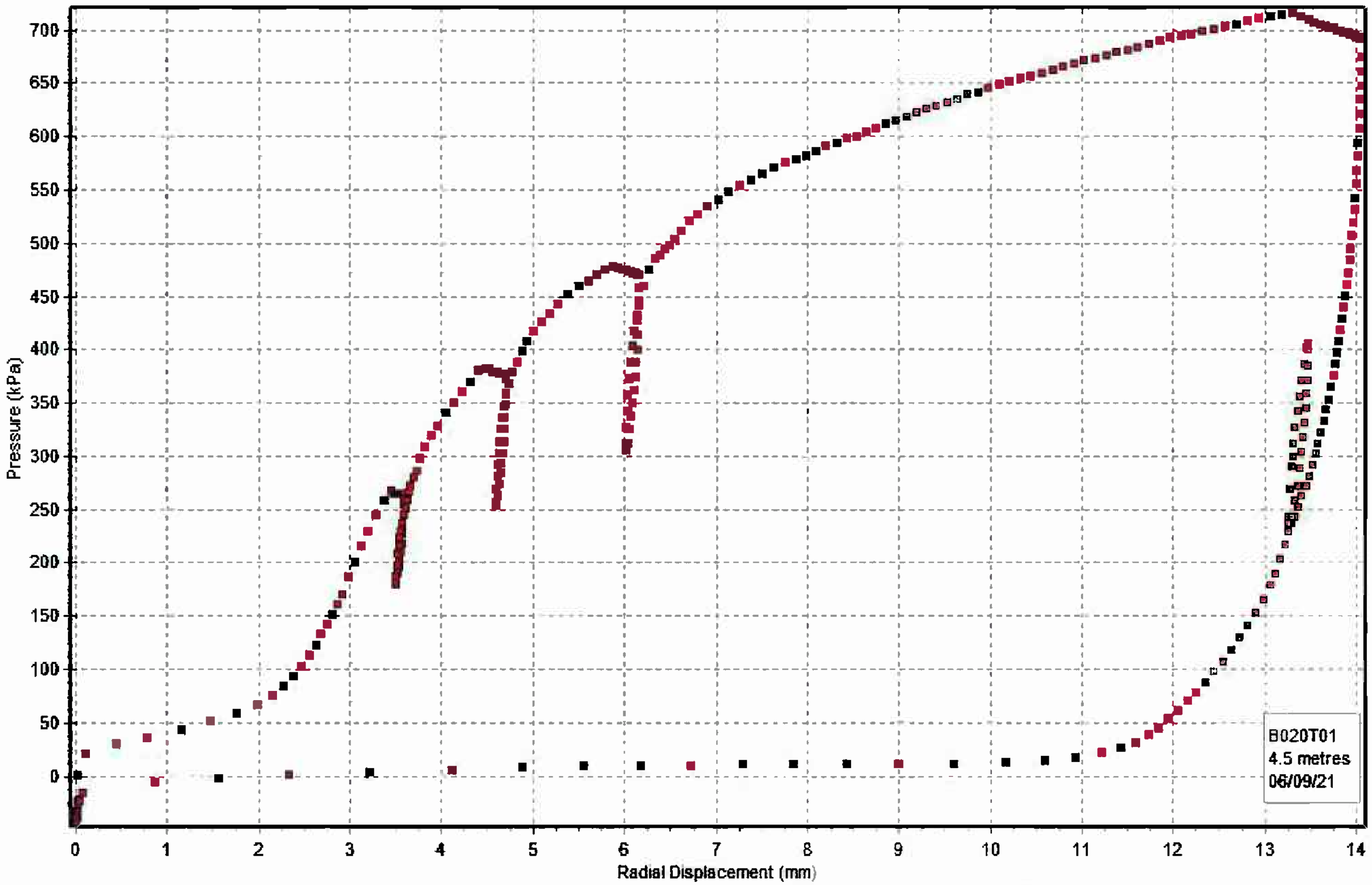

All Arms vs Total Pressure
■ Arm 1
● Arm 2
▵ Arm 3
▾ Arm 4
+ Arm 5
× Arm 6
B020T01
4.5 metres
06/09/21
Pressure (kPa)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
Radial Displacement (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
CAMBRIDGE INSITU, Little Eversden, Cambridge. CB23 1HE Tel +44 (0)1223 262361

CIR1506/21

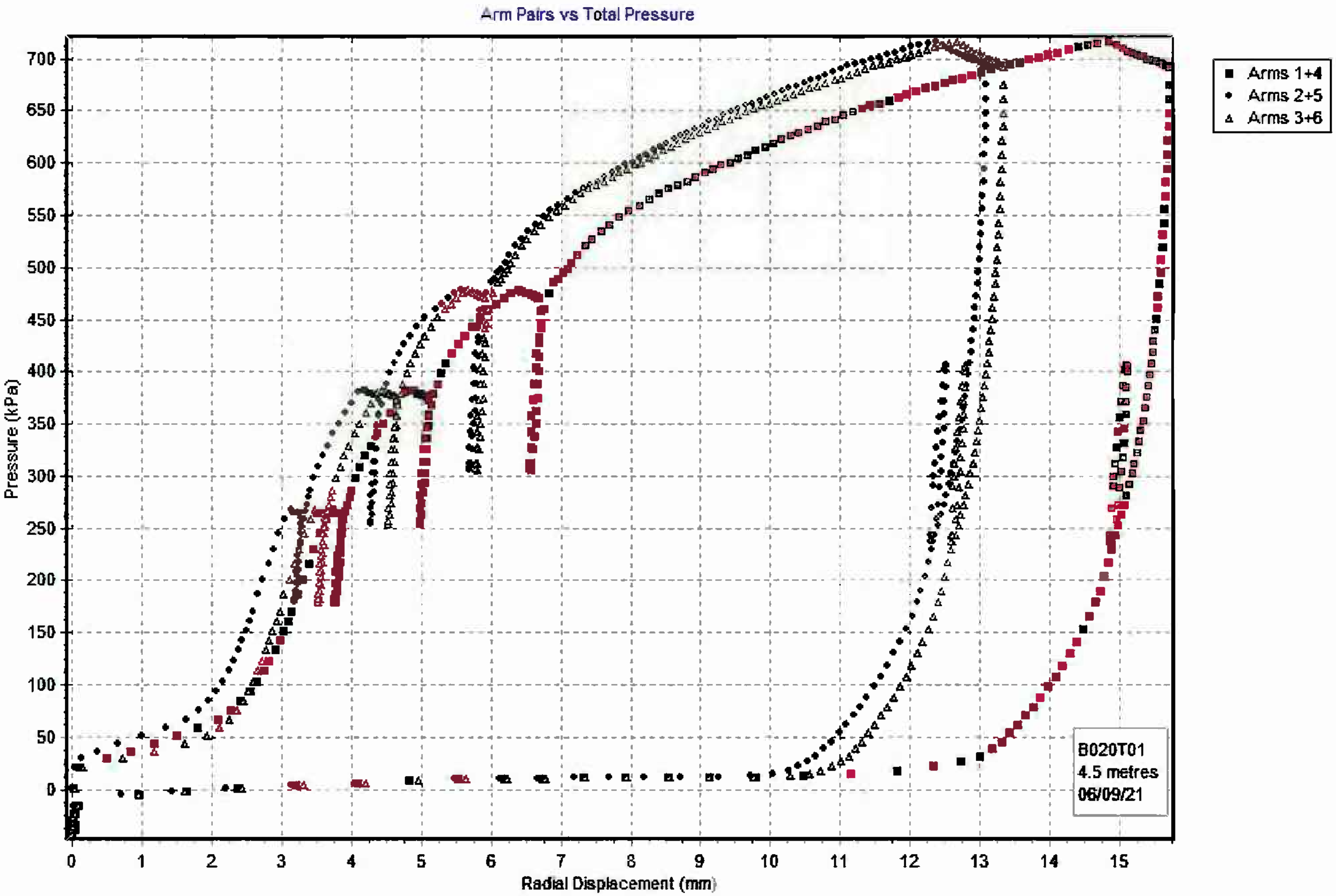
Cambridge WWTPR

Pressuremeter Testing

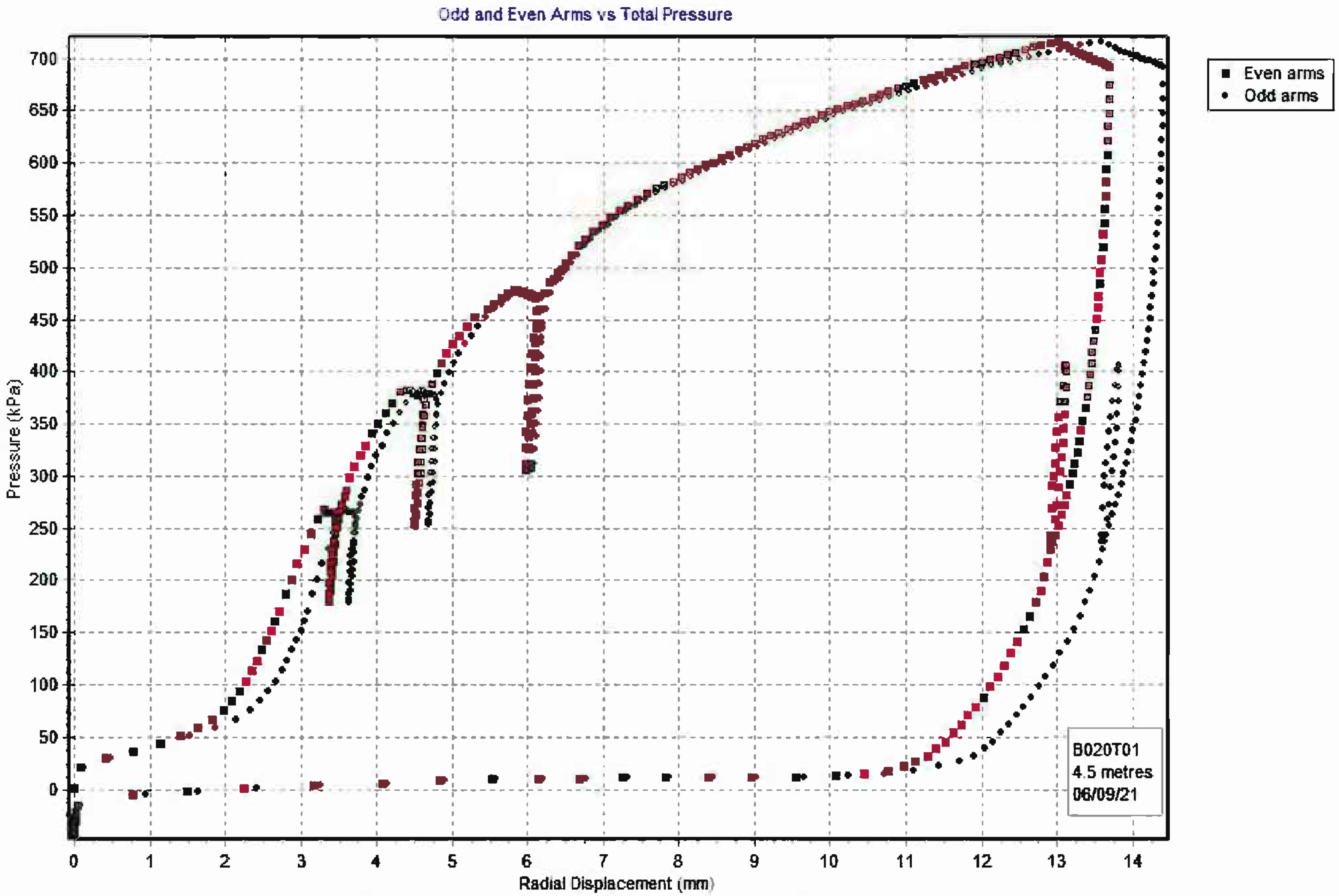
Arm Average vs Total Pressure



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel +44 (0)1223 262361



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel +44 (0)1223 262361



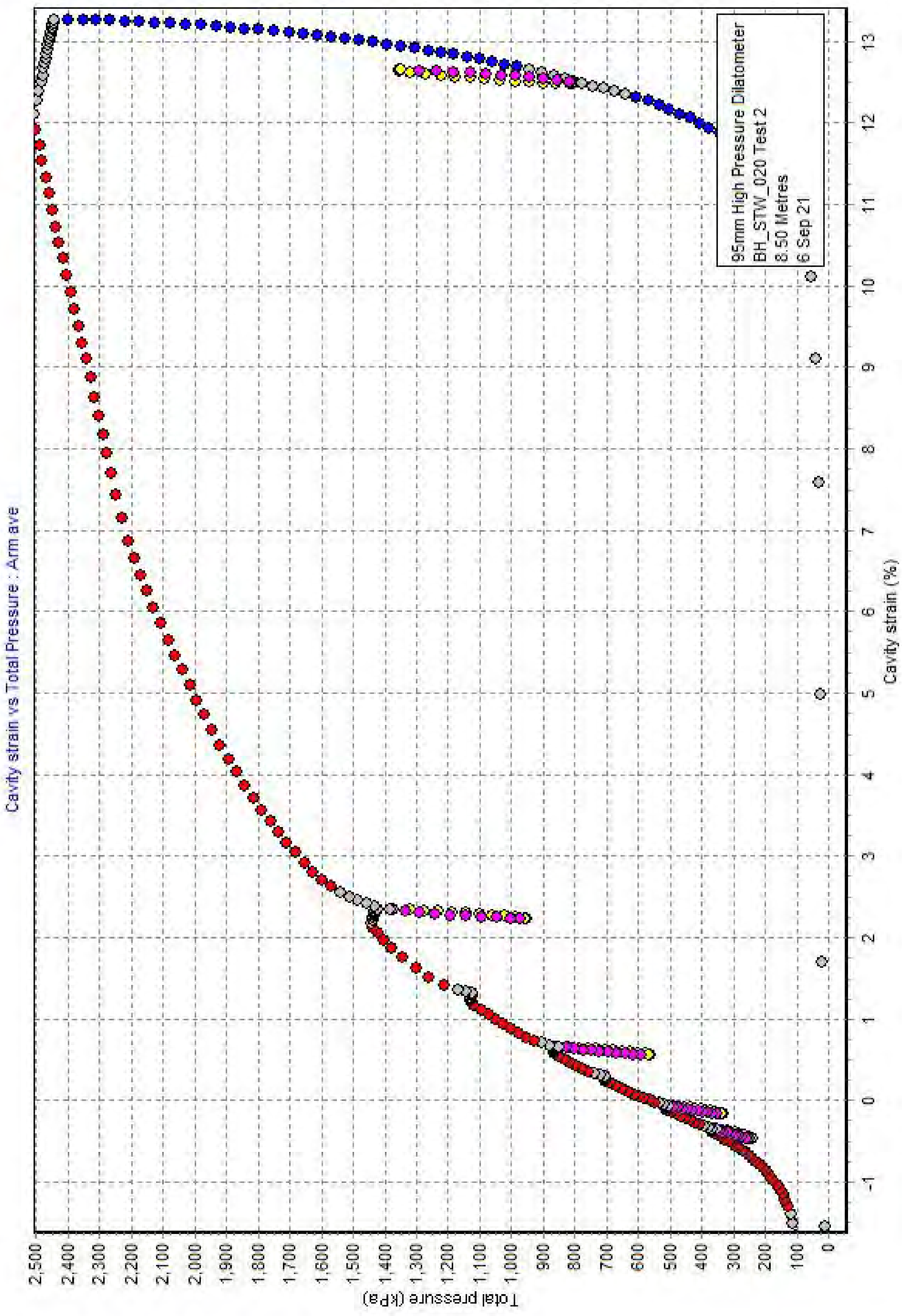
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel +44 (0)1223 262361

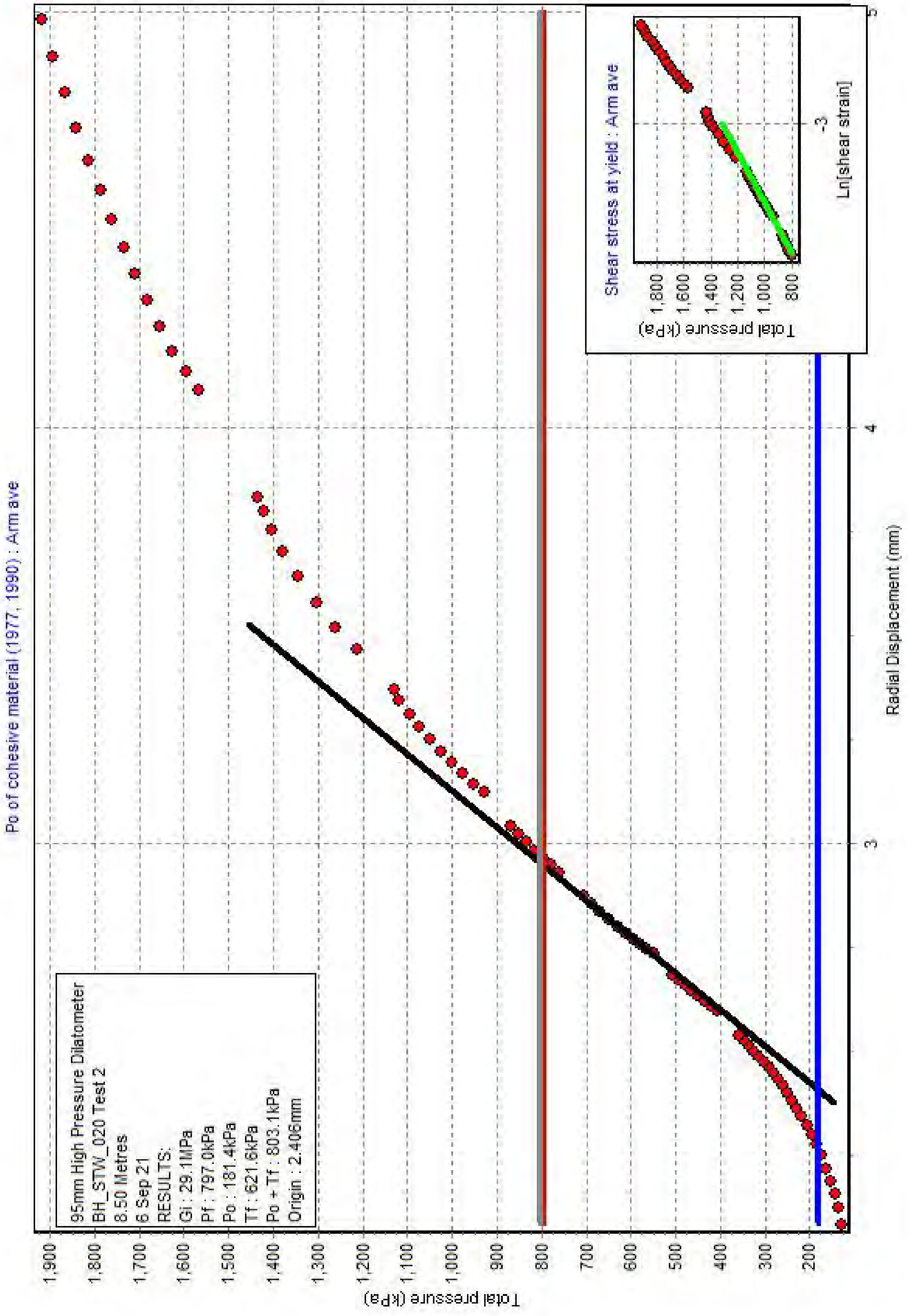
```
BH_STW_020 Test 2 - SUMMARY OF RESULTS
[File made with WinSitu ]

[DETAILS OF TEST]
Project        :   TE8364
Site           :   Cambridge Waste Water Treatment Plant Relocation Project
Borehole       :   BH_STW_020
Test name      :   BH_STW_020 Test 2
Test date      :   6 Sep 21
Test depth     :   8.50 Metres
Water table    :   2.1 Metres
Ambient PWP    :   0.0 kPa
Material       :   Chalk
Probe          :   95mm High Pressure Dilatometer
Diameter       :   97.0 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out
The file includes results from a curve fitting analysis

Analysed by ES/YB/RW on 6 Sep 21

Remarks:  Curve modelling doesn't work very well because after 6.5% cavity
strain the material structure begins to break down.

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm)                  :   "Arm ave=2.74"
Po from Marsland & Randolph (kPa)   :   "Arm ave=181.4"
Best estimate of Po (kPa)           :   "Arm ave=194.0"

[UNDRAINED STRENGTH PARAMETERS]
Undrained yield stress (kPa)        :   "Arm ave=797.0"

[DRAINED ANALYSIS OF SANDS]
[Hughes et al 1977]
Constant volume friction angle (°)  :   32.0
Angle of internal friction (°)      :   "Arm ave=35.5"
Dilation angle (°)                  :   "Arm ave=4.2"
Gradient of log-log plot            :   "Arm ave=0.394"

[Withers et al 1989]
Angle of internal friction (°)      :   "Arm ave=34.2"
Dilation angle (°)                  :   "Arm ave=2.7"
Gradient of log-log plot            :   "Arm ave=-2.390"

[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=29.1"
Axis       Loop   Value    Mean Strain  Mean Pc  dE      dPc
           No     (MPa)    (%)          (kPa)    (%)     (kPa)
Arm ave    1      49.8     -0.402       293      0.209   104
Arm ave    2      82.3     -0.107       413      0.190   156
Arm ave    3      148.5    0.618        695      0.177   262
Arm ave    4      187.5    2.297        1144     0.203   381
Arm ave    5      188.3    12.582       1088     0.279   525

[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]
Axis       Loop   Intercept  Alpha      Gradient
           No     (MPa)      (MPa)
Arm ave    1      13.203     10.301     0.780
Arm ave    2      15.401     11.272     0.732
Arm ave    3      19.997     13.628     0.681
Arm ave    4      30.957     21.494     0.694
Arm ave    5      24.818     15.956     0.643


[PARAMETERS USED FOR DRAINED CURVE MODELLING]
{Axis is  Arm ave}
Strain Origin (mm)                  :   2.74
Po (kPa)                            :   194
Cohesion (kPa)                      :   117
```

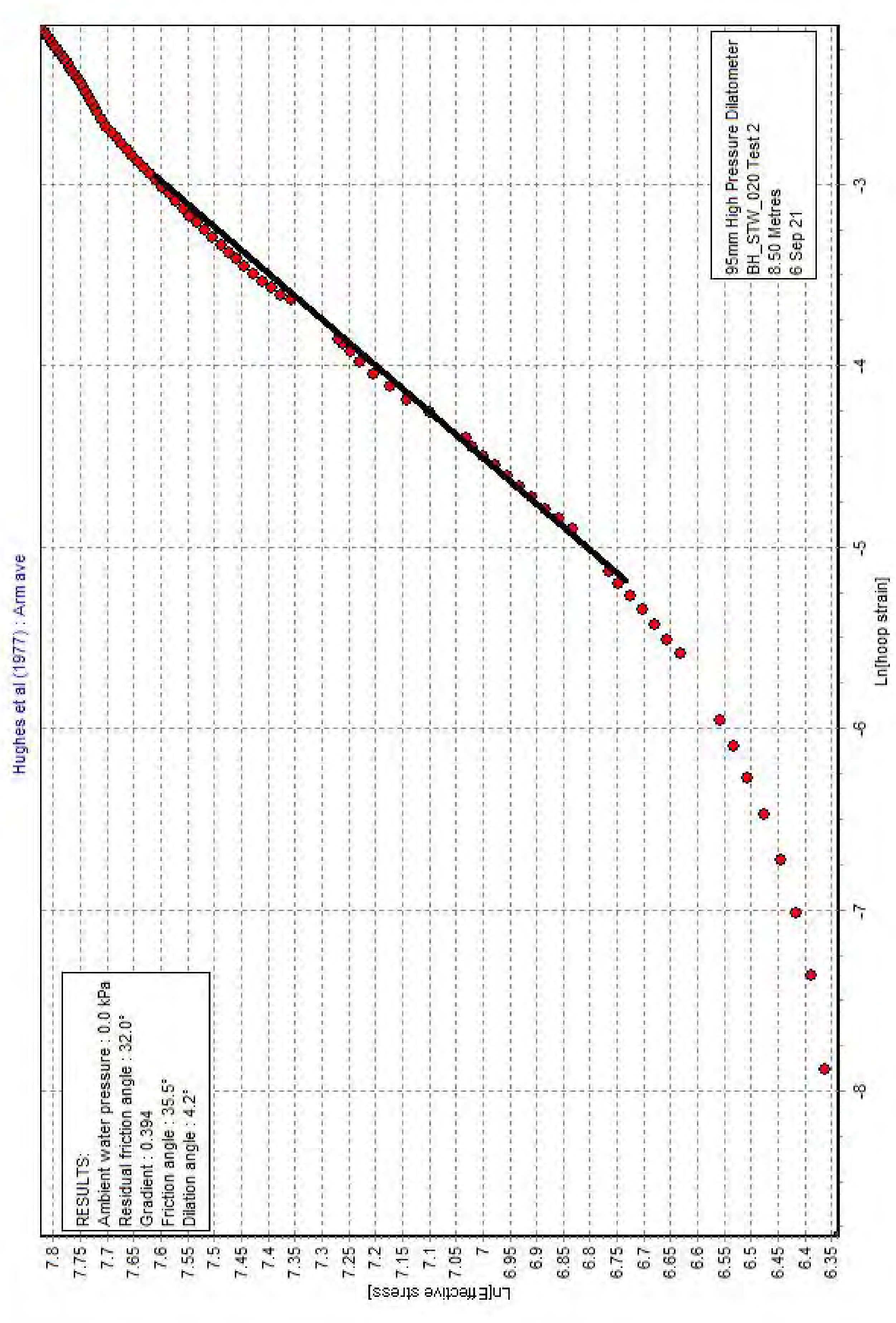
BH_STW_020 Test 2 - SUMMARY OF RESULTS

Angle of peak friction (deg) : 35.5
Angle of peak dilation (deg) : 4.2
Total yield stress (kPa) : 597
Total limit stress (kPa) : 5092
G at first yield (MPa) : 58.1
Non-linear exponent : 0.694
Janbu exponent : 0.432
Correlation : 0.911

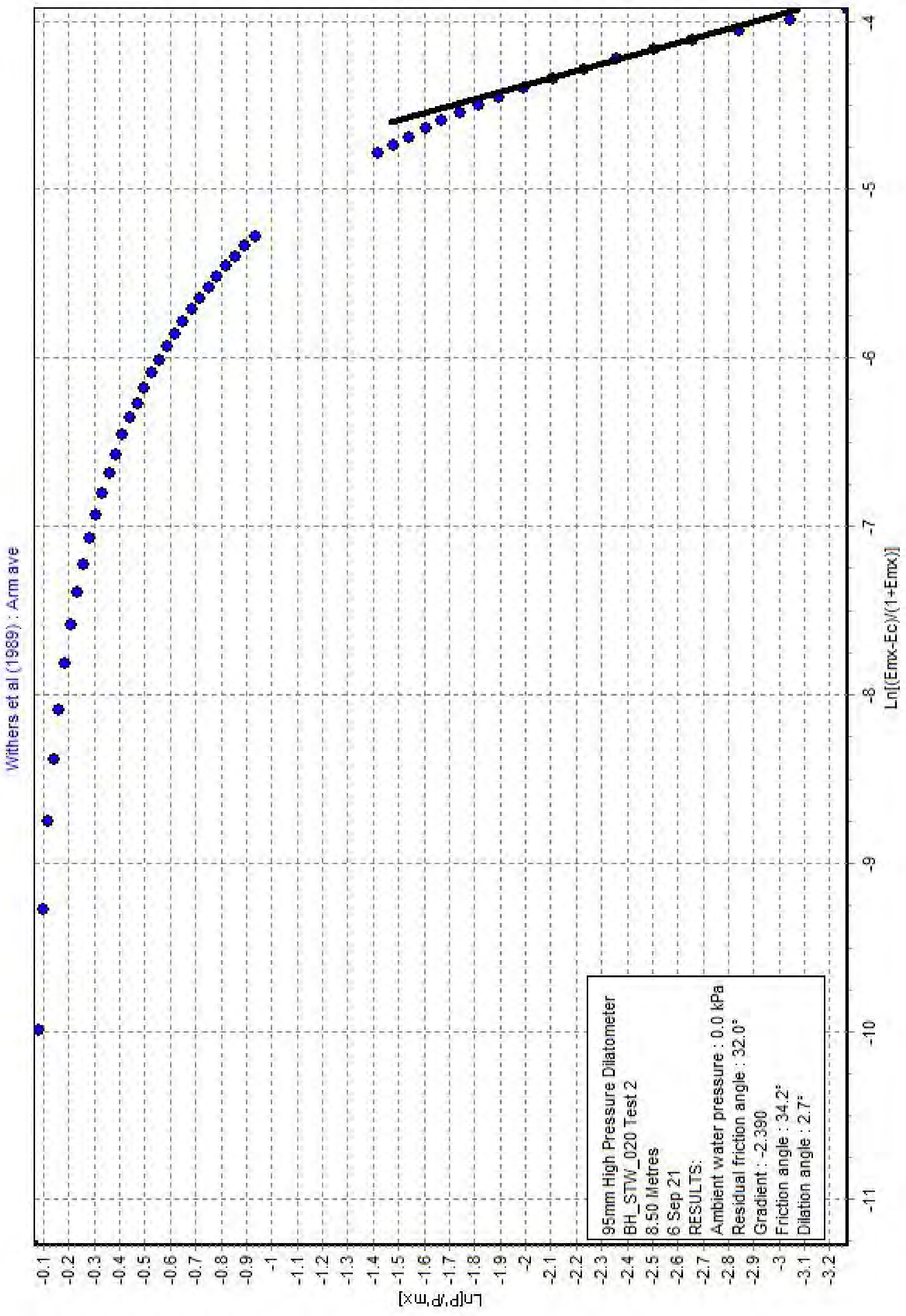
Ambient pore water pressure (kPa) : 0
Residual friction angle (deg) : 32.0
Poisson's ratio : 0.25

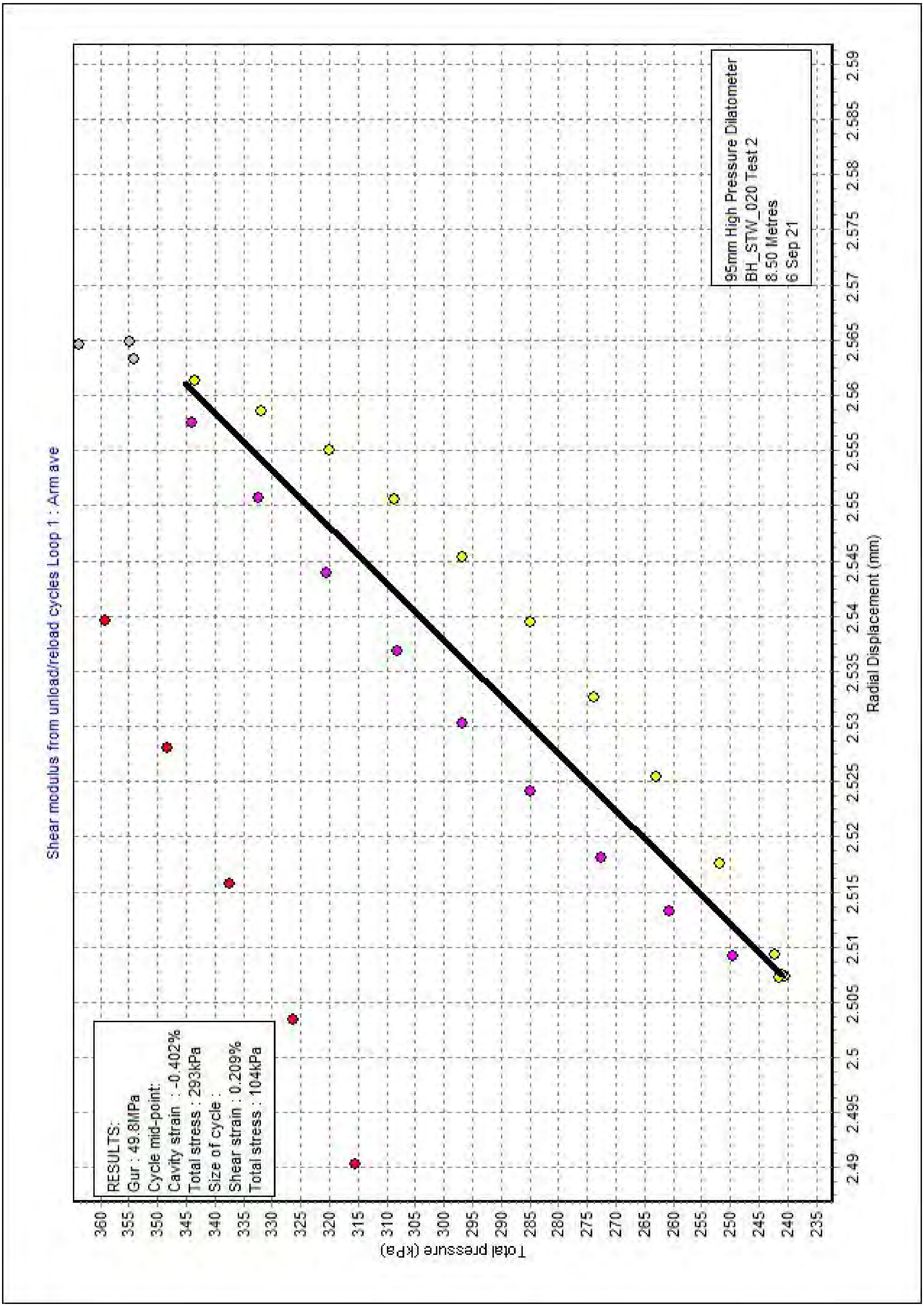

Cavity strain vs Total Pressure : Arm ave
95mm High Pressure Dilatometer
BH_STW_020 Test 2
8.50 Metres
6 Sep 21
Cavity strain (%)
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
Total pressure (kPa)
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
1,300
1,400
1,500
1,600
1,700
1,800
1,900
2,000
2,100
2,200
2,300
2,400
2,500

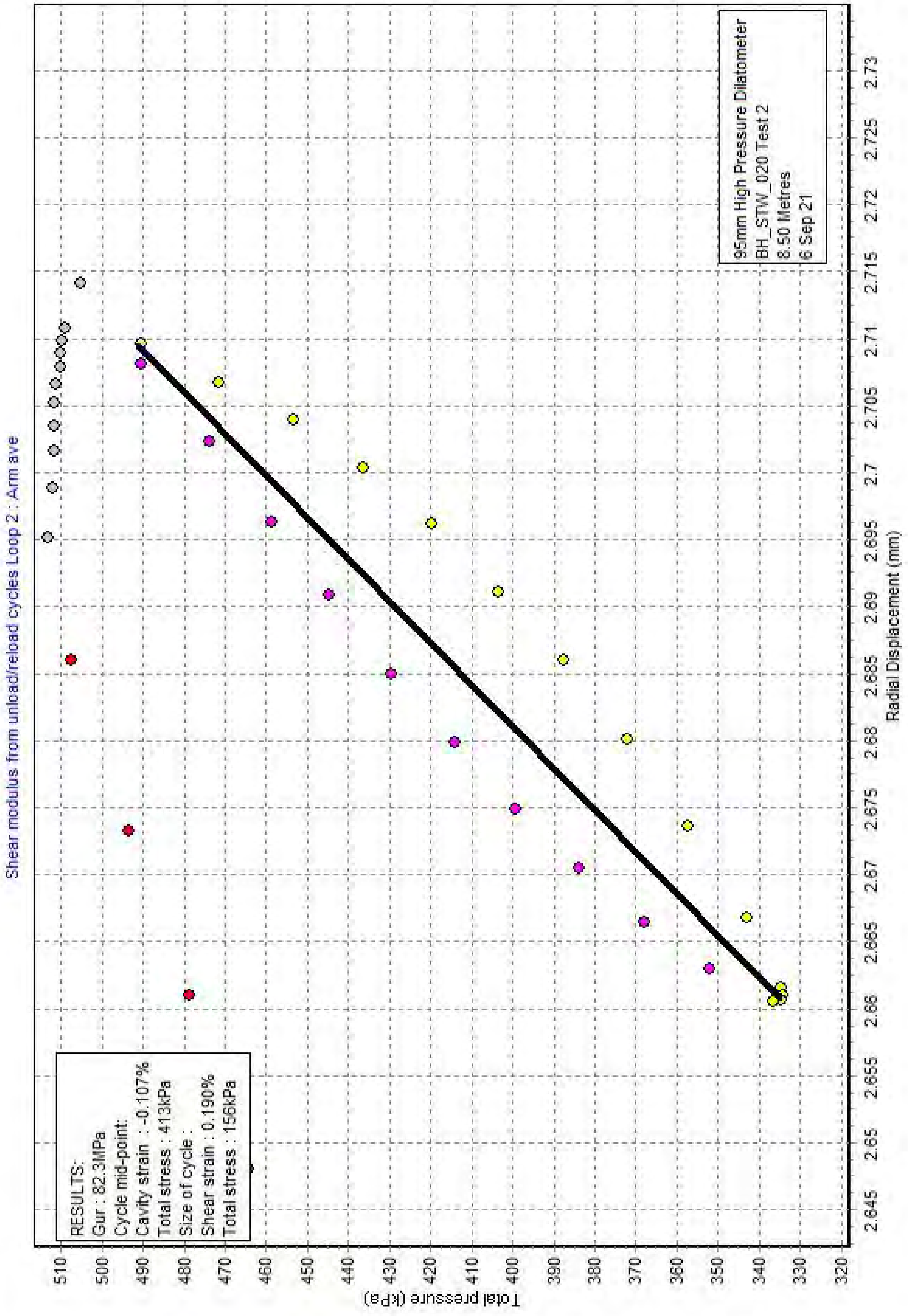

Po of cohesive material (1977, 1990) : Arm ave
95mm High Pressure Dilatometer
BH_STW_020 Test 2
8.50 Metres
6 Sep 21
RESULTS:
Gi : 29.1MPa
Pf : 797.0kPa
Po : 181.4kPa
Tf : 621.6kPa
Po + Tf : 803.1kPa
Origin : 2.406mm
Total pressure (kPa)
1,900
1,800
1,700
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
Radial Displacement (mm)
3
4
5
Shear stress at yield : Arm ave
Total pressure (kPa)
1,800
1,600
1,400
1,200
1,000
800
Ln[shear strain]
-3



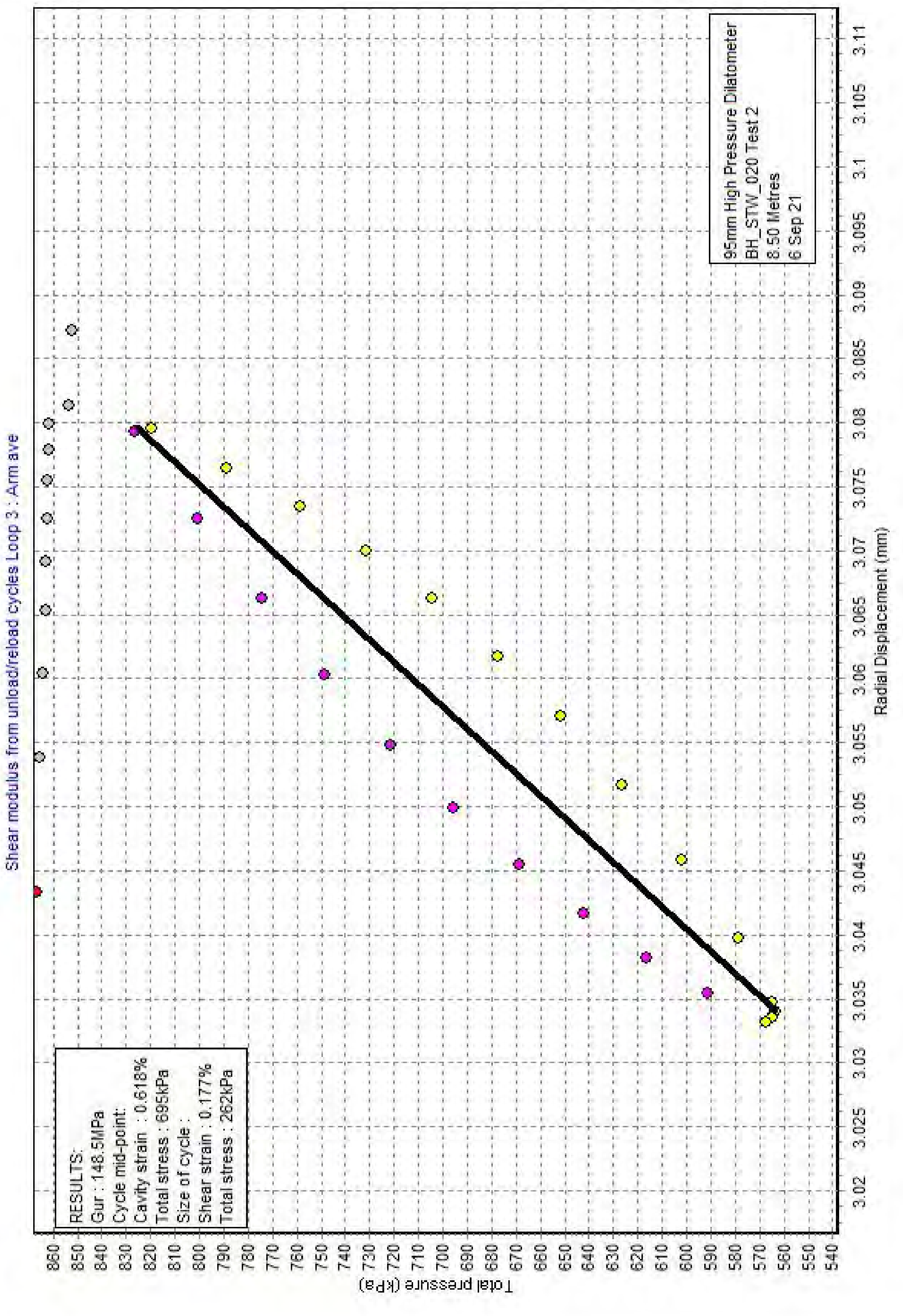
RESULTS:
Ambient water pressure : 0.0 kPa
Residual friction angle : 32.0°
Gradient : 0.394
Friction angle : 35.5°
Dilation angle : 4.2°

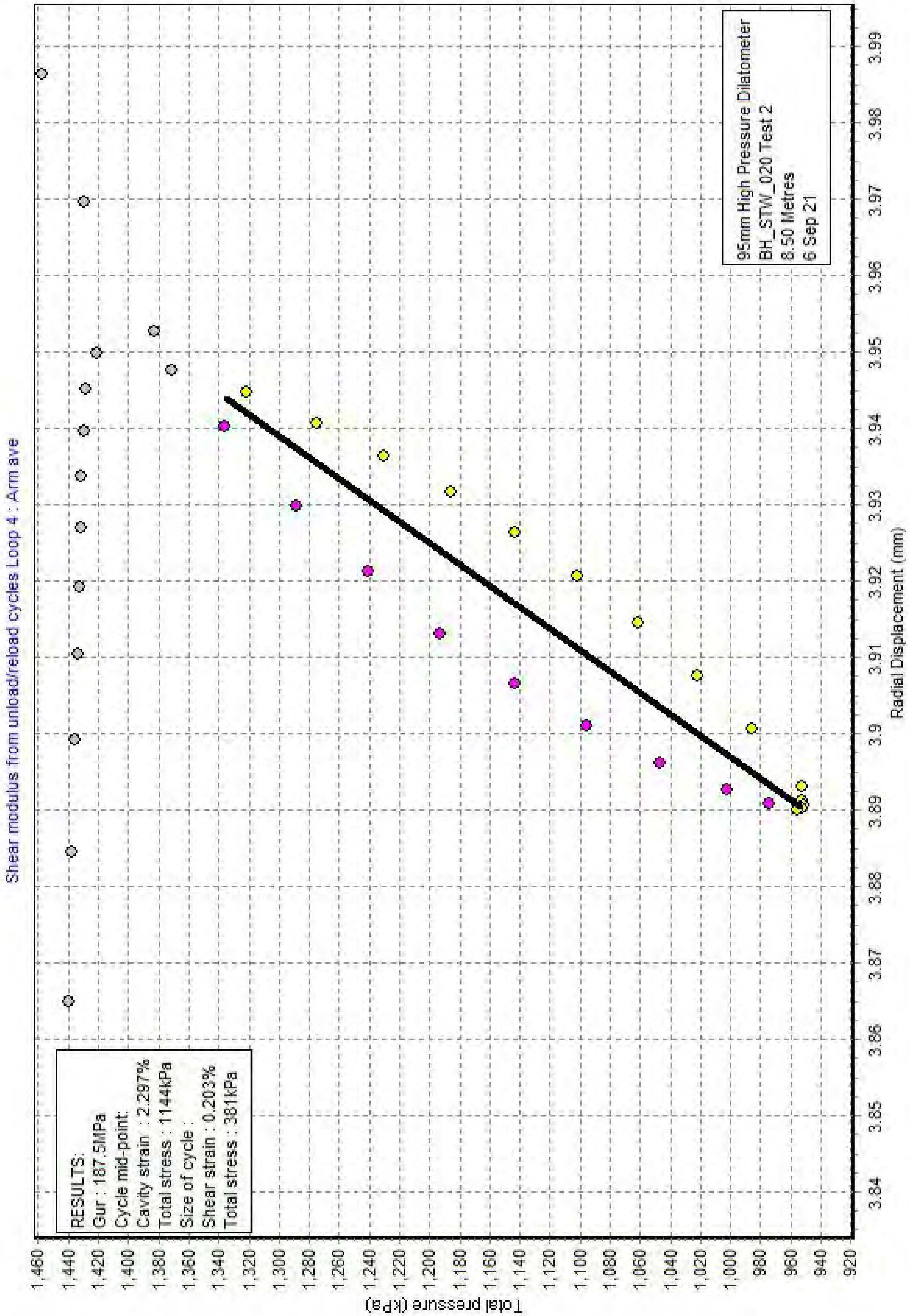

Withers et al (1989) : Arm ave
95mm High Pressure Dilatometer
BH_STW_020 Test 2
8.50 Metres
6 Sep 21
RESULTS:
Ambient water pressure : 0.0 kPa
Residual friction angle : 32.0°
Gradient : -2.390
Friction angle : 34.2°
Dilation angle : 2.7°
Ln[(Emx-Ec)/(1+Emx)]
-4
-5
-6
-7
-8
-9
-10
-11
Ln[P'/P'mx]
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1
-1.1
-1.2
-1.3
-1.4
-1.5
-1.6
-1.7
-1.8
-1.9
-2
-2.1
-2.2
-2.3
-2.4
-2.5
-2.6
-2.7
-2.8
-2.9
-3
-3.1
-3.2

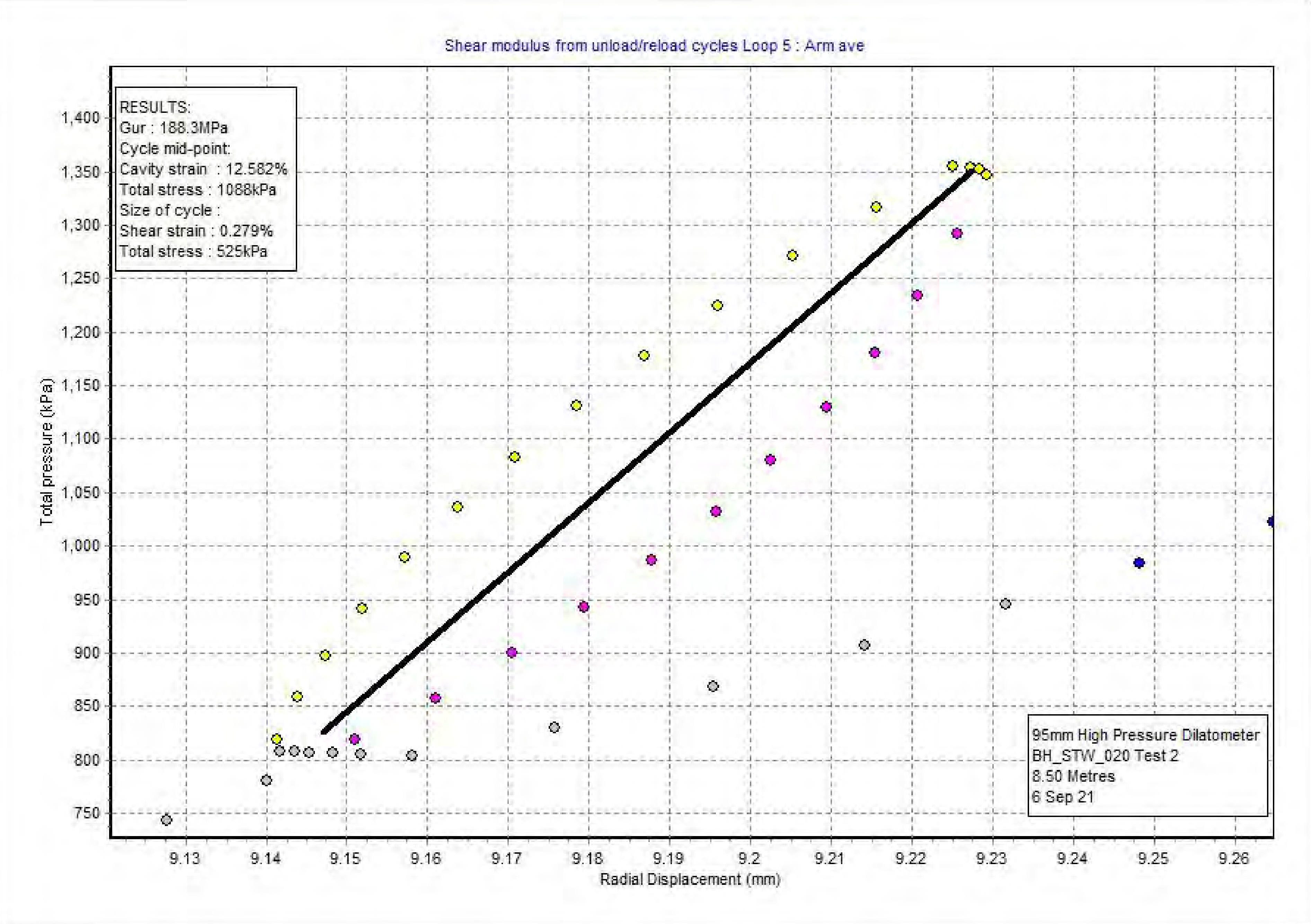

Shear modulus from unload/reload cycles Loop 1 : Arm ave
RESULTS:
Gur : 49.8MPa
Cycle mid-point:
Cavity strain : -0.402%
Total stress : 293kPa
Size of cycle :
Shear strain : 0.209%
Total stress : 104kPa
95mm High Pressure Dilatometer
BH_STW_020 Test 2
8.50 Metres
6 Sep 21
Radial Displacement (mm)
2.49
2.495
2.5
2.505
2.51
2.515
2.52
2.525
2.53
2.535
2.54
2.545
2.55
2.555
2.56
2.565
2.57
2.575
2.58
2.585
2.59
Total pressure (kPa)
360
355
350
345
340
335
330
325
320
315
310
305
300
295
290
285
280
275
270
265
260
255
250
245
240
235

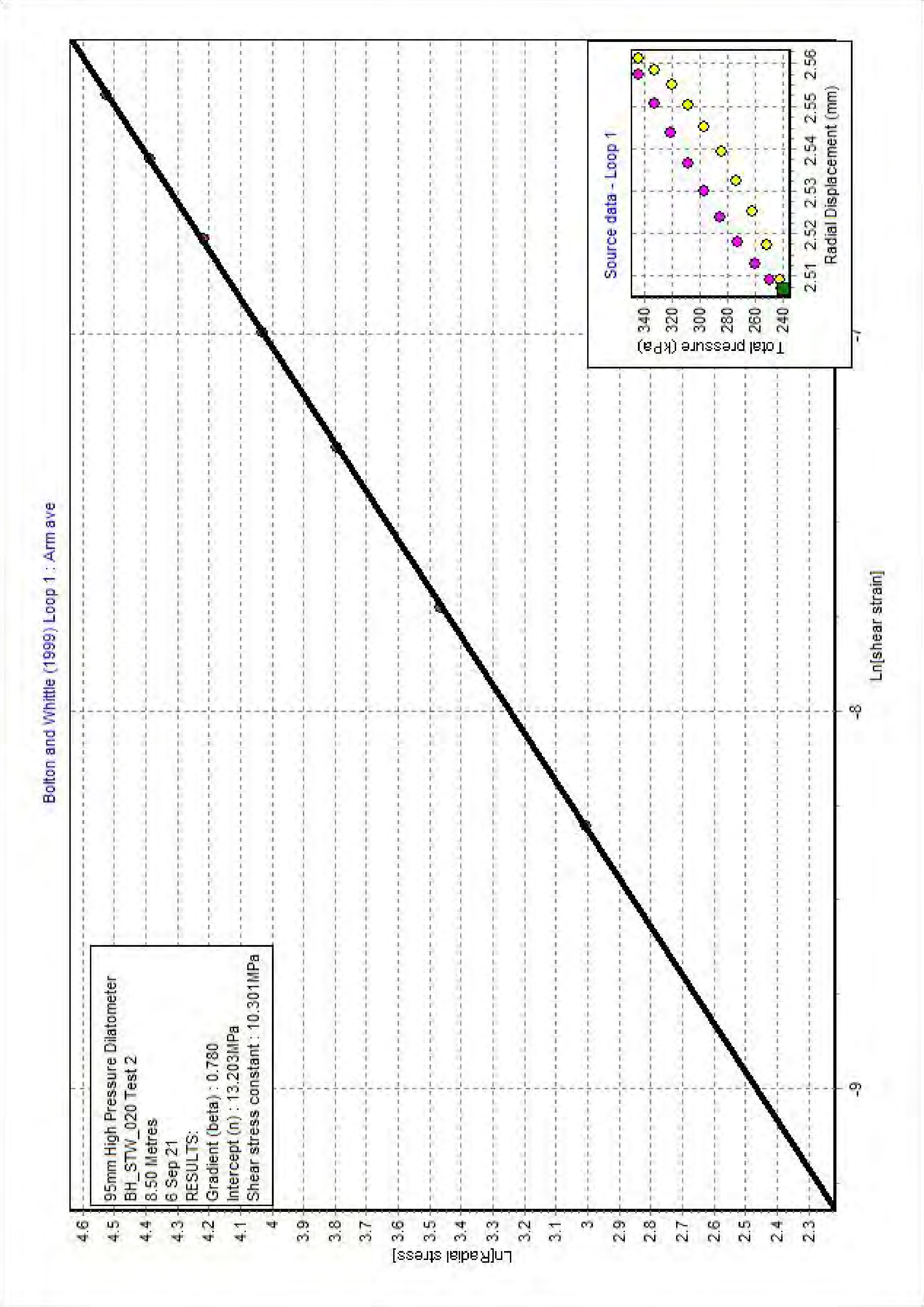


RESULTS:
Gur : 82.3MPa
Cycle mid-point:
Cavity strain : -0.107%
Total stress : 413kPa
Size of cycle :
Shear strain : 0.190%
Total stress : 156kPa

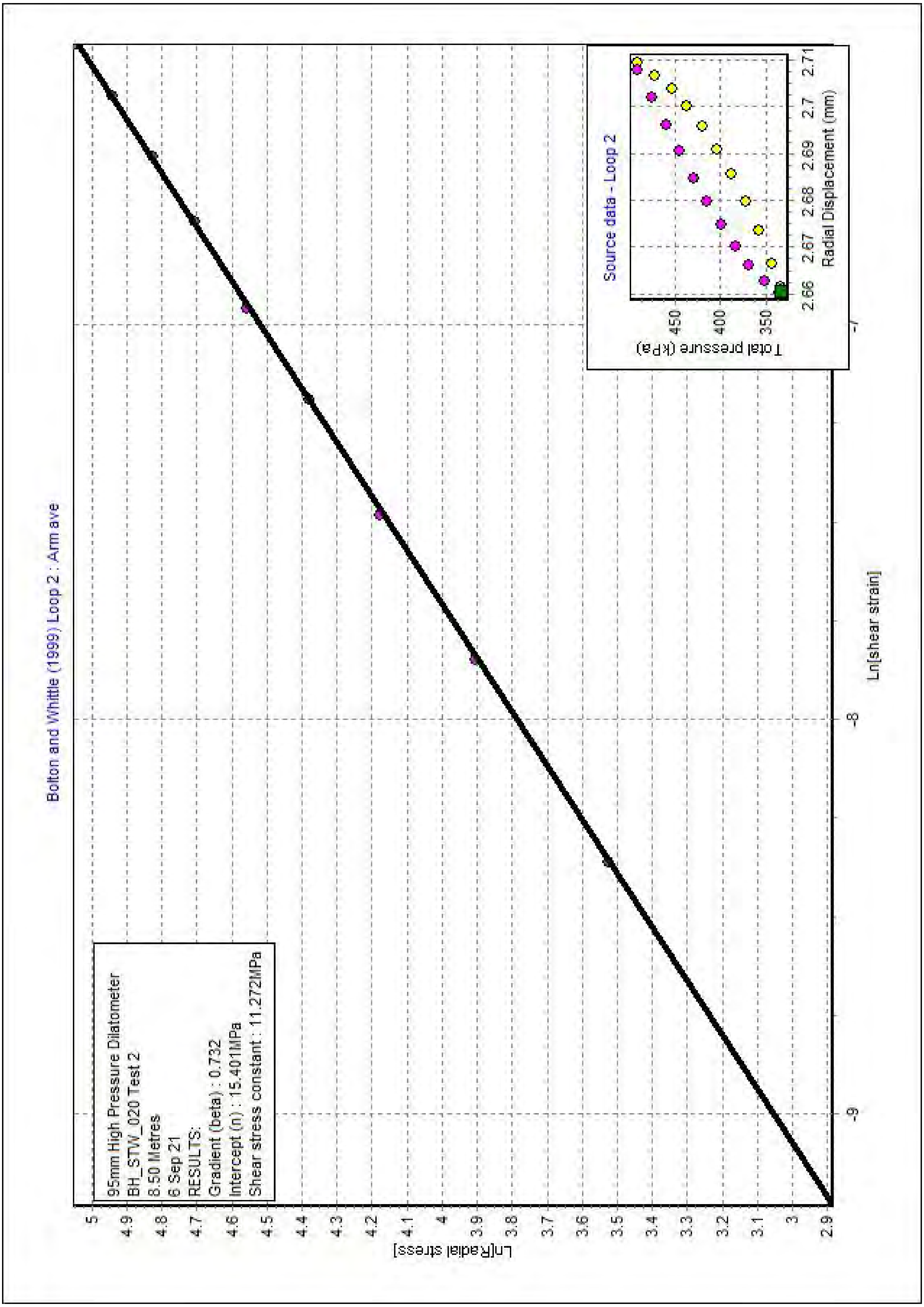

Shear modulus from unload/reload cycles Loop 3 : Arm ave
95mm High Pressure Dilatometer
BH_STW_020 Test 2
8.50 Metres
6 Sep 21
RESULTS:
Gur : 148.5MPa
Cycle mid-point:
Cavity strain : 0.618%
Total stress : 695kPa
Size of cycle :
Shear strain : 0.177%
Total stress : 262kPa
Radial Displacement (mm)
3.02
3.025
3.03
3.035
3.04
3.045
3.05
3.055
3.06
3.065
3.07
3.075
3.08
3.085
3.09
3.095
3.1
3.105
3.11
Total pressure (kPa)
860
850
840
830
820
810
800
790
780
770
760
750
740
730
720
710
700
690
680
670
660
650
640
630
620
610
600
590
580
570
560
550
540


Shear modulus from unload/reload cycles Loop 4 : Arm ave
95mm High Pressure Dilatometer
BH_STW_020 Test 2
8.50 Metres
6 Sep 21
RESULTS:
Gur : 187.5MPa
Cycle mid-point:
Cavity strain : 2.297%
Total stress : 1144kPa
Size of cycle :
Shear strain : 0.203%
Total stress : 381kPa
Radial Displacement (mm)
3.84
3.85
3.86
3.87
3.88
3.89
3.9
3.91
3.92
3.93
3.94
3.95
3.96
3.97
3.98
3.99
Total pressure (kPa)
1,460
1,440
1,420
1,400
1,380
1,360
1,340
1,320
1,300
1,280
1,260
1,240
1,220
1,200
1,180
1,160
1,140
1,120
1,100
1,080
1,060
1,040
1,020
1,000
980
960
940
920


Shear modulus from unload/reload cycles Loop 5 : Arm ave
RESULTS:
Gur : 188.3MPa
Cycle mid-point:
Cavity strain : 12.582%
Total stress : 1088kPa
Size of cycle :
Shear strain : 0.279%
Total stress : 525kPa
95mm High Pressure Dilatometer
BH_STW_020 Test 2
8.50 Metres
6 Sep 21
Total pressure (kPa)
1,400
1,350
1,300
1,250
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
Radial Displacement (mm)
9.13
9.14
9.15
9.16
9.17
9.18
9.19
9.2
9.21
9.22
9.23
9.24
9.25
9.26

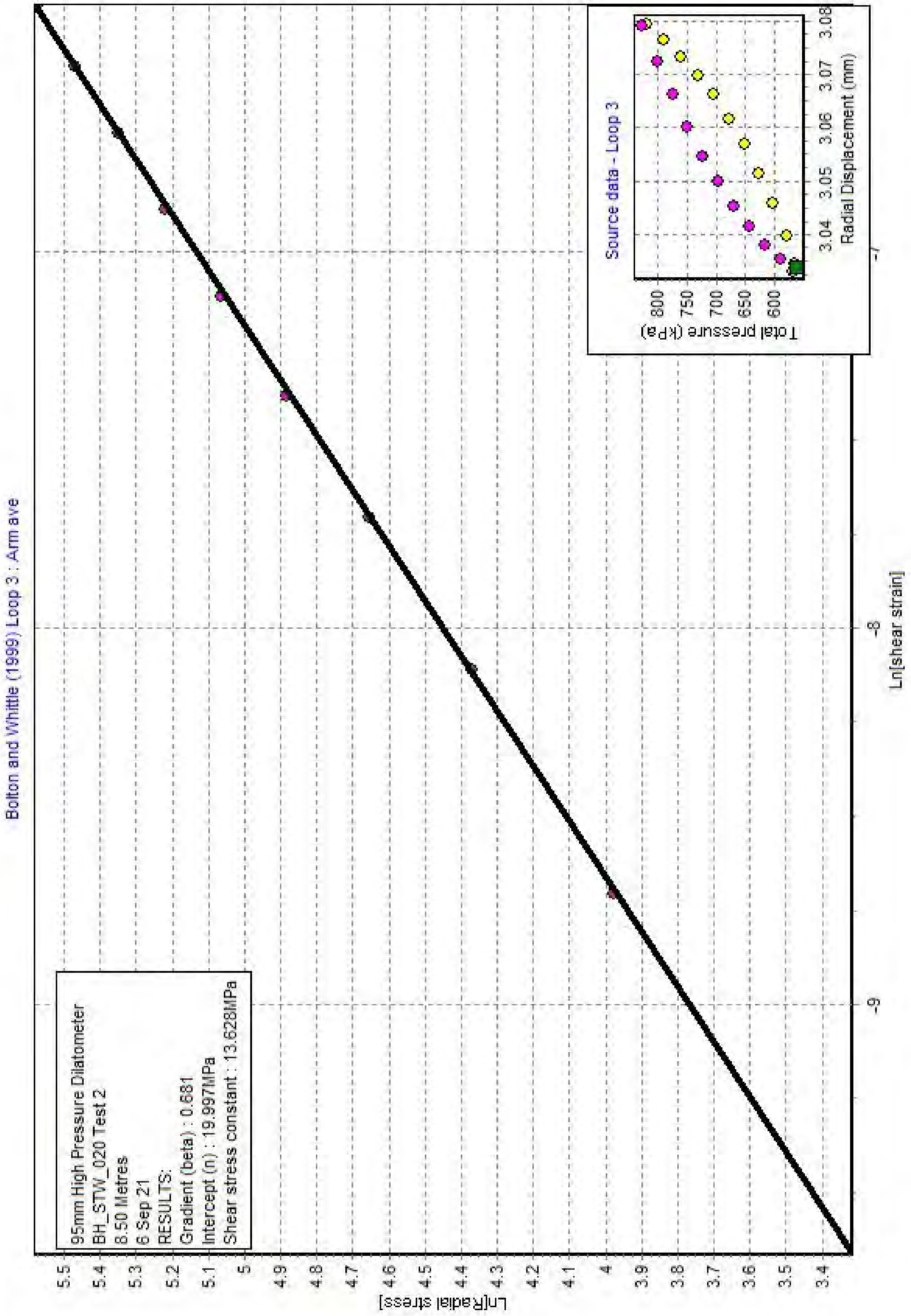


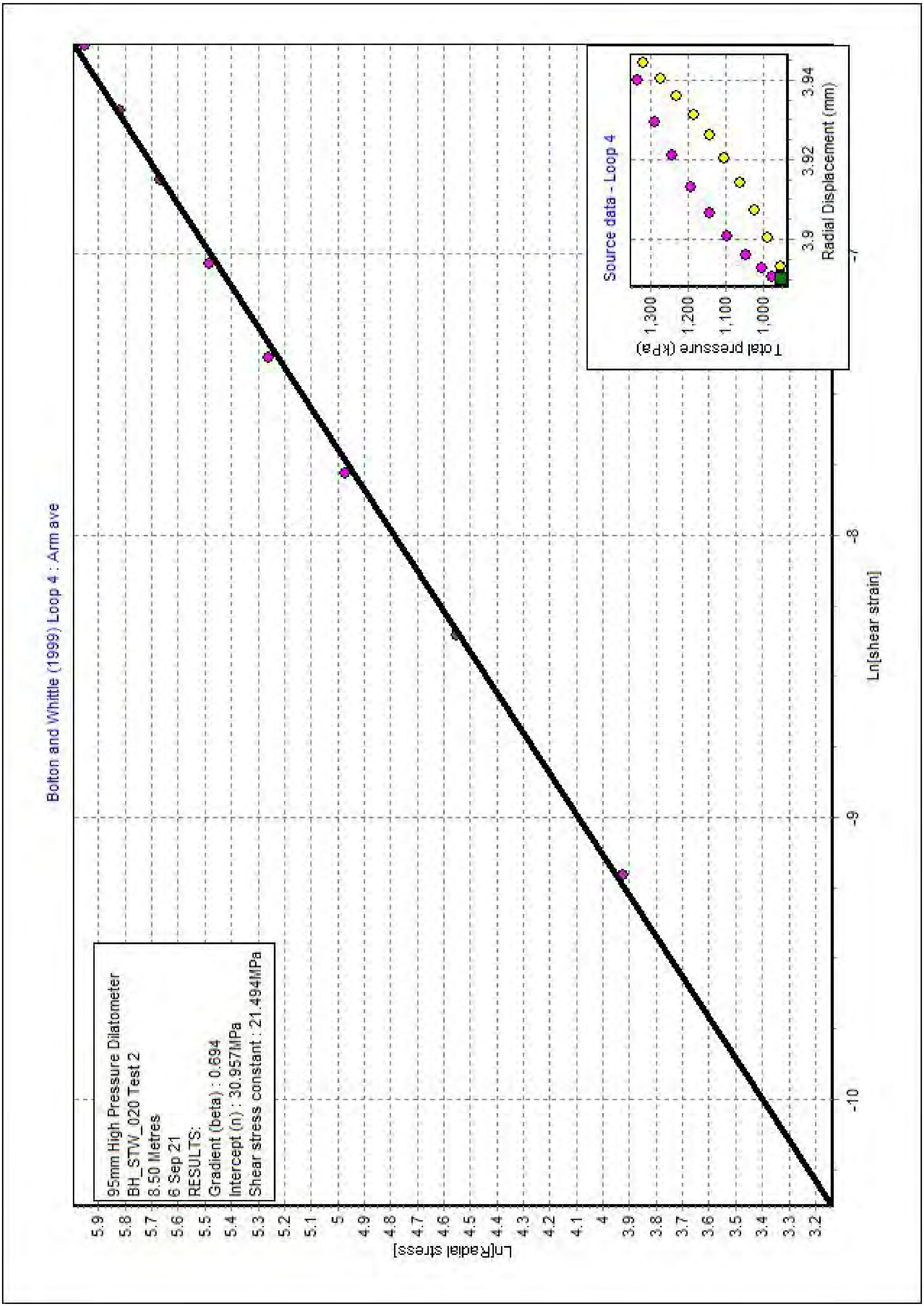
Bolton and Whittle (1999) Loop 1 : Arm ave
95mm High Pressure Dilatometer
BH_STW_020 Test 2
8.50 Metres
6 Sep 21
RESULTS:
Gradient (beta) : 0.780
Intercept (n) : 13.203MPa
Shear stress constant : 10.301MPa
Ln[Radial stress]
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
2.7
2.6
2.5
2.4
2.3
Ln[shear strain]
-9
-8
-7
Source data - Loop 1
Total pressure (kPa)
340
320
300
280
260
240
Radial Displacement (mm)
2.51
2.52
2.53
2.54
2.55
2.56

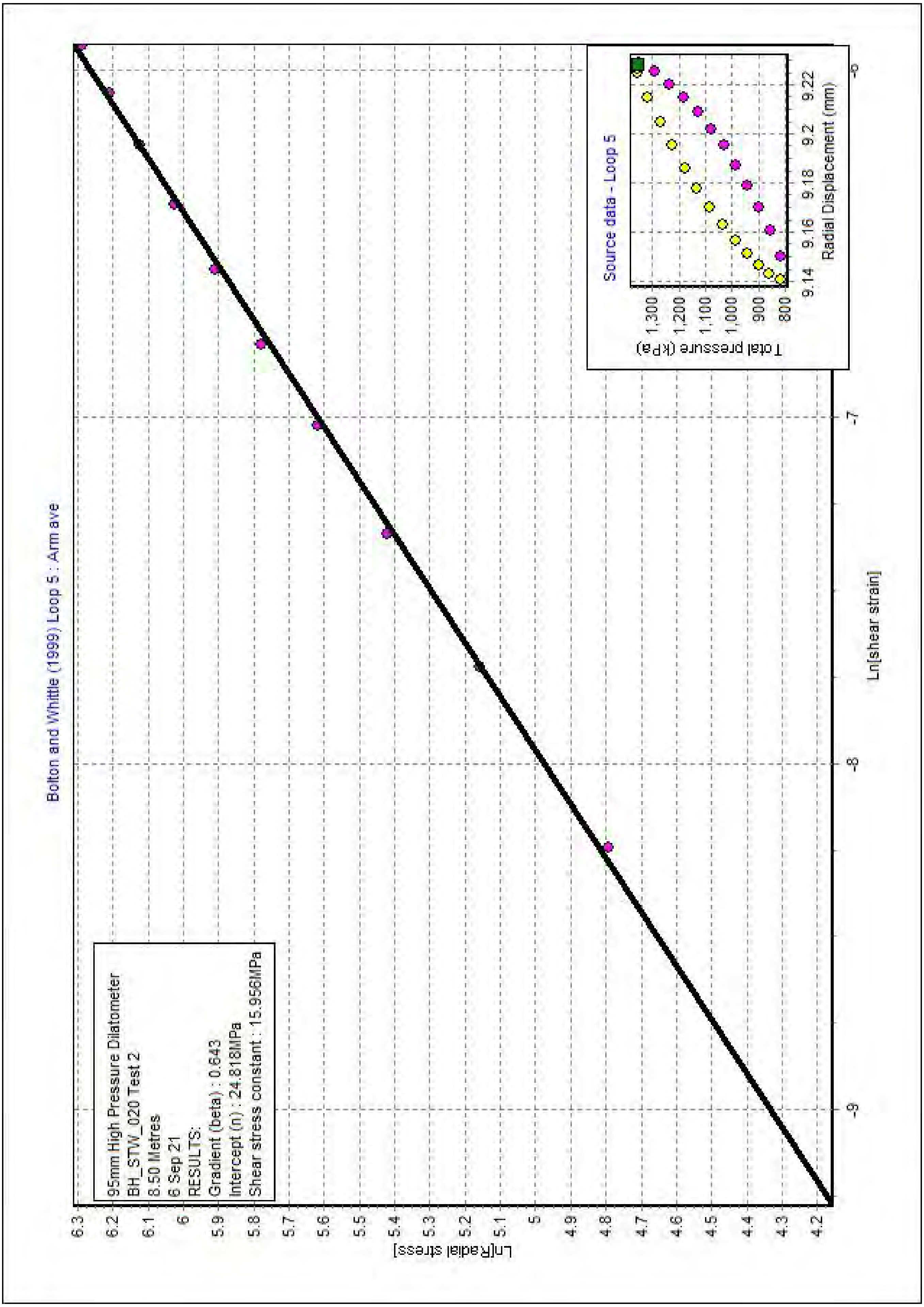


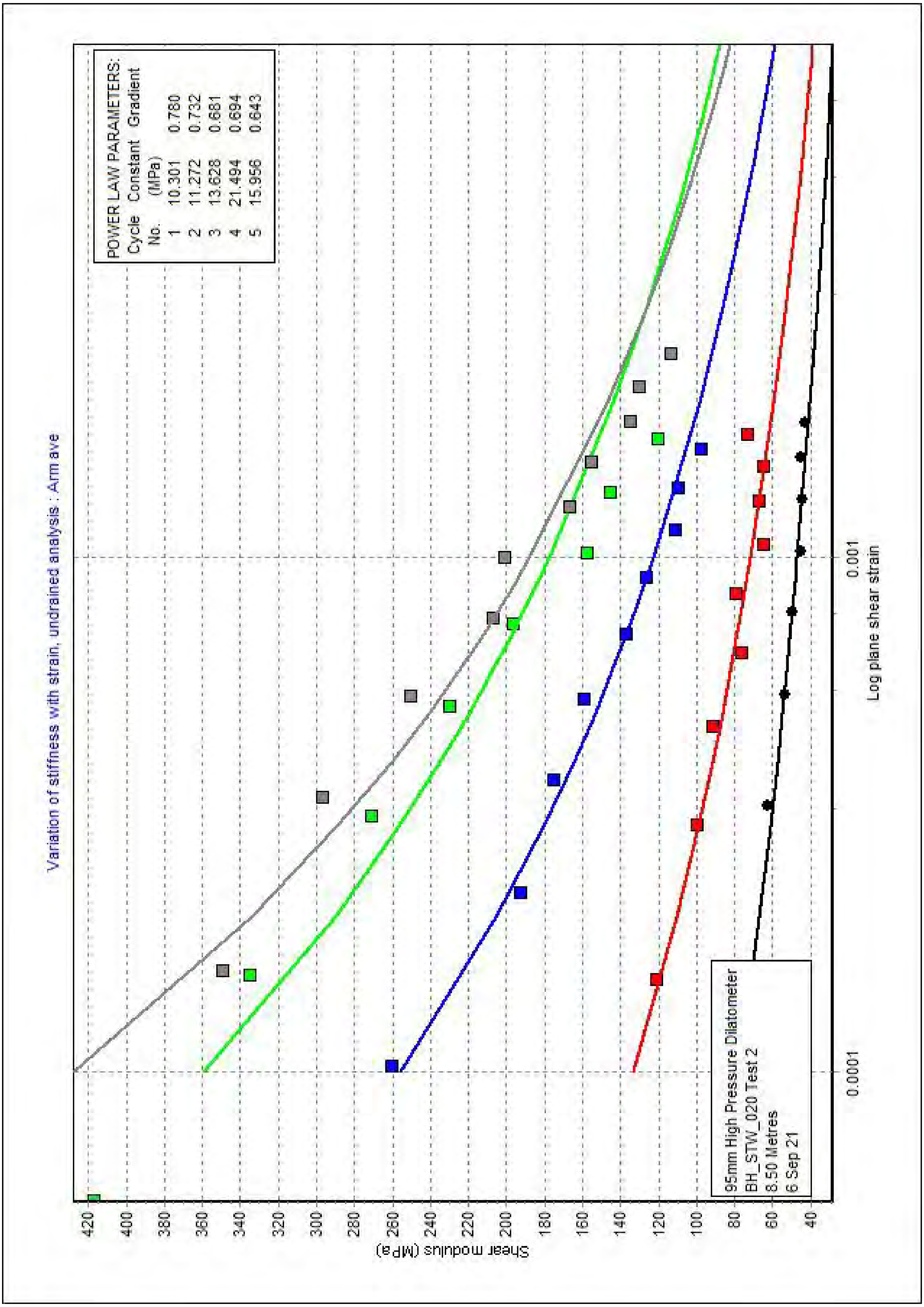
Bolton and Whittle (1999) Loop 2 : Arm ave

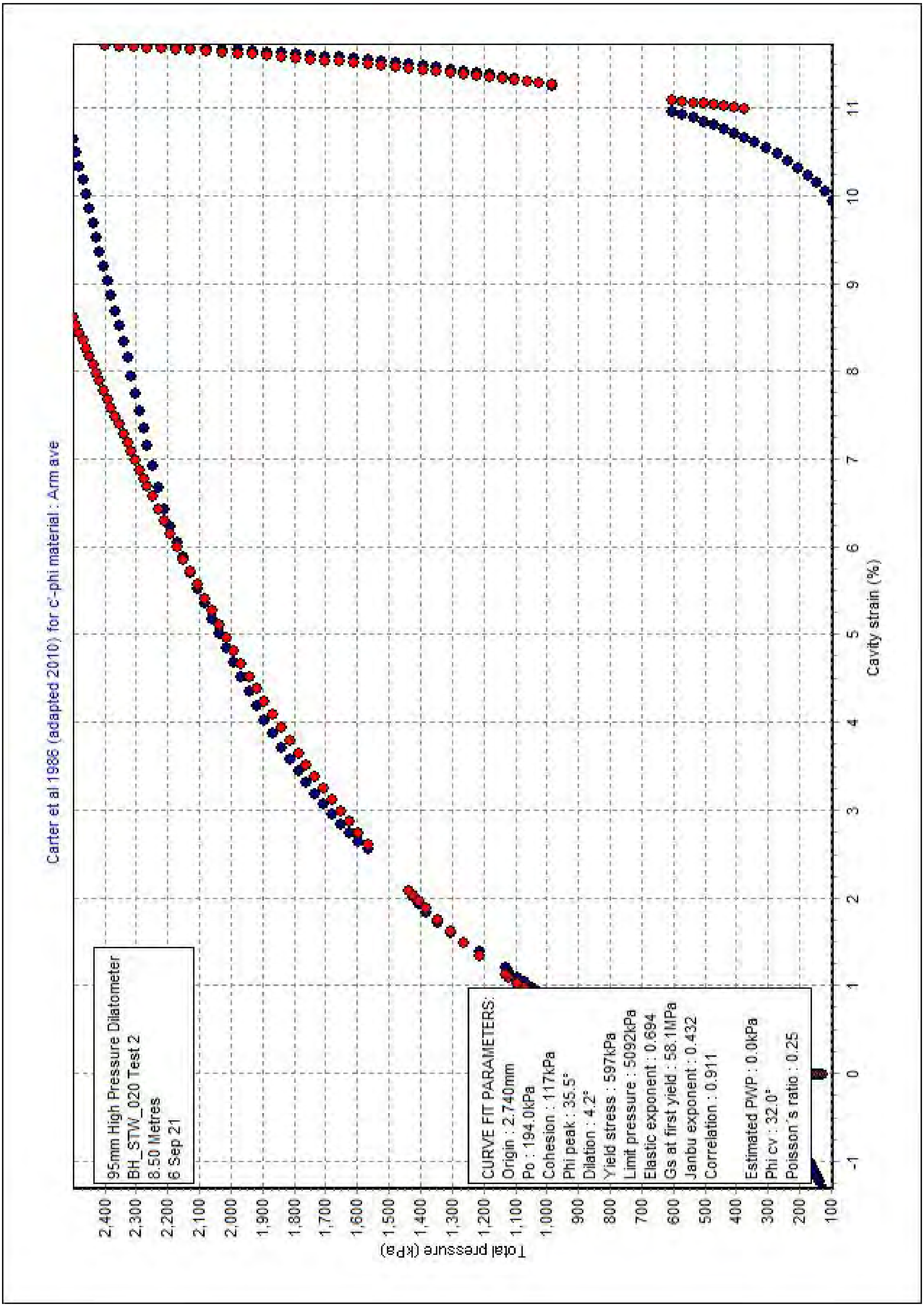
95mm High Pressure Dilatometer
BH_STW_020 Test 2
8.50 Metres
6 Sep 21
RESULTS:
Gradient (beta) : 0.732
Intercept (n) : 15.401MPa
Shear stress constant : 11.272MPa

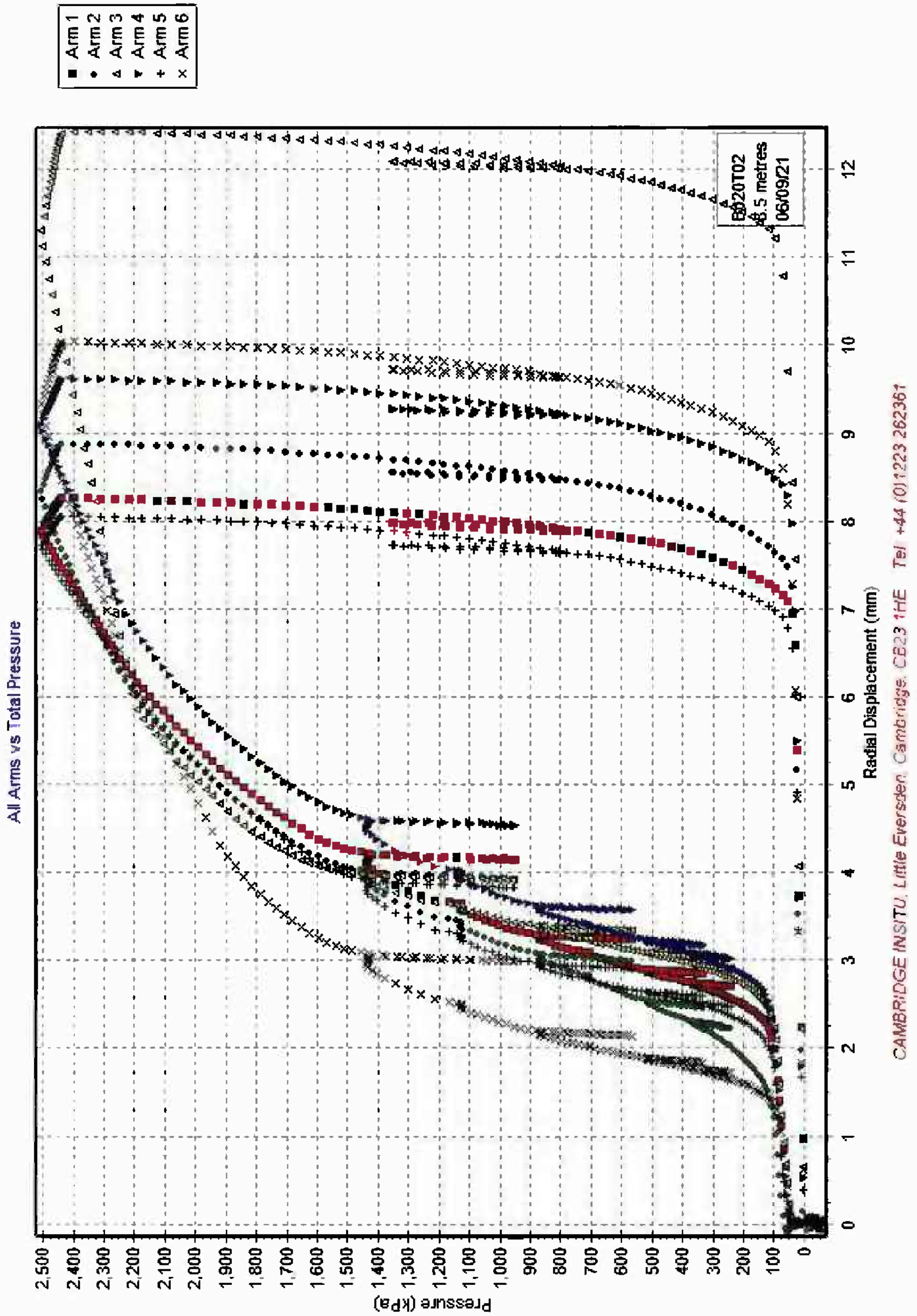

Bolton and Whittle (1999) Loop 3 : Arm ave
95mm High Pressure Dilatometer
BH_STW_020 Test 2
8.50 Metres
6 Sep 21
RESULTS:
Gradient (beta) : 0.681
Intercept (n) : 19.997MPa
Shear stress constant : 13.628MPa
Ln[Radial stress]
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
Ln[shear strain]
-9
-8
-7
Source data - Loop 3
Total pressure (kPa)
800
750
700
650
600
Radial Displacement (mm)
3.04
3.05
3.06
3.07
3.08


Bolton and Whittle (1999) Loop 4 : Arm ave
95mm High Pressure Dilatometer
BH_STW_020 Test 2
8.50 Metres
6 Sep 21
RESULTS:
Gradient (beta) : 0.694
Intercept (n) : 30.957MPa
Shear stress constant : 21.494MPa
Ln[Radial stress]
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
Ln[shear strain]
-10
-9
-8
-7
Source data - Loop 4
Total pressure (kPa)
1,300
1,200
1,100
1,000
Radial Displacement (mm)
3.9
3.92
3.94


Bolton and Whittle (1999) Loop 5 : Arm ave
95mm High Pressure Dilatometer
BH_STW_020 Test 2
8.50 Metres
6 Sep 21
RESULTS:
Gradient (beta) : 0.643
Intercept (n) : 24.818MPa
Shear stress constant : 15.956MPa
Ln[Radial stress]
6.3
6.2
6.1
6
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
Ln[shear strain]
-9
-8
-7
-6
Source data - Loop 5
Total pressure (kPa)
1,300
1,200
1,100
1,000
900
800
Radial Displacement (mm)
9.14
9.16
9.18
9.2
9.22


Variation of stiffness with strain, undrained analysis : Arm ave
POWER LAW PARAMETERS:
Cycle No. | Constant (MPa) | Gradient
1 | 10.301 | 0.780
2 | 11.272 | 0.732
3 | 13.628 | 0.681
4 | 21.494 | 0.694
5 | 15.956 | 0.643
95mm High Pressure Dilatometer
BH_STW_020 Test 2
8.50 Metres
6 Sep 21
Shear modulus (MPa)
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
Log plane shear strain
0.0001
0.001

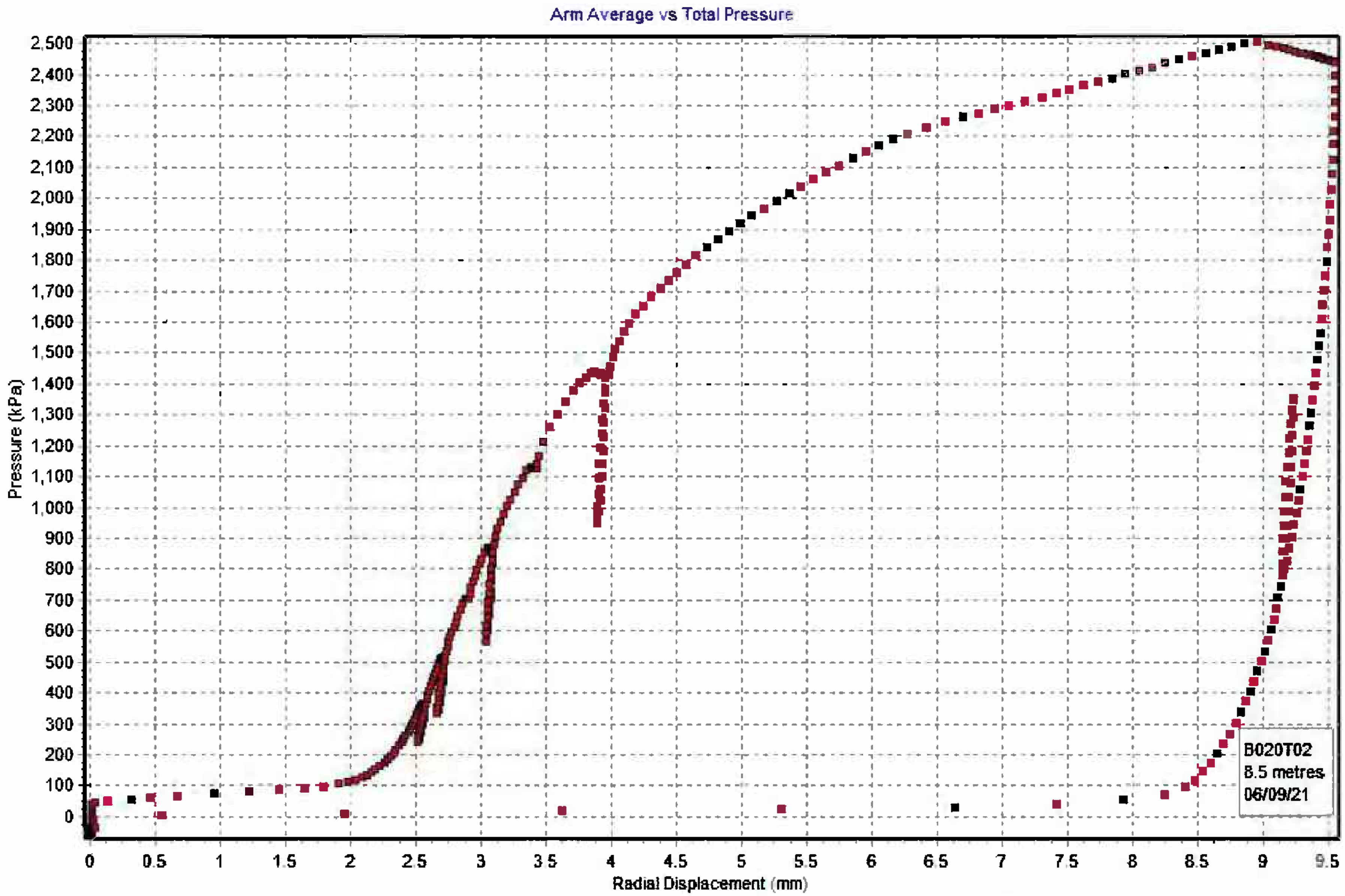

Carter et al 1986 (adapted 2010) for c'-phi material : Arm ave
95mm High Pressure Dilatometer
BH_STW_020 Test 2
8.50 Metres
6 Sep 21
CURVE FIT PARAMETERS:
Origin : 2.740mm
Po : 194.0kPa
Cohesion : 117kPa
Phi peak : 35.5°
Dilation : 4.2°
Yield stress : 597kPa
Limit pressure : 5092kPa
Elastic exponent : 0.694
Gs at first yield : 58.1MPa
Janbu exponent : 0.432
Correlation : 0.911
Estimated PWP : 0.0kPa
Phi cv : 32.0°
Poisson's ratio : 0.25
Total pressure (kPa)
2,400
2,300
2,200
2,100
2,000
1,900
1,800
1,700
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
Cavity strain (%)
-1
0
1
2
3
4
5
6
7
8
9
10
11


All Arms vs Total Pressure
Arm 1
Arm 2
Arm 3
Arm 4
Arm 5
Arm 6
BD20T02
8.5 metres
06/09/21
Radial Displacement (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
Pressure (kPa)
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
1,300
1,400
1,500
1,600
1,700
1,800
1,900
2,000
2,100
2,200
2,300
2,400
2,500
CAMBRIDGE INSITU, Little Eversden, Cambridge. CB23 1HE Tel +44 (0)1223 262361

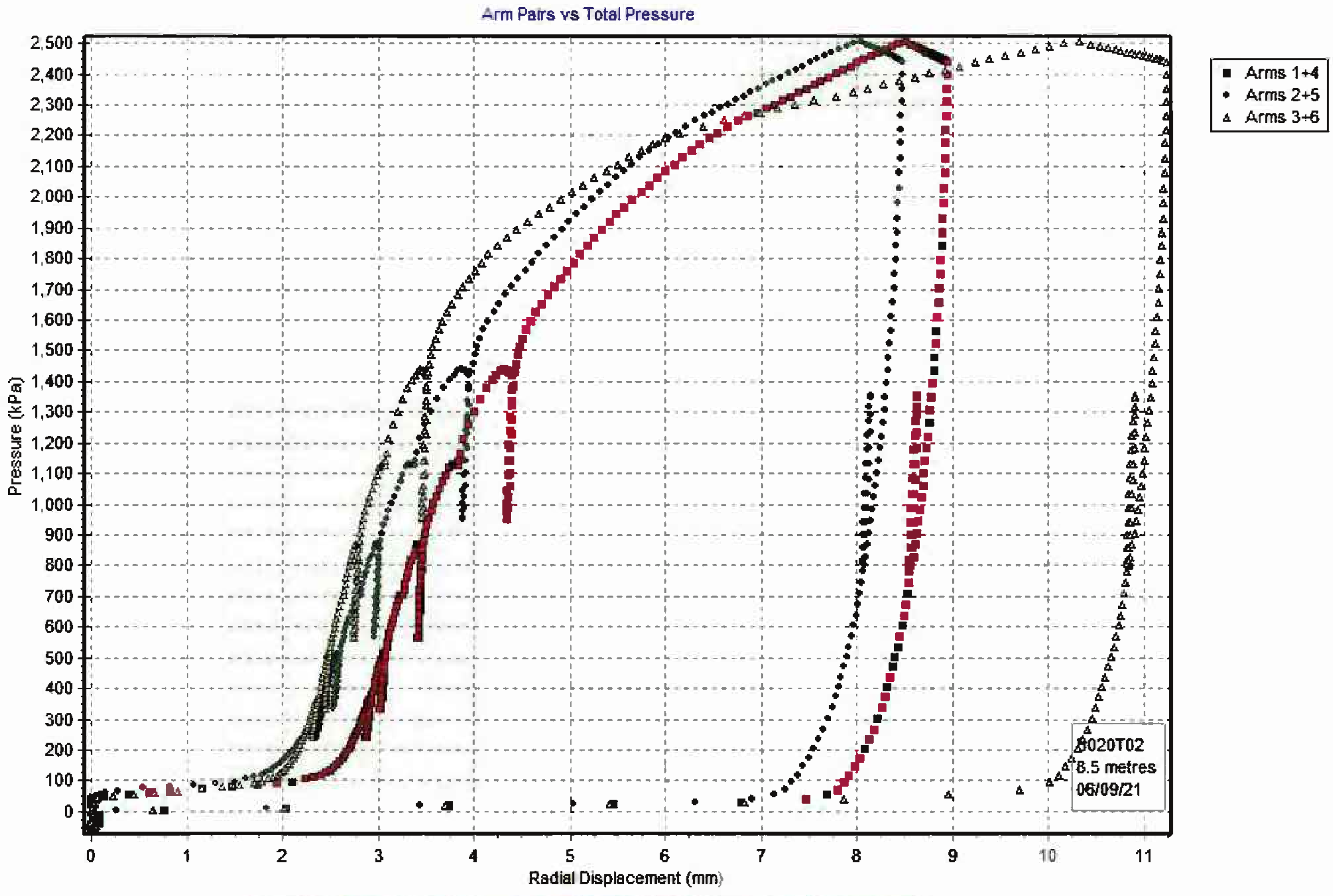
CIR1506/21

Cambridge WWTPR

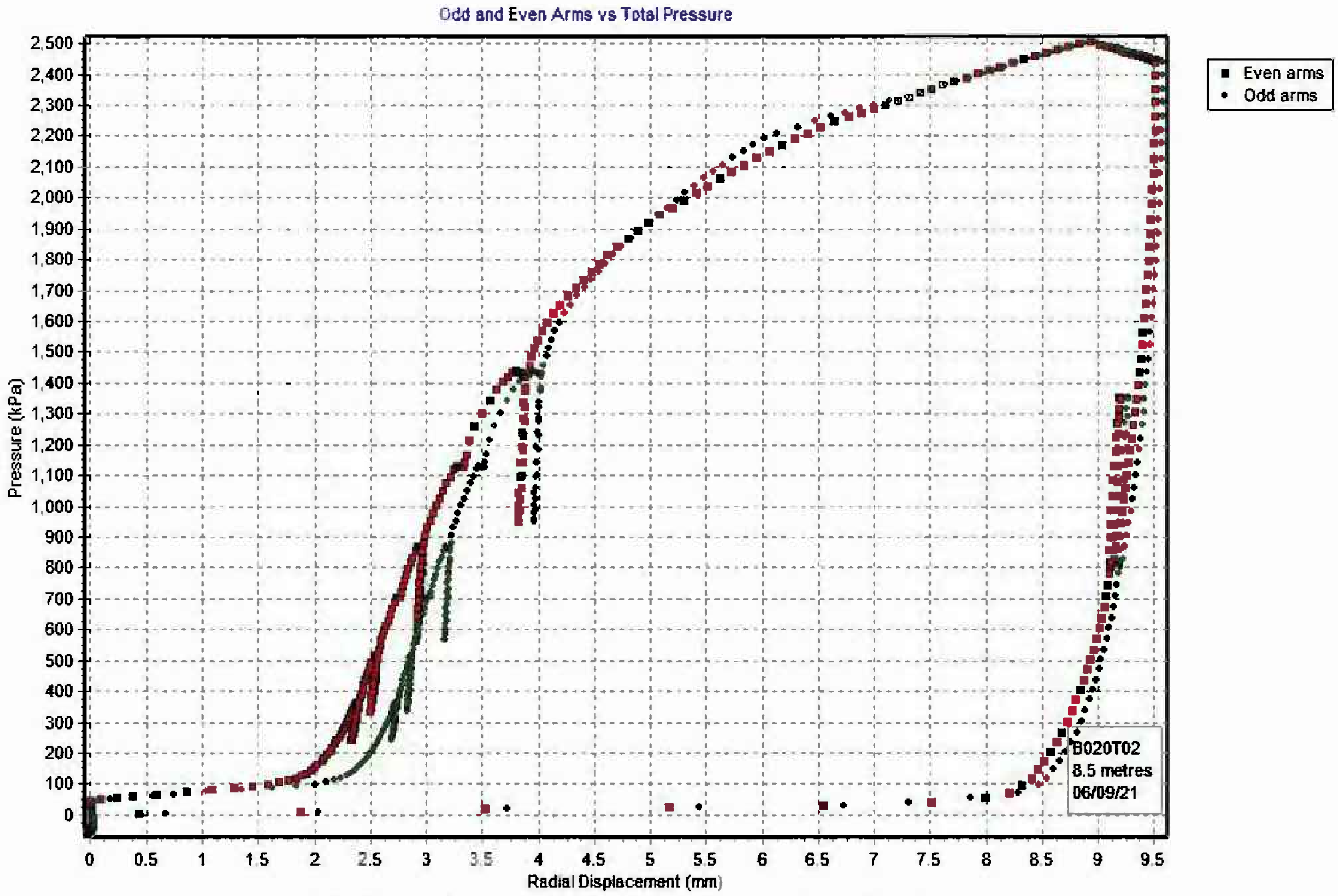
Pressuremeter Testing



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361

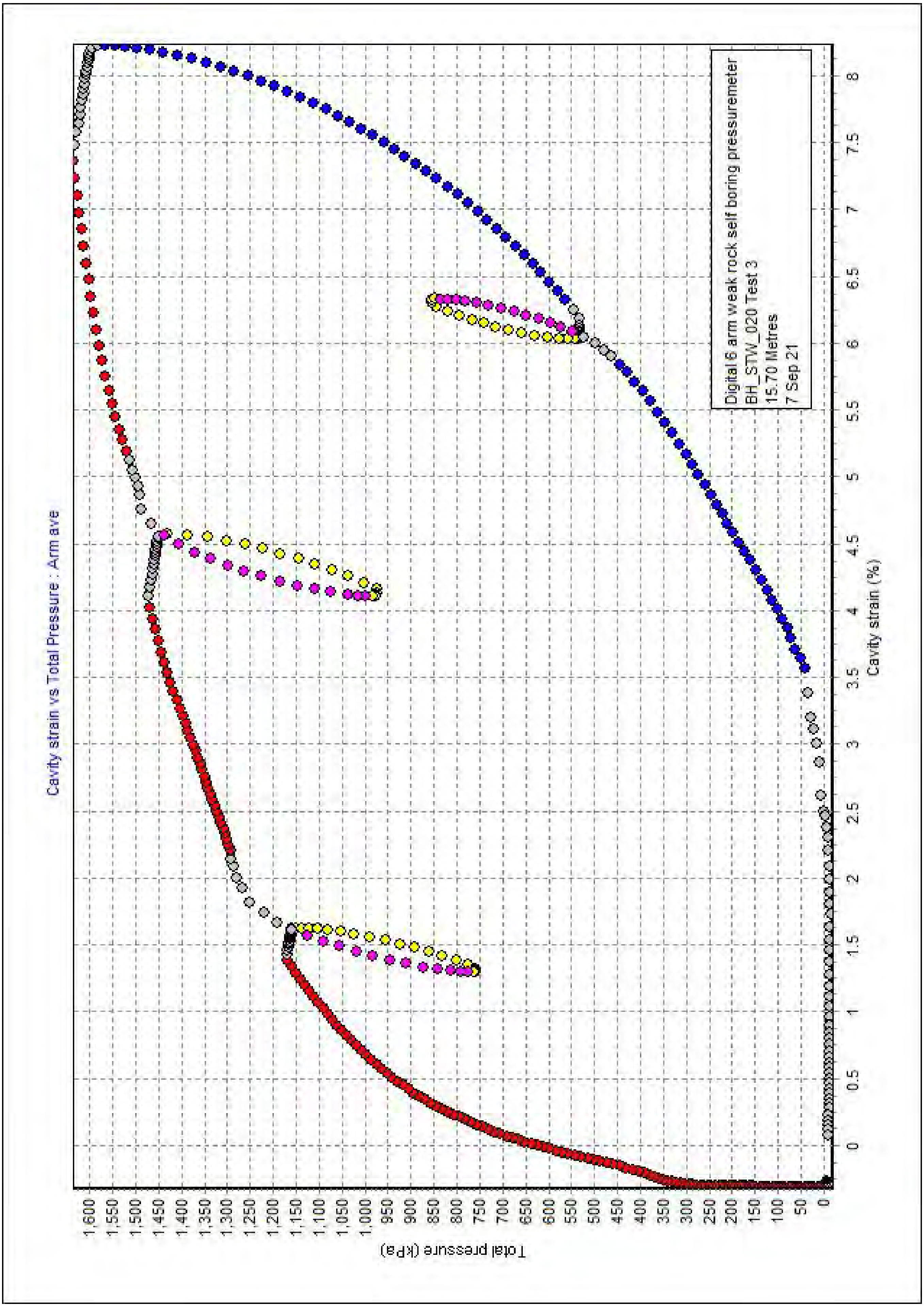


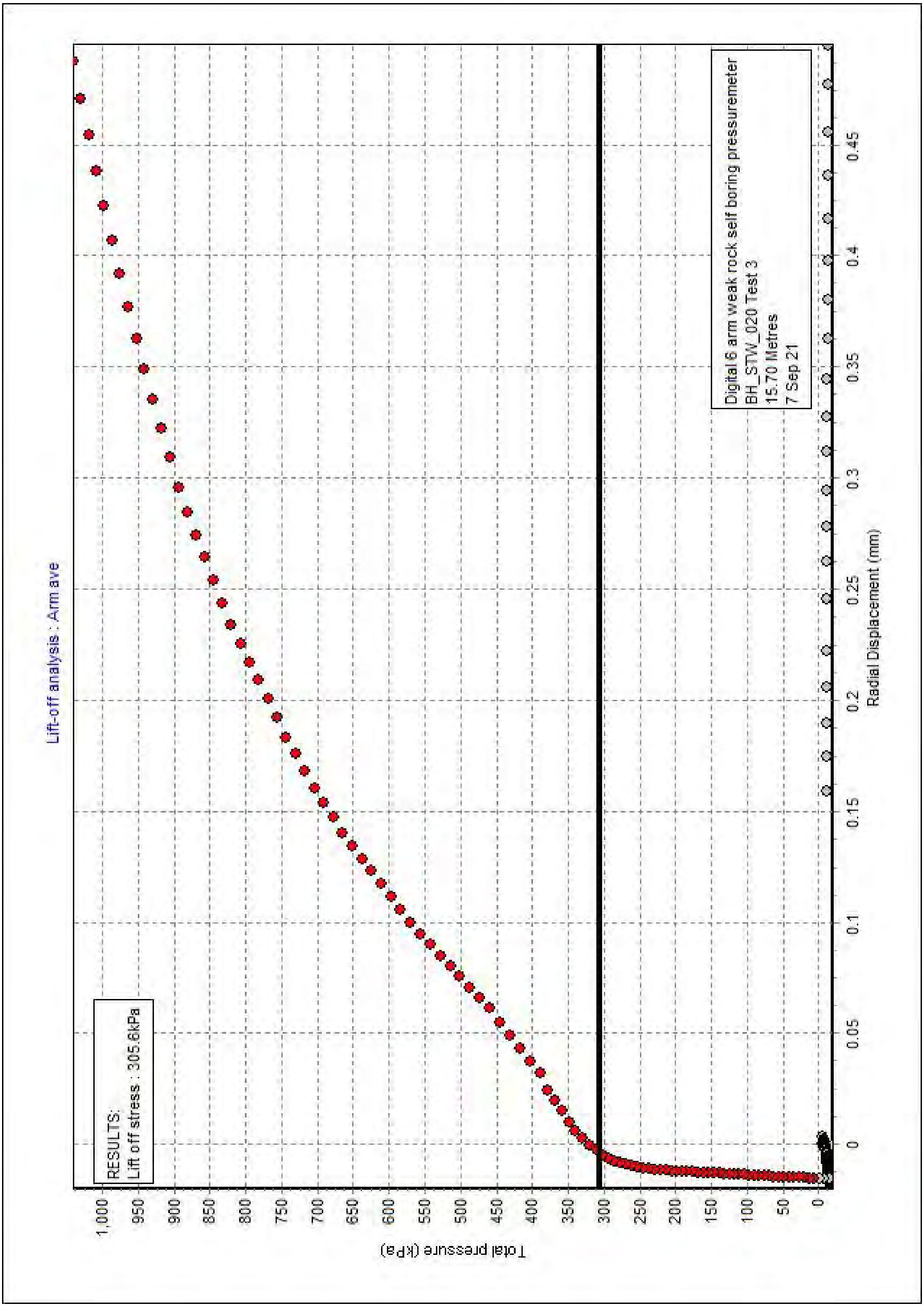
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel: +44 (0)1223 262361

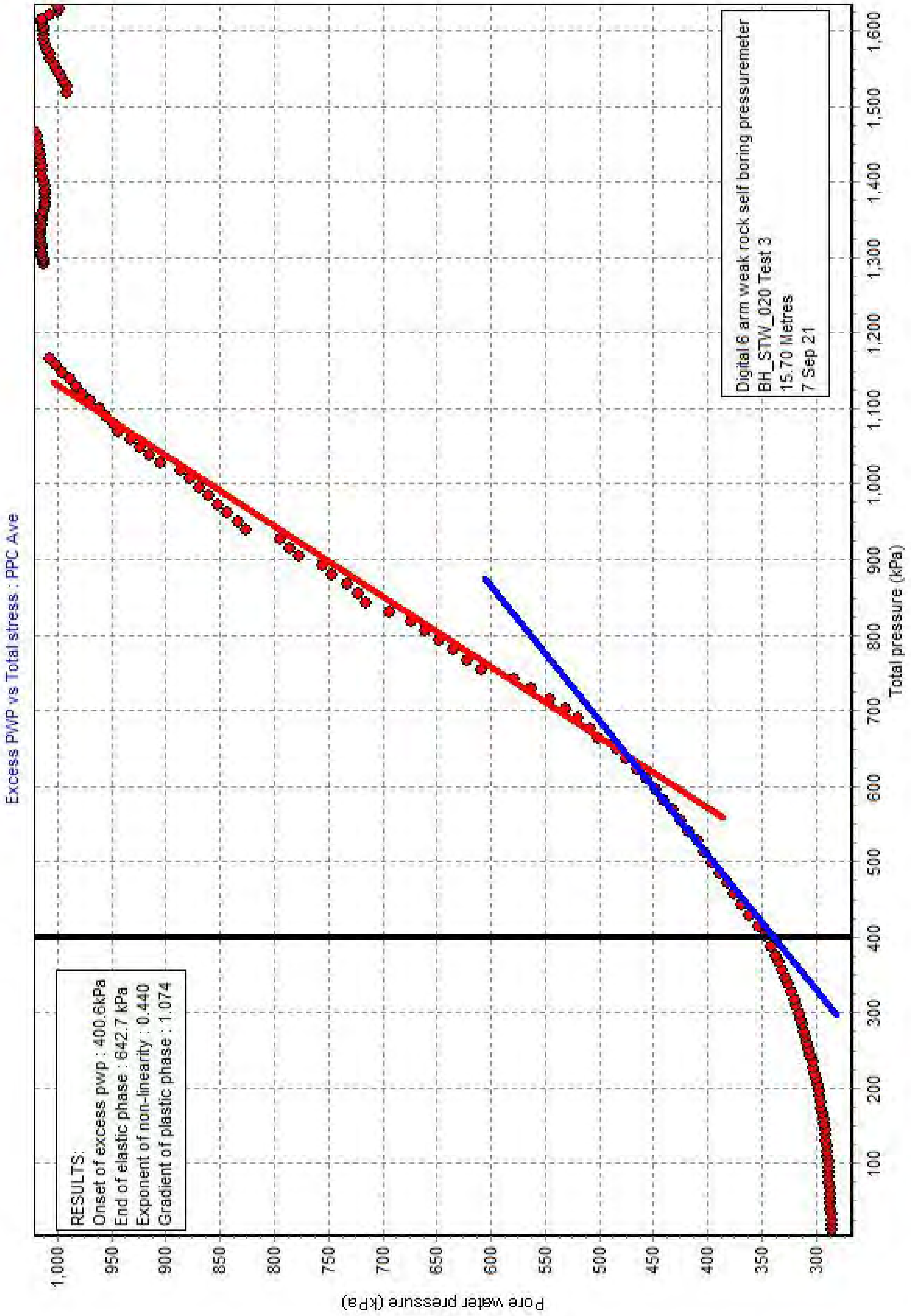


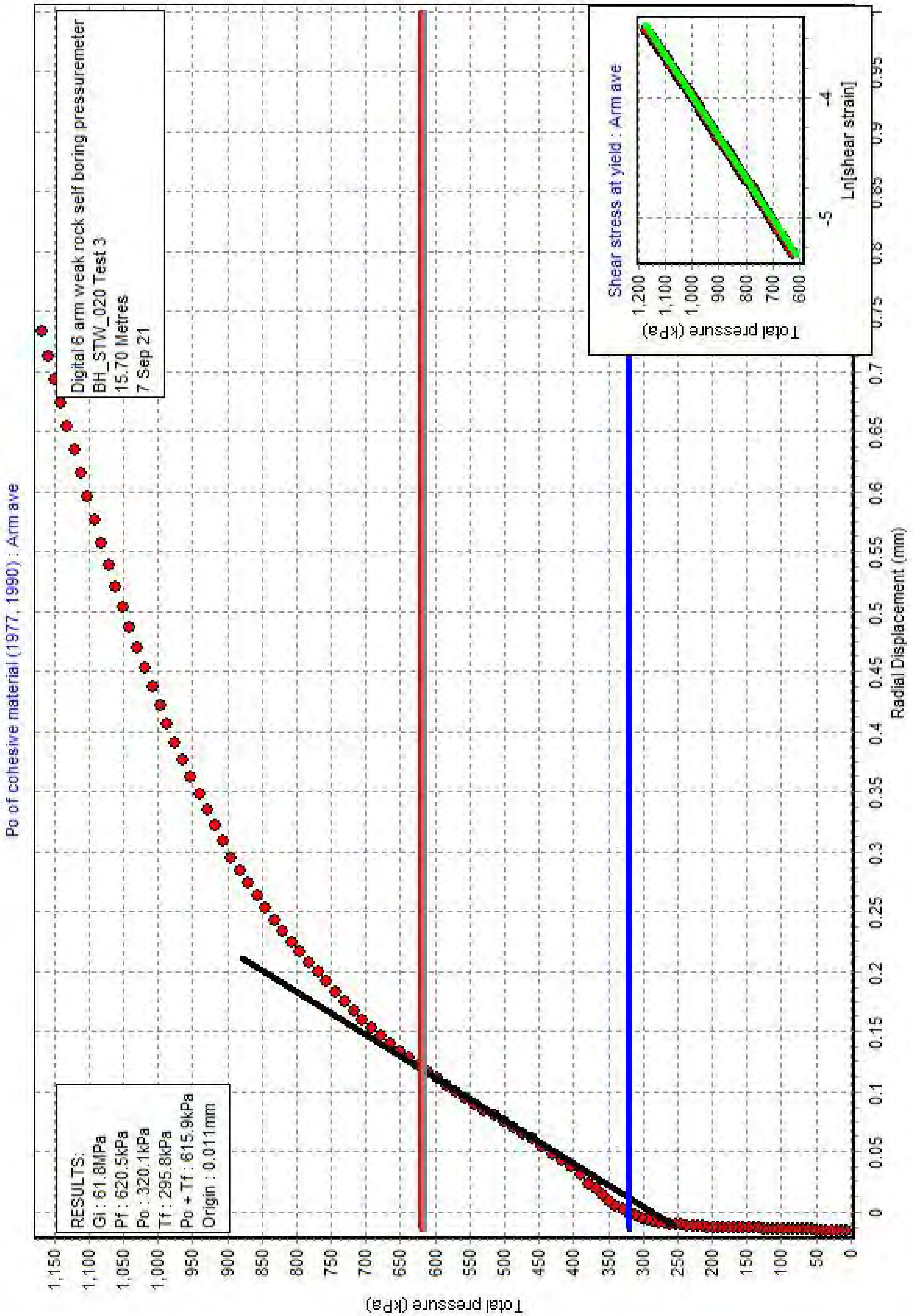
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361

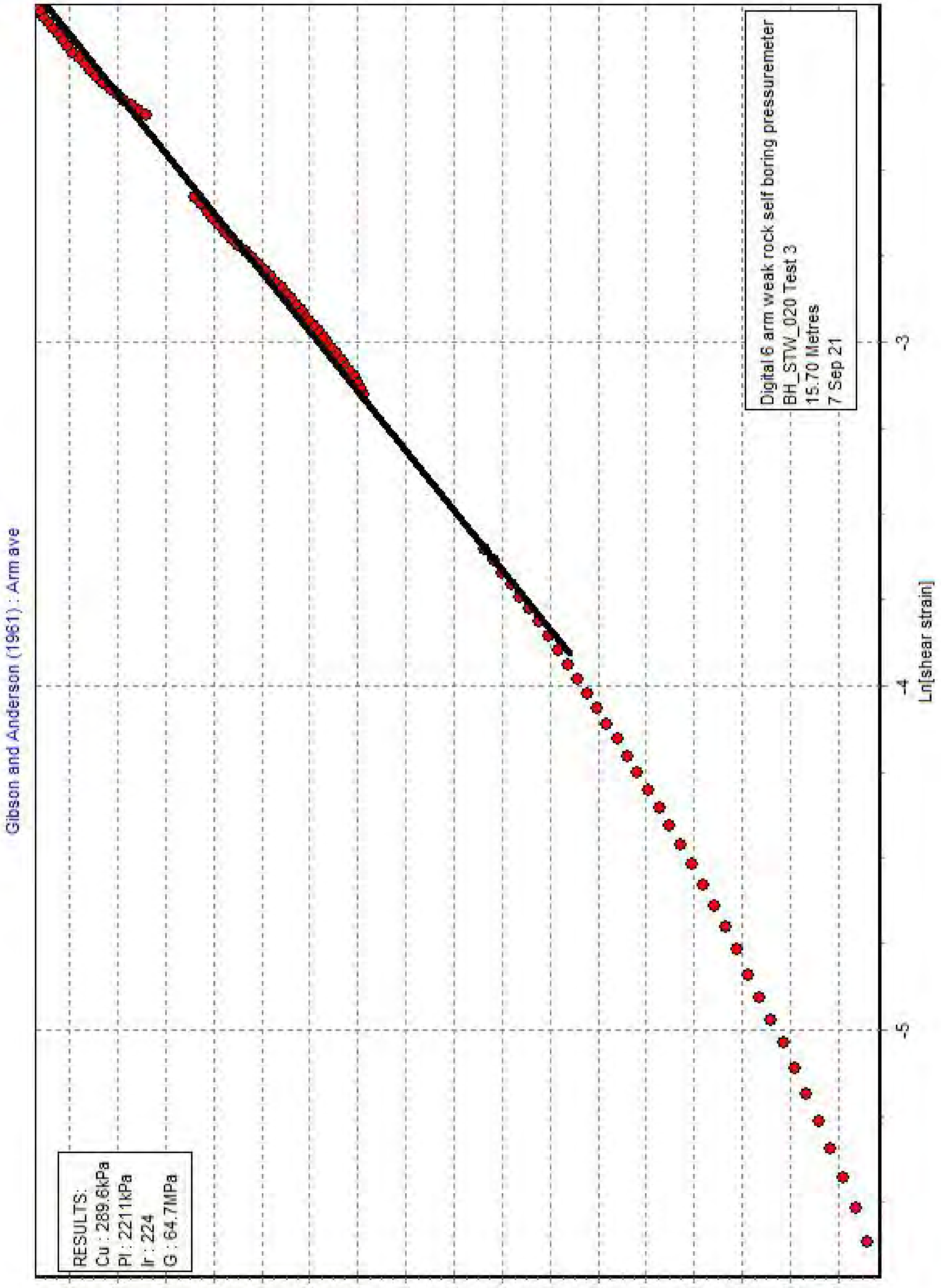
```
BH_STW_020 Test 3 - SUMMARY OF RESULTS
[File made with WinSitu ]

[DETAILS OF TEST]
Project        :   TE8364
Site           :   Cambridge Waste Water Treatment Plant Relocation Project
Borehole       :   BH_STW_020
Test name      :   BH_STW_020 Test 3
Test date      :   7 Sep 21
Test depth     :   15.70 Metres
Water table    :   3.75 Metres
Ambient PWP    :   117.0 kPa
Material       :   Gault Clay
Probe          :   Digital 6 arm weak rock self boring pressuremeter
Diameter       :   88.1 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out
The file includes results from a curve fitting analysis

Analysed by ES/RW on 7 Sep 21

Remarks:

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm)                  :   "Arm ave=0.12"
Po from Marsland & Randolph (kPa)   :   "Arm ave=320.1"
Po from Lift off (kPa)              :   "Arm ave=305.6"
PWP versus Total Stress (kPa)       :   "PPC Ave=400.6"
Best estimate of Po (kPa)           :   "Arm ave=355.0"

[UNDRAINED STRENGTH PARAMETERS]
Gibson & Anderson 1961 - Cu (kPa)   :   "Arm ave=289.6"
Limit pressure (kPa)                :   "Arm ave=2211"
Jefferies 1988 - Cu (kPa)           :   "Arm ave=287.0"
Undrained yield stress (kPa)        :   "Arm ave=620.5"
PWP derived yield stress (kPa)      :   "PPC Ave=642.7"

[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=61.8"
Axis       Loop   Value    Mean Strain  Mean Pc  dE      dPc
           No     (MPa)    (%)          (kPa)    (%)     (kPa)
Arm ave    1      60.1     1.468        956      0.644   388
Arm ave    2      51.6     4.348        1203     0.877   455
Arm ave    3      56.6     6.193        699      0.545   309

[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]
Axis       Loop   Intercept  Alpha      Gradient
           No     (MPa)      (MPa)
Arm ave    1      11.876     7.889      0.664
Arm ave    2      9.418      5.888      0.625
Arm ave    3      6.762      3.878      0.574

Non-linear exponent from PWP response :   "PPC Ave=0.440"

[PARAMETERS USED FOR UNDRAINED CURVE MODELLING]
{Axis is  Arm ave}
Strain Origin (mm)                  :   0.12
Po (kPa)                            :   355
Cu (kPa)                            :   289.6
Limit pressure (kPa)                :   2211
Non-linear exponent                 :   0.574
Calculated alpha (MPa)              :   4.220
G at yield (MPa)                    :   30.8
```

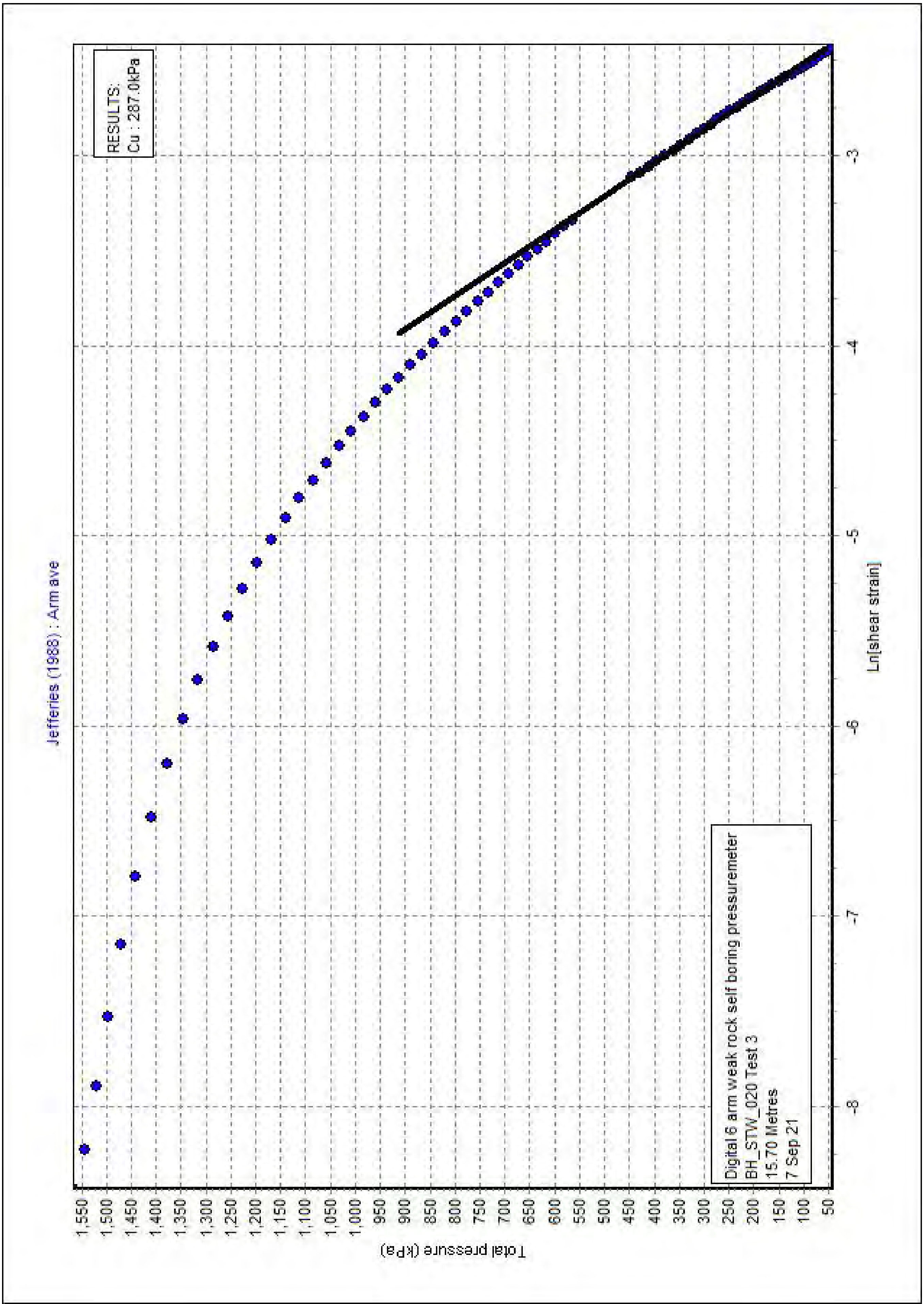

Cavity strain vs Total Pressure : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_020 Test 3
15.70 Metres
7 Sep 21
Total pressure (kPa)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1,000
1,050
1,100
1,150
1,200
1,250
1,300
1,350
1,400
1,450
1,500
1,550
1,600
Cavity strain (%)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8

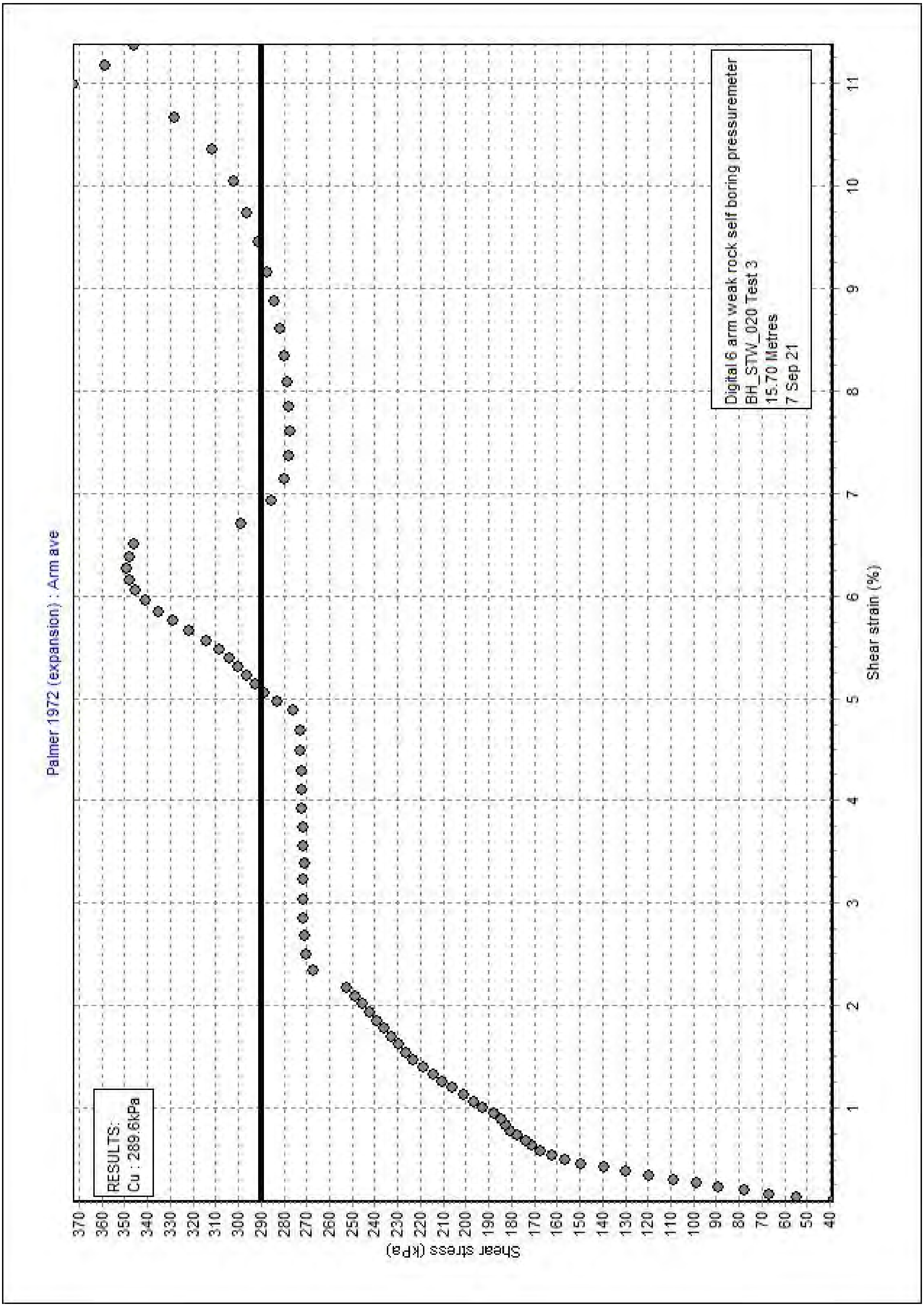

Lift-off analysis : Arm ave
RESULTS:
Lift off stress : 305.6kPa
Digital 6 arm weak rock self boring pressuremeter
BH_STW_020 Test 3
15.70 Metres
7 Sep 21
Total pressure (kPa)
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Radial Displacement (mm)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45

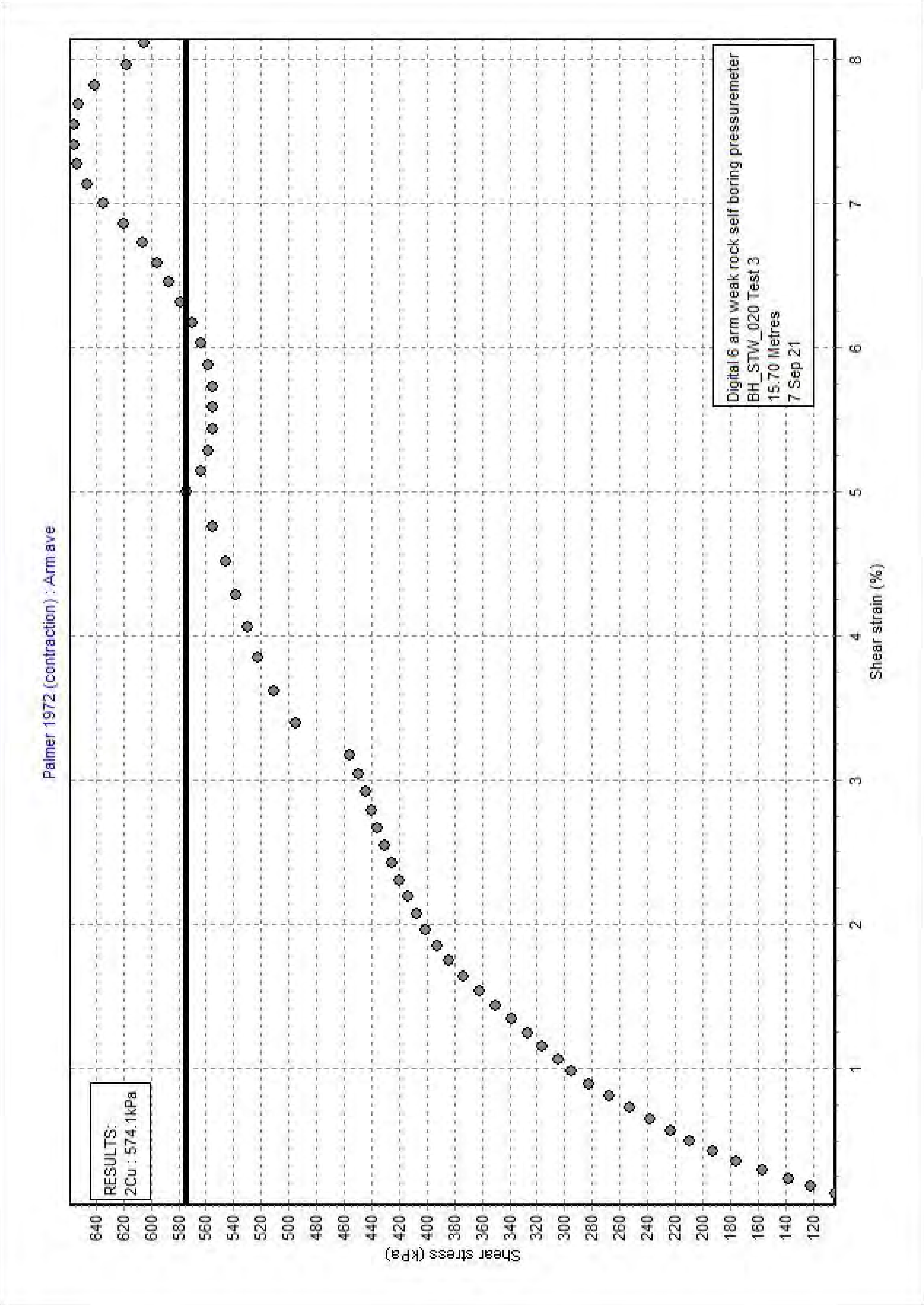

Excess PWP vs Total stress : PPC Ave
RESULTS:
Onset of excess pwp : 400.6kPa
End of elastic phase : 642.7 kPa
Exponent of non-linearity : 0.440
Gradient of plastic phase : 1.074
Digital 6 arm weak rock self boring pressuremeter
BH_STW_020 Test 3
15.70 Metres
7 Sep 21
Total pressure (kPa)
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
1,300
1,400
1,500
1,600
Pore water pressure (kPa)
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300

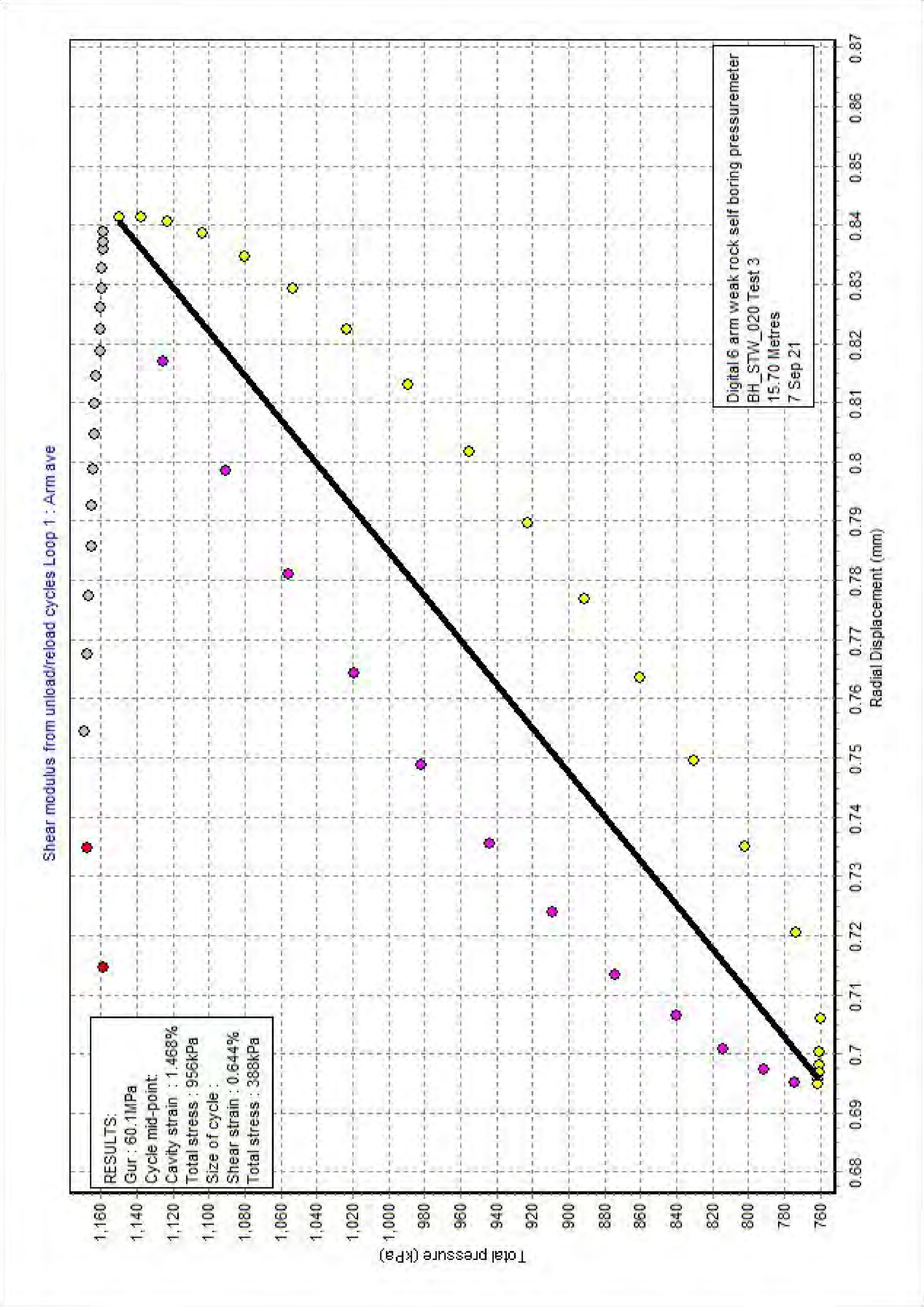

Po of cohesive material (1977, 1990) : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_020 Test 3
15.70 Metres
7 Sep 21
RESULTS:
Gi : 61.8MPa
Pf : 620.5kPa
Po : 320.1kPa
Tf : 295.8kPa
Po + Tf : 615.9kPa
Origin : 0.011mm
Total pressure (kPa)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1,000
1,050
1,100
1,150
Radial Displacement (mm)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0.75
0.8
0.85
0.9
0.95
Shear stress at yield : Arm ave
Total pressure (kPa)
600
700
800
900
1,000
1,100
1,200
Ln[shear strain]
-5
-4

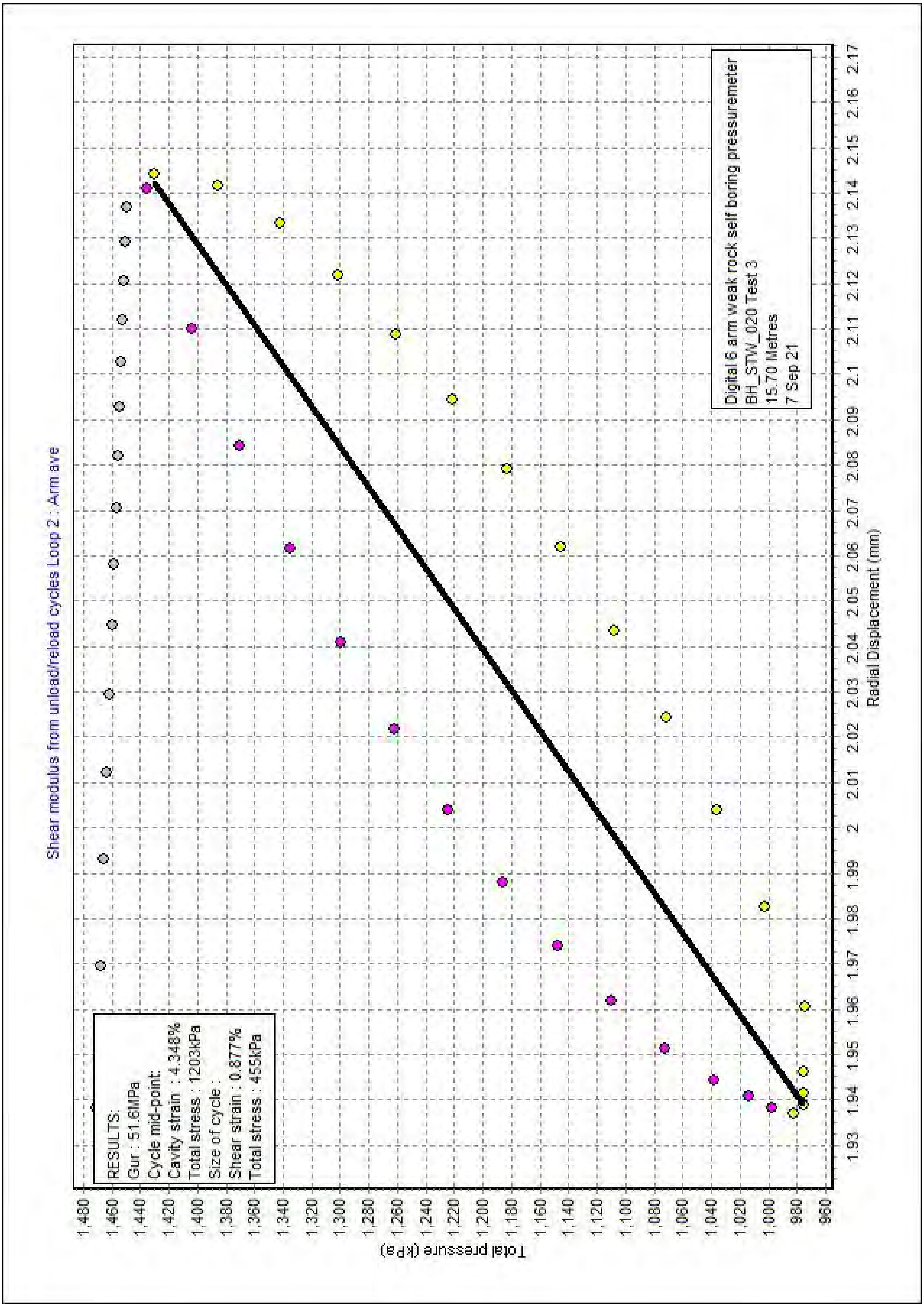

Gibson and Anderson (1961) : Arm ave
RESULTS:
Cu : 289.6kPa
Pl : 2211kPa
Ir : 224
G : 64.7MPa
Digital 6 arm weak rock self boring pressuremeter
BH_STW_020 Test 3
15.70 Metres
7 Sep 21
Total pressure (kPa)
1,600
1,550
1,500
1,450
1,400
1,350
1,300
1,250
1,200
1,150
1,100
1,050
1,000
950
900
850
800
Ln[shear strain]
-5
-4
-3

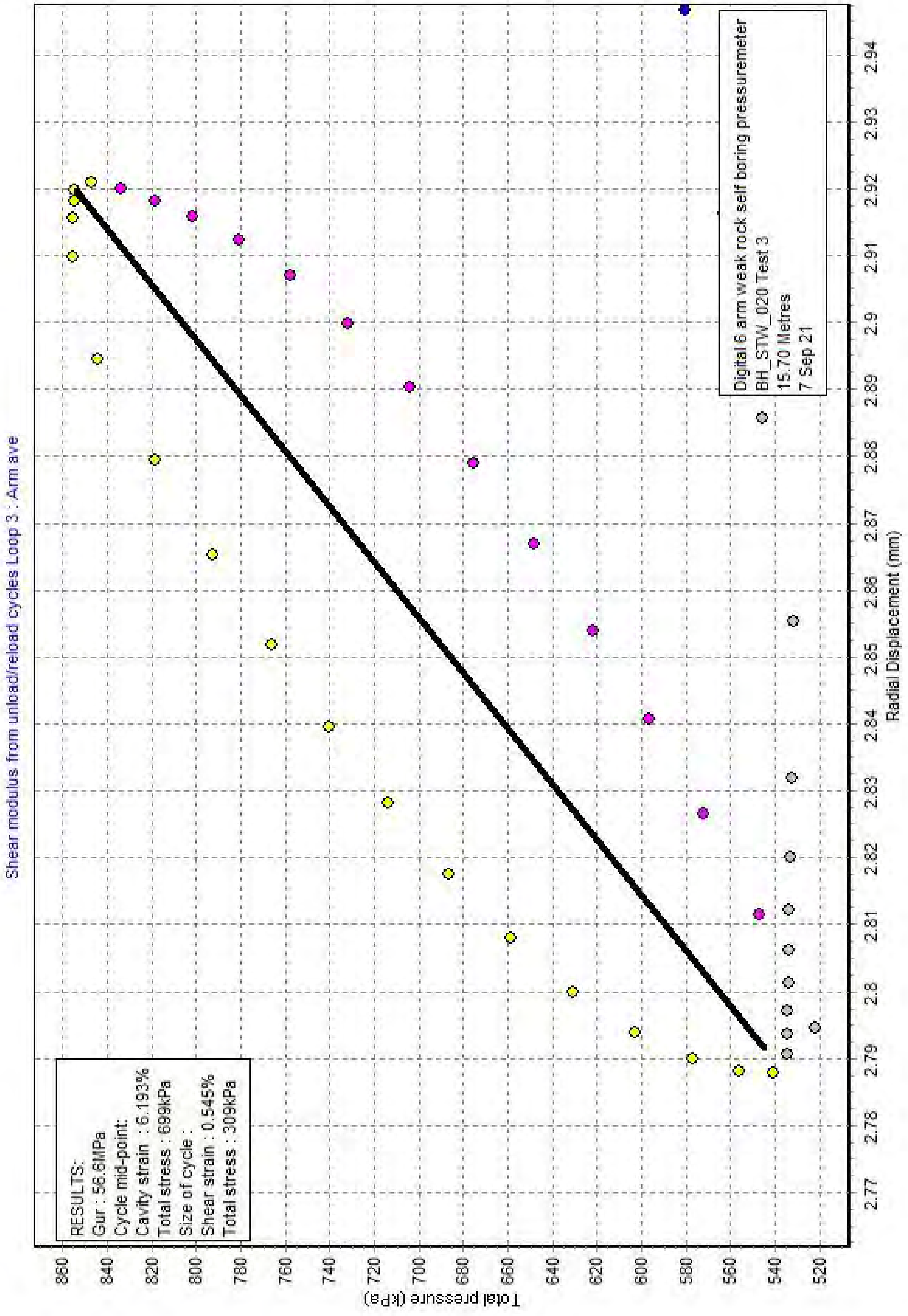

Jefferies (1988) : Arm ave
RESULTS:
Cu : 287.0kPa
Digital 6 arm weak rock self boring pressuremeter
BH_STW_020 Test 3
15.70 Metres
7 Sep 21
Ln[shear strain]
-3
-4
-5
-6
-7
-8
Total pressure (kPa)
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1,000
1,050
1,100
1,150
1,200
1,250
1,300
1,350
1,400
1,450
1,500
1,550

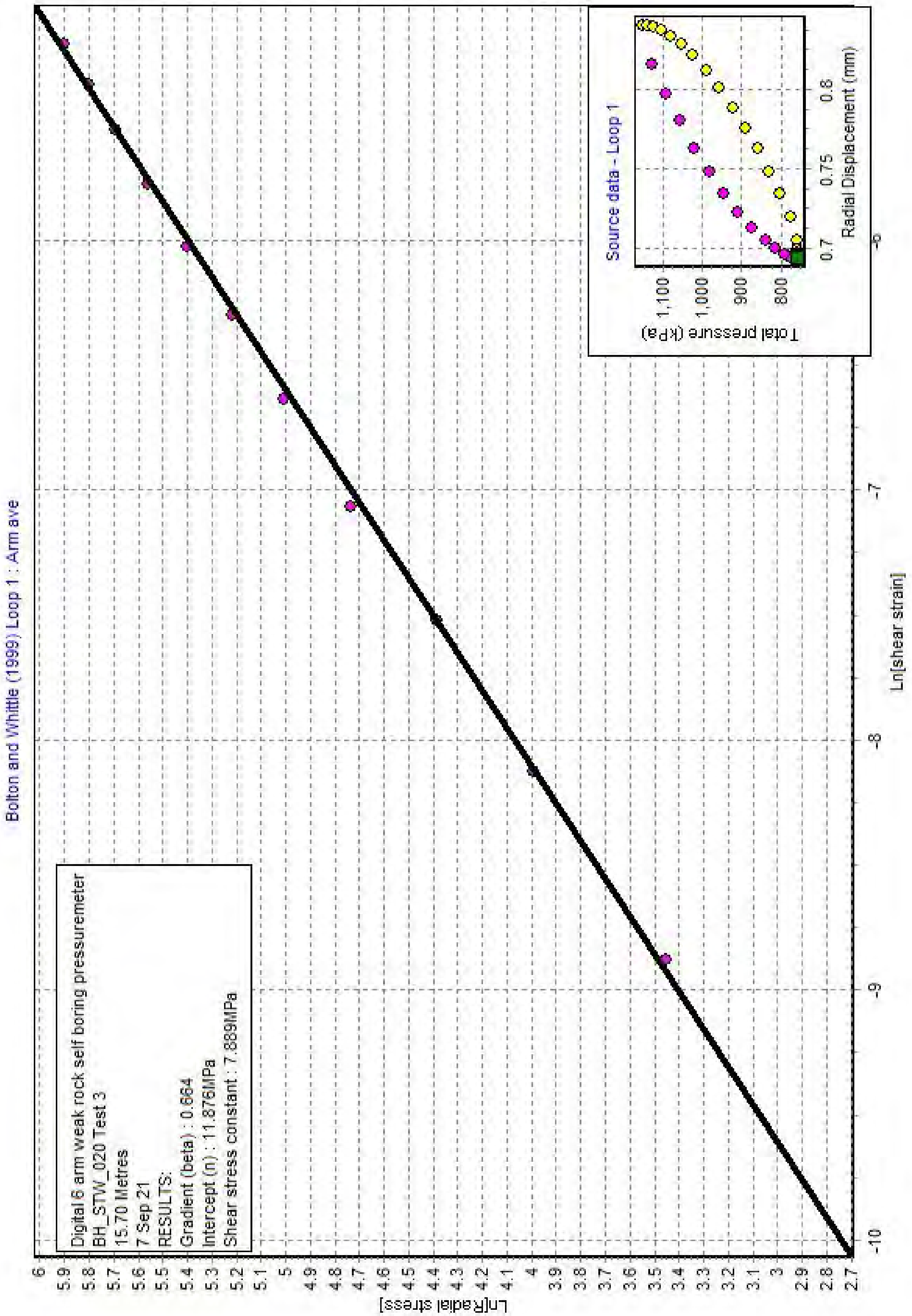

Palmer 1972 (expansion) : Arm ave
RESULTS:
Cu : 289.6kPa
Digital 6 arm weak rock self boring pressuremeter
BH_STW_020 Test 3
15.70 Metres
7 Sep 21
Shear stress (kPa)
370
360
350
340
330
320
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
Shear strain (%)
1
2
3
4
5
6
7
8
9
10
11


Palmer 1972 (contraction) : Arm ave
RESULTS:
2Cu : 574.1kPa
Digital 6 arm weak rock self boring pressuremeter
BH_STW_020 Test 3
15.70 Metres
7 Sep 21
Shear stress (kPa)
640
620
600
580
560
540
520
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
Shear strain (%)
1
2
3
4
5
6
7
8

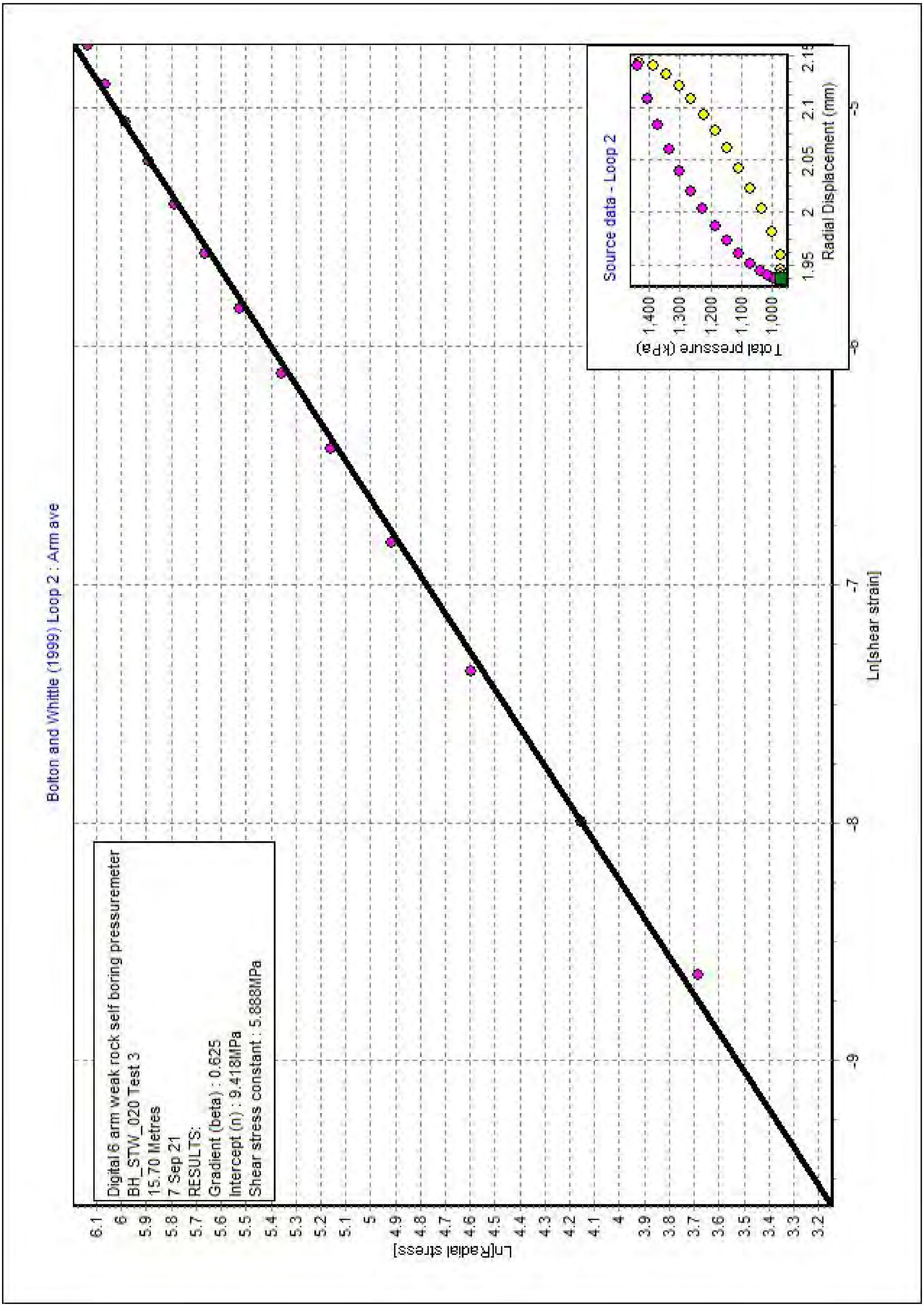

Shear modulus from unload/reload cycles Loop 1 : Arm ave
RESULTS:
Gur : 60.1MPa
Cycle mid-point:
Cavity strain : 1.468%
Total stress : 956kPa
Size of cycle :
Shear strain : 0.644%
Total stress : 388kPa
Digital 6 arm weak rock self boring pressuremeter
BH_STW_020 Test 3
15.70 Metres
7 Sep 21
Radial Displacement (mm)
0.68
0.69
0.7
0.71
0.72
0.73
0.74
0.75
0.76
0.77
0.78
0.79
0.8
0.81
0.82
0.83
0.84
0.85
0.86
0.87
Total pressure (kPa)
760
780
800
820
840
860
880
900
920
940
960
980
1,000
1,020
1,040
1,060
1,080
1,100
1,120
1,140
1,160

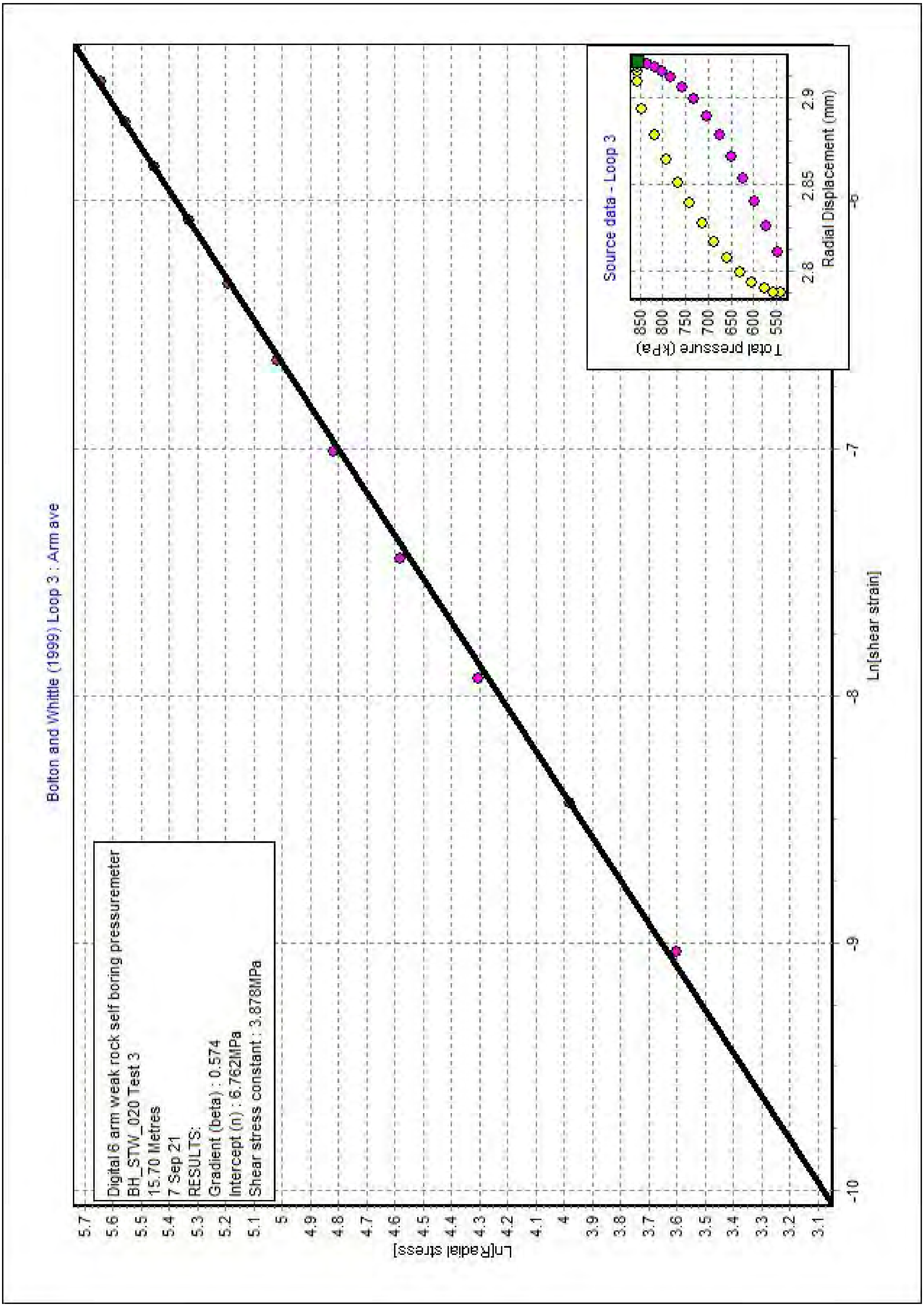

Shear modulus from unload/reload cycles Loop 2 : Arm ave
RESULTS:
Gur : 51.6MPa
Cycle mid-point:
Cavity strain : 4.348%
Total stress : 1203kPa
Size of cycle :
Shear strain : 0.877%
Total stress : 455kPa
Digital 6 arm weak rock self boring pressuremeter
BH_STW_020 Test 3
15.70 Metres
7 Sep 21
Total pressure (kPa)
1,480
1,460
1,440
1,420
1,400
1,380
1,360
1,340
1,320
1,300
1,280
1,260
1,240
1,220
1,200
1,180
1,160
1,140
1,120
1,100
1,080
1,060
1,040
1,020
1,000
980
960
Radial Displacement (mm)
1.93
1.94
1.95
1.96
1.97
1.98
1.99
2
2.01
2.02
2.03
2.04
2.05
2.06
2.07
2.08
2.09
2.1
2.11
2.12
2.13
2.14
2.15
2.16
2.17

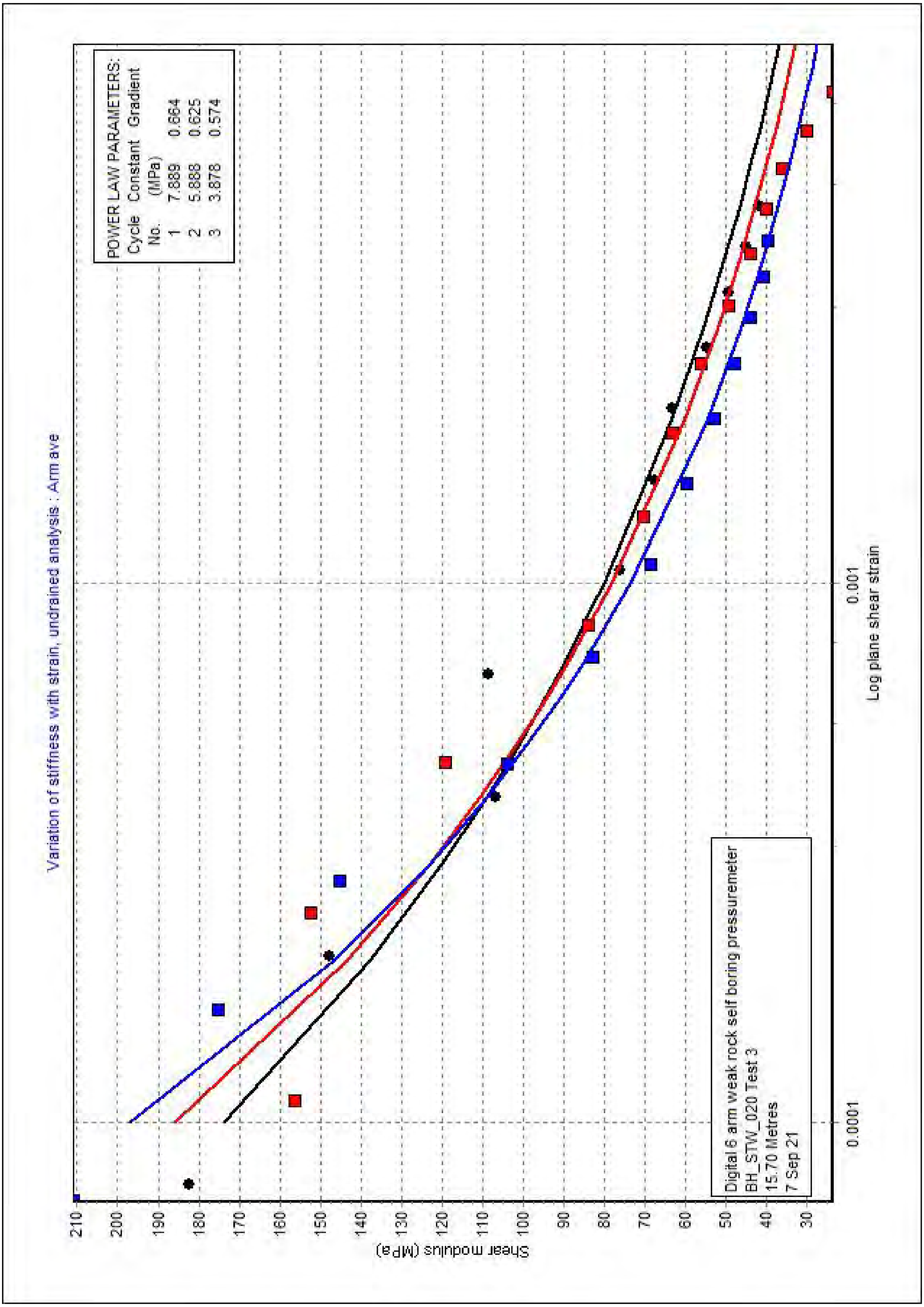

Shear modulus from unload/reload cycles Loop 3 : Arm ave
RESULTS:
Gur : 56.6MPa
Cycle mid-point:
Cavity strain : 6.193%
Total stress : 699kPa
Size of cycle :
Shear strain : 0.545%
Total stress : 309kPa
Digital 6 arm weak rock self boring pressuremeter
BH_STW_020 Test 3
15.70 Metres
7 Sep 21
Radial Displacement (mm)
2.77
2.78
2.79
2.8
2.81
2.82
2.83
2.84
2.85
2.86
2.87
2.88
2.89
2.9
2.91
2.92
2.93
2.94
Total pressure (kPa)
860
840
820
800
780
760
740
720
700
680
660
640
620
600
580
560
540
520

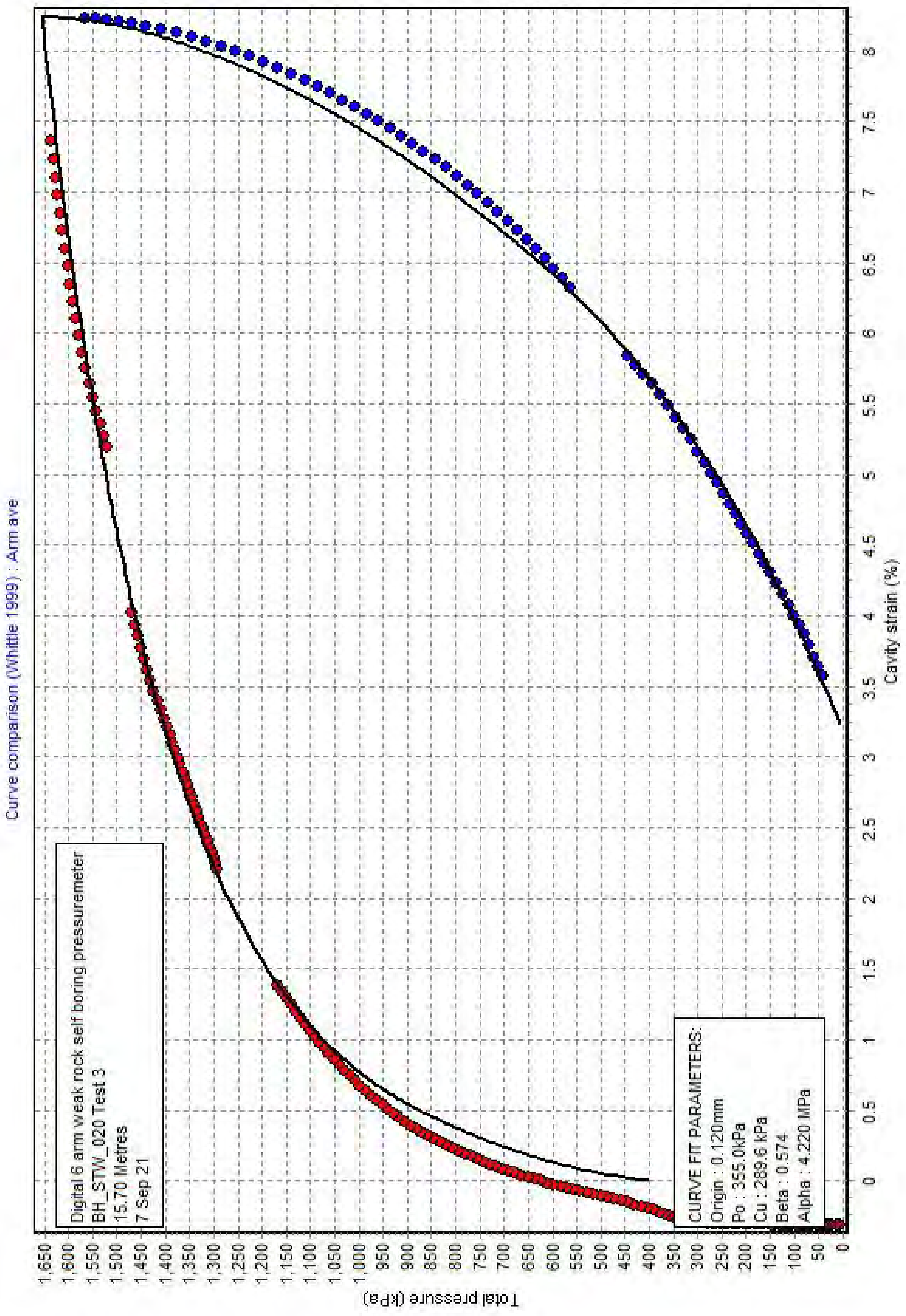


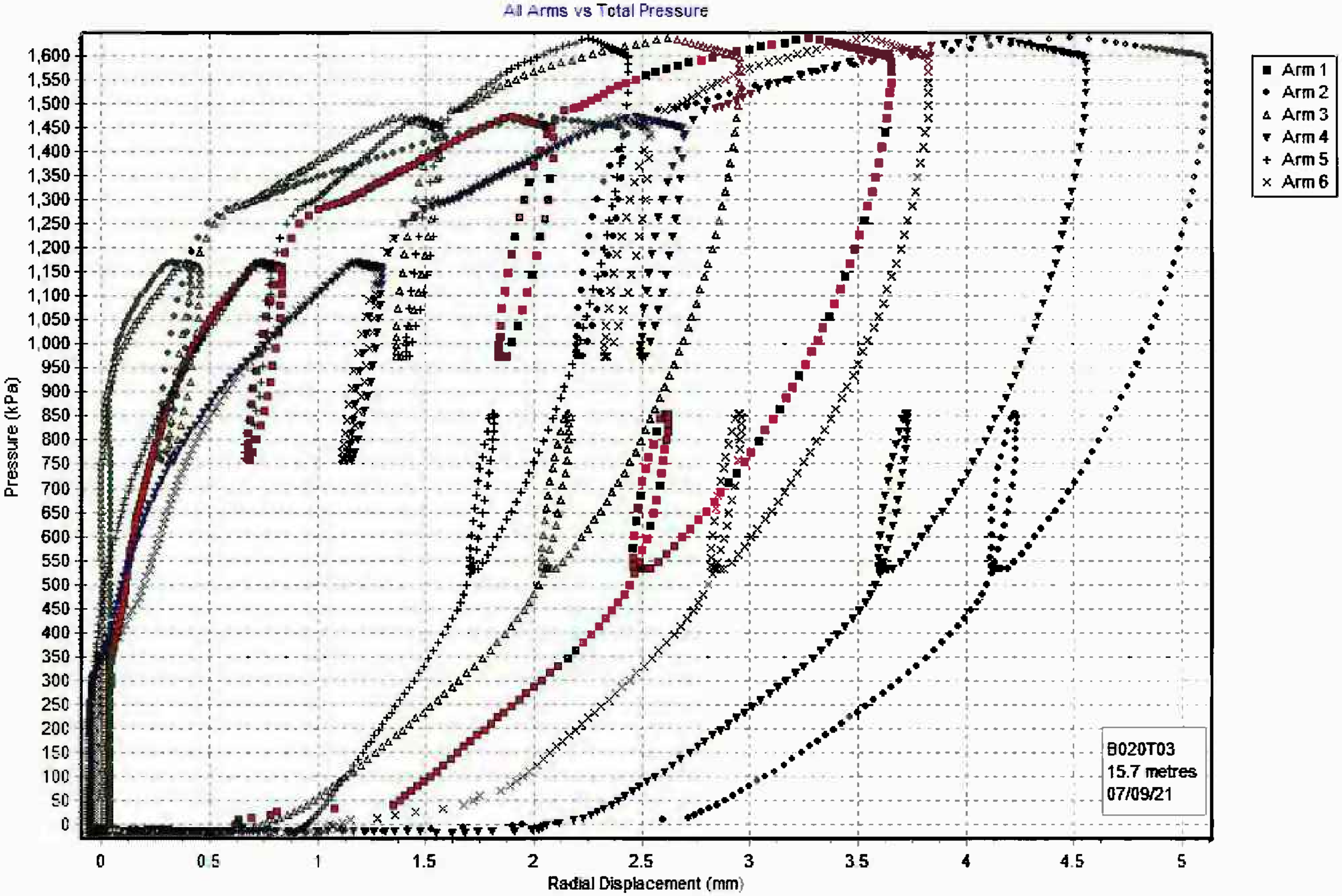
Digital 6 arm weak rock self boring pressuremeter
BH_STW_020 Test 3
15.70 Metres
7 Sep 21
RESULTS:
Gradient (beta) : 0.664
Intercept (n) : 11.876MPa
Shear stress constant : 7.889MPa


Bolton and Whittle (1999) Loop 2 : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_020 Test 3
15.70 Metres
7 Sep 21
RESULTS:
Gradient (beta) : 0.625
Intercept (n) : 9.418MPa
Shear stress constant : 5.888MPa
Ln[Radial stress]
6.1
6
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
Ln[shear strain]
-9
-8
-7
-6
-5
Source data - Loop 2
Total pressure (kPa)
1,000
1,100
1,200
1,300
1,400
Radial Displacement (mm)
1.95
2
2.05
2.1
2.15


Bolton and Whittle (1999) Loop 3 : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_020 Test 3
15.70 Metres
7 Sep 21
RESULTS:
Gradient (beta) : 0.574
Intercept (n) : 6.762MPa
Shear stress constant : 3.878MPa
Ln[Radial stress]
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
Ln[shear strain]
-10
-9
-8
-7
-6
Source data - Loop 3
Total pressure (kPa)
850
800
750
700
650
600
550
Radial Displacement (mm)
2.8
2.85
2.9


Variation of stiffness with strain, undrained analysis : Arm ave
POWER LAW PARAMETERS:
Cycle No. | Constant (MPa) | Gradient
1 | 7.889 | 0.664
2 | 5.888 | 0.625
3 | 3.878 | 0.574
Digital 6 arm weak rock self boring pressuremeter
BH_STW_020 Test 3
15.70 Metres
7 Sep 21
Shear modulus (MPa)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
Log plane shear strain
0.0001
0.001


Curve comparison (Whittle 1999) : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_020 Test 3
15.70 Metres
7 Sep 21
CURVE FIT PARAMETERS:
Origin : 0.120mm
Po : 355.0kPa
Cu : 289.6 kPa
Beta : 0.574
Alpha : 4.220 MPa
Total pressure (kPa)
1,650
1,600
1,550
1,500
1,450
1,400
1,350
1,300
1,250
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Cavity strain (%)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8

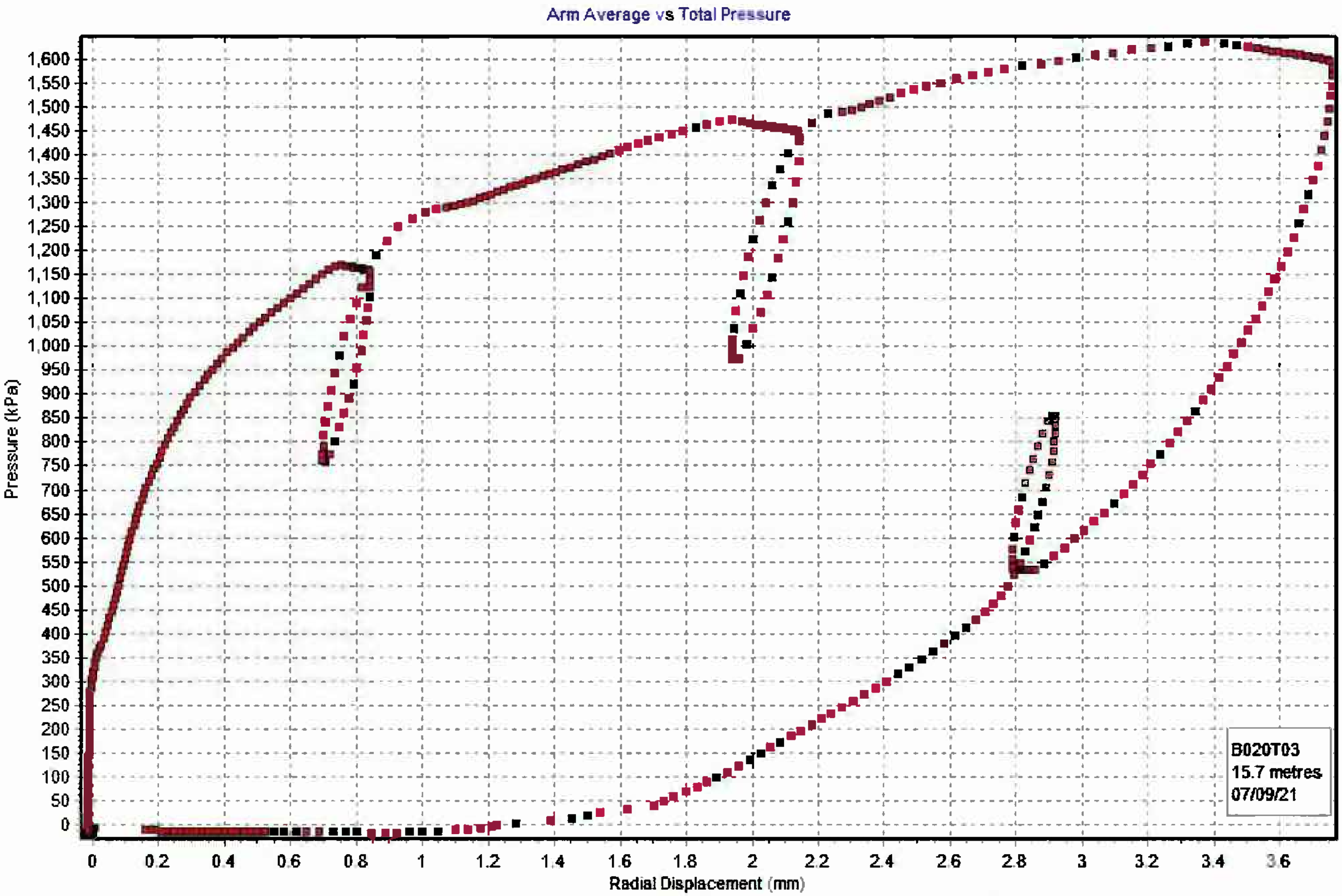


CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel +44 (0)1223 262361

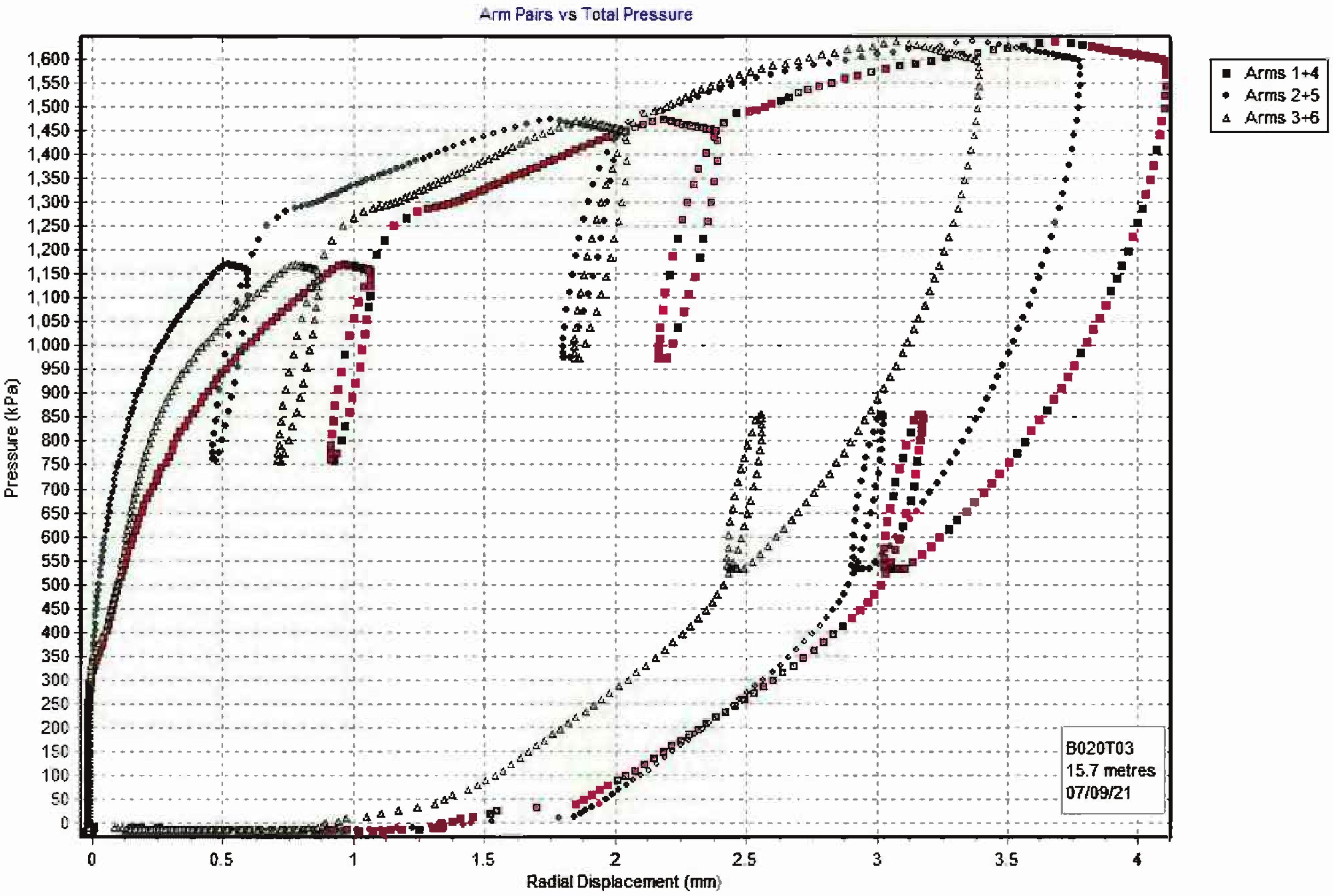
CIR1506/21

Cambridge WWTPR

Pressuremeter Testing



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel +44 (0)1223 262361

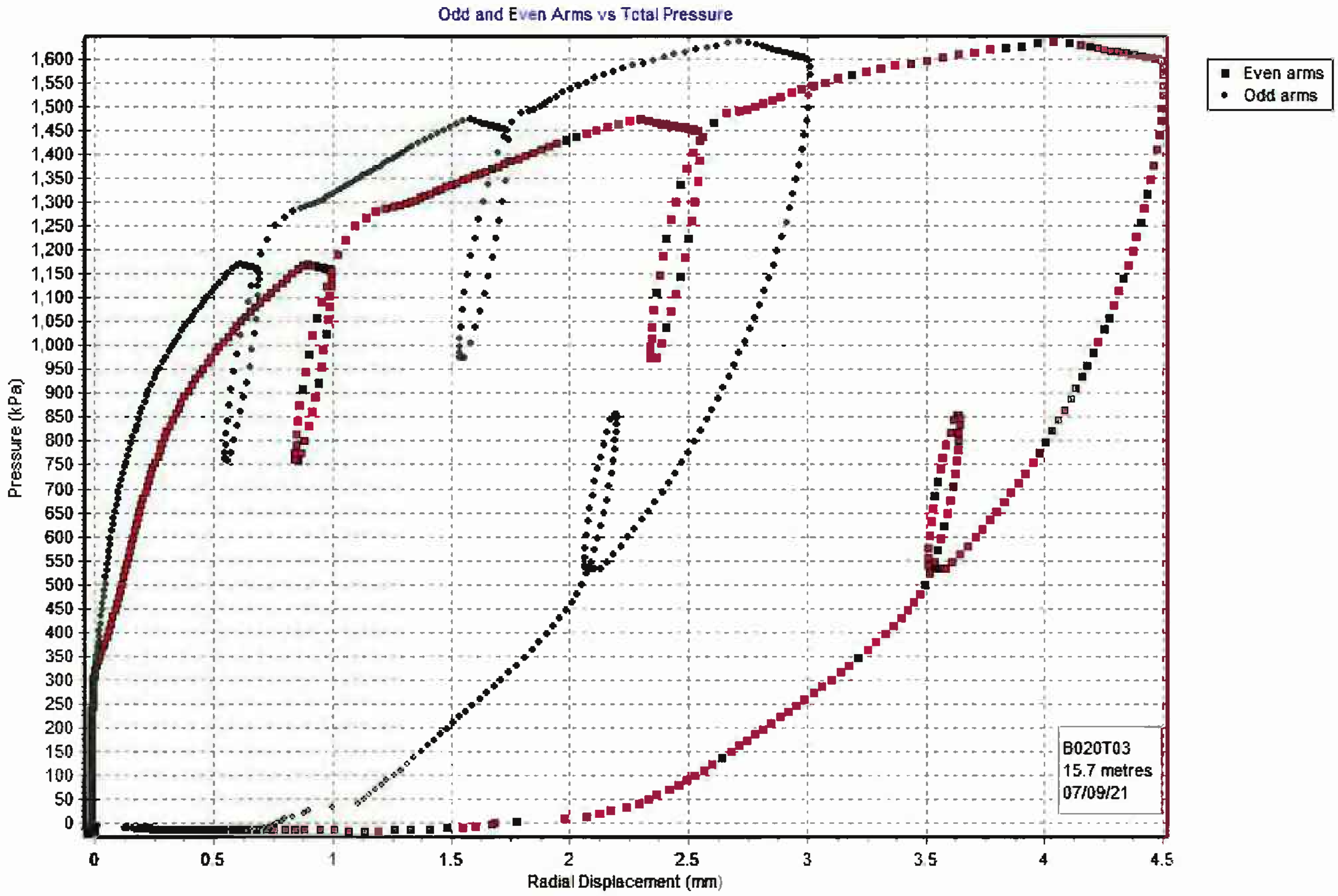


CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361

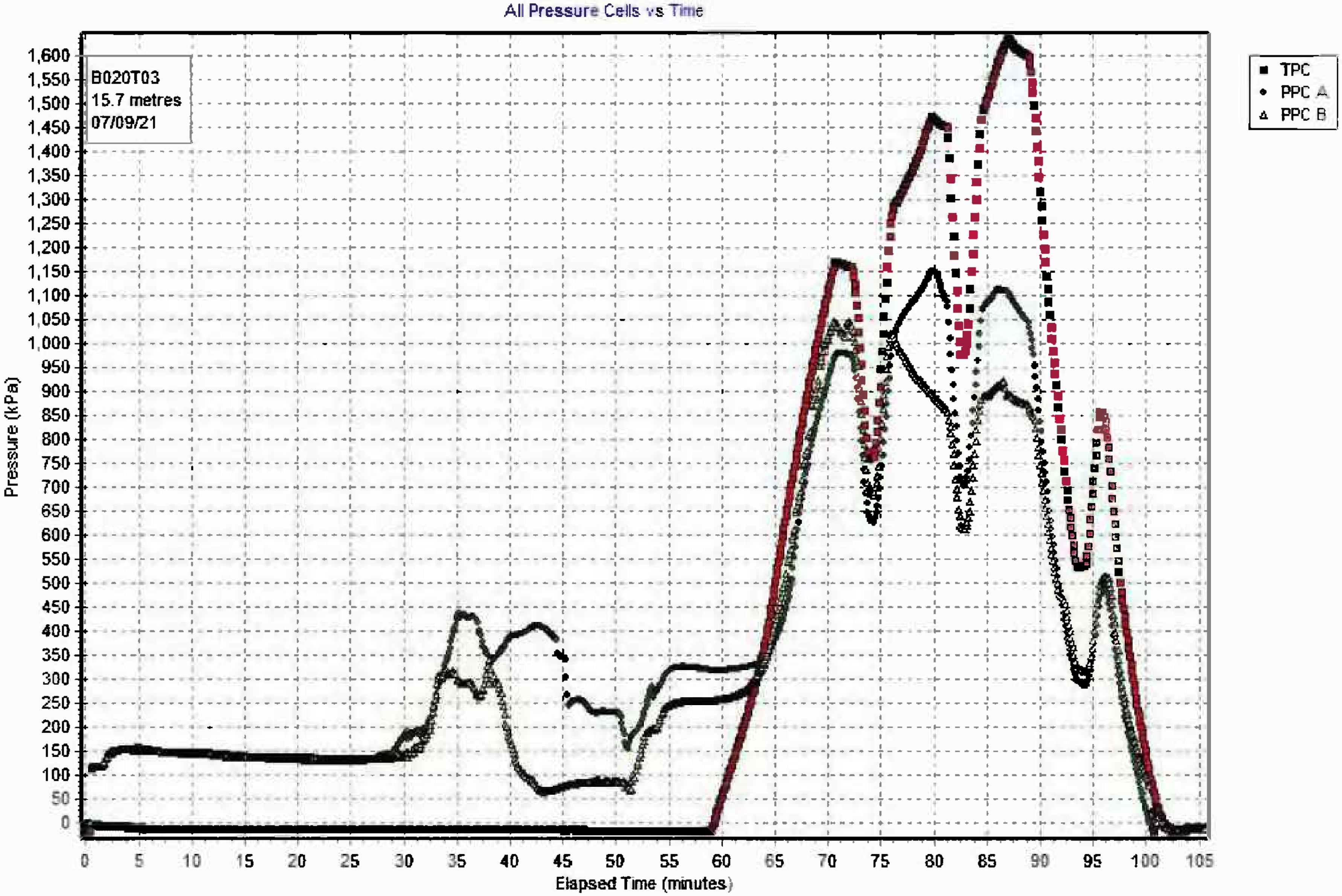
CIR1506/21

Cambridge WWTPR

Pressuremeter Testing



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361



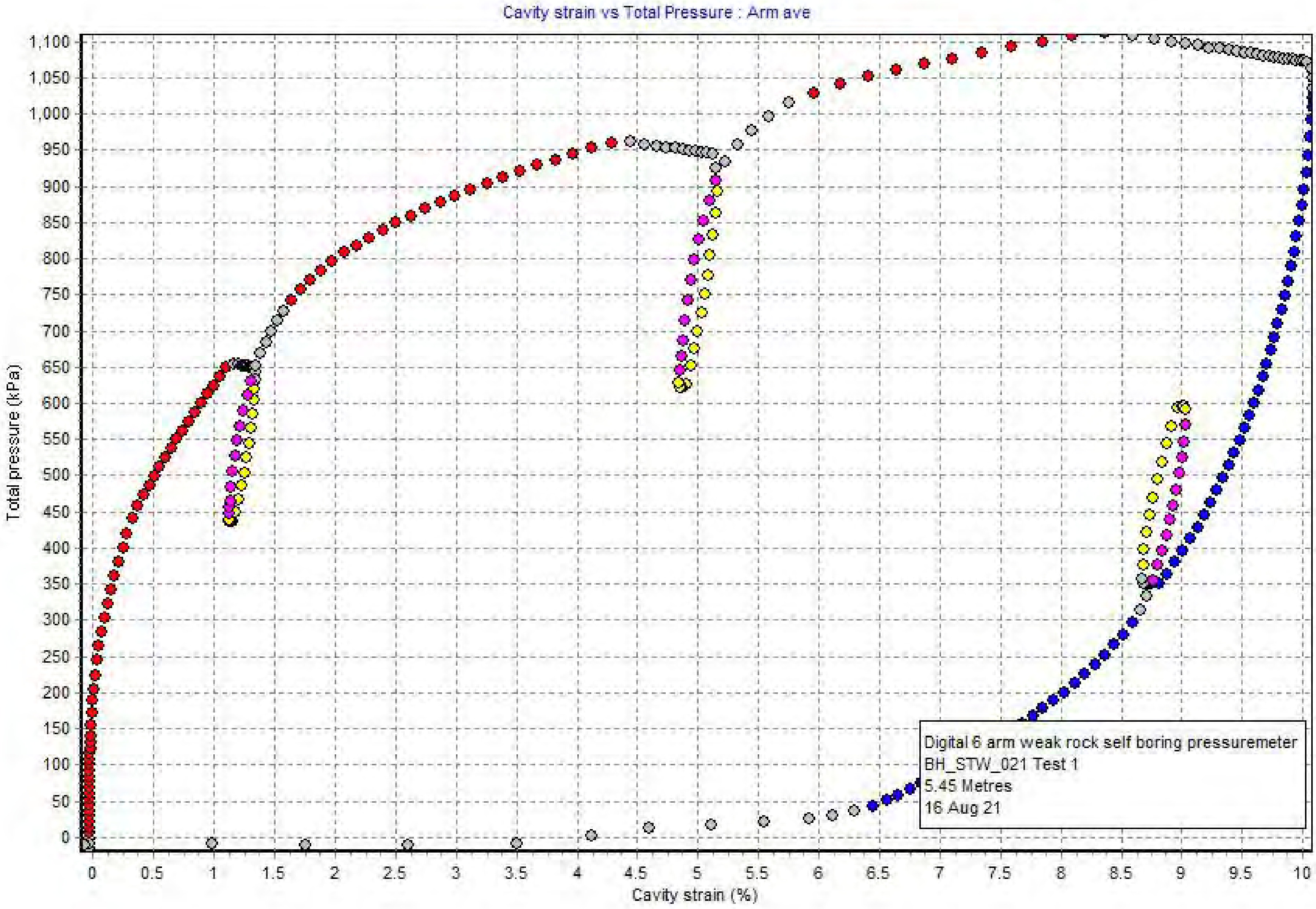
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361

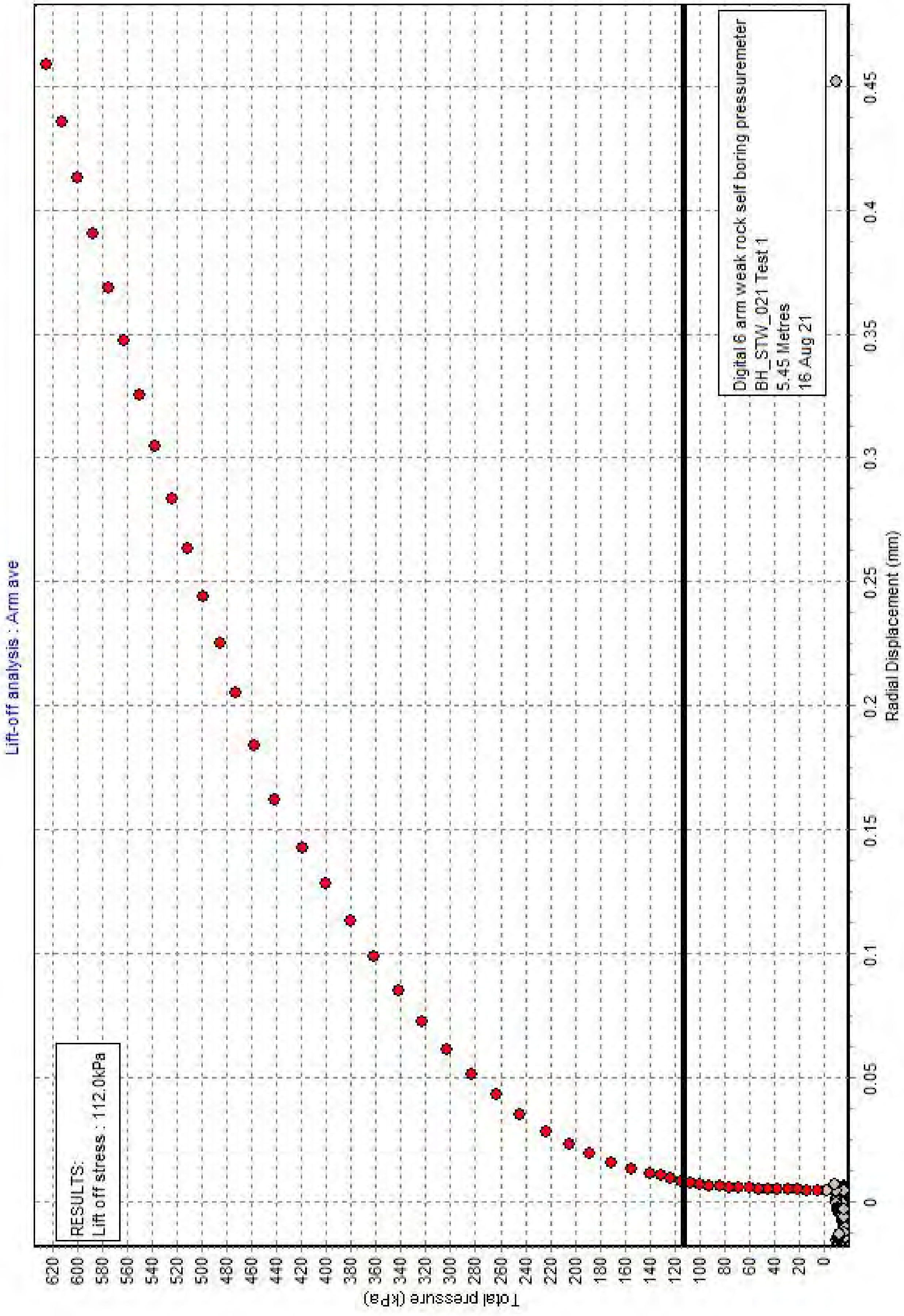
```
BH_STW_021 Test 1 - SUMMARY OF RESULTS
[File made with WinSitu ]

[DETAILS OF TEST]
Project        :   TE8364
Site           :   Cambridge Wastewater Treatment Plant Relocation Project
Borehole       :   BH_STW_021
Test name      :   BH_STW_021 Test 1
Test date      :   16 Aug 21
Test depth     :   5.45 Metres
Water table    :   3.75 Metres
Ambient PWP    :   17.0 kPa
Material       :   Structureless Chalk
Probe          :   Digital 6 arm weak rock self boring pressuremeter
Diameter       :   88.1 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out
The file includes results from a curve fitting analysis

Analysed by SP/RW on 16 Aug 21

Remarks:  Material clearly has some structure but this breaks down at
about 3% cavity strain and this prevents curve modelling from
fitting the latter part of the loading.

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm)                   :   "Arm ave=0.02"
Po from Marsland & Randolph (kPa)    :   "Arm ave=183.9"
Po from Lift off (kPa)               :   "Arm ave=112.0"
PWP versus Total Stress (kPa)        :   "PPC Ave=91.2"
Best estimate of Po (kPa)            :   "Arm ave=150.0"

[UNDRAINED STRENGTH PARAMETERS]
Undrained yield stress (kPa)         :   "Arm ave=448.3"
PWP derived yield stress (kPa)       :   "PPC Ave=355.5"

[DRAINED ANALYSIS OF SANDS]
[Hughes et al 1977]
Constant volume friction angle (°)   :   30.0
Angle of internal friction (°)       :   "Arm ave=30.3"
Dilation angle (°)                   :   "Arm ave=0.4"
Gradient of log-log plot             :   "Arm ave=0.337"

[Withers et al 1989]
Angle of internal friction (°)       :   "Arm ave=36.1"
Dilation angle (°)                   :   "Arm ave=7.3"
Gradient of log-log plot             :   "Arm ave=-2.332"

[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=27.1"
Axis       Loop   Value    Mean Strain  Mean Pc  dE      dPc
           No     (MPa)    (%)          (kPa)    (%)     (kPa)
Arm ave    1      47.3     1.227        531      0.400   190
Arm ave    2      48.4     5.003        762      0.584   283
Arm ave    3      40.9     8.865        477      0.577   237

[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]
Axis       Loop   Intercept  Alpha      Gradient
           No     (MPa)      (MPa)
Arm ave    1      7.211      4.605      0.639
Arm ave    2      7.269      4.516      0.621
Arm ave    3      4.850      2.749      0.567

Non-linear exponent from PWP response :   "PPC Ave=0.656"

[PARAMETERS USED FOR DRAINED CURVE MODELLING]
{Axis is  Arm ave}
Strain Origin (mm)                   :   0.02
Po (kPa)                             :   150
```

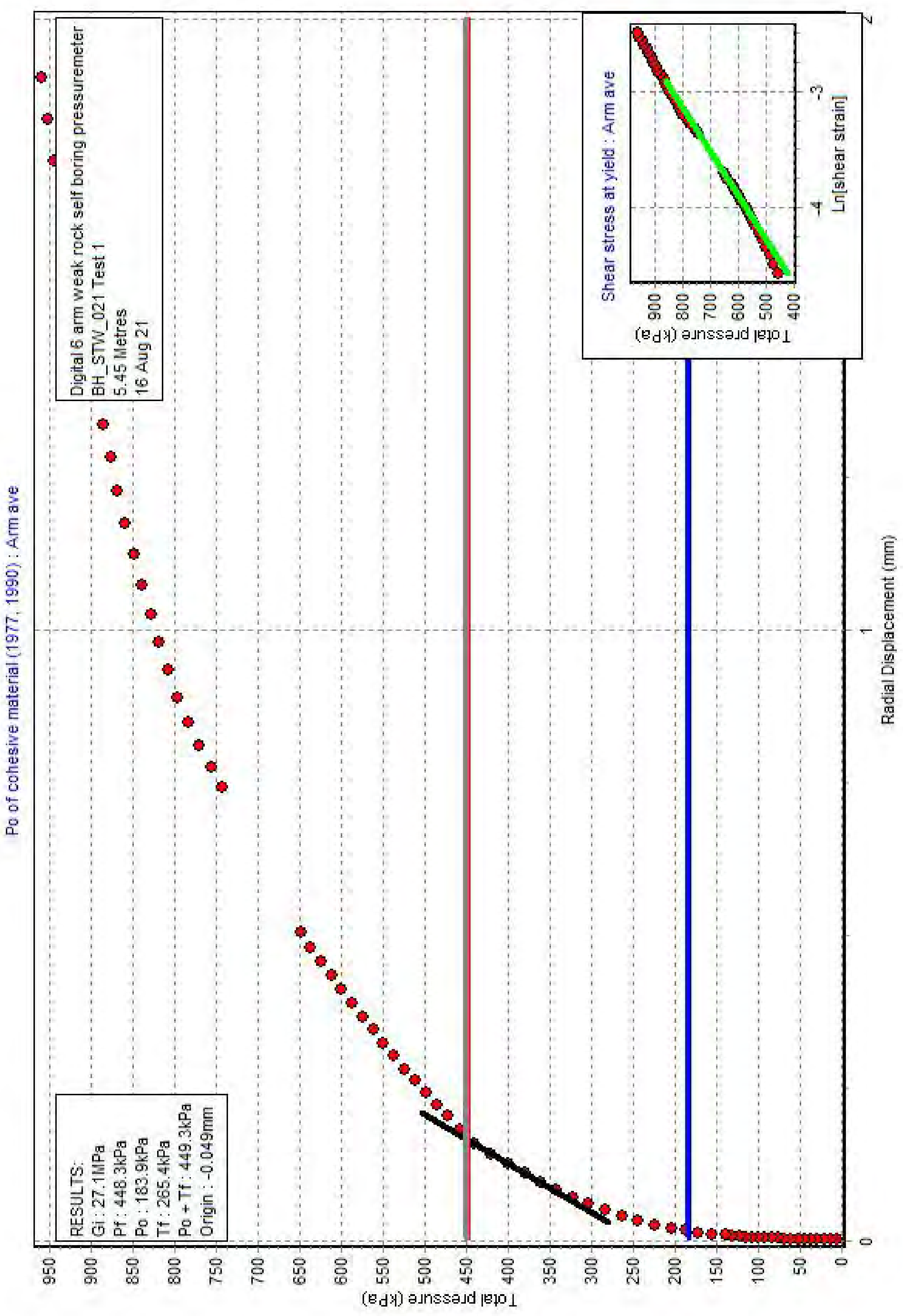
BH_STW_021 Test 1 - SUMMARY OF RESULTS

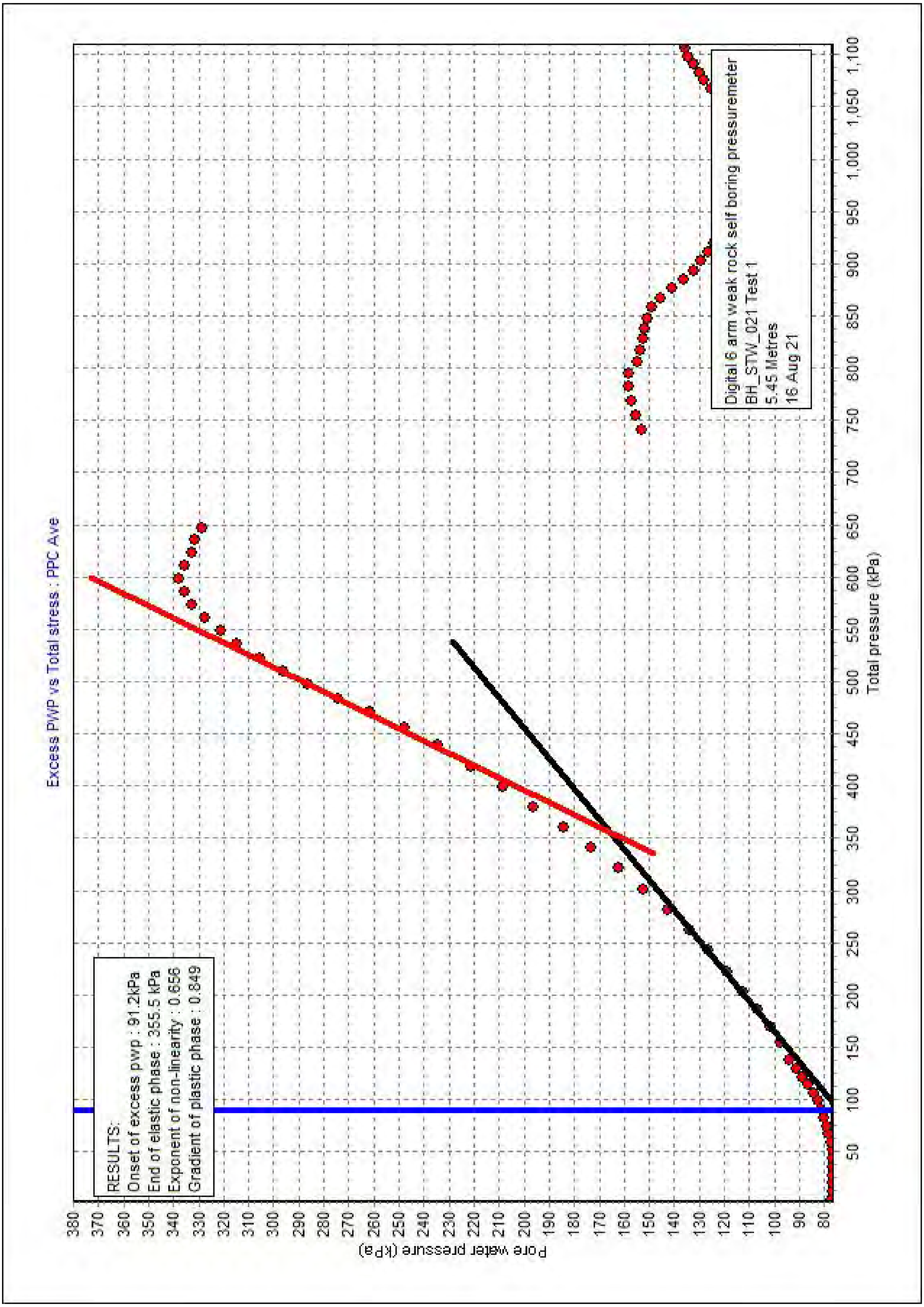
Cohesion (kPa) : 8
Angle of peak friction (deg) : 30.3
Angle of peak dilation (deg) : 0.4
Total yield stress (kPa) : 322
Total limit stress (kPa) : 2236
G at first yield (MPa) : 51.1
Non-linear exponent : 0.621
Janbu exponent : -0.057
Correlation : 0.039

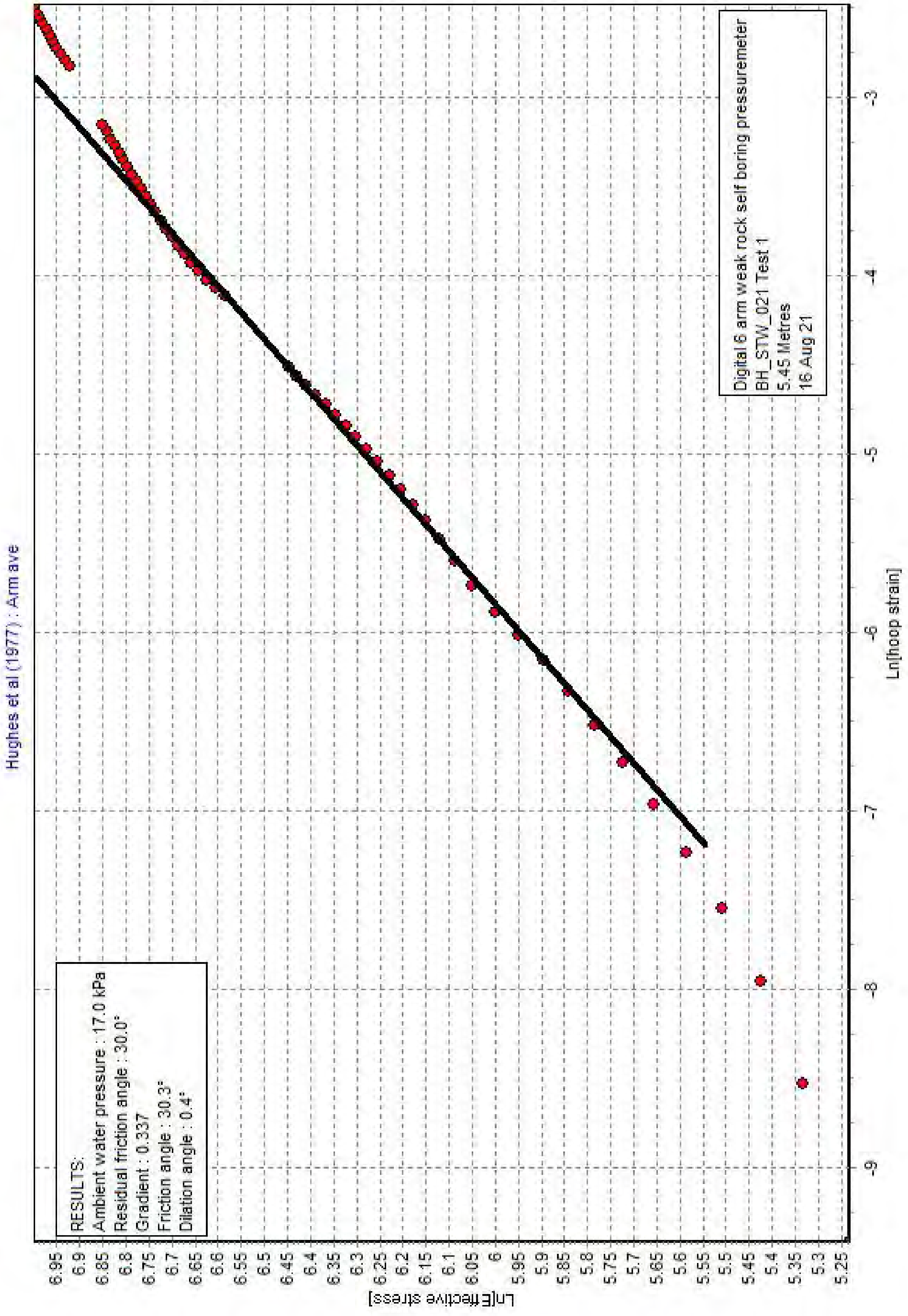
Ambient pore water pressure (kPa) : 17
Residual friction angle (deg) : 30.0
Poisson's ratio : 0.25

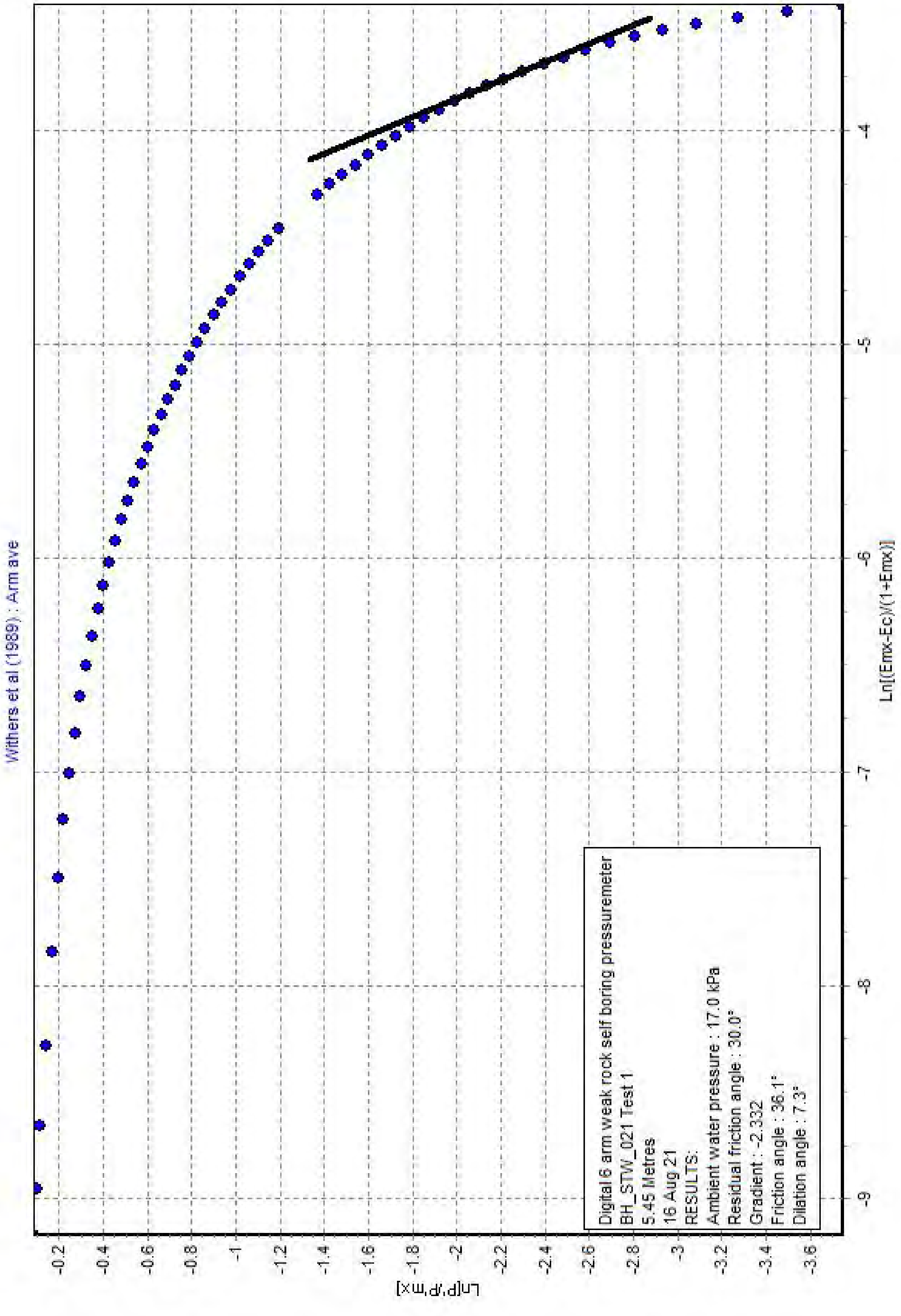

Cavity strain vs Total Pressure : Arm ave
Total pressure (kPa)
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Cavity strain (%)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
Digital 6 arm weak rock self boring pressuremeter
BH_STW_021 Test 1
5.45 Metres
16 Aug 21

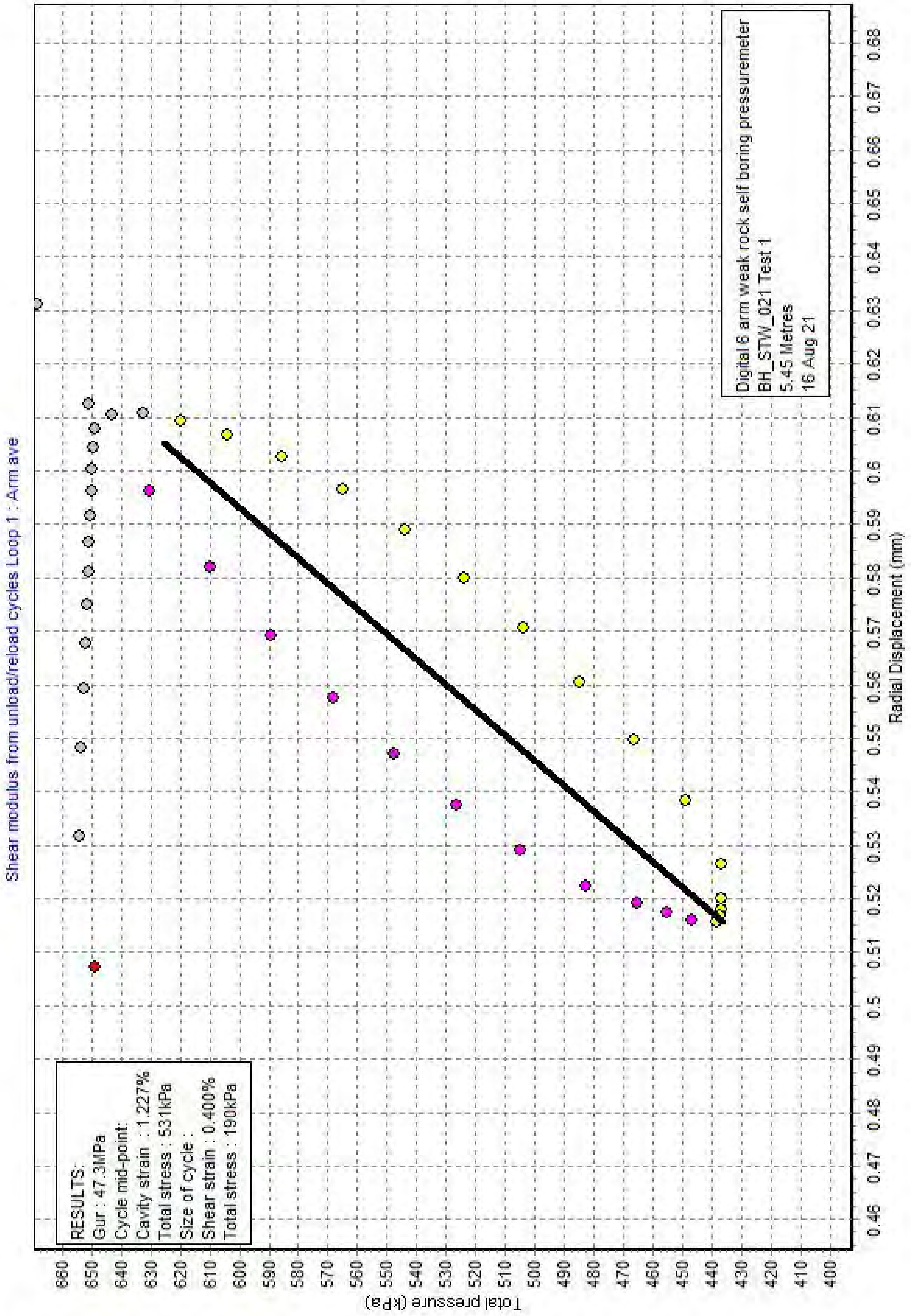

Lift-off analysis : Arm ave
RESULTS:
Lift off stress : 112.0kPa
Digital 6 arm weak rock self boring pressuremeter
BH_STW_021 Test 1
5.45 Metres
16 Aug 21
Total pressure (kPa)
620
600
580
560
540
520
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
Radial Displacement (mm)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45


Po of cohesive material (1977, 1990) : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_021 Test 1
5.45 Metres
16 Aug 21
RESULTS:
Gi : 27.1MPa
Pf : 448.3kPa
Po : 183.9kPa
Tf : 265.4kPa
Po + Tf : 449.3kPa
Origin : -0.049mm
Total pressure (kPa)
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Radial Displacement (mm)
0
1
2
Shear stress at yield : Arm ave
Total pressure (kPa)
900
800
700
600
500
400
-4
-3
Ln[shear strain]


Excess PWP vs Total stress : PPC Ave
RESULTS:
Onset of excess pwp : 91.2kPa
End of elastic phase : 355.5 kPa
Exponent of non-linearity : 0.656
Gradient of plastic phase : 0.849
Digital 6 arm weak rock self boring pressuremeter
BH_STW_021 Test 1
5.45 Metres
16 Aug 21
Pore water pressure (kPa)
380
370
360
350
340
330
320
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
Total pressure (kPa)
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1,000
1,050
1,100

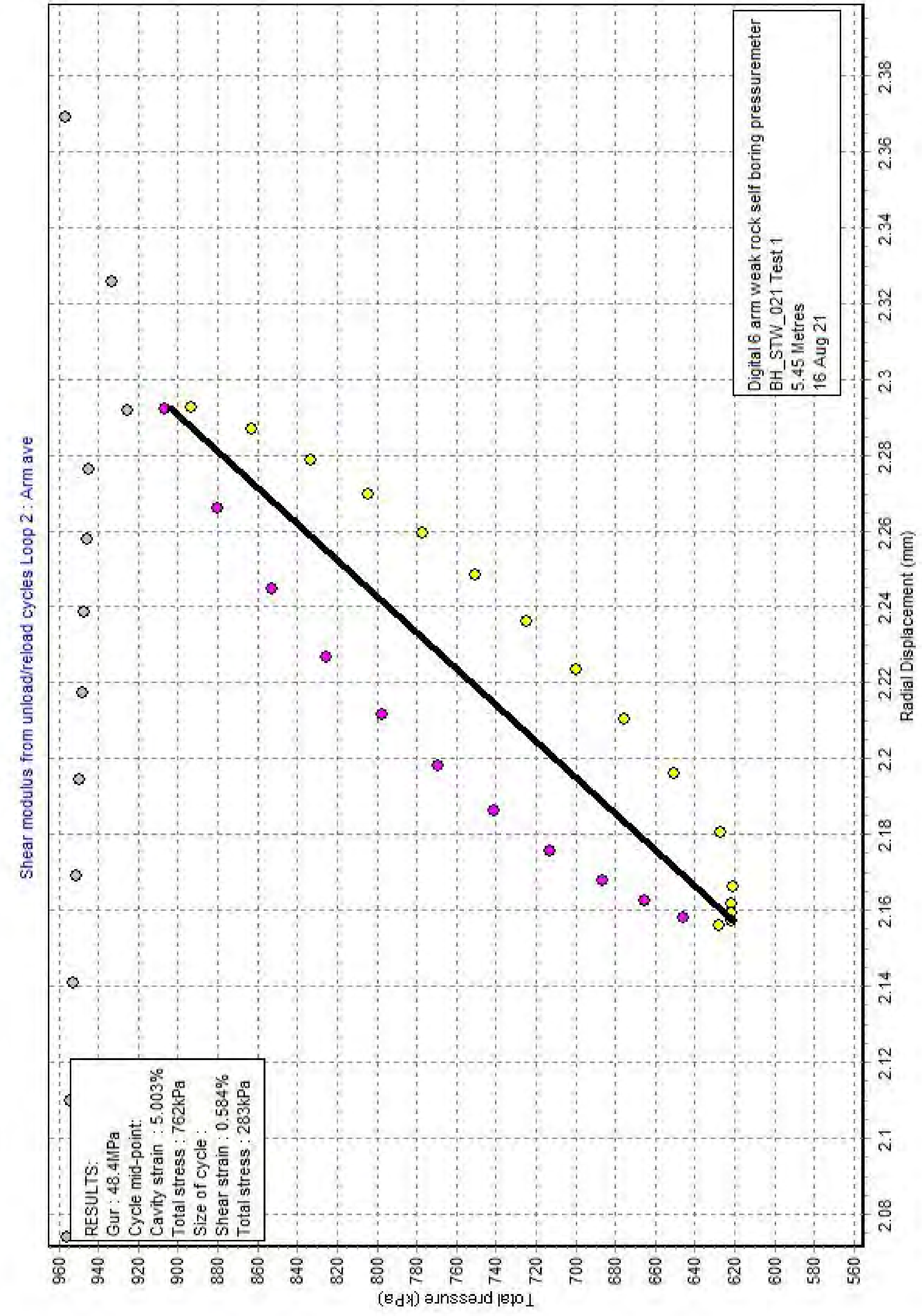

Hughes et al (1977) : Arm ave
RESULTS:
Ambient water pressure : 17.0 kPa
Residual friction angle : 30.0°
Gradient : 0.337
Friction angle : 30.3°
Dilation angle : 0.4°
Digital 6 arm weak rock self boring pressuremeter
BH_STW_021 Test 1
5.45 Metres
16 Aug 21
Ln[Effective stress]
6.95
6.9
6.85
6.8
6.75
6.7
6.65
6.6
6.55
6.5
6.45
6.4
6.35
6.3
6.25
6.2
6.15
6.1
6.05
6
5.95
5.9
5.85
5.8
5.75
5.7
5.65
5.6
5.55
5.5
5.45
5.4
5.35
5.3
5.25
Ln[hoop strain]
-3
-4
-5
-6
-7
-8
-9

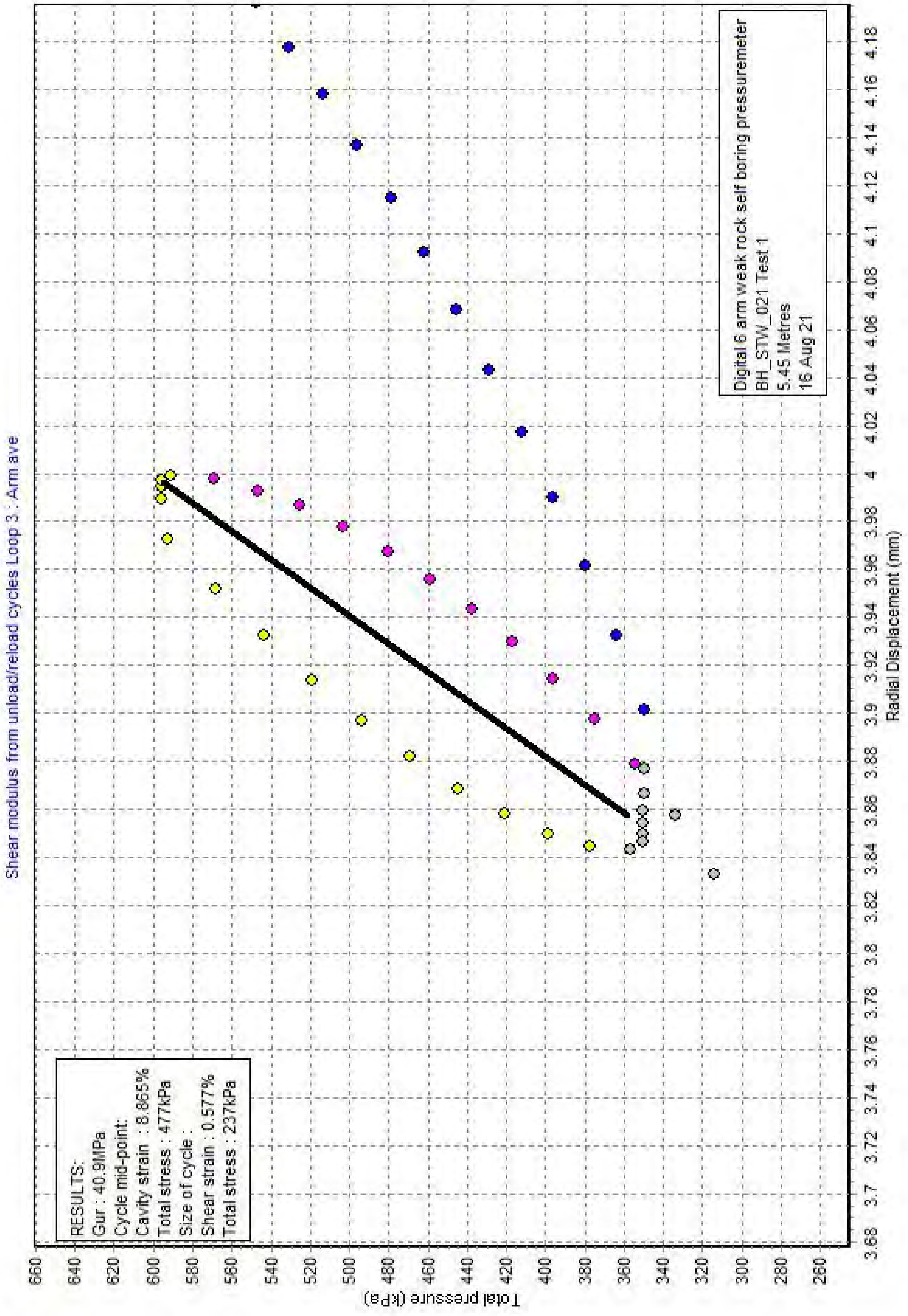

Withers et al (1989) : Arm ave
Ln[(Emx-Ec)/(1+Emx)]
Ln[P'/P'mx]
-9
-8
-7
-6
-5
-4
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-1.8
-2
-2.2
-2.4
-2.6
-2.8
-3
-3.2
-3.4
-3.6
Digital 6 arm weak rock self boring pressuremeter
BH_STW_021 Test 1
5.45 Metres
16 Aug 21
RESULTS:
Ambient water pressure : 17.0 kPa
Residual friction angle : 30.0°
Gradient : -2.332
Friction angle : 36.1°
Dilation angle : 7.3°

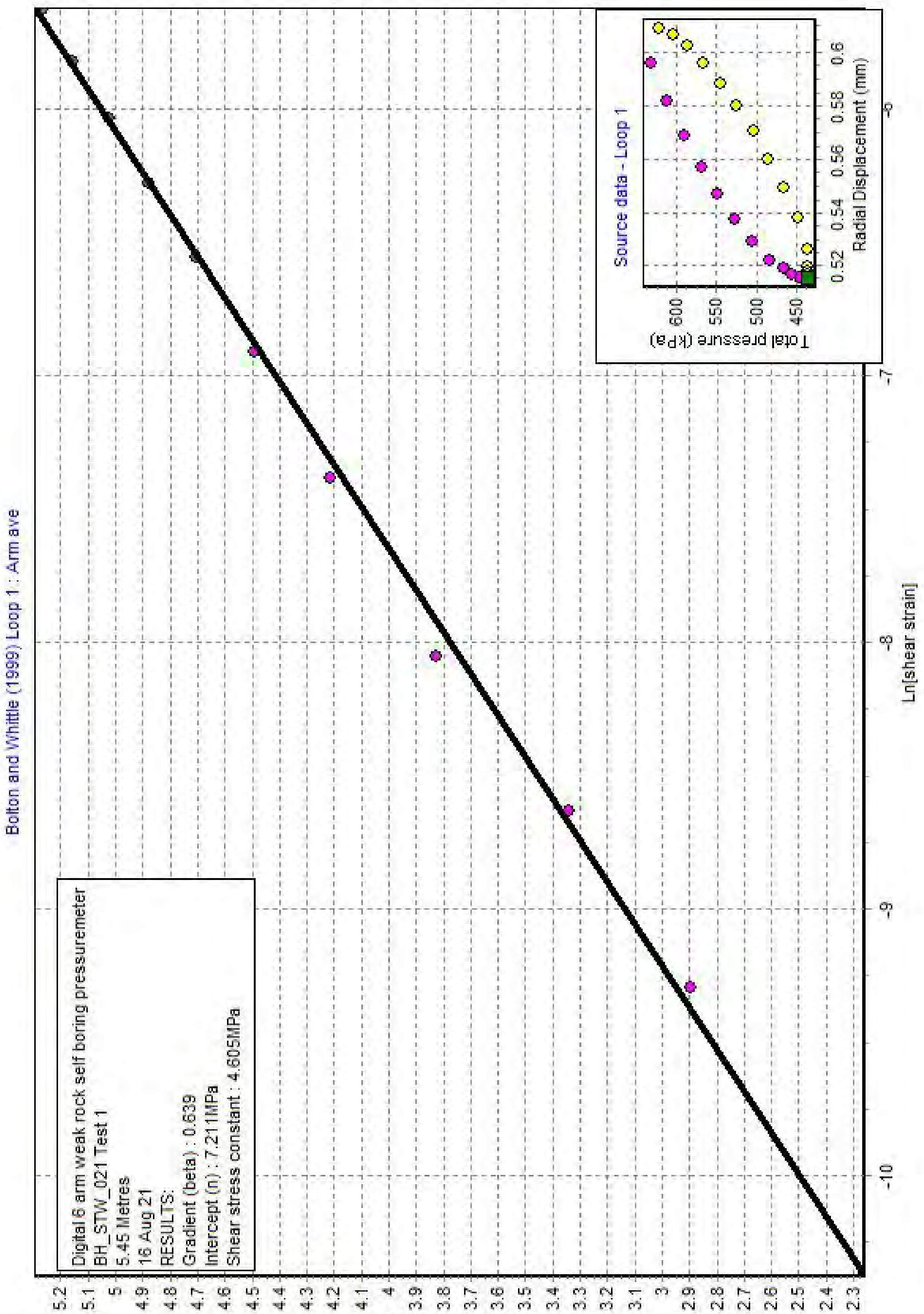


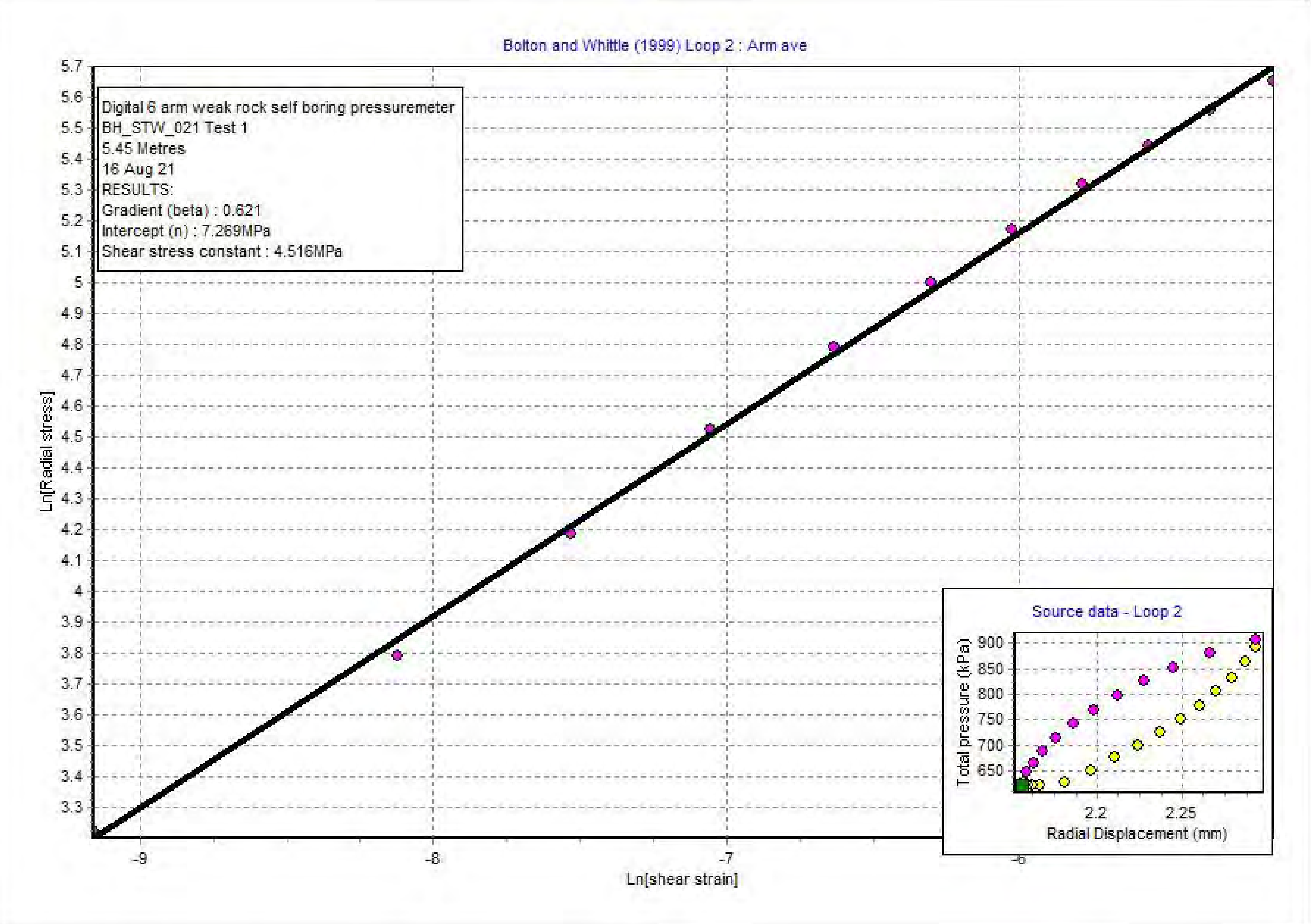
RESULTS:
Gur : 47.3MPa
Cycle mid-point:
Cavity strain : 1.227%
Total stress : 531kPa
Size of cycle :
Shear strain : 0.400%
Total stress : 190kPa

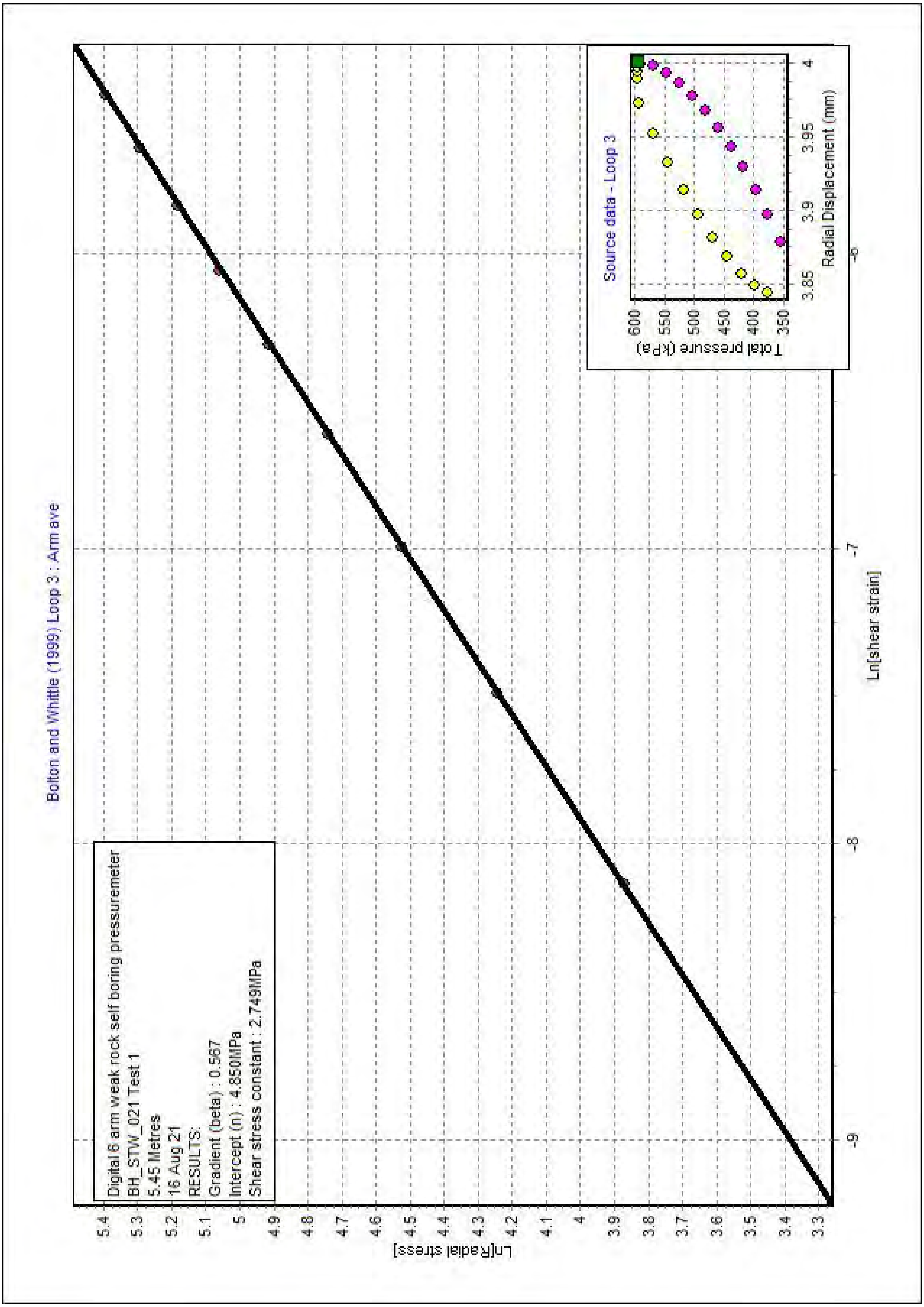
Digital 6 arm weak rock self boring pressuremeter
BH_STW_021 Test 1
5.45 Metres
16 Aug 21

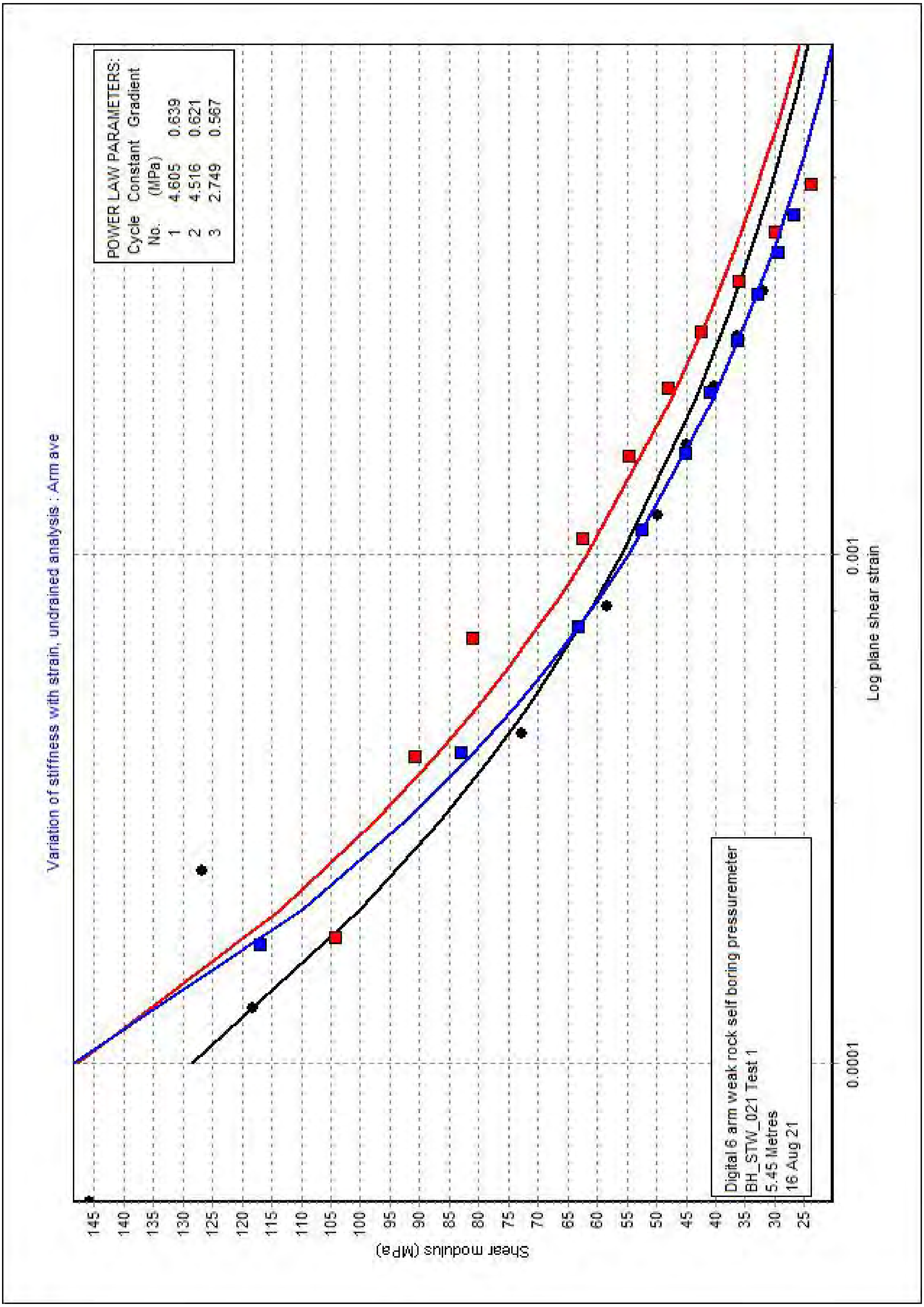

Shear modulus from unload/reload cycles Loop 2 : Arm ave
RESULTS:
Gur : 48.4MPa
Cycle mid-point:
Cavity strain : 5.003%
Total stress : 762kPa
Size of cycle :
Shear strain : 0.584%
Total stress : 283kPa
Digital 6 arm weak rock self boring pressuremeter
BH_STW_021 Test 1
5.45 Metres
16 Aug 21
Total pressure (kPa)
960
940
920
900
880
860
840
820
800
780
760
740
720
700
680
660
640
620
600
580
560
Radial Displacement (mm)
2.08
2.1
2.12
2.14
2.16
2.18
2.2
2.22
2.24
2.26
2.28
2.3
2.32
2.34
2.36
2.38

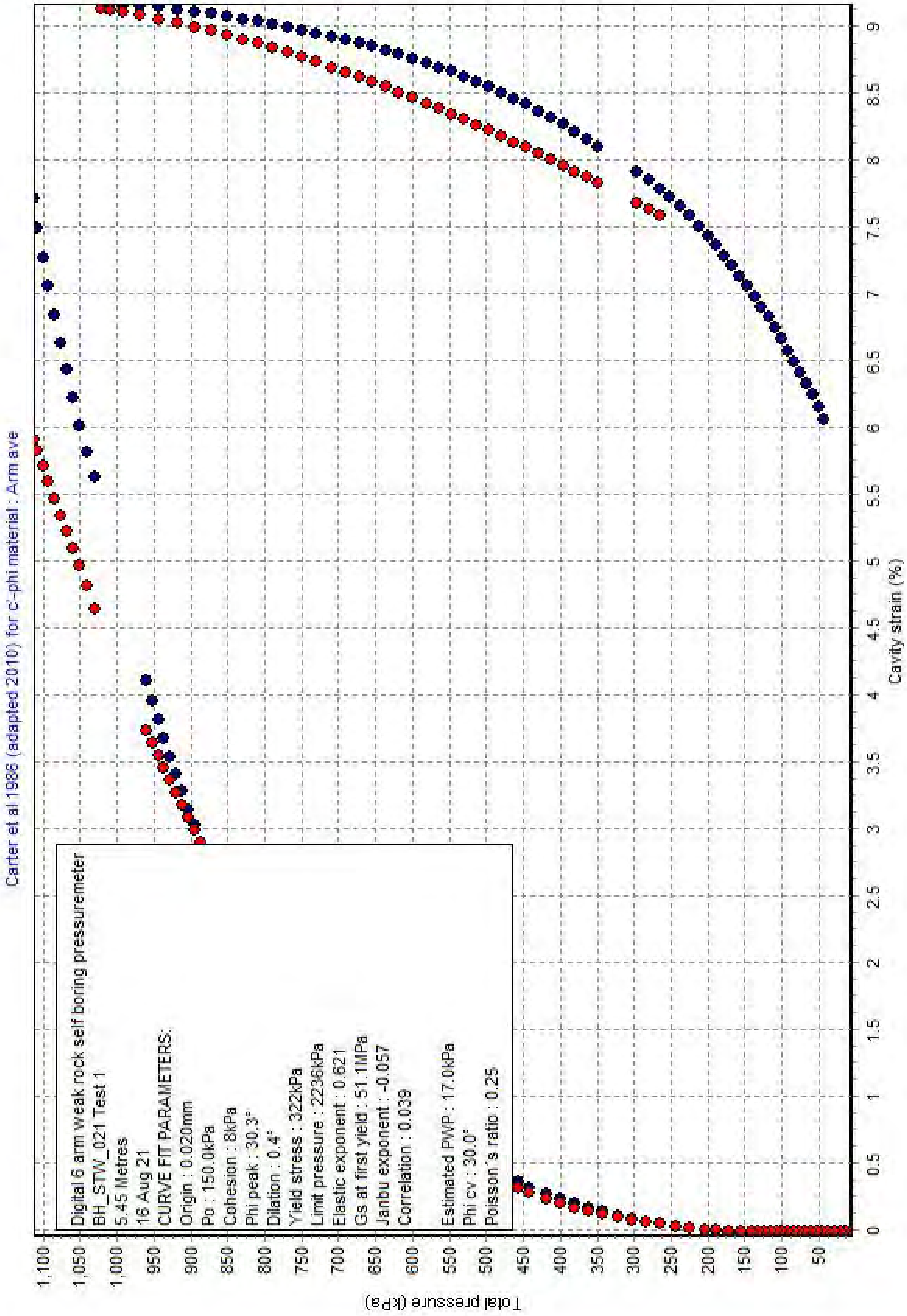

Shear modulus from unload/reload cycles Loop 3 : Arm ave
Total pressure (kPa)
660
640
620
600
580
560
540
520
500
480
460
440
420
400
380
360
340
320
300
280
260
Radial Displacement (mm)
3.68
3.7
3.72
3.74
3.76
3.78
3.8
3.82
3.84
3.86
3.88
3.9
3.92
3.94
3.96
3.98
4
4.02
4.04
4.06
4.08
4.1
4.12
4.14
4.16
4.18
RESULTS:
Gur : 40.9MPa
Cycle mid-point:
Cavity strain : 8.865%
Total stress : 477kPa
Size of cycle :
Shear strain : 0.577%
Total stress : 237kPa
Digital 6 arm weak rock self boring pressuremeter
BH_STW_021 Test 1
5.45 Metres
16 Aug 21

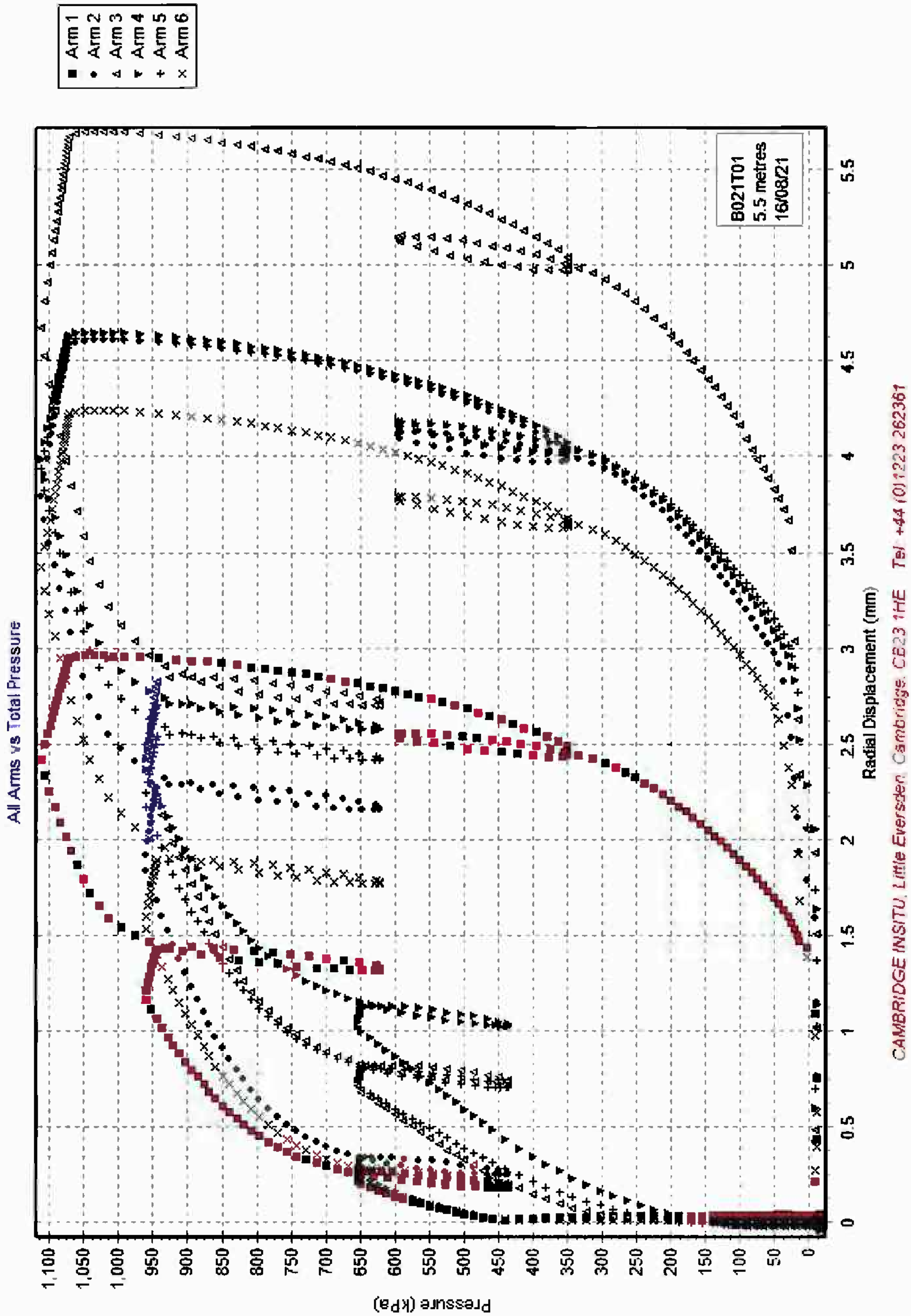

Bolton and Whittle (1999) Loop 1 : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_021 Test 1
5.45 Metres
16 Aug 21
RESULTS:
Gradient (beta) : 0.639
Intercept (n) : 7.211MPa
Shear stress constant : 4.605MPa
Ln[Radial stress]
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
2.7
2.6
2.5
2.4
2.3
Ln[shear strain]
-10
-9
-8
-7
-6
Source data - Loop 1
Total pressure (kPa)
450
500
550
600
Radial Displacement (mm)
0.52
0.54
0.56
0.58
0.6


Bolton and Whittle (1999) Loop 2 : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_021 Test 1
5.45 Metres
16 Aug 21
RESULTS:
Gradient (beta) : 0.621
Intercept (n) : 7.269MPa
Shear stress constant : 4.516MPa
Ln[Radial stress]
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
-9
-8
-7
-6
Ln[shear strain]
Source data - Loop 2
Total pressure (kPa)
900
850
800
750
700
650
2.2
2.25
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 3 : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_021 Test 1
5.45 Metres
16 Aug 21
RESULTS:
Gradient (beta) : 0.567
Intercept (n) : 4.850MPa
Shear stress constant : 2.749MPa
Ln[Radial stress]
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
Ln[shear strain]
-9
-8
-7
-6
Source data - Loop 3
Total pressure (kPa)
600
550
500
450
400
350
Radial Displacement (mm)
3.85
3.9
3.95
4


Variation of stiffness with strain, undrained analysis : Arm ave
POWER LAW PARAMETERS:
Cycle No. | Constant (MPa) | Gradient
1 | 4.605 | 0.639
2 | 4.516 | 0.621
3 | 2.749 | 0.567
Shear modulus (MPa)
145
140
135
130
125
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
0.0001
0.001
Log plane shear strain
Digital 6 arm weak rock self boring pressuremeter
BH_STW_021 Test 1
5.45 Metres
16 Aug 21

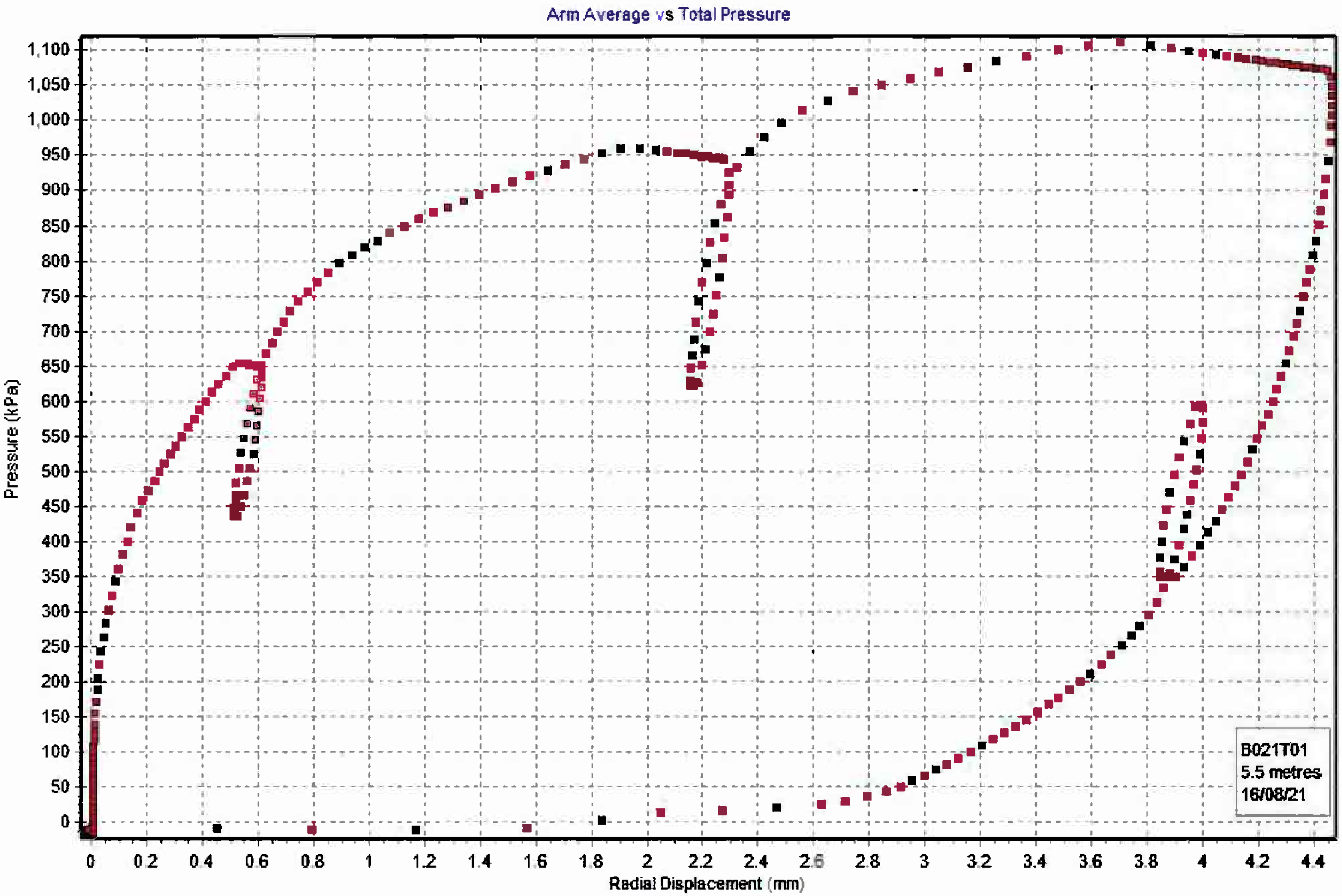

Carter et al 1986 (adapted 2010) for c'-phi material : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_STW_021 Test 1
5.45 Metres
16 Aug 21
CURVE FIT PARAMETERS:
Origin : 0.020mm
Po : 150.0kPa
Cohesion : 8kPa
Phi peak : 30.3°
Dilation : 0.4°
Yield stress : 322kPa
Limit pressure : 2236kPa
Elastic exponent : 0.621
Gs at first yield : 51.1MPa
Janbu exponent : -0.057
Correlation : 0.039
Estimated PWP : 17.0kPa
Phi cv : 30.0°
Poisson's ratio : 0.25
Total pressure (kPa)
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
Cavity strain (%)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9


■ Arm 1
● Arm 2
▵ Arm 3
▾ Arm 4
+ Arm 5
× Arm 6
All Arms vs Total Pressure
B021T01
5.5 metres
16/08/21
Pressure (kPa)
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Radial Displacement (mm)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel: +44 (0)1223 262361

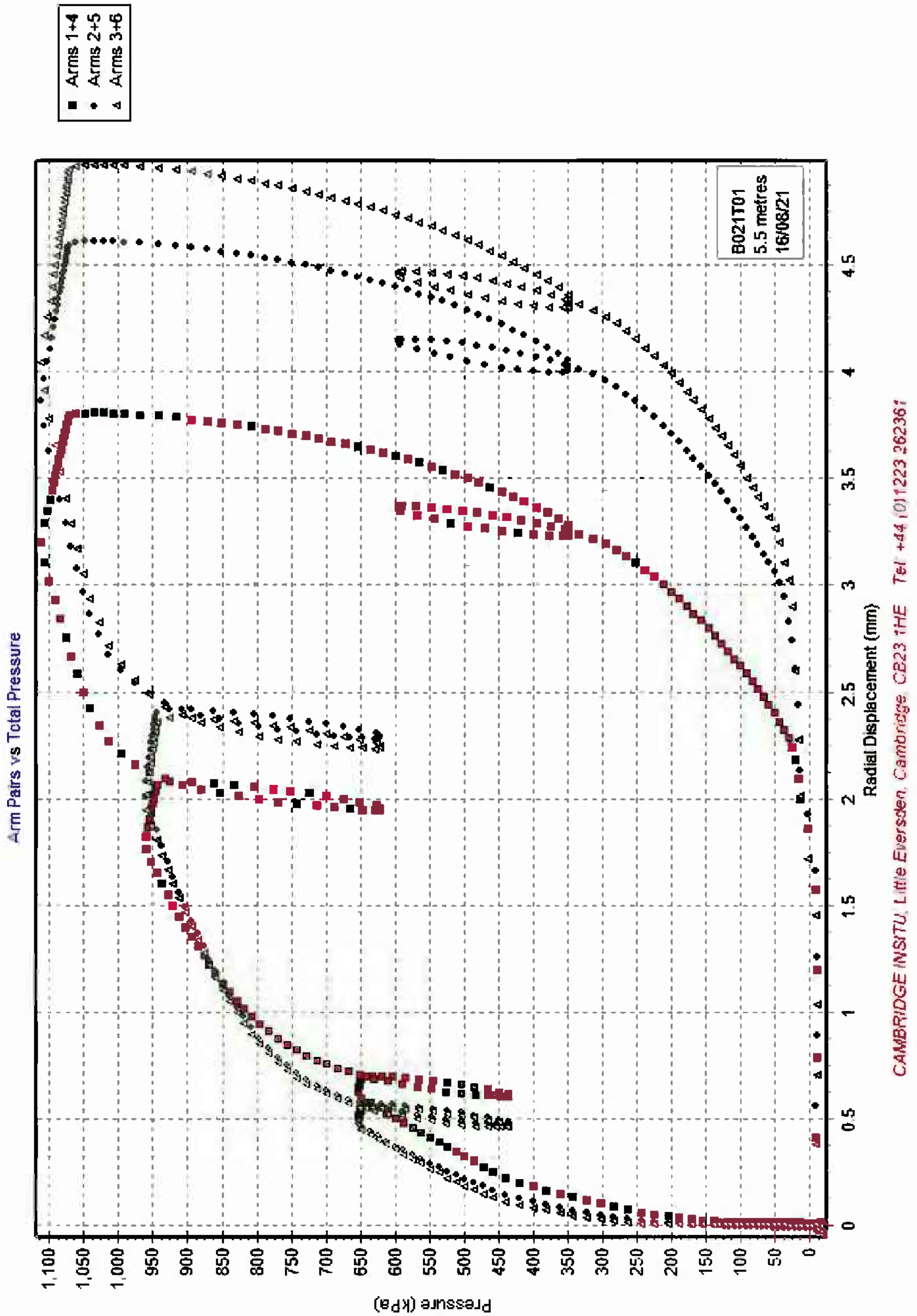
CIR1506/21

Cambridge WWTPR

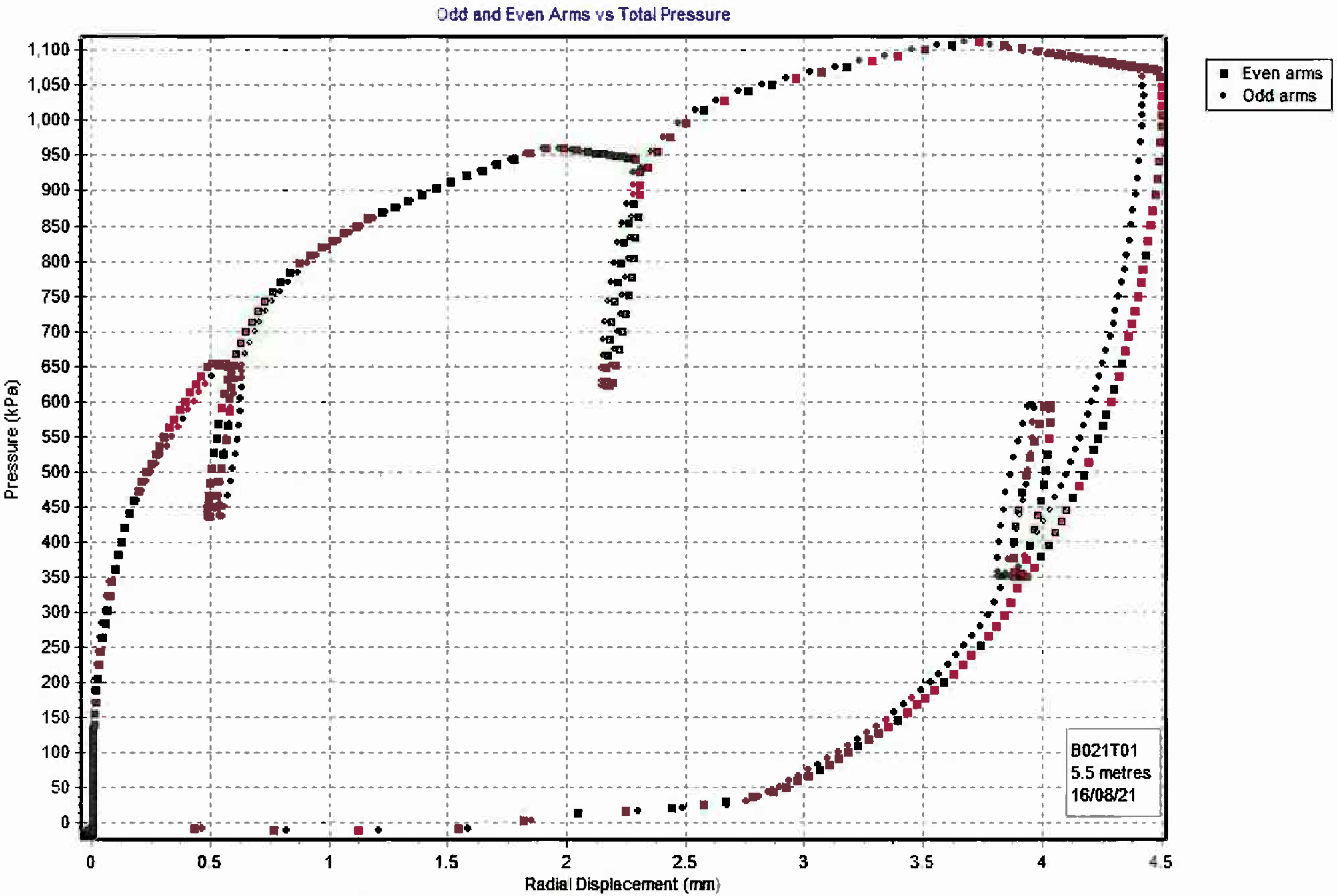
Pressuremeter Testing



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361


Arm Pairs vs Total Pressure
■ Arms 1+4
● Arms 2+5
▵ Arms 3+6
B021T01
5.5 metres
16/08/21
Radial Displacement (mm)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Pressure (kPa)
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
CAMBRIDGE INSITU, Little Eversden, Cambridge CB23 1HE Tel +44 (0)1223 262361

CIR1506/21



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361

Cambridge WWTPR

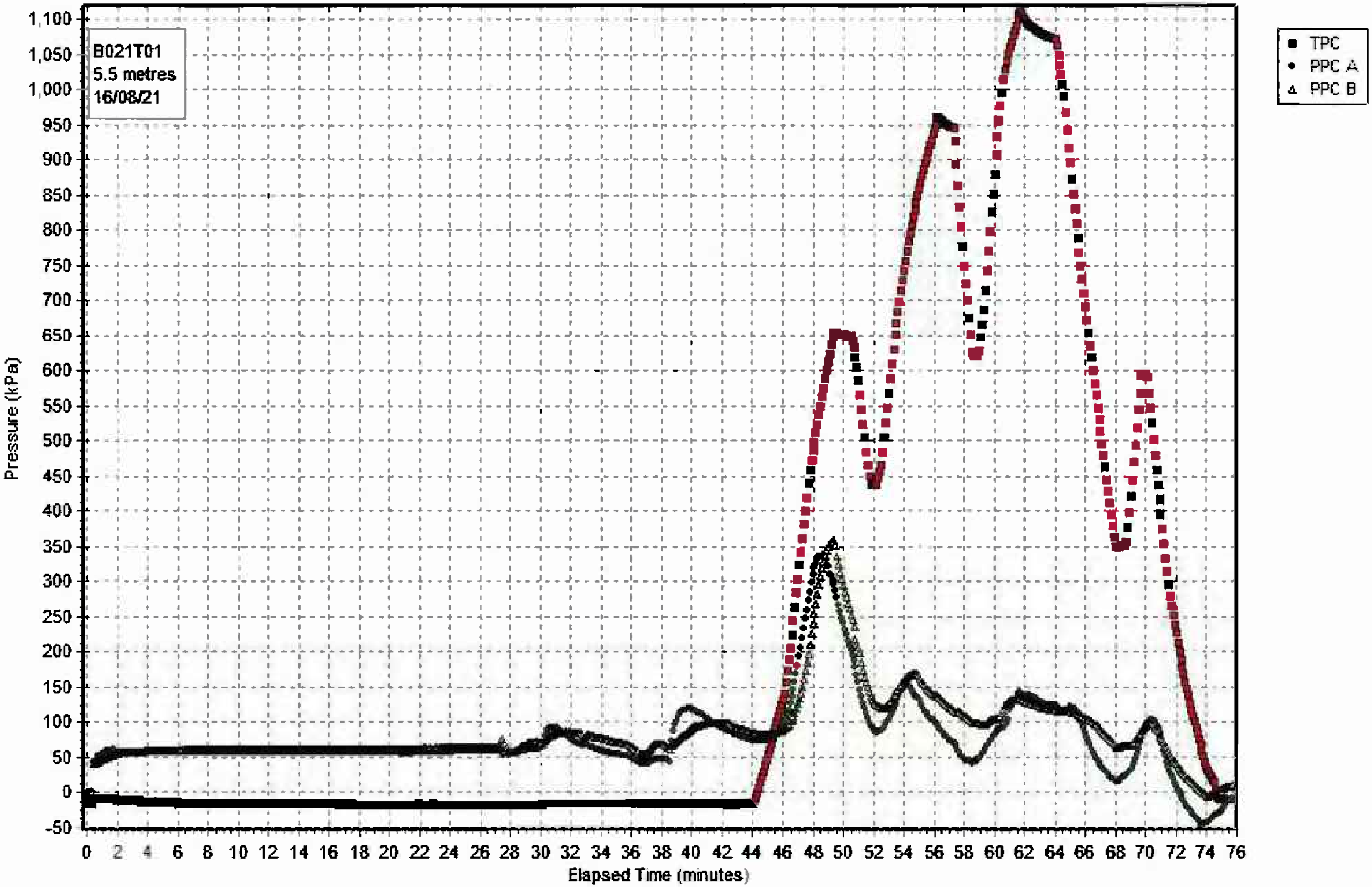
Pressuremeter Testing

CIR1506/21

Cambridge WWTPR

Pressuremeter Testing

All Pressure Cells vs Time



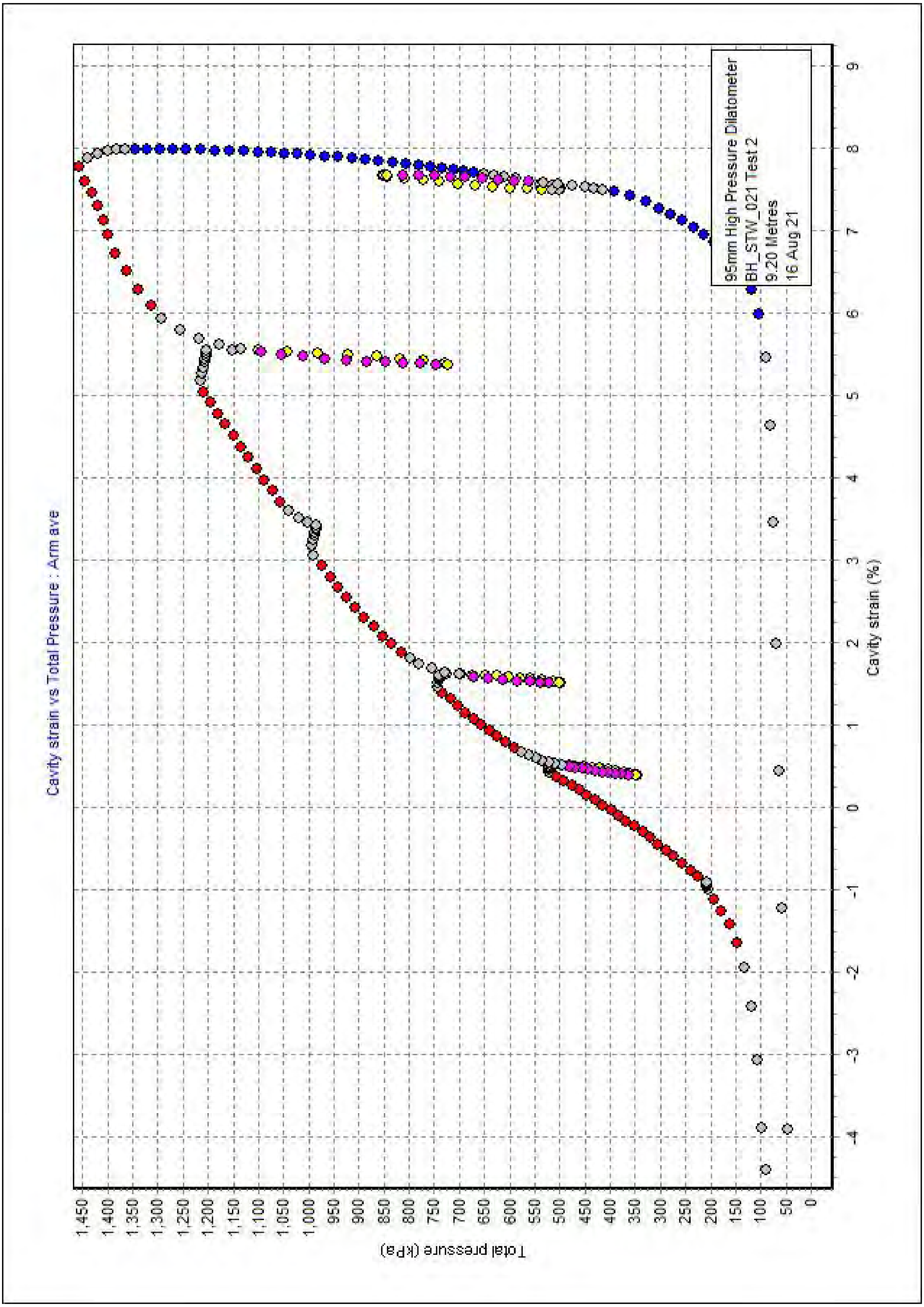
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361

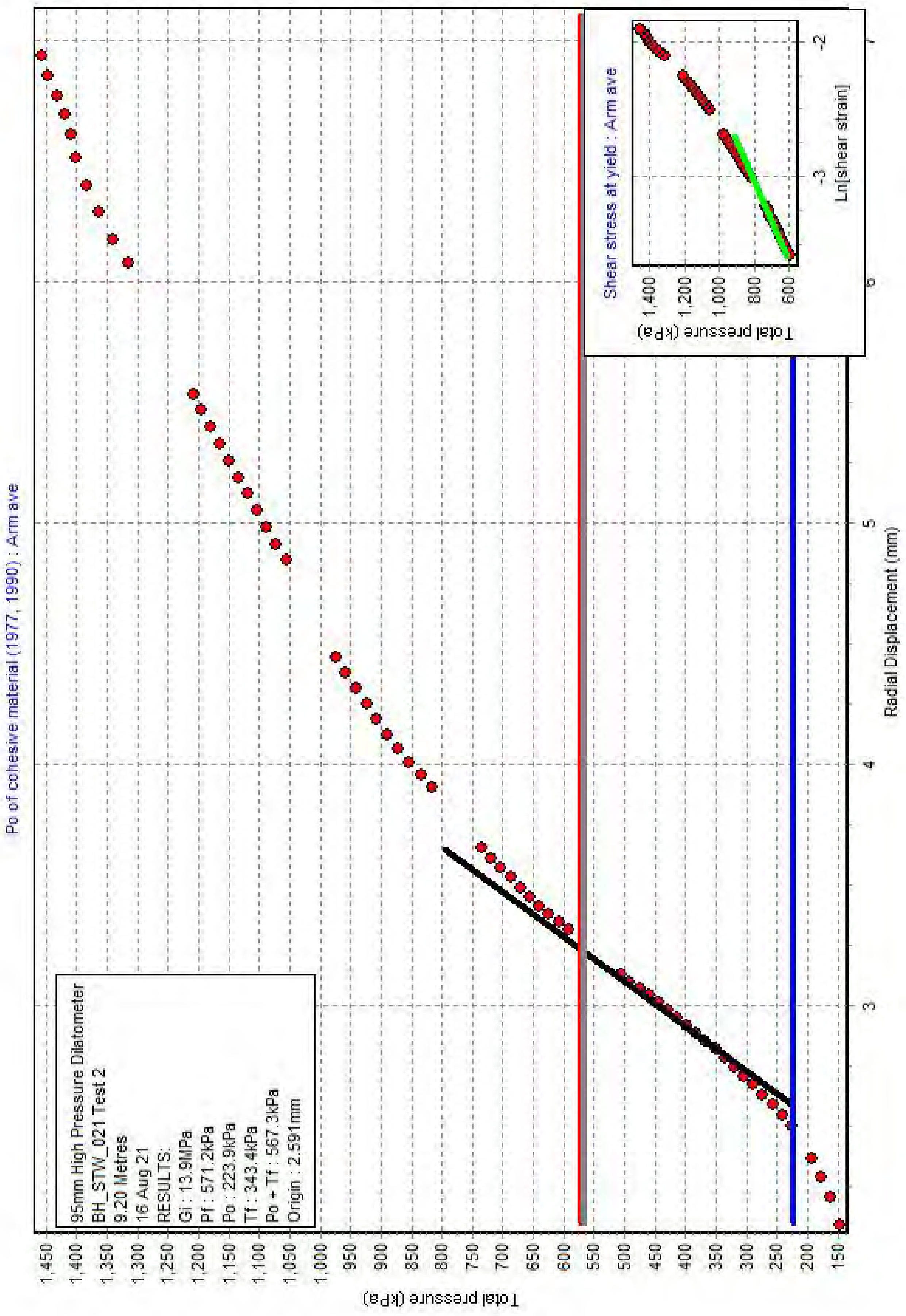
```
BH_STW_021 Test 2 - SUMMARY OF RESULTS
[File made with WinSitu ]

[DETAILS OF TEST]
Project        :   TE8364
Site           :   Cambridge Waste Water Treatment Plant Relocation Project
Borehole       :   BH_STW_021
Test name      :   BH_STW_021 Test 2
Test date      :   16 Aug 21
Test depth     :   9.20 Metres
Water table    :   3.75 Metres
Ambient PWP    :   53.0 kPa
Material       :   Structureless Chalk
Probe          :   95mm High Pressure Dilatometer
Diameter       :   97.0 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out
The file includes results from a curve fitting analysis

Analysed by SP/RW on 17 Aug 21

Remarks:  Poor core recovery. Early unload, arm behaviour indicating burst
likely.

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm)                   :   "Arm ave=2.94"
Po from Marsland & Randolph (kPa)    :   "Arm ave=223.9"
Best estimate of Po (kPa)            :   "Arm ave=162.0"

[UNDRAINED STRENGTH PARAMETERS]
Undrained yield stress (kPa)         :   "Arm ave=571.2"

[DRAINED ANALYSIS OF SANDS]
[Hughes et al 1977]
Constant volume friction angle (°)   :   28.0
Angle of internal friction (°)       :   "Arm ave=37.2"
Dilation angle (°)                   :   "Arm ave=10.8"
Gradient of log-log plot             :   "Arm ave=0.447"

[Withers et al 1989]
Angle of internal friction (°)       :   "Arm ave=28.4"
Dilation angle (°)                   :   "Arm ave=0.5"
Gradient of log-log plot             :   "Arm ave=-1.793"

[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=13.9"
Axis       Loop   Value    Mean Strain  Mean Pc  dE      dPc
           No     (MPa)    (%)          (kPa)    (%)     (kPa)
Arm ave    1      59.1     0.458        421      0.255   151
Arm ave    2      97.0     1.568        599      0.209   203
Arm ave    3      123.0    5.464        914      0.314   387
Arm ave    4      115.6    7.606        686      0.281   326

[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]
Axis       Loop   Intercept  Alpha      Gradient
           No     (MPa)      (MPa)
Arm ave    1      13.975     10.577     0.757
Arm ave    2      18.255     13.214     0.724
Arm ave    3      17.263     11.253     0.652
Arm ave    4      12.440     7.231      0.581


[PARAMETERS USED FOR DRAINED CURVE MODELLING]
{Axis is  Arm ave}
Strain Origin (mm)                   :   2.94
Po (kPa)                             :   162
Cohesion (kPa)                       :   57
Angle of peak friction (deg)         :   37.2
Angle of peak dilation (deg)         :   10.8
```

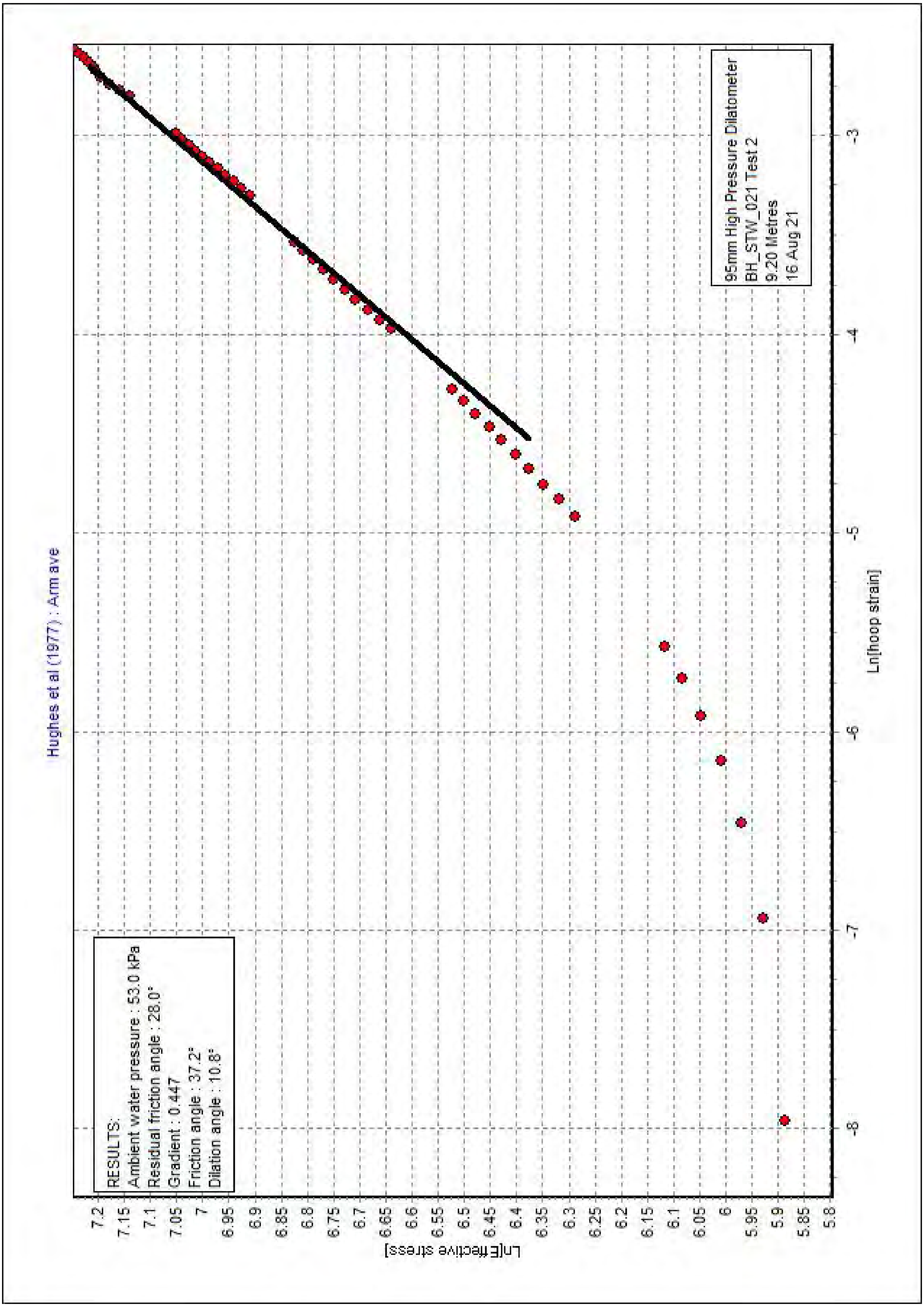
BH_STW_021 Test 2 - SUMMARY OF RESULTS

Total yield stress (kPa) : 414
Total limit stress (kPa) : 3501
G at first yield (MPa) : 28.7
Non-linear exponent : 0.652
Janbu exponent : 0.464
Correlation : 0.842

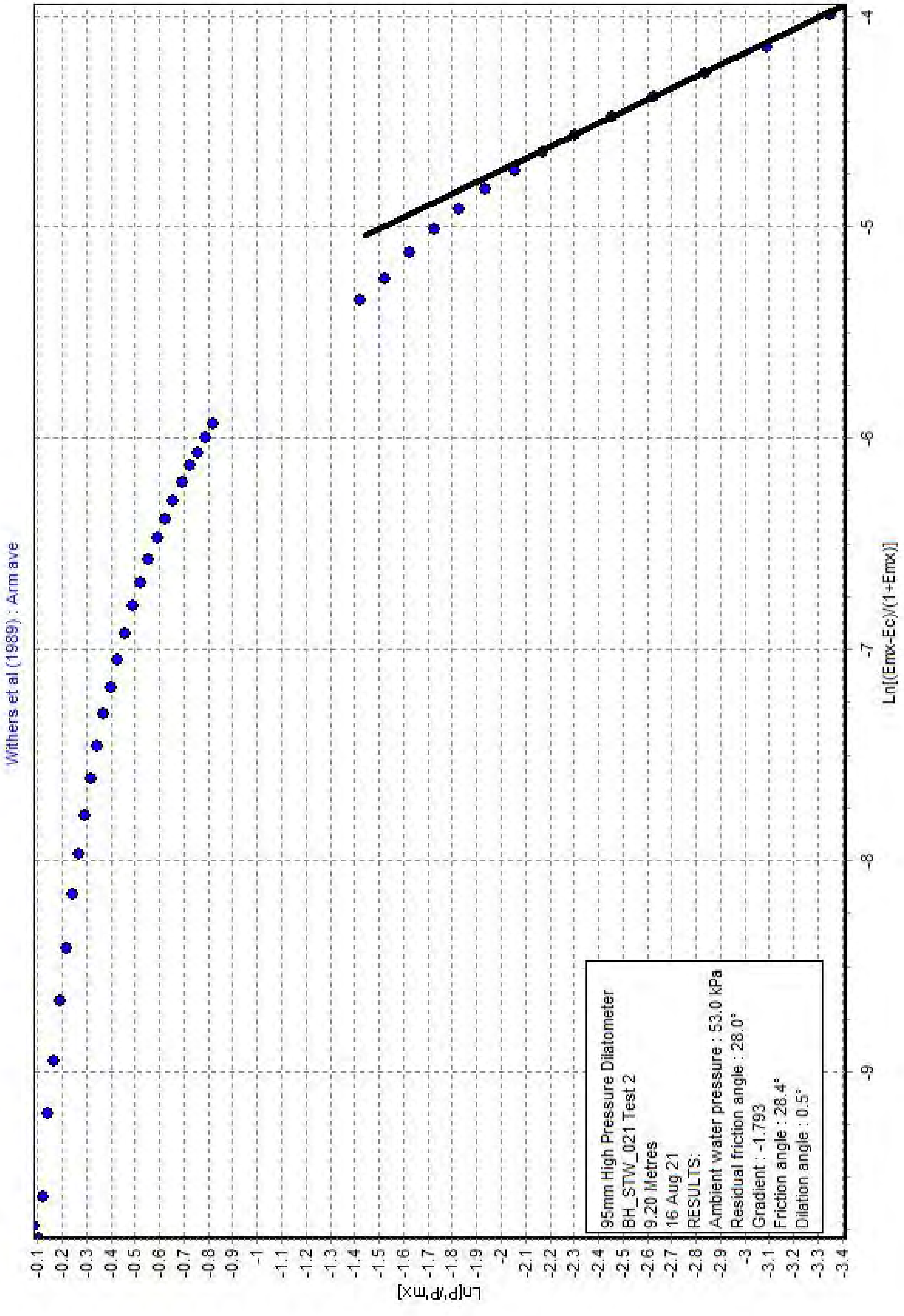
Ambient pore water pressure (kPa) : 53
Residual friction angle (deg) : 28.0
Poisson's ratio : 0.25

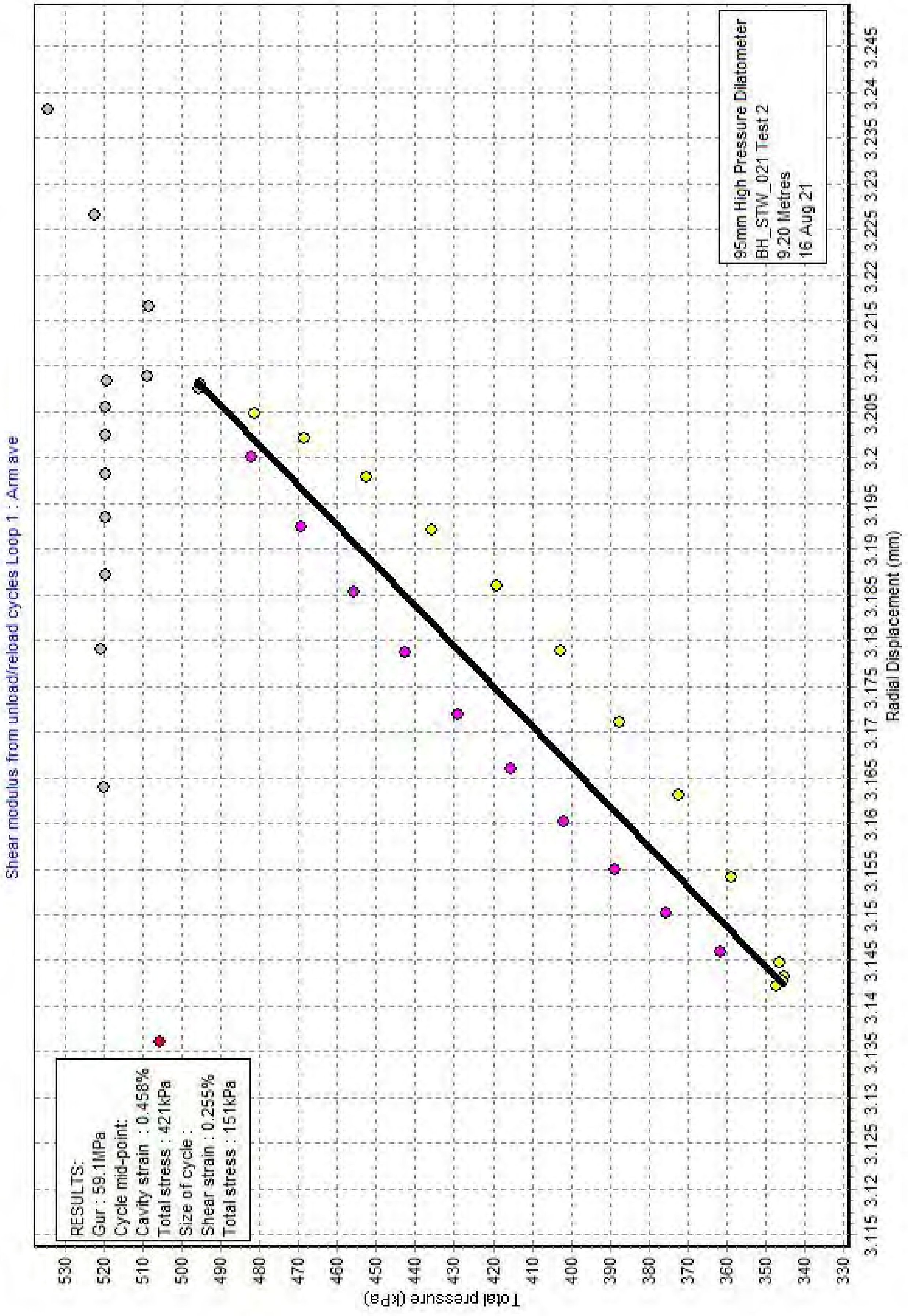

Cavity strain vs Total Pressure : Arm ave
95mm High Pressure Dilatometer
BH_STW_021 Test 2
9.20 Metres
16 Aug 21
Total pressure (kPa)
1,450
1,400
1,350
1,300
1,250
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Cavity strain (%)
-4
-3
-2
-1
0
1
2
3
4
5
6
7
8
9

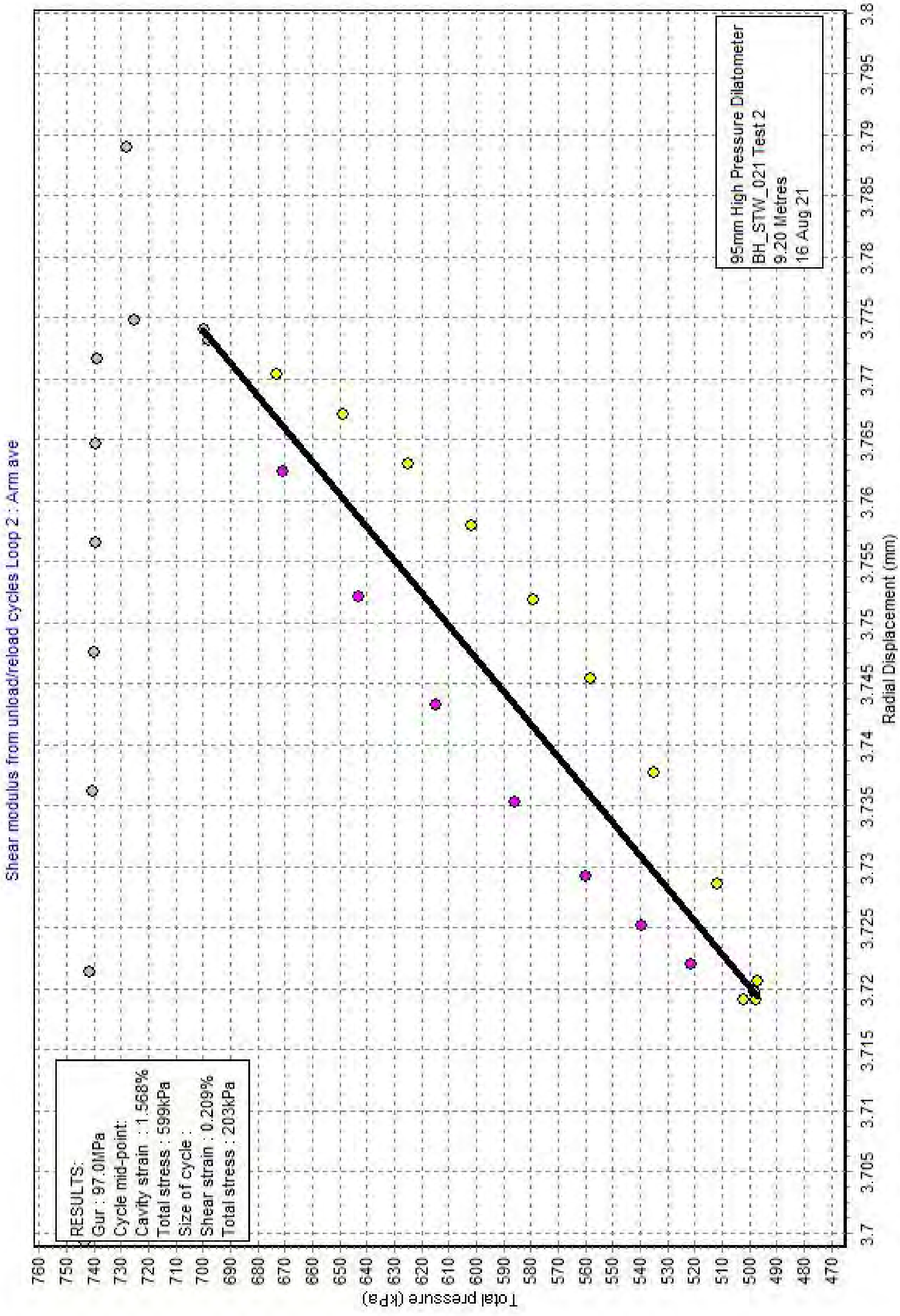

Po of cohesive material (1977, 1990) : Arm ave
95mm High Pressure Dilatometer
BH_STW_021 Test 2
9.20 Metres
16 Aug 21
RESULTS:
Gi : 13.9MPa
Pf : 571.2kPa
Po : 223.9kPa
Tf : 343.4kPa
Po + Tf : 567.3kPa
Origin : 2.591mm
Total pressure (kPa)
1,450
1,400
1,350
1,300
1,250
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
Radial Displacement (mm)
3
4
5
6
7
Shear stress at yield : Arm ave
Total pressure (kPa)
1,400
1,200
1,000
800
600
Ln[shear strain]
-3
-2



RESULTS:
Ambient water pressure : 53.0 kPa
Residual friction angle : 28.0°
Gradient : 0.447
Friction angle : 37.2°
Dilation angle : 10.8°


Withers et al (1989) : Arm ave
Ln[(Emx-Ec)/(1+Emx)]
Ln[P'/P'mx]
-4
-5
-6
-7
-8
-9
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1
-1.1
-1.2
-1.3
-1.4
-1.5
-1.6
-1.7
-1.8
-1.9
-2
-2.1
-2.2
-2.3
-2.4
-2.5
-2.6
-2.7
-2.8
-2.9
-3
-3.1
-3.2
-3.3
-3.4
95mm High Pressure Dilatometer
BH_STW_021 Test 2
9.20 Metres
16 Aug 21
RESULTS:
Ambient water pressure : 53.0 kPa
Residual friction angle : 28.0°
Gradient : -1.793
Friction angle : 28.4°
Dilation angle : 0.5°

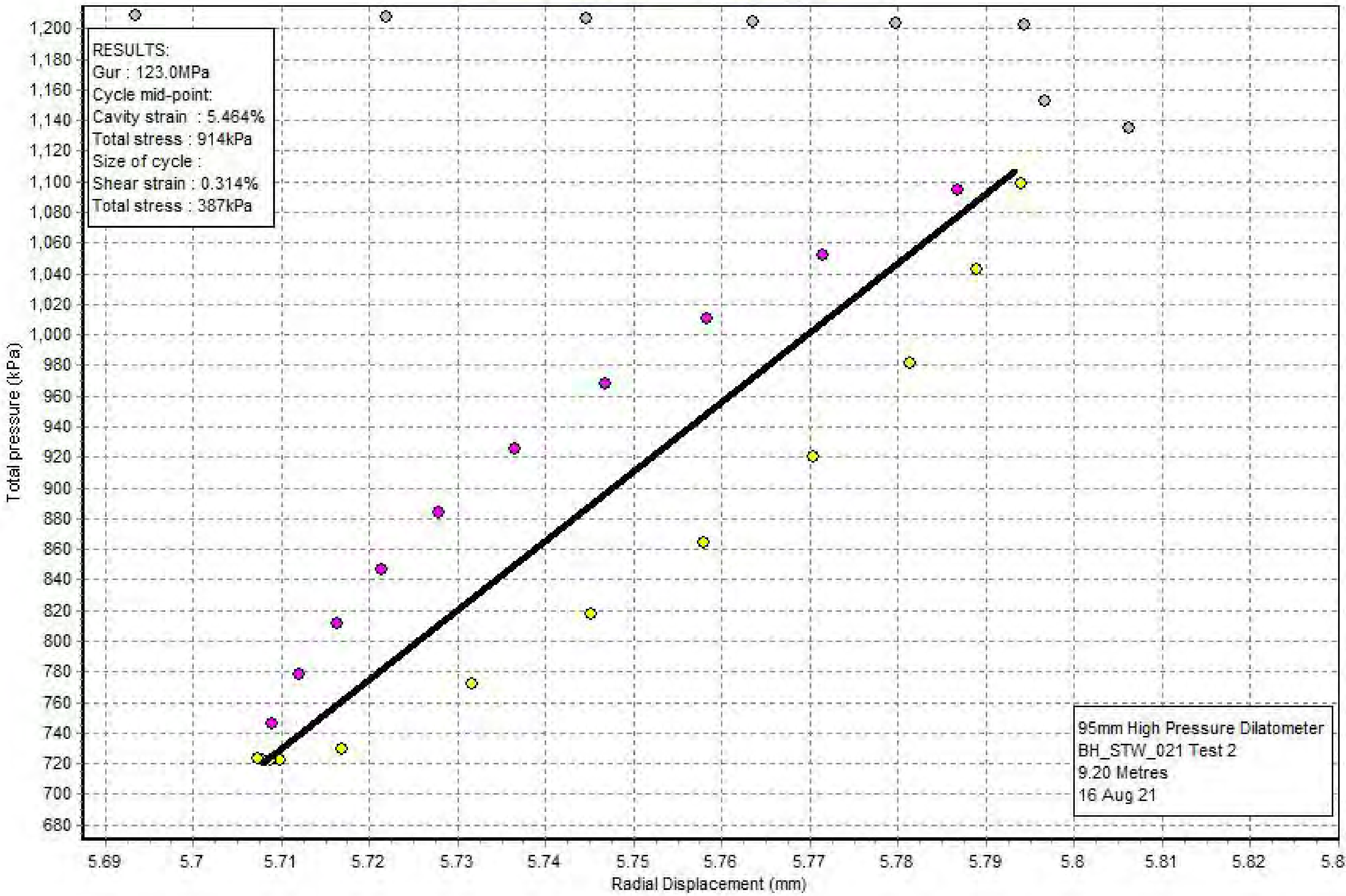

Shear modulus from unload/reload cycles Loop 1 : Arm ave
95mm High Pressure Dilatometer
BH_STW_021 Test 2
9.20 Metres
16 Aug 21
RESULTS:
Gur : 59.1MPa
Cycle mid-point:
Cavity strain : 0.458%
Total stress : 421kPa
Size of cycle :
Shear strain : 0.255%
Total stress : 151kPa
Total pressure (kPa)
330
340
350
360
370
380
390
400
410
420
430
440
450
460
470
480
490
500
510
520
530
Radial Displacement (mm)
3.115
3.12
3.125
3.13
3.135
3.14
3.145
3.15
3.155
3.16
3.165
3.17
3.175
3.18
3.185
3.19
3.195
3.2
3.205
3.21
3.215
3.22
3.225
3.23
3.235
3.24
3.245

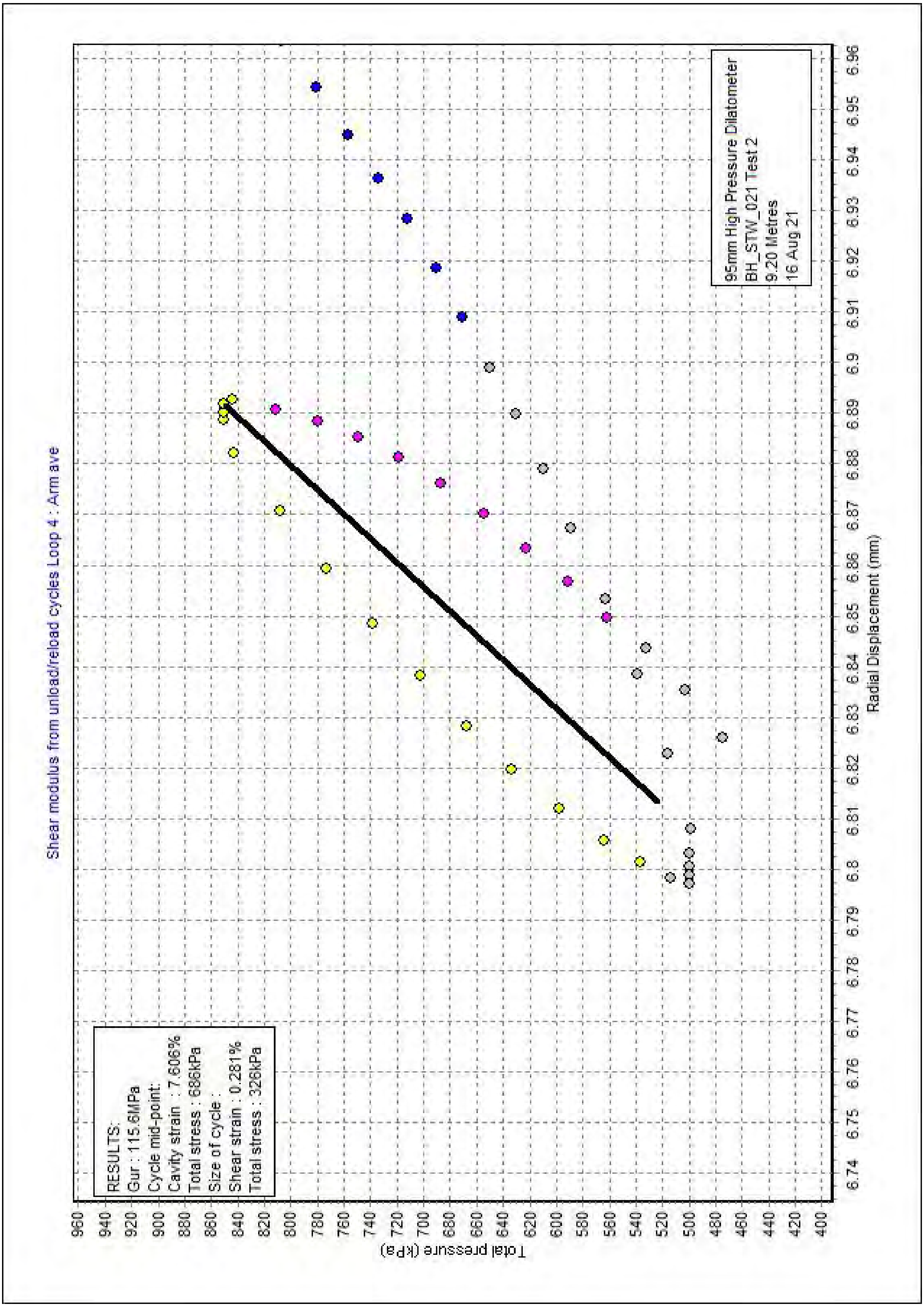


RESULTS:
Gur : 97.0MPa
Cycle mid-point:
Cavity strain : 1.568%
Total stress : 599kPa
Size of cycle :
Shear strain : 0.209%
Total stress : 203kPa

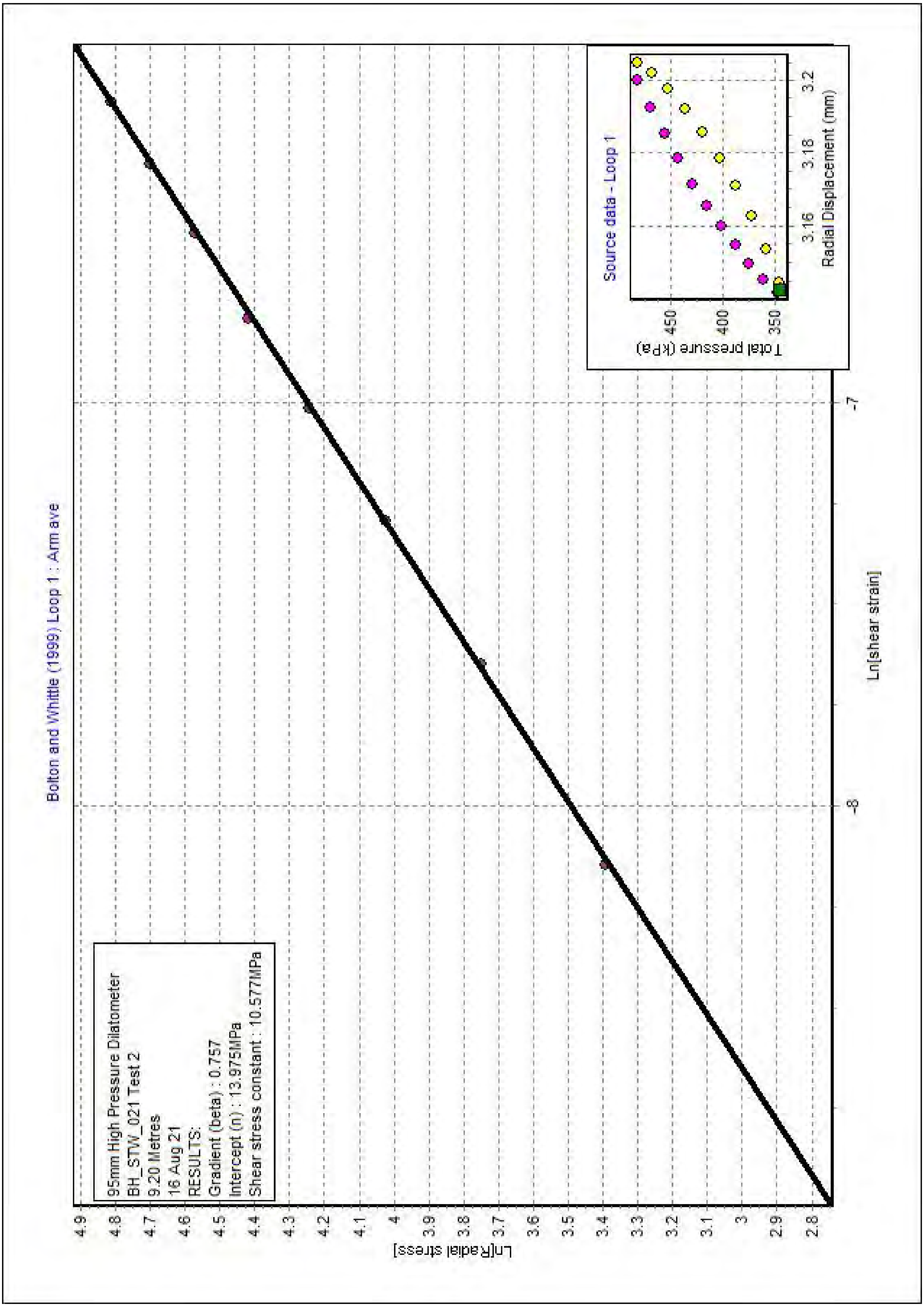
95mm High Pressure Dilatometer
BH_STW_021 Test 2
9.20 Metres
16 Aug 21

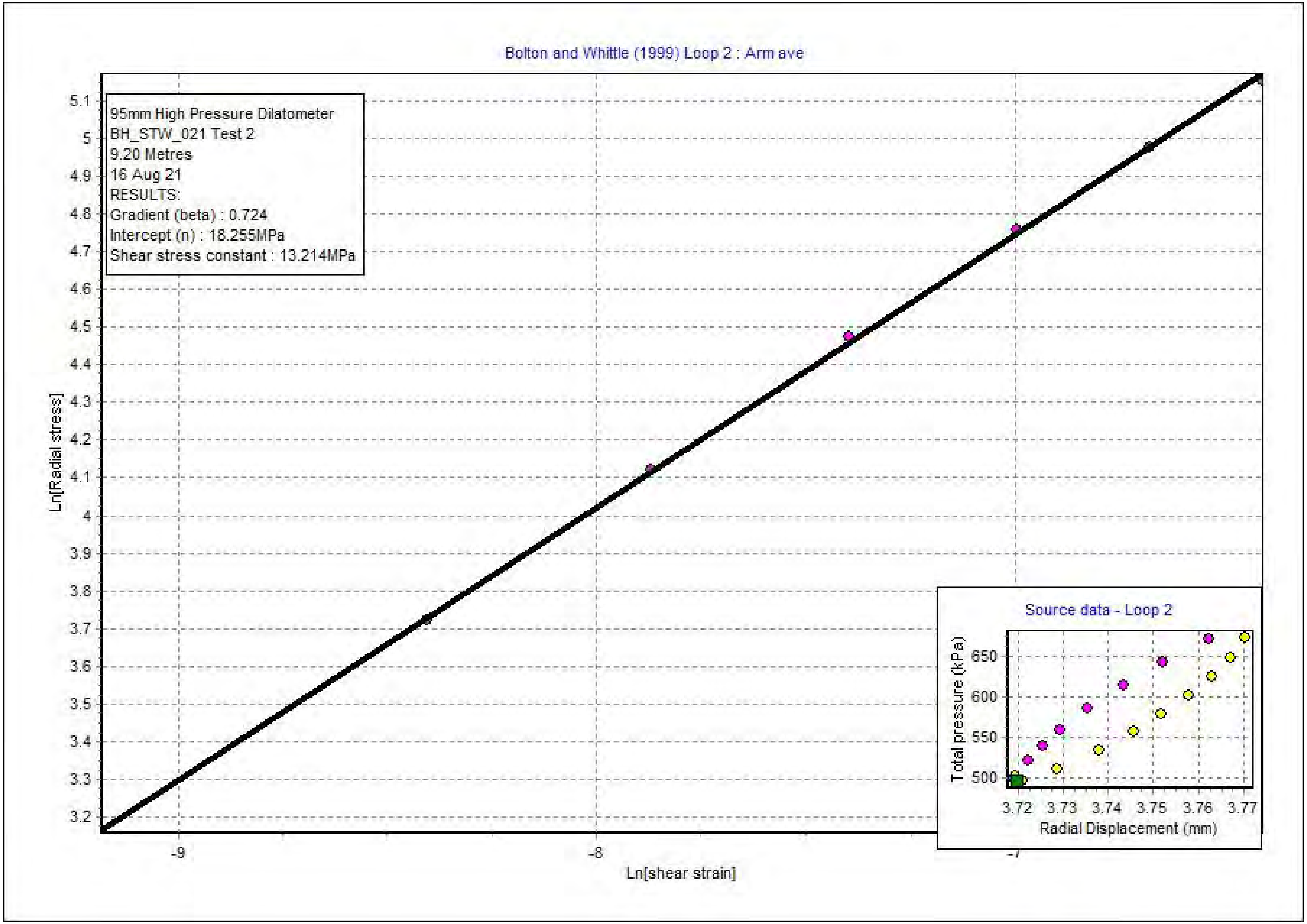
Shear modulus from unload/reload cycles Loop 3 : Arm ave

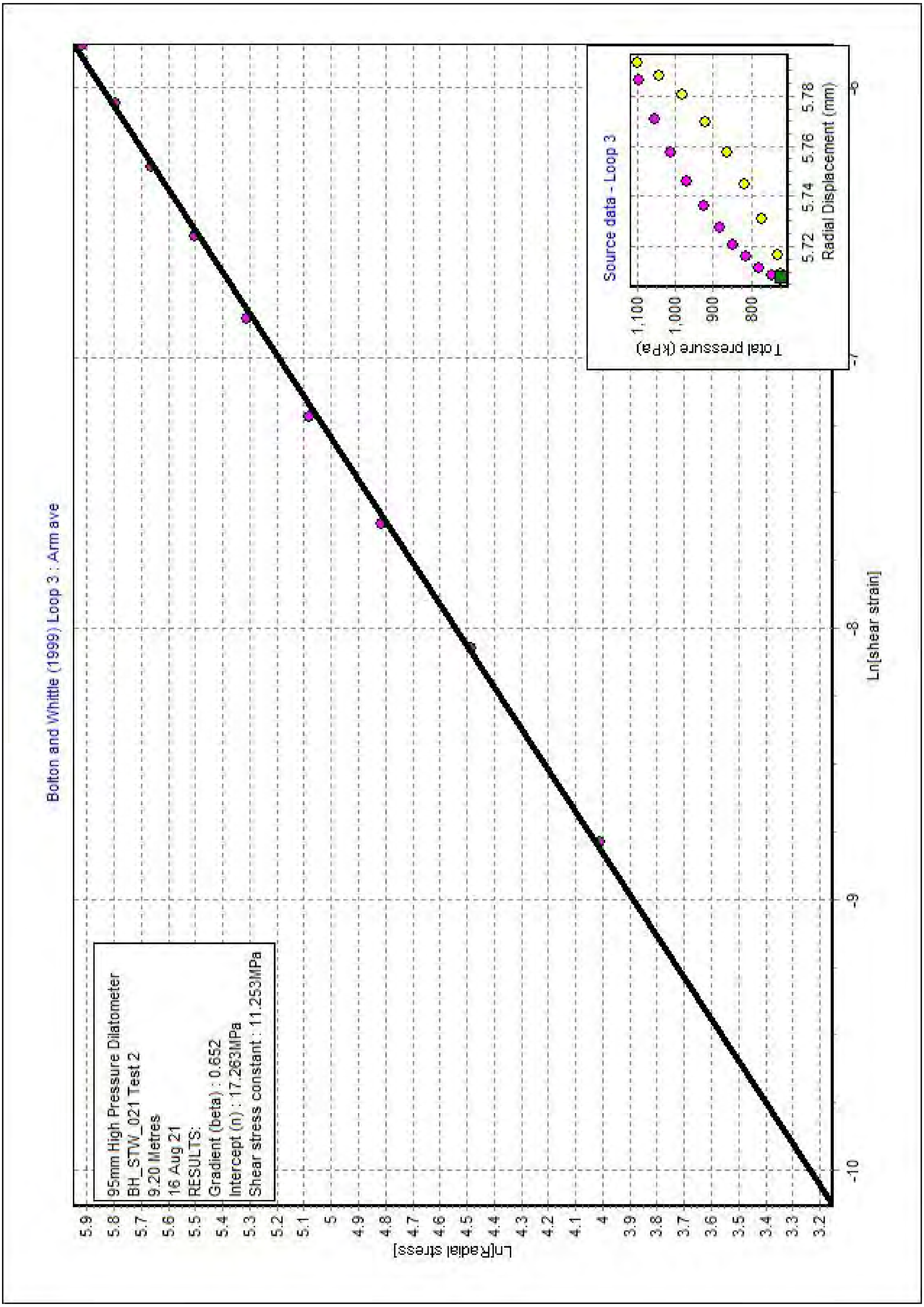


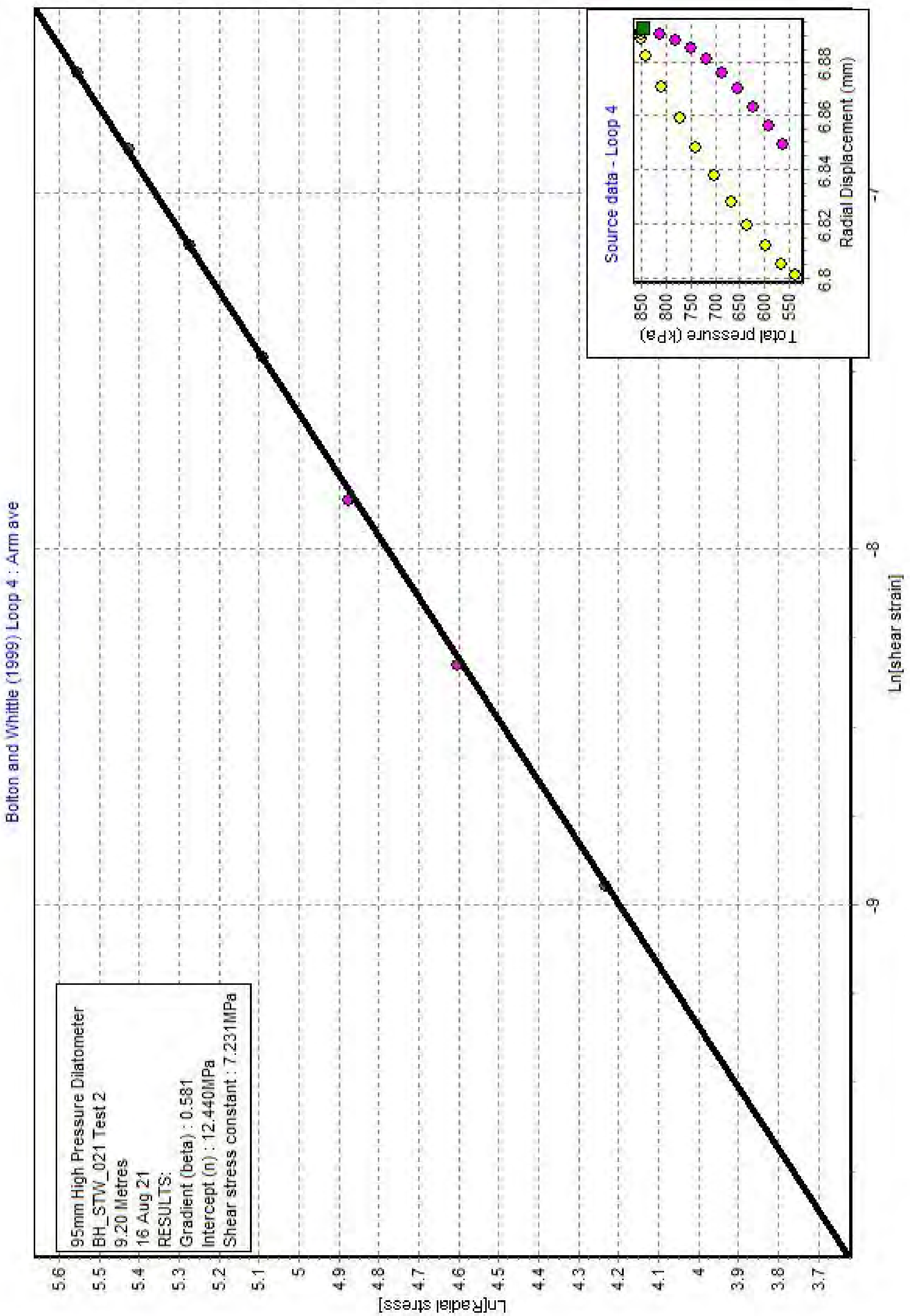


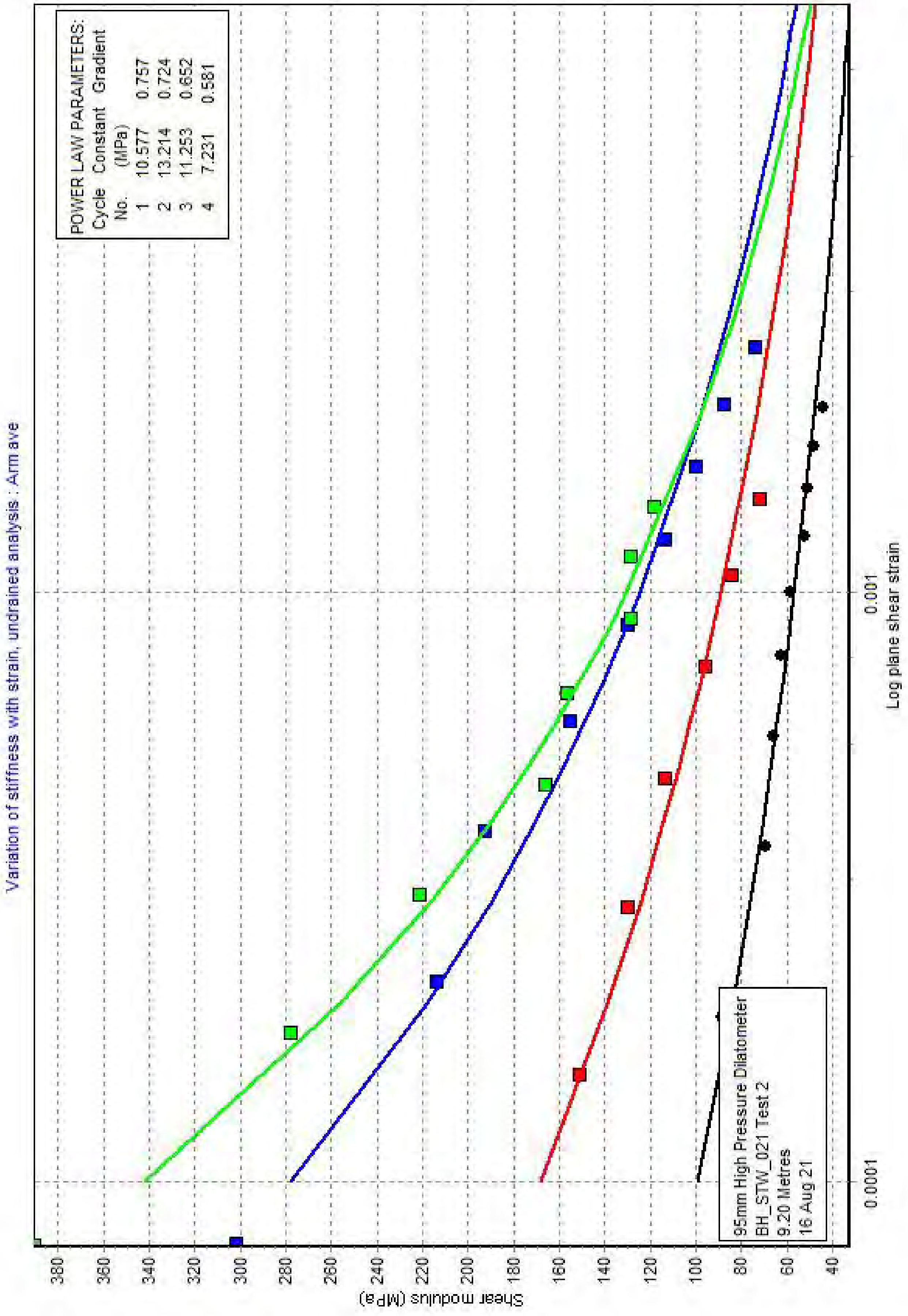
RESULTS:
Gur : 115.6MPa
Cycle mid-point:
Cavity strain : 7.606%
Total stress : 686kPa
Size of cycle :
Shear strain : 0.281%
Total stress : 326kPa

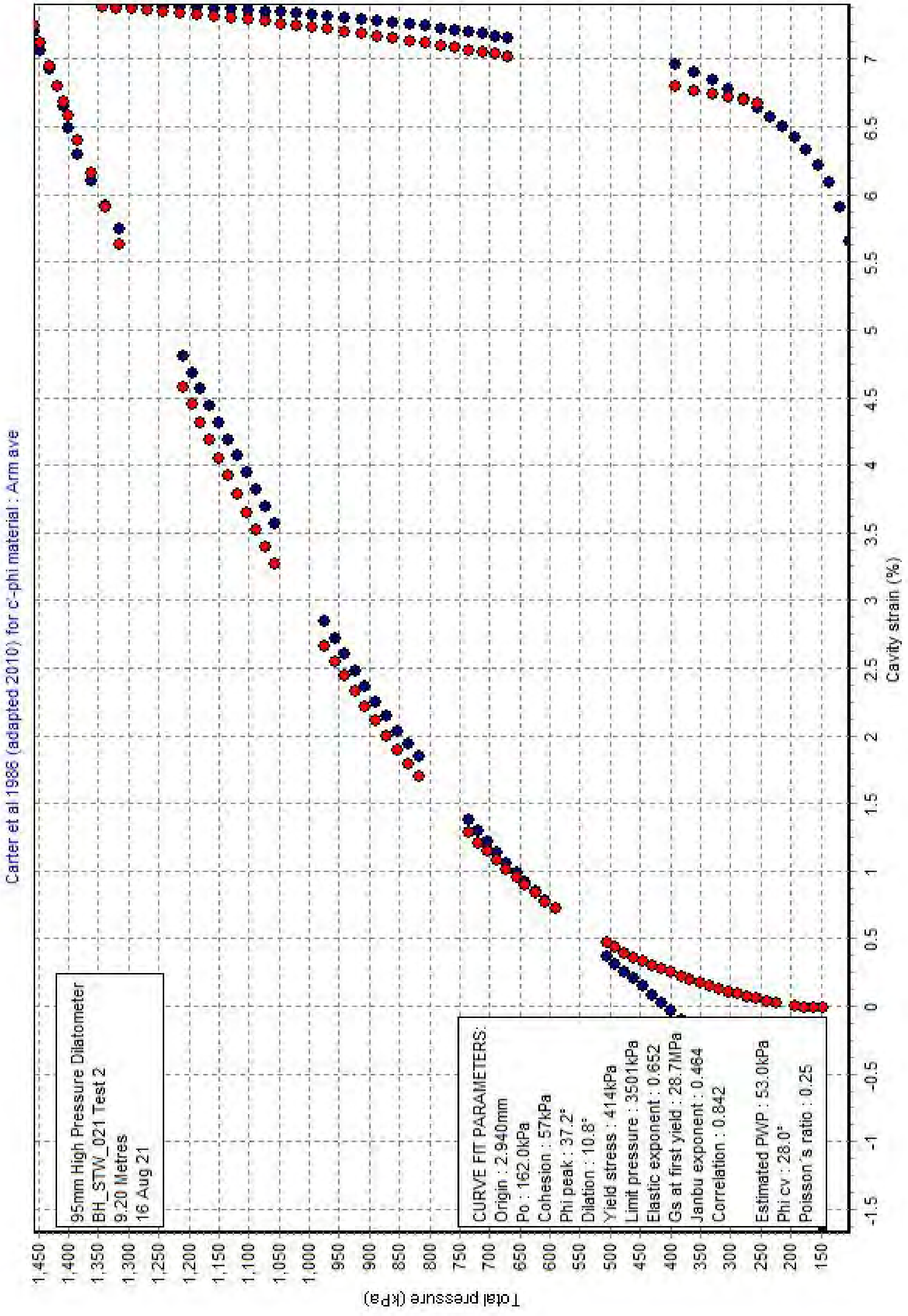

Bolton and Whittle (1999) Loop 1 : Arm ave
95mm High Pressure Dilatometer
BH_STW_021 Test 2
9.20 Metres
16 Aug 21
RESULTS:
Gradient (beta) : 0.757
Intercept (n) : 13.975MPa
Shear stress constant : 10.577MPa
Ln[Radial stress]
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
Ln[shear strain]
-8
-7
Source data - Loop 1
Total pressure (kPa)
350
400
450
Radial Displacement (mm)
3.16
3.18
3.2


Bolton and Whittle (1999) Loop 2 : Arm ave
95mm High Pressure Dilatometer
BH_STW_021 Test 2
9.20 Metres
16 Aug 21
RESULTS:
Gradient (beta) : 0.724
Intercept (n) : 18.255MPa
Shear stress constant : 13.214MPa
Ln[Radial stress]
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
-9
-8
-7
Ln[shear strain]
Source data - Loop 2
Total pressure (kPa)
650
600
550
500
3.72
3.73
3.74
3.75
3.76
3.77
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 3 : Arm ave
95mm High Pressure Dilatometer
BH_STW_021 Test 2
9.20 Metres
16 Aug 21
RESULTS:
Gradient (beta) : 0.652
Intercept (n) : 17.263MPa
Shear stress constant : 11.253MPa
Ln[Radial stress]
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
Ln[shear strain]
-10
-9
-8
-7
-6
Source data - Loop 3
Total pressure (kPa)
1,100
1,000
900
800
Radial Displacement (mm)
5.72
5.74
5.76
5.78


Bolton and Whittle (1999) Loop 4 : Arm ave
95mm High Pressure Dilatometer
BH_STW_021 Test 2
9.20 Metres
16 Aug 21
RESULTS:
Gradient (beta) : 0.581
Intercept (n) : 12.440MPa
Shear stress constant : 7.231MPa
Ln[Radial stress]
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
Ln[shear strain]
-9
-8
-7
Source data - Loop 4
Total pressure (kPa)
850
800
750
700
650
600
550
Radial Displacement (mm)
6.8
6.82
6.84
6.86
6.88

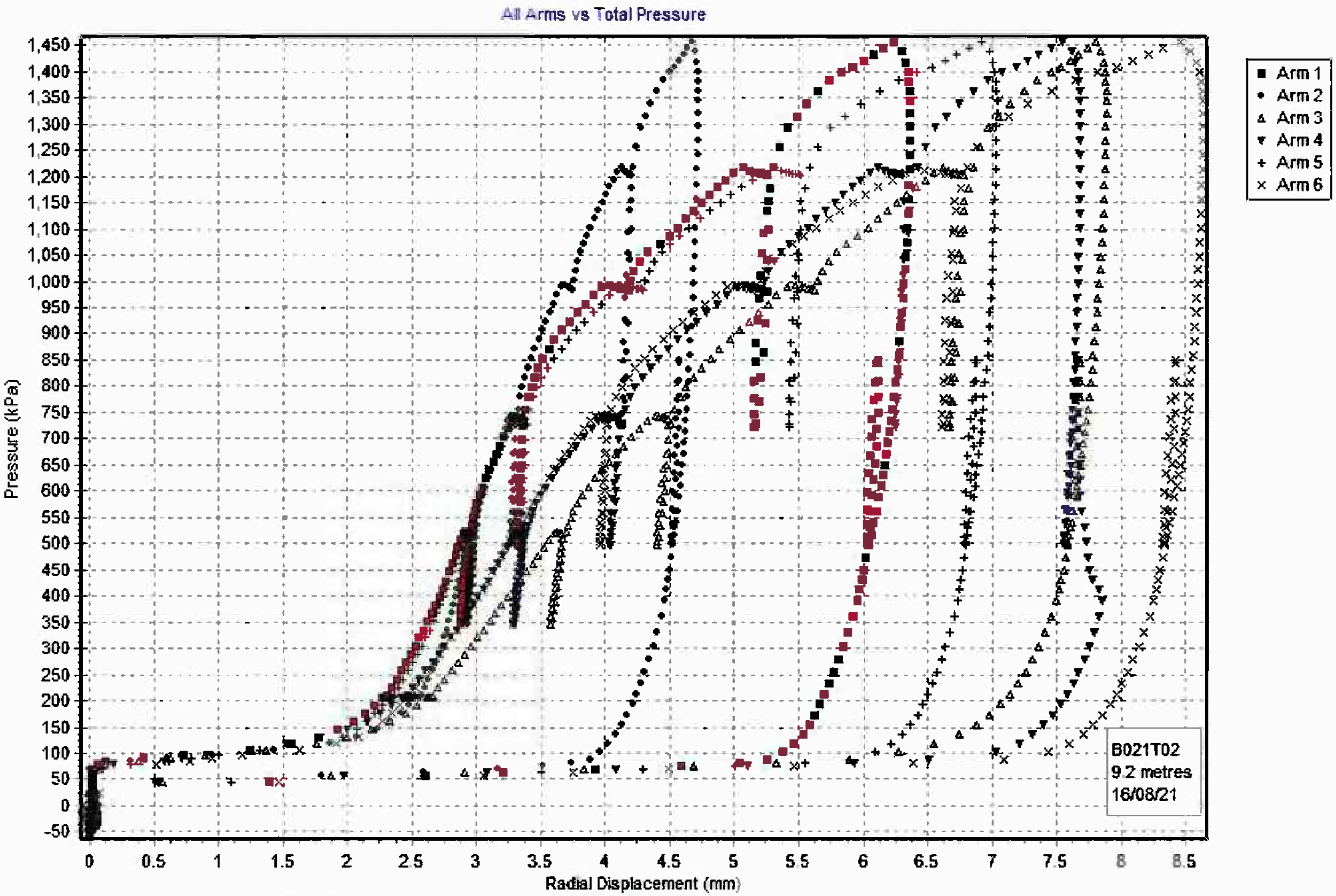

Variation of stiffness with strain, undrained analysis : Arm ave
POWER LAW PARAMETERS:
Cycle No. | Constant (MPa) | Gradient
1 | 10.577 | 0.757
2 | 13.214 | 0.724
3 | 11.253 | 0.652
4 | 7.231 | 0.581
Shear modulus (MPa)
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
Log plane shear strain
0.0001
0.001
95mm High Pressure Dilatometer
BH_STW_021 Test 2
9.20 Metres
16 Aug 21



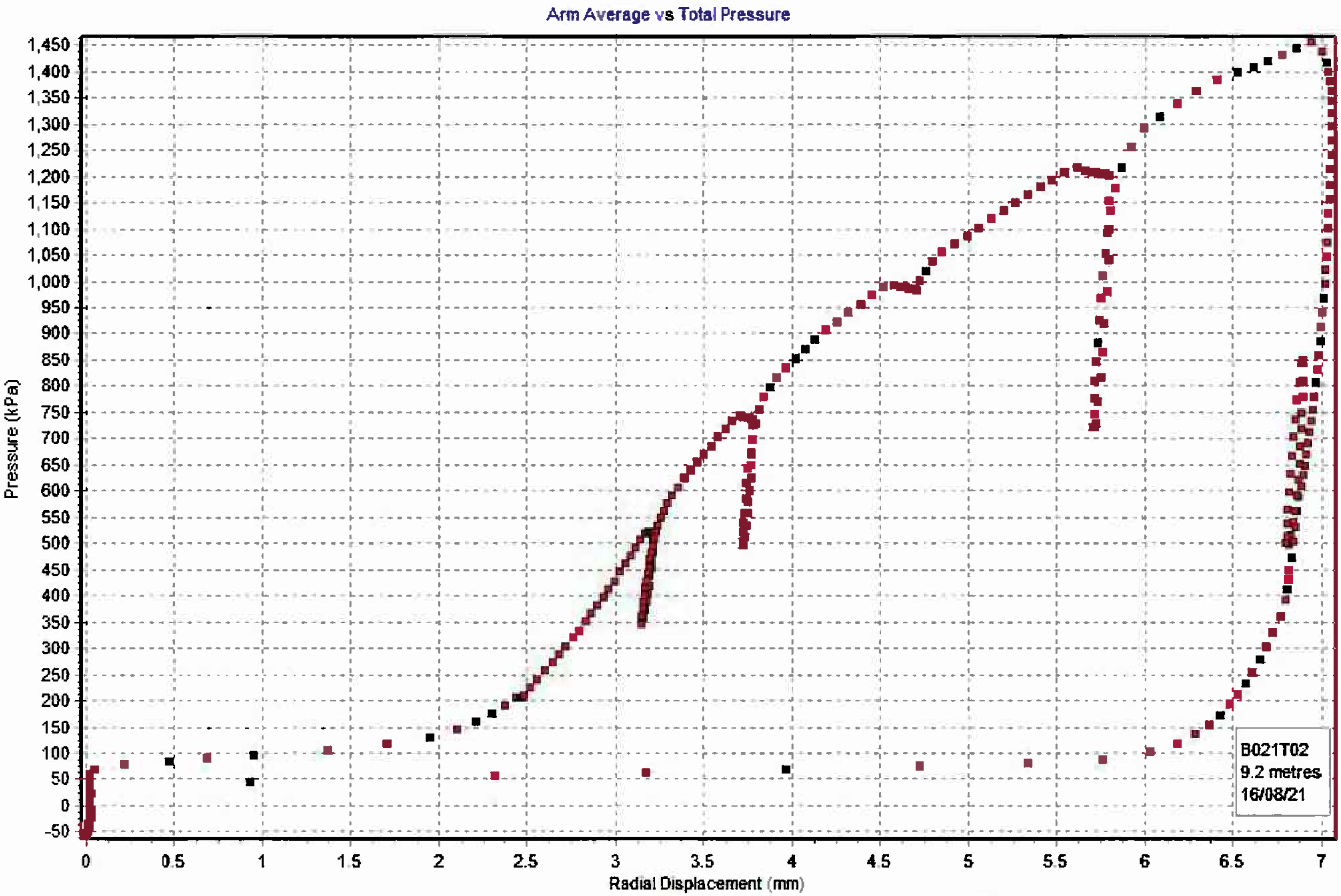
95mm High Pressure Dilatometer
BH_STW_021 Test 2
9.20 Metres
16 Aug 21

CURVE FIT PARAMETERS:
Origin : 2.940mm
Po : 162.0kPa
Cohesion : 57kPa
Phi peak : 37.2°
Dilation : 10.8°
Yield stress : 414kPa
Limit pressure : 3501kPa
Elastic exponent : 0.652
Gs at first yield : 28.7MPa
Janbu exponent : 0.464
Correlation : 0.842

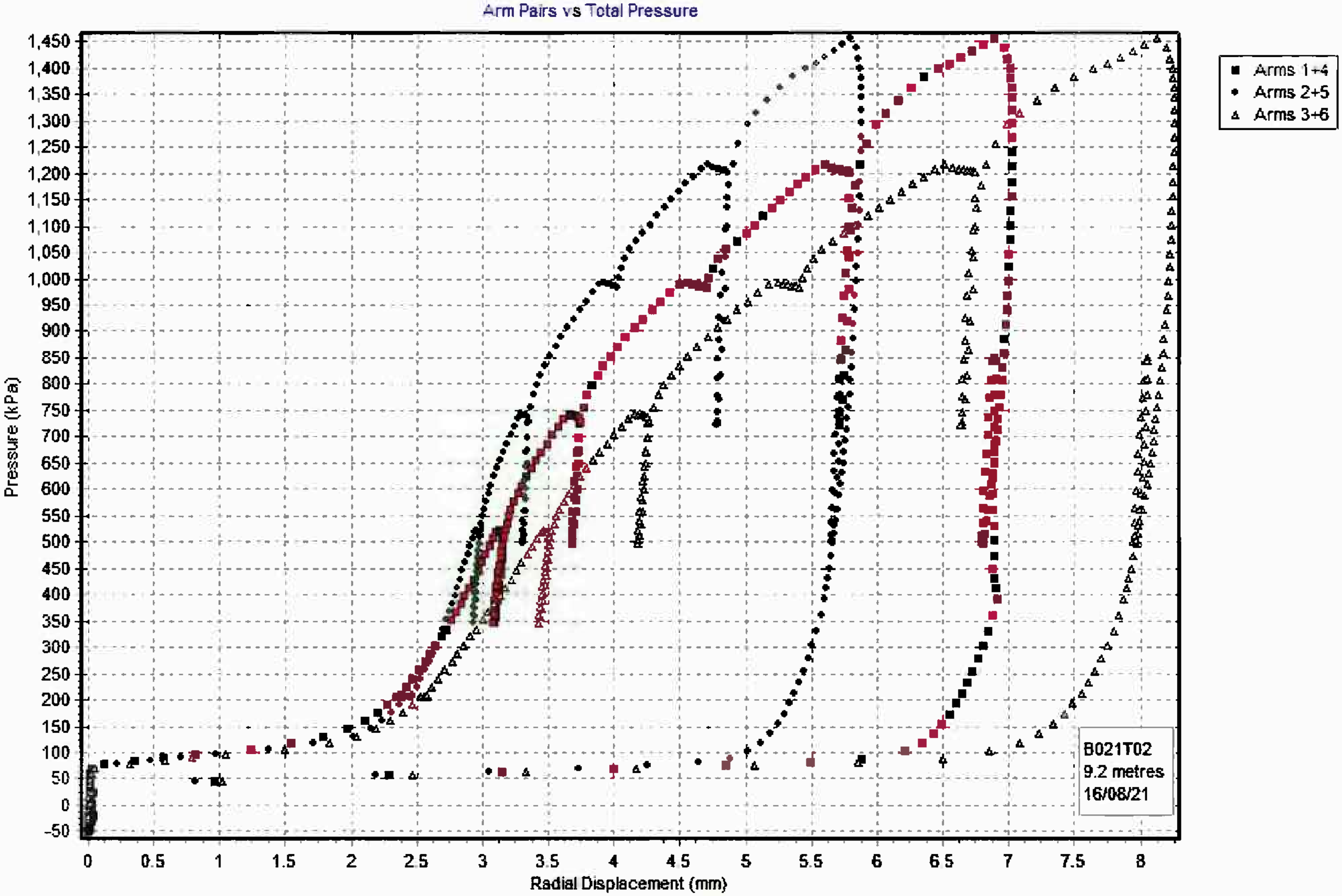
Estimated PWP : 53.0kPa
Phi cv : 28.0°
Poisson's ratio : 0.25



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361

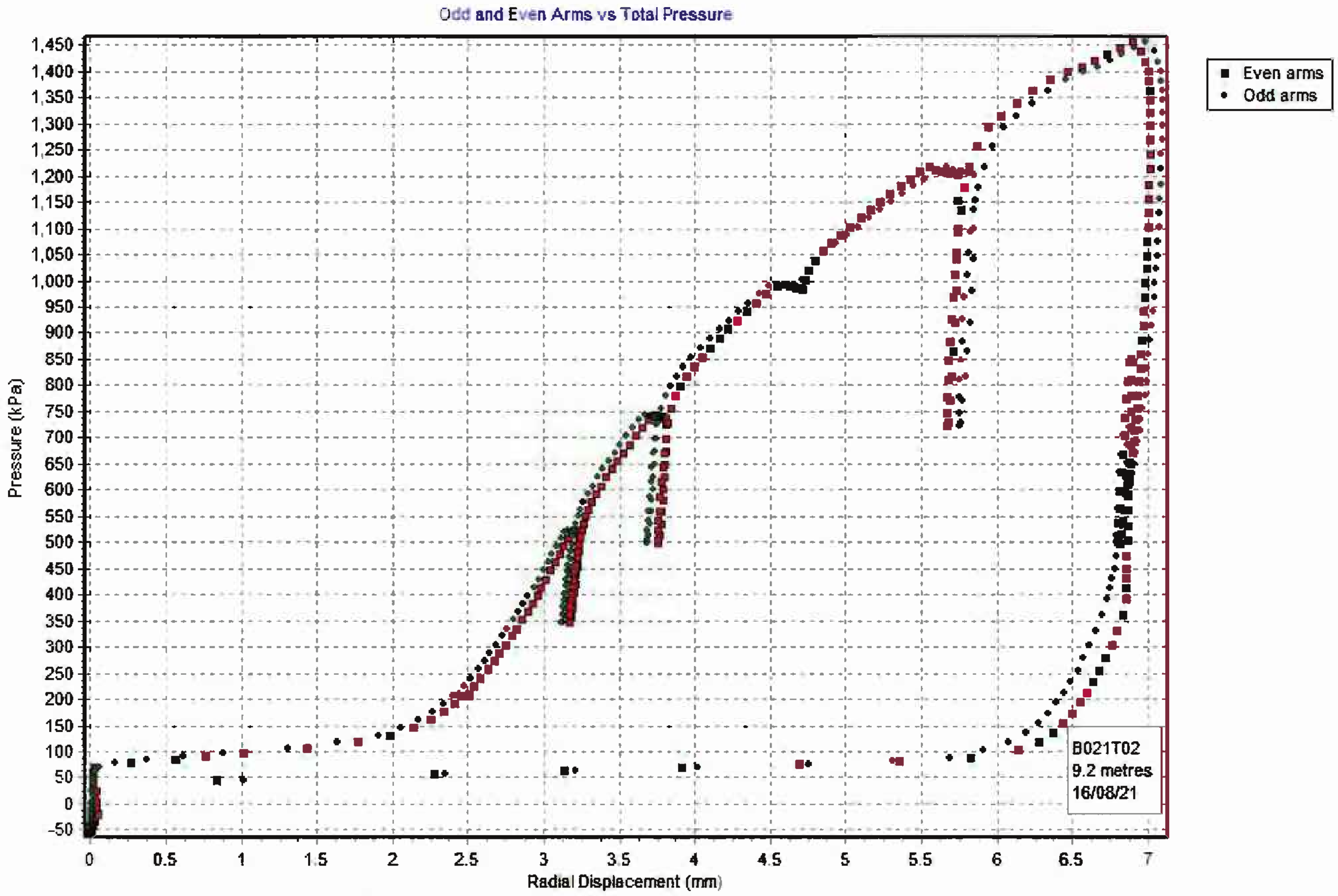


CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel. +44 (0)1223 262361

CIR1506/21

Cambridge WWTPR

Pressuremeter Testing

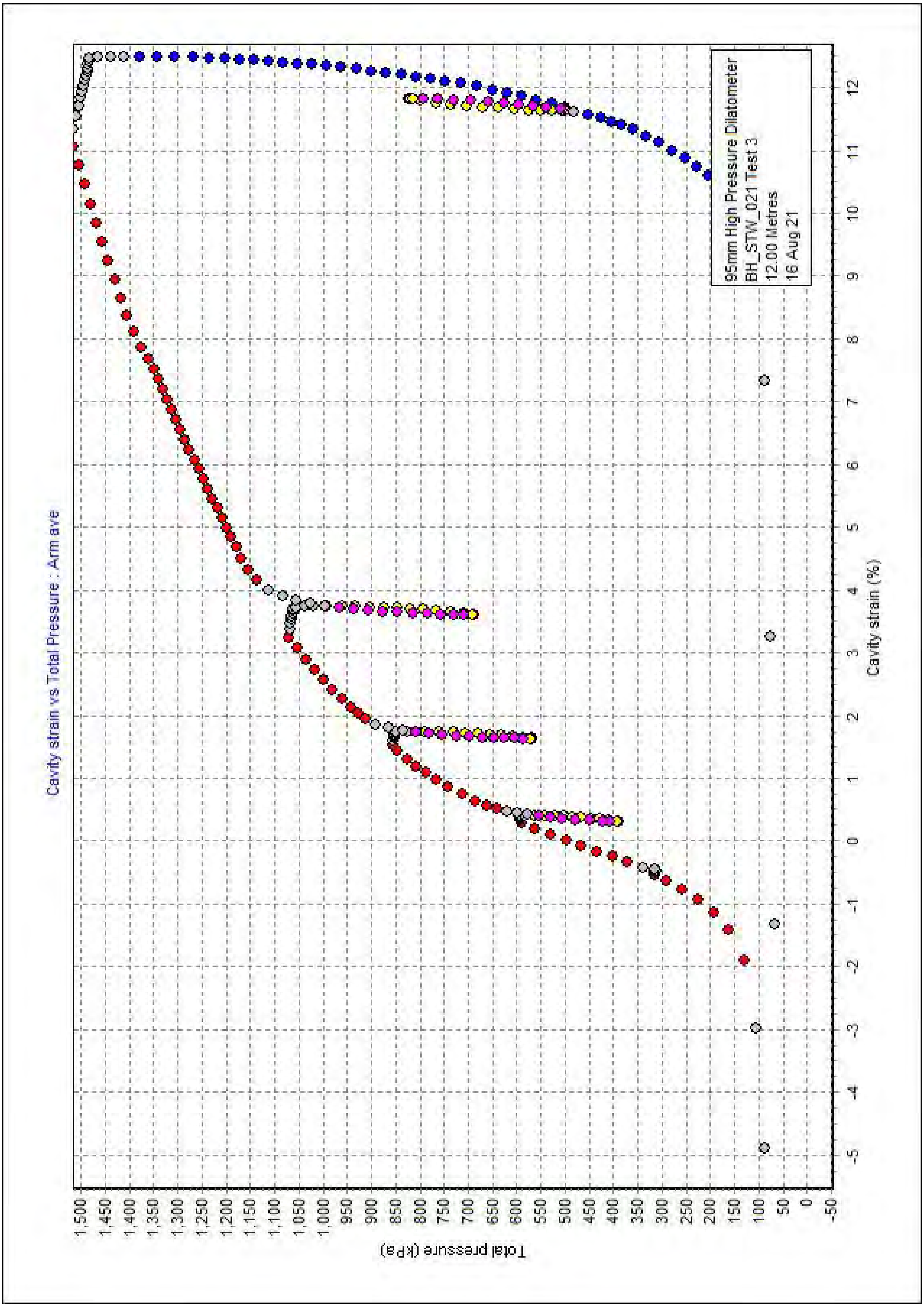


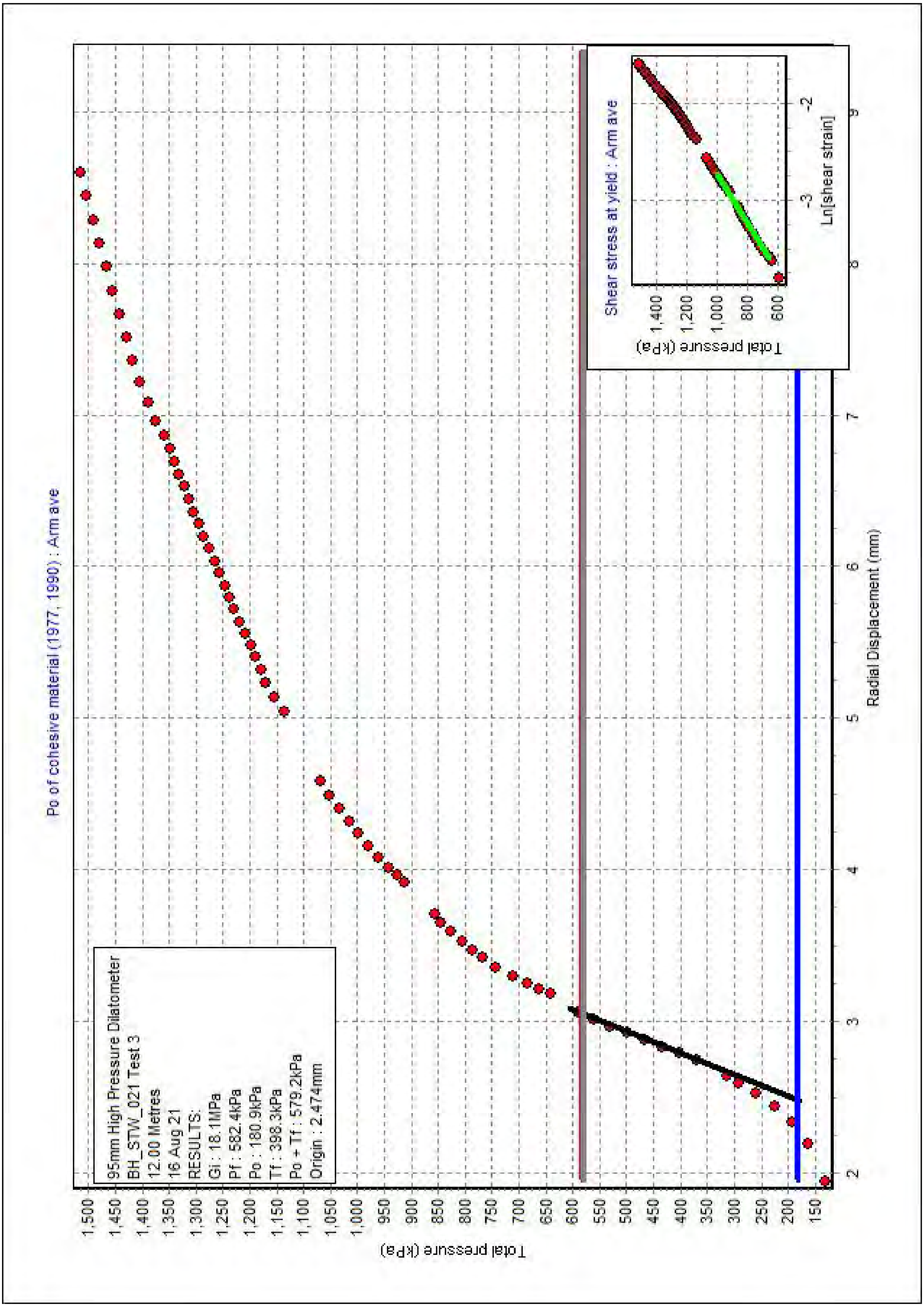
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel: +44 (0)1223 262361

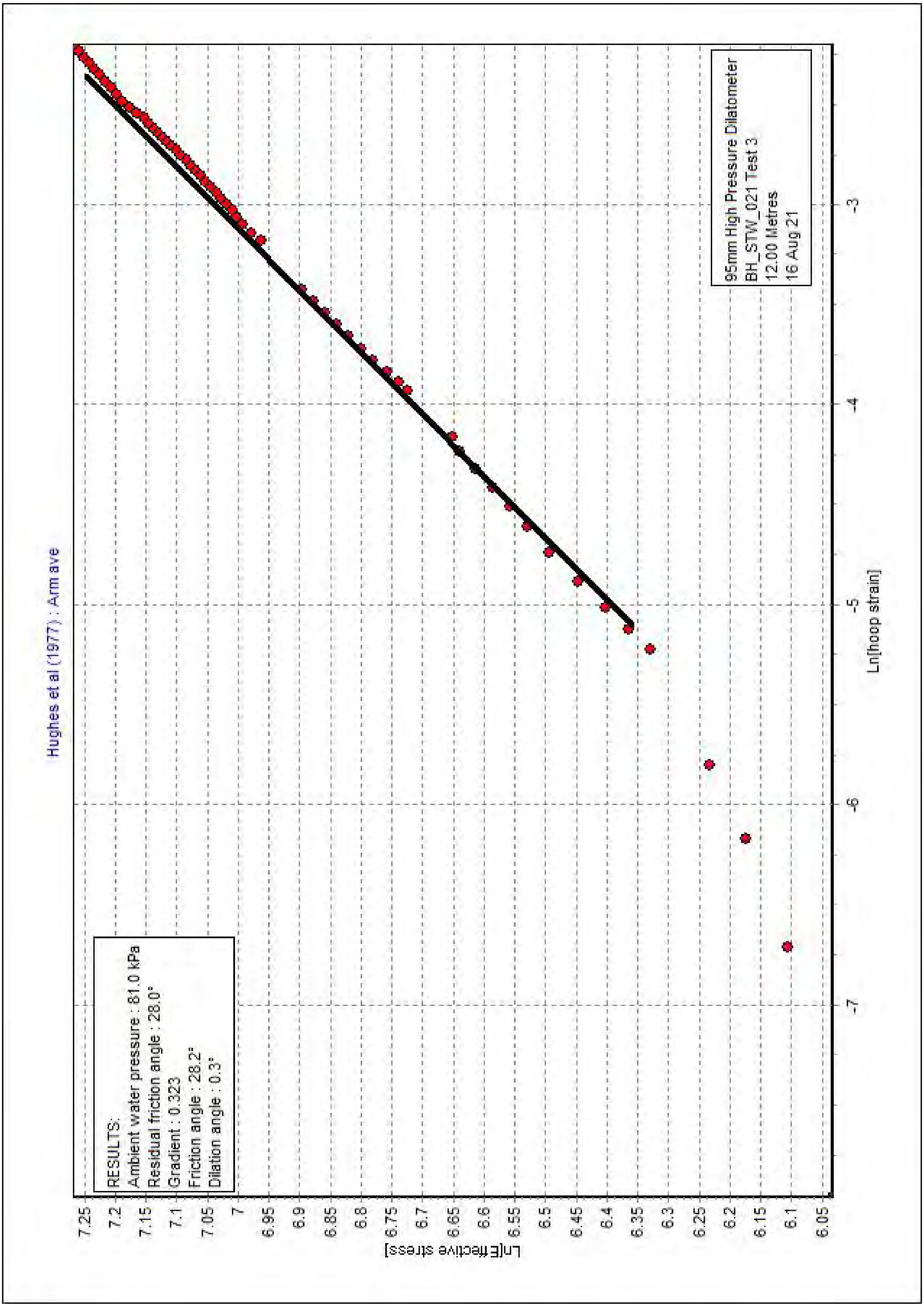
```
BH_STW_021 Test 3 - SUMMARY OF RESULTS
[File made with WinSitu ]

[DETAILS OF TEST]
Project         :   TE8364
Site            :   Cambridge Wastewater Treatment Plant Relocation Project
Borehole        :   BH_STW_021
Test name       :   BH_STW_021 Test 3
Test date       :   16 Aug 21
Test depth      :   12.00 Metres
Water table     :   2.2 Metres
Ambient PWP     :   81.0 kPa
Material        :   Chalk
Probe           :   95mm High Pressure Dilatometer
Diameter        :   97.0 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out
The file includes results from a curve fitting analysis

Analysed by ES/RW on 17 Aug 21

Remarks:

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm)                  :   "Arm ave=2.91"
Po from Marsland & Randolph (kPa)   :   "Arm ave=180.9"
Best estimate of Po (kPa)           :   "Arm ave=199.0"

[UNDRAINED STRENGTH PARAMETERS]
Undrained yield stress (kPa)        :   "Arm ave=582.4"

[DRAINED ANALYSIS OF SANDS]
[Hughes et al 1977]
Constant volume friction angle (°)  :   28.0
Angle of internal friction (°)      :   "Arm ave=28.2"
Dilation angle (°)                  :   "Arm ave=0.3"
Gradient of log-log plot            :   "Arm ave=0.323"

[Withers et al 1989]
Angle of internal friction (°)      :   "Arm ave=28.7"
Dilation angle (°)                  :   "Arm ave=0.8"
Gradient of log-log plot            :   "Arm ave=-1.809"

[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=18.1"
Axis       Loop   Value    Mean Strain  Mean Pc  dE      dPc
           No     (MPa)    (%)          (kPa)    (%)     (kPa)
Arm ave    1      95.3     0.381        478      0.181   173
Arm ave    2      114.0    1.706        684      0.207   236
Arm ave    3      121.4    3.692        841      0.249   303
Arm ave    4      96.2     11.750       662      0.331   319

[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]
Axis       Loop   Intercept  Alpha      Gradient
           No     (MPa)      (MPa)
Arm ave    1      7.983      4.830      0.605
Arm ave    2      6.519      3.454      0.530
Arm ave    3      7.152      3.743      0.523
Arm ave    4      6.771      3.555      0.525


[PARAMETERS USED FOR DRAINED CURVE MODELLING]
{Axis is  Arm ave}
Strain Origin (mm)                  :   2.91
Po (kPa)                            :   199
Cohesion (kPa)                      :   28
Angle of peak friction (deg)        :   28.2
Angle of peak dilation (deg)        :   0.0
Total yield stress (kPa)            :   467
```

BH_STW_021 Test 3 - SUMMARY OF RESULTS

Total limit stress (kPa)	:	2449
G at first yield (MPa)	:	43.7
Non-linear exponent	:	0.523
Janbu exponent	:	0.163
Correlation	:	0.641
Ambient pore water pressure (kPa)	:	81
Residual friction angle (deg)	:	28.0
Poisson's ratio	:	0.25

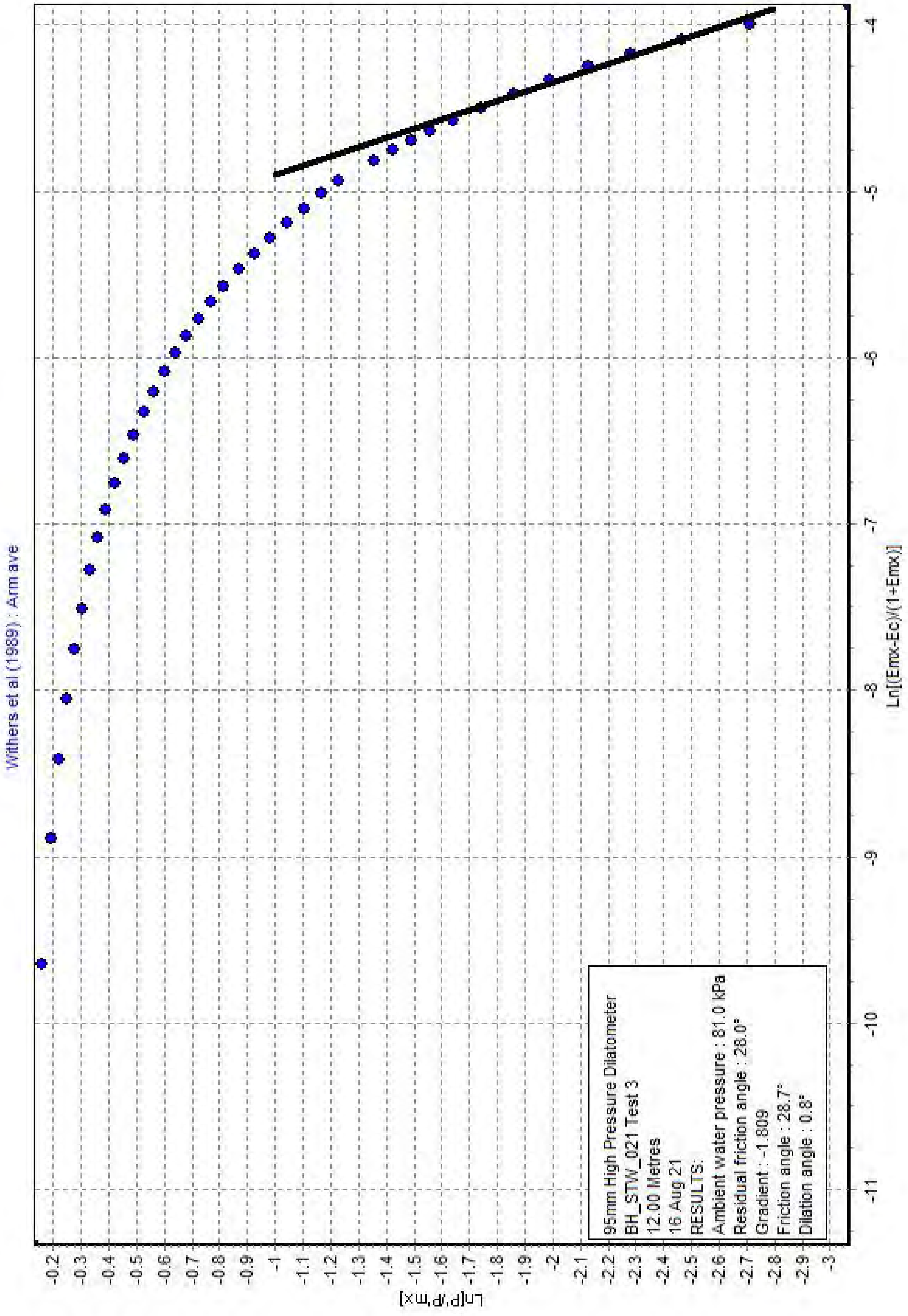

Cavity strain vs Total Pressure : Arm ave
95mm High Pressure Dilatometer
BH_STW_021 Test 3
12.00 Metres
16 Aug 21
Total pressure (kPa)
-50
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1,000
1,050
1,100
1,150
1,200
1,250
1,300
1,350
1,400
1,450
1,500
Cavity strain (%)
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
7
8
9
10
11
12

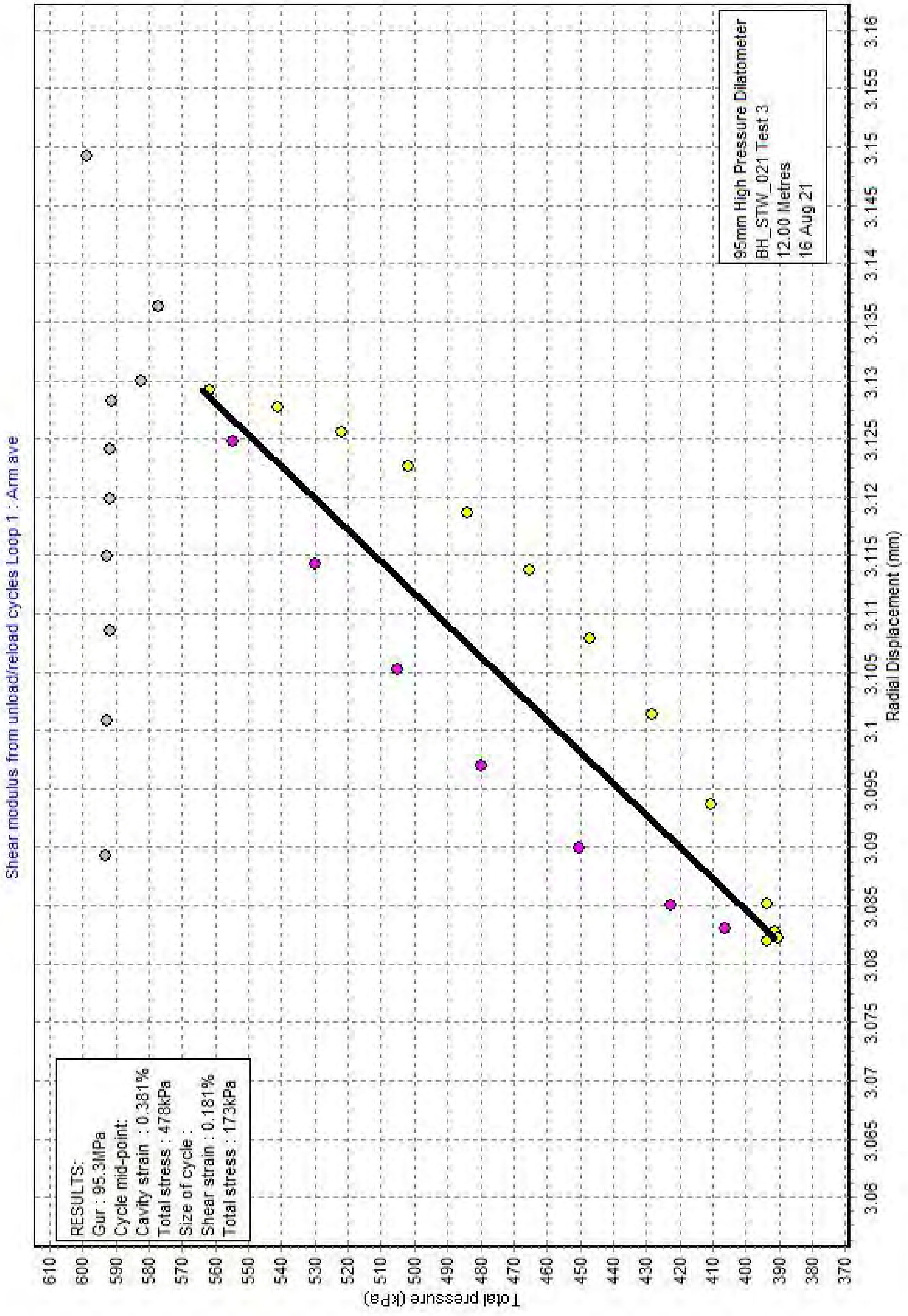

Po of cohesive material (1977, 1990) : Arm ave
95mm High Pressure Dilatometer
BH_STW_021 Test 3
12.00 Metres
16 Aug 21
RESULTS:
Gi : 18.1MPa
Pf : 582.4kPa
Po : 180.9kPa
Tf : 398.3kPa
Po + Tf : 579.2kPa
Origin : 2.474mm
Total pressure (kPa)
1,500
1,450
1,400
1,350
1,300
1,250
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
Radial Displacement (mm)
2
3
4
5
6
7
8
9
Shear stress at yield : Arm ave
Total pressure (kPa)
1,400
1,200
1,000
800
600
Ln[shear strain]
-3
-2



RESULTS:
Ambient water pressure : 81.0 kPa
Residual friction angle : 28.0°
Gradient : 0.323
Friction angle : 28.2°
Dilation angle : 0.3°

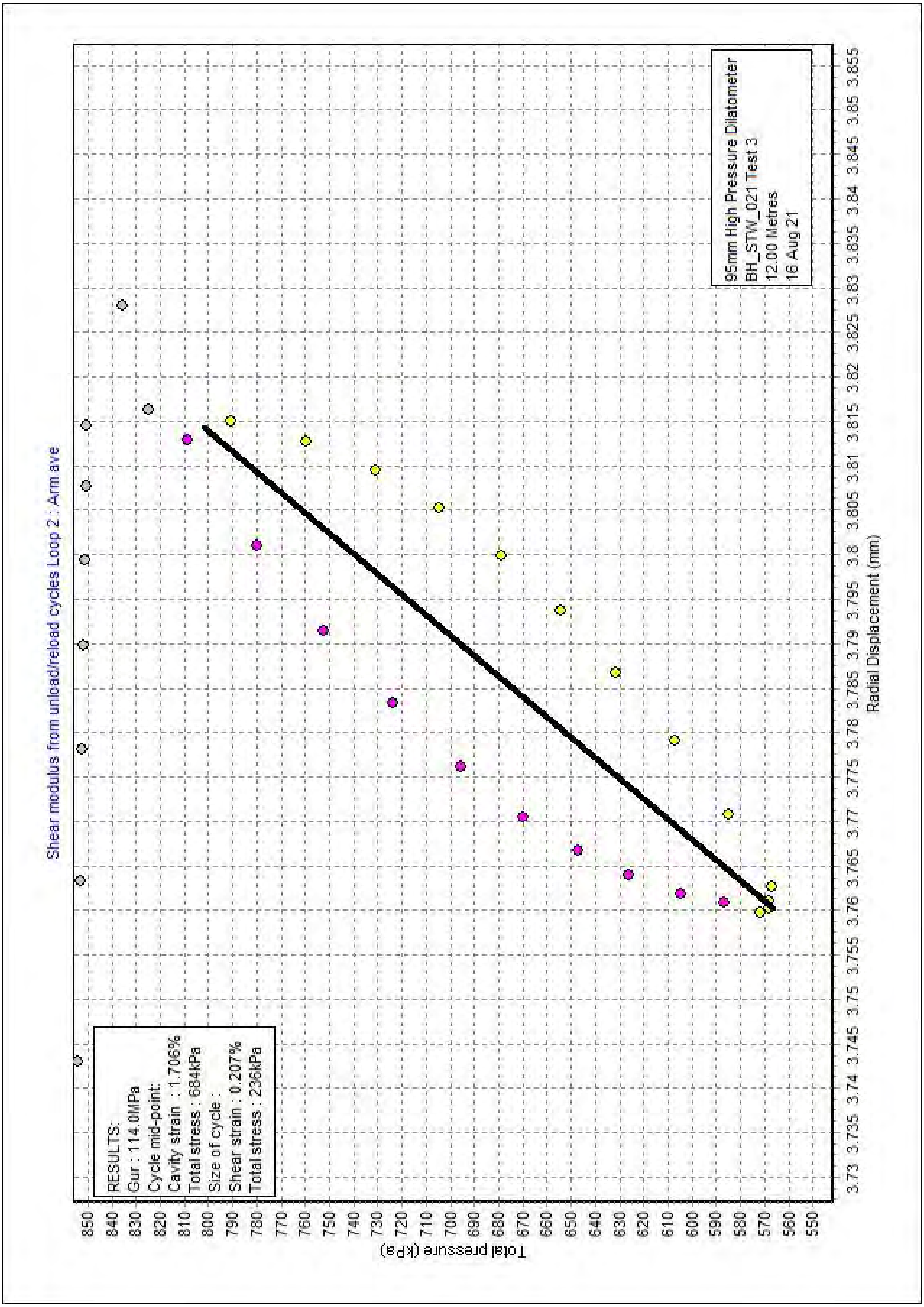
95mm High Pressure Dilatometer
BH_STW_021 Test 3
12.00 Metres
16 Aug 21


Withers et al (1989) : Arm ave
95mm High Pressure Dilatometer
BH_STW_021 Test 3
12.00 Metres
16 Aug 21
RESULTS:
Ambient water pressure : 81.0 kPa
Residual friction angle : 28.0°
Gradient : -1.809
Friction angle : 28.7°
Dilation angle : 0.8°
Ln[(Emx-Ec)/(1+Emx)]
-4
-5
-6
-7
-8
-9
-10
-11
Ln[P'/P'mx]
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1
-1.1
-1.2
-1.3
-1.4
-1.5
-1.6
-1.7
-1.8
-1.9
-2
-2.1
-2.2
-2.3
-2.4
-2.5
-2.6
-2.7
-2.8
-2.9
-3

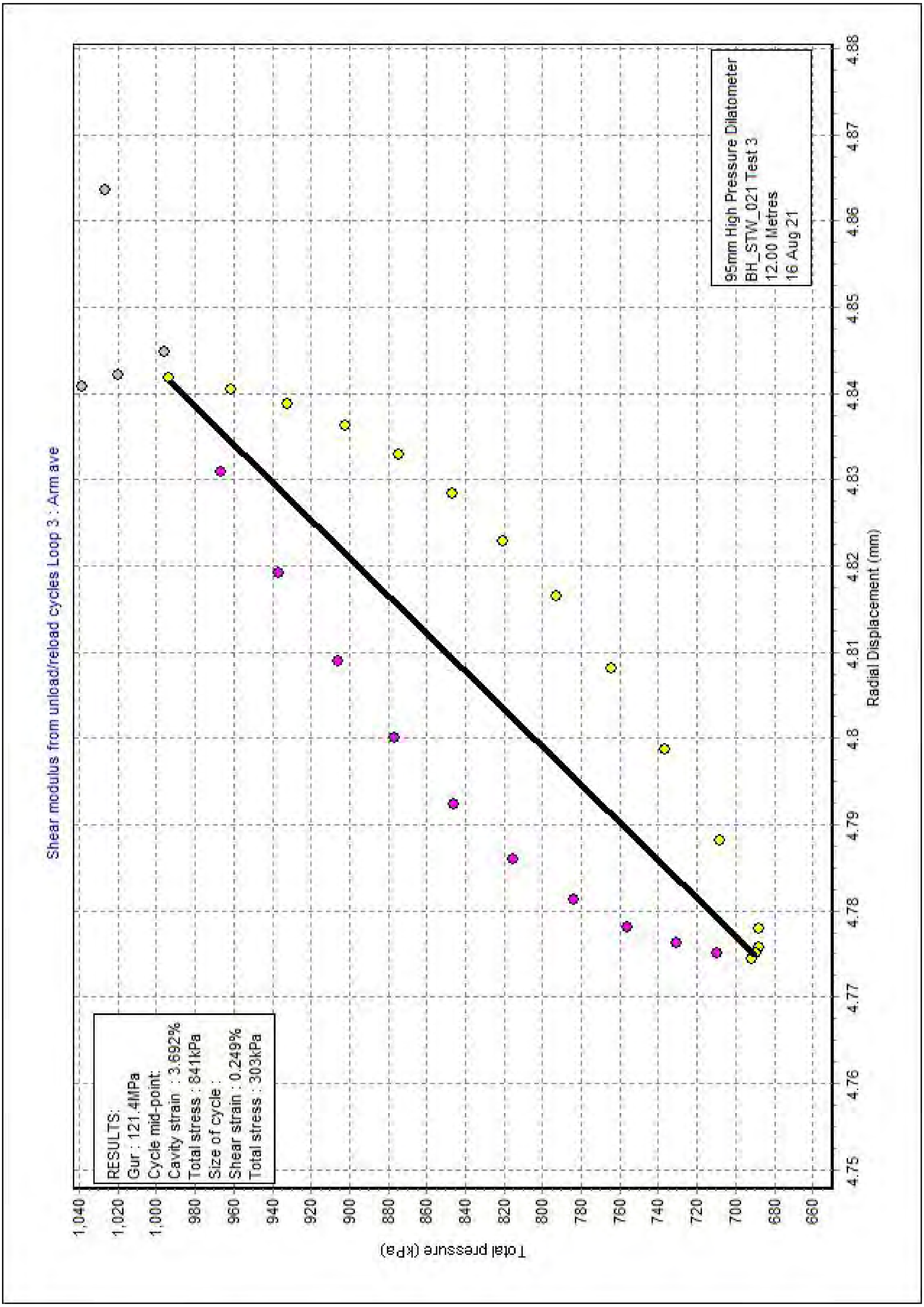


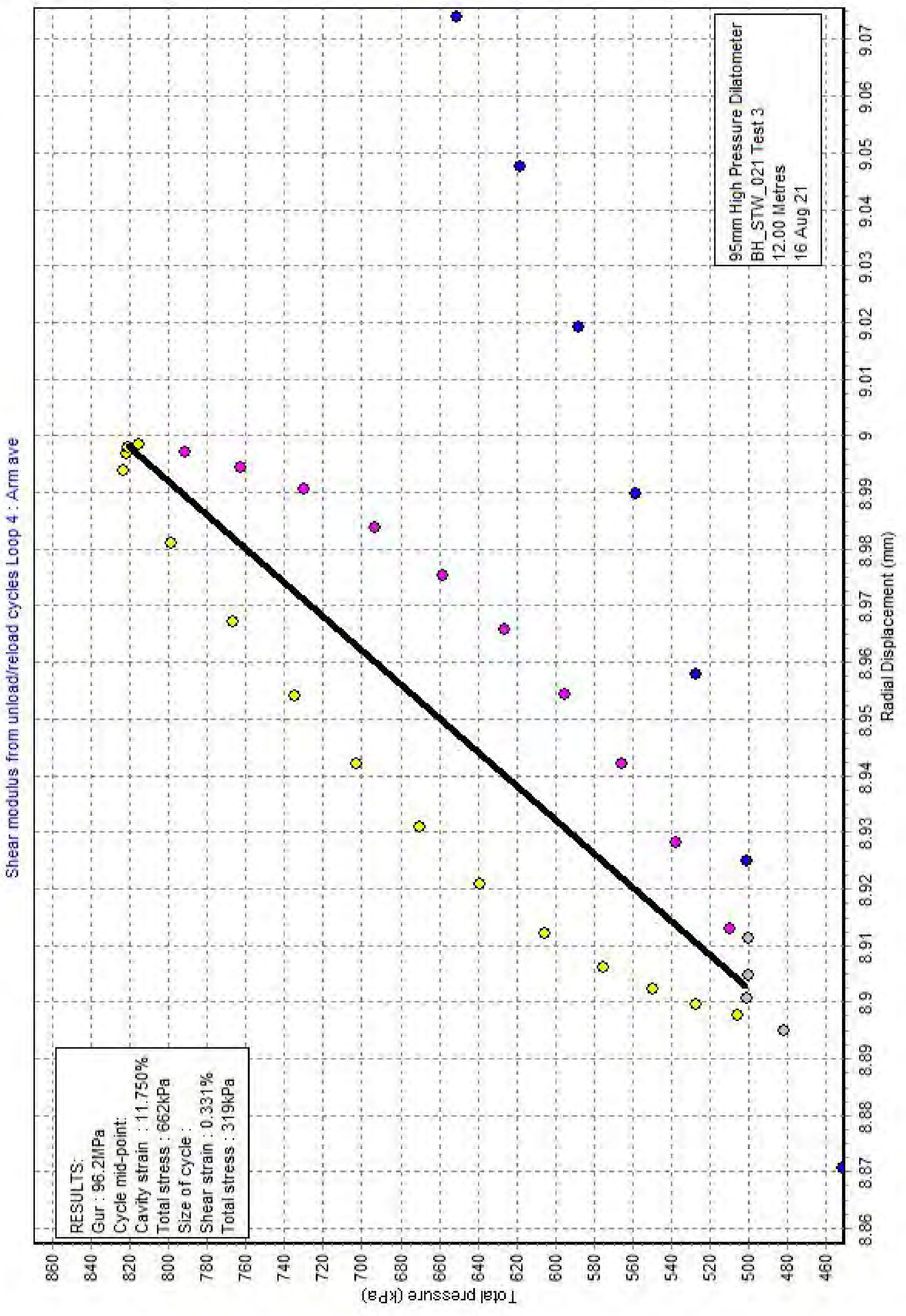
RESULTS:
Gur : 95.3MPa
Cycle mid-point:
Cavity strain : 0.381%
Total stress : 478kPa
Size of cycle :
Shear strain : 0.181%
Total stress : 173kPa

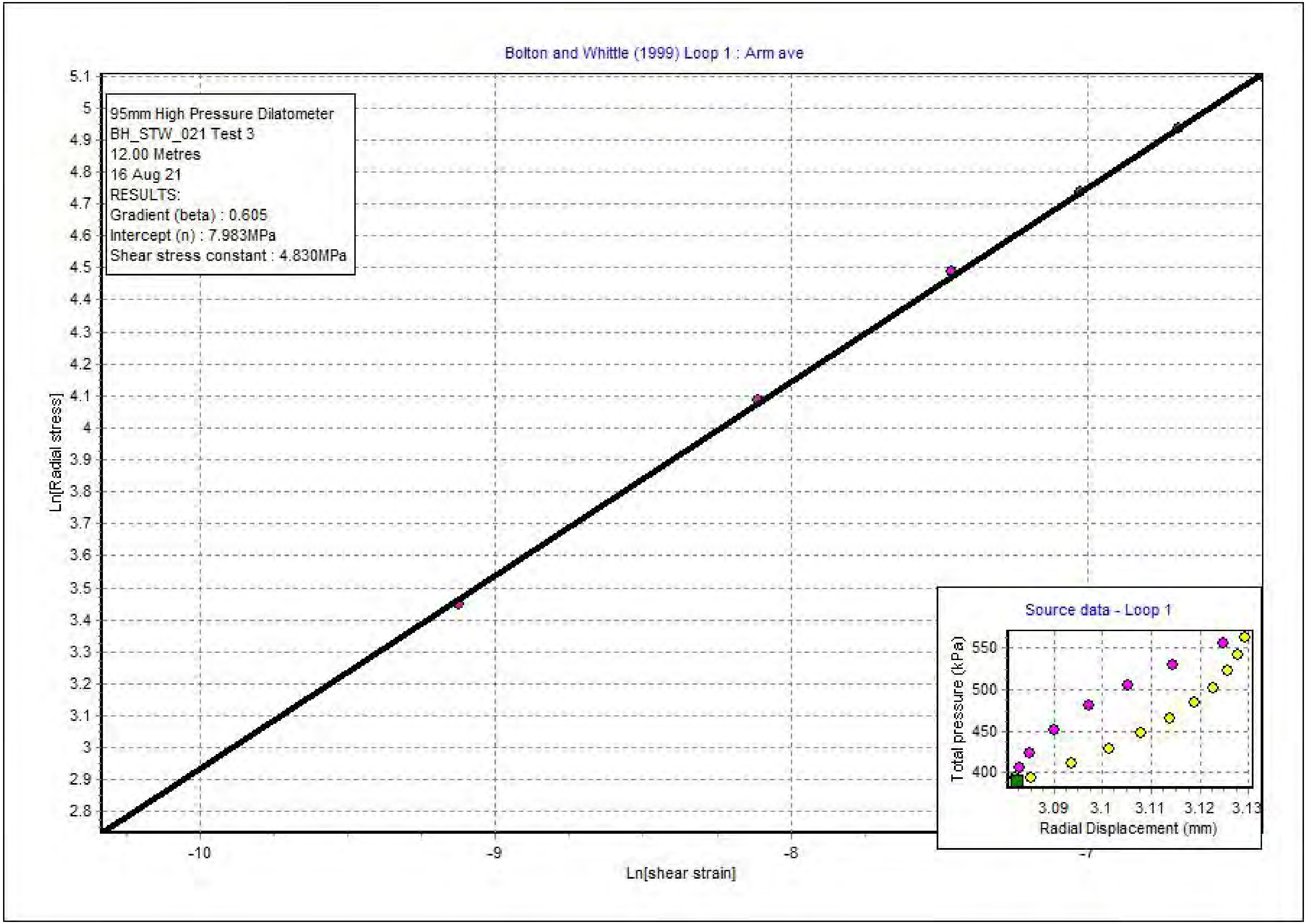
95mm High Pressure Dilatometer
BH_STW_021 Test 3
12.00 Metres
16 Aug 21

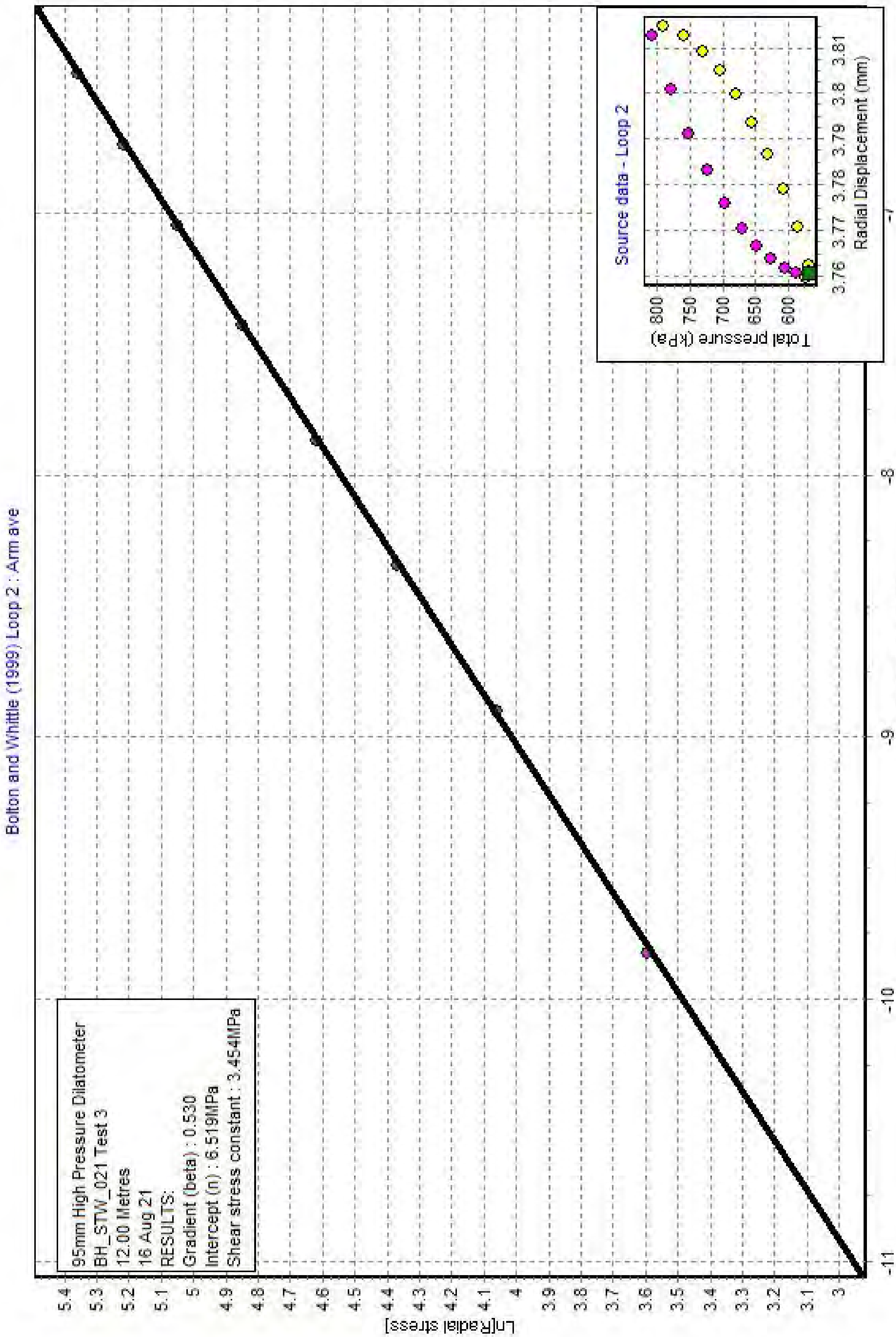


RESULTS:
Gur : 114.0MPa
Cycle mid-point:
Cavity strain : 1.706%
Total stress : 684kPa
Size of cycle :
Shear strain : 0.207%
Total stress : 236kPa


Shear modulus from unload/reload cycles Loop 3 : Arm ave
95mm High Pressure Dilatometer
BH_STW_021 Test 3
12.00 Metres
16 Aug 21
RESULTS:
Gur : 121.4MPa
Cycle mid-point:
Cavity strain : 3.692%
Total stress : 841kPa
Size of cycle :
Shear strain : 0.249%
Total stress : 303kPa
Radial Displacement (mm)
4.75
4.76
4.77
4.78
4.79
4.8
4.81
4.82
4.83
4.84
4.85
4.86
4.87
4.88
Total pressure (kPa)
1,040
1,020
1,000
980
960
940
920
900
880
860
840
820
800
780
760
740
720
700
680
660

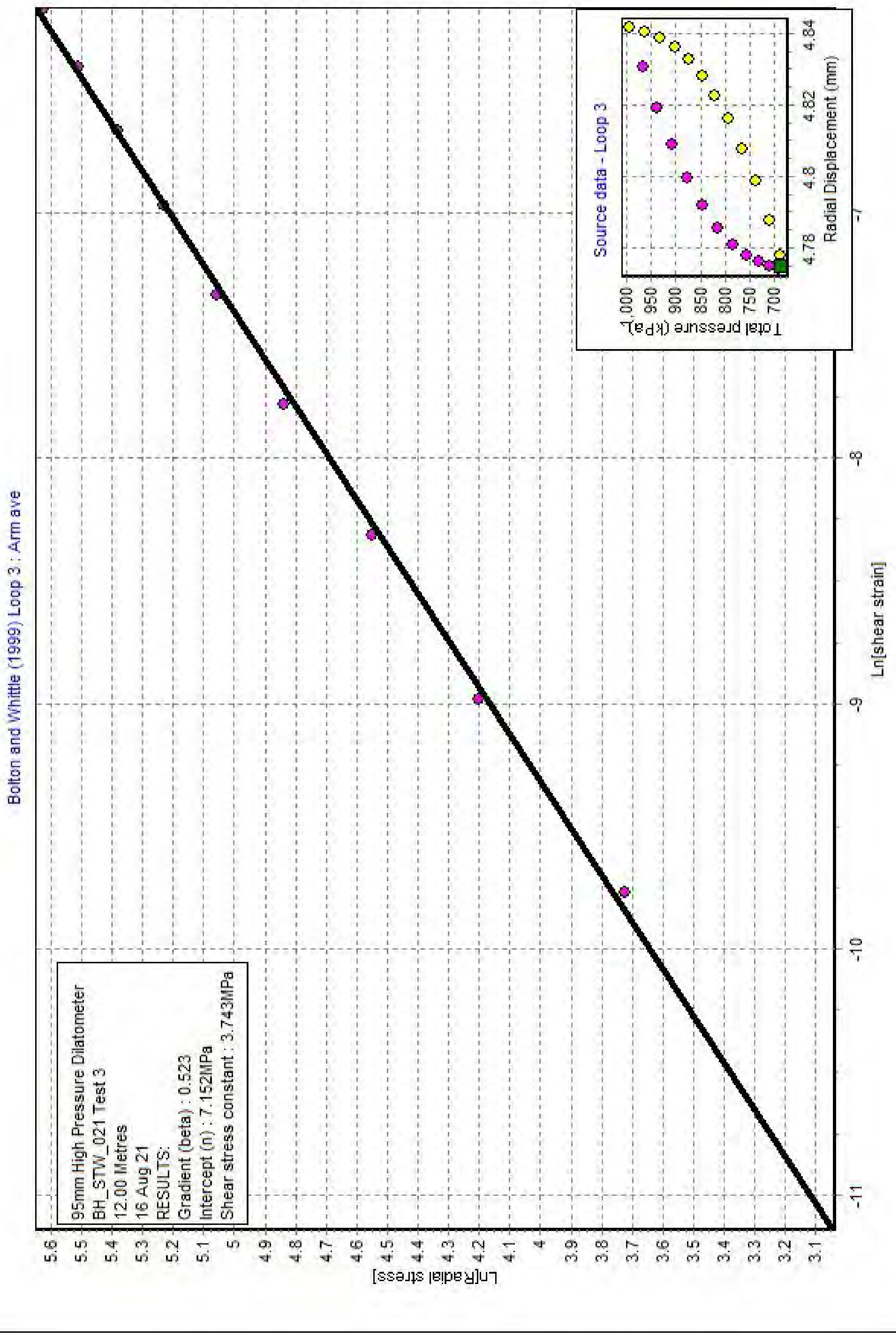

Shear modulus from unload/reload cycles Loop 4 : Arm ave
RESULTS:
Gur : 96.2MPa
Cycle mid-point:
Cavity strain : 11.750%
Total stress : 662kPa
Size of cycle :
Shear strain : 0.331%
Total stress : 319kPa
95mm High Pressure Dilatometer
BH_STW_021 Test 3
12.00 Metres
16 Aug 21
Total pressure (kPa)
860
840
820
800
780
760
740
720
700
680
660
640
620
600
580
560
540
520
500
480
460
Radial Displacement (mm)
8.86
8.87
8.88
8.89
8.9
8.91
8.92
8.93
8.94
8.95
8.96
8.97
8.98
8.99
9
9.01
9.02
9.03
9.04
9.05
9.06
9.07

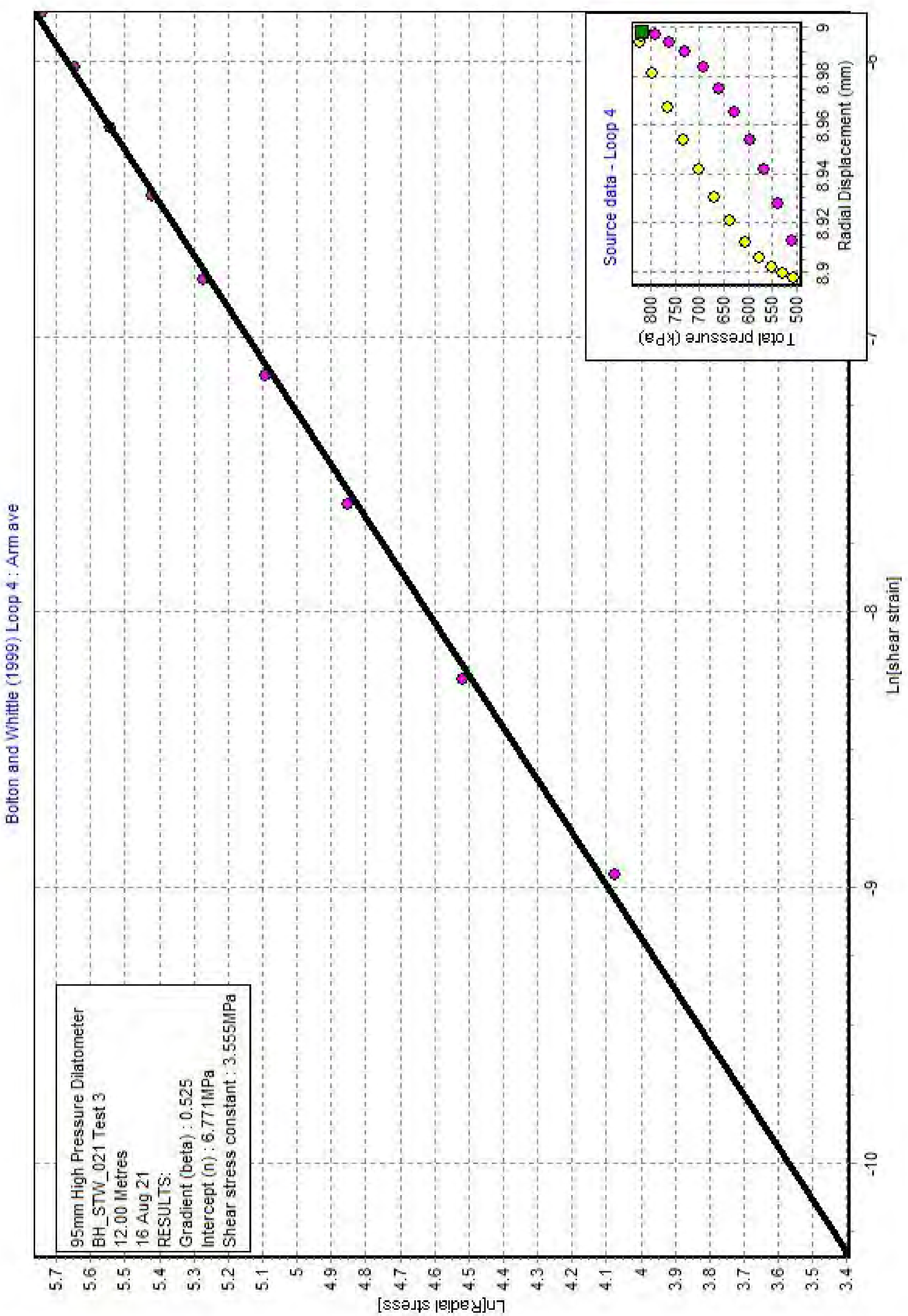

Bolton and Whittle (1999) Loop 1 : Arm ave
95mm High Pressure Dilatometer
BH_STW_021 Test 3
12.00 Metres
16 Aug 21
RESULTS:
Gradient (beta) : 0.605
Intercept (n) : 7.983MPa
Shear stress constant : 4.830MPa
Ln[Radial stress]
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
-10
-9
-8
-7
Ln[shear strain]
Source data - Loop 1
Total pressure (kPa)
550
500
450
400
3.09
3.1
3.11
3.12
3.13
Radial Displacement (mm)

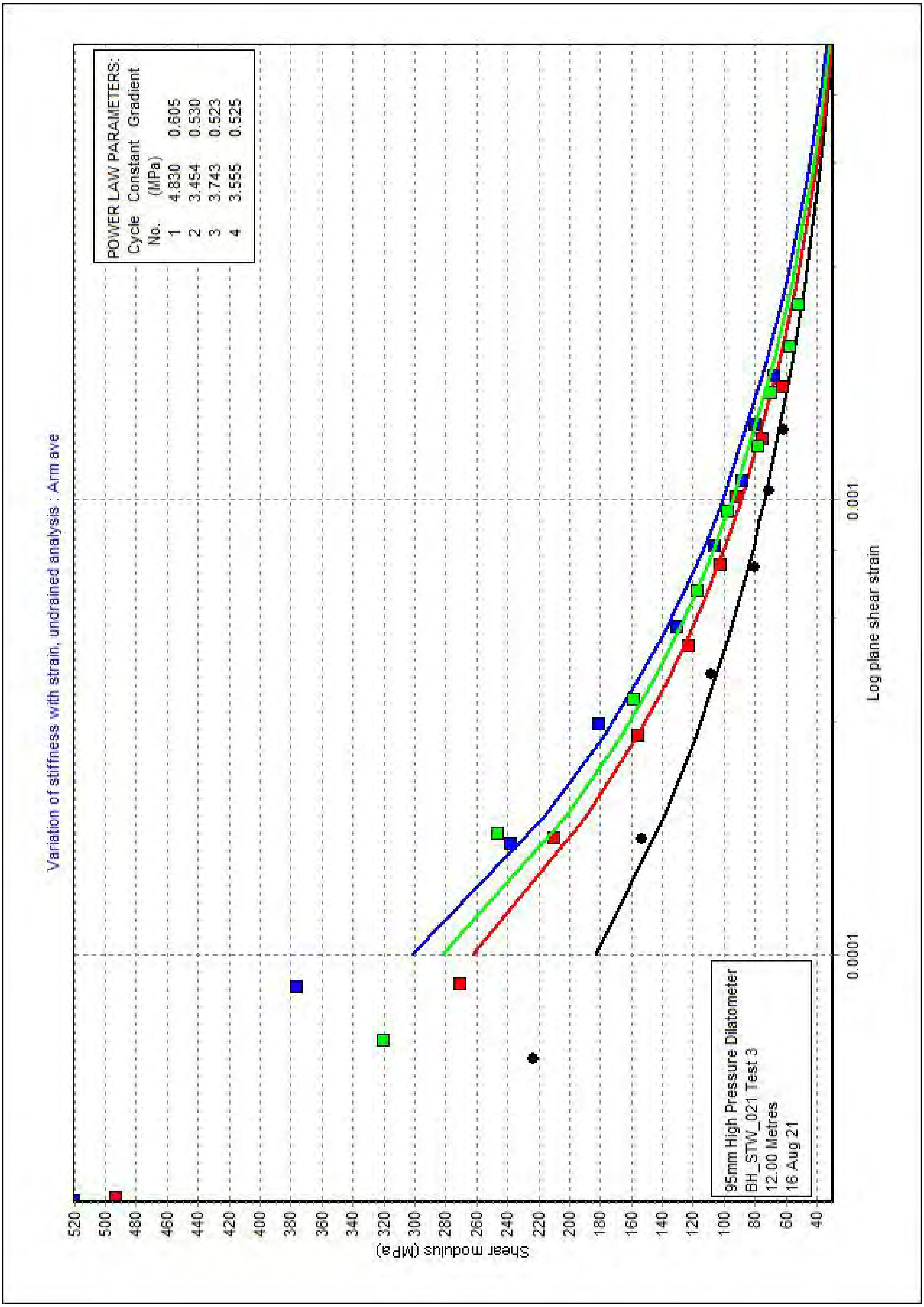


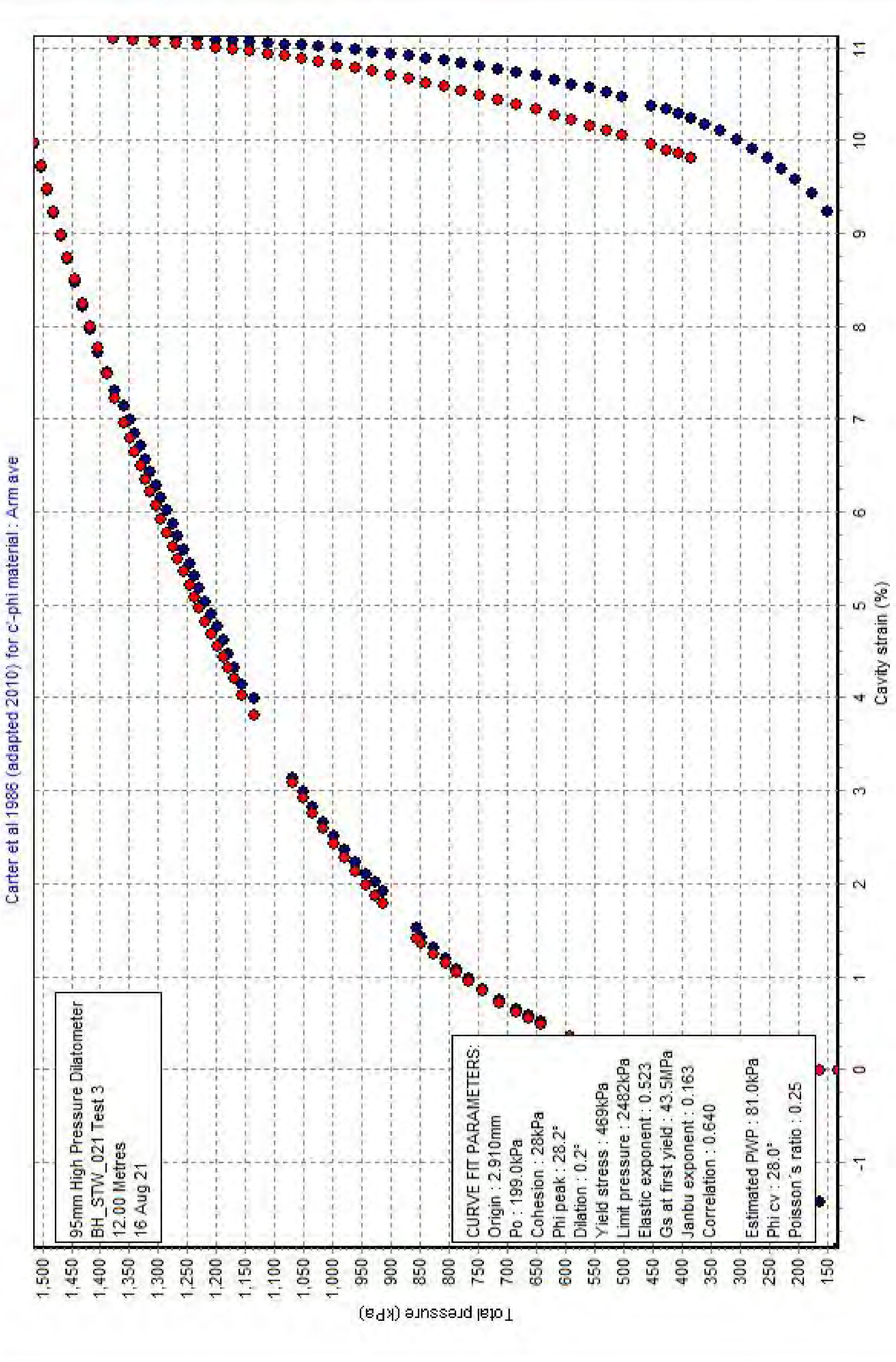
Bolton and Whittle (1999) Loop 2 : Arm ave

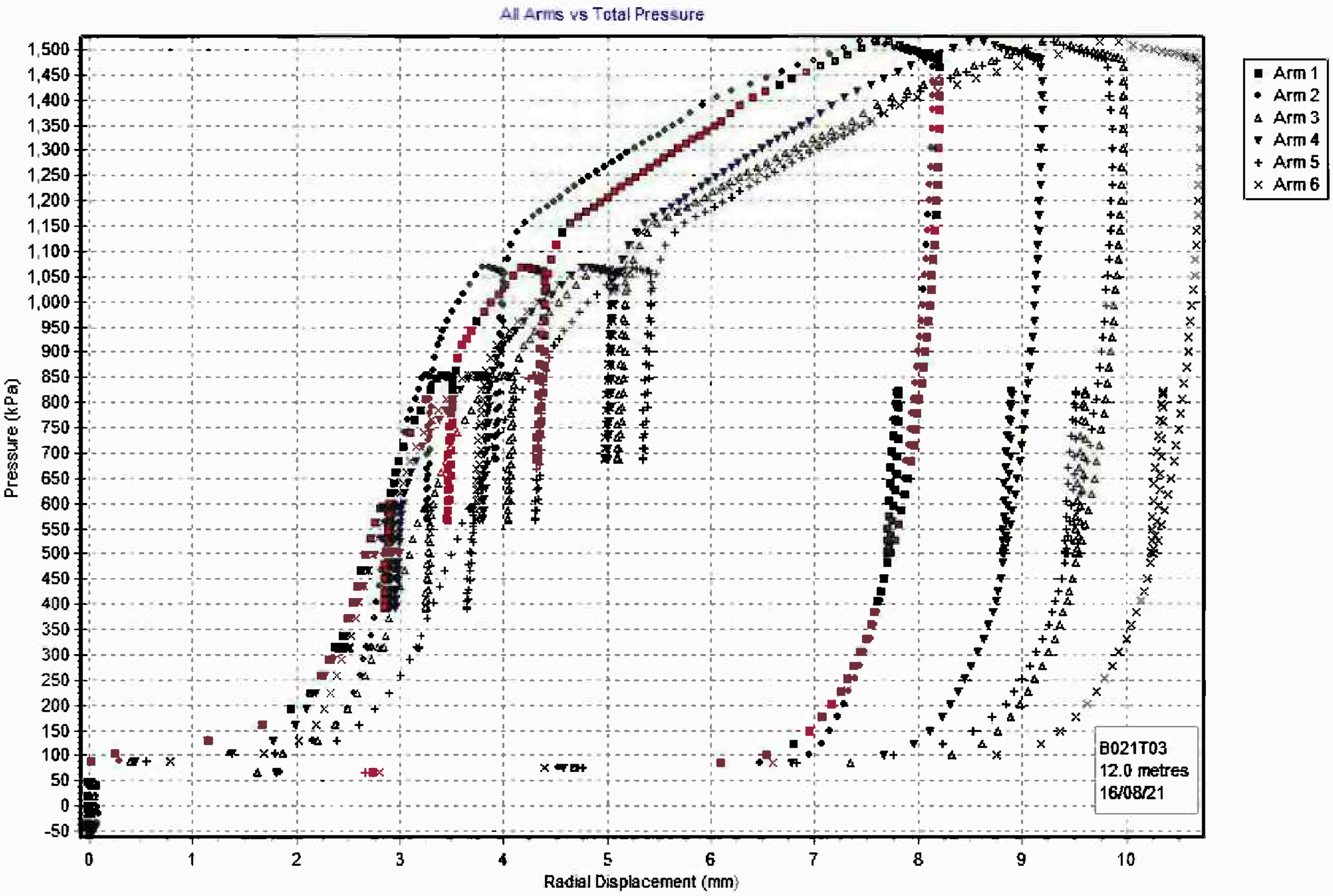
95mm High Pressure Dilatometer
BH_STW_021 Test 3
12.00 Metres
16 Aug 21
RESULTS:
Gradient (beta) : 0.530
Intercept (n) : 6.519MPa
Shear stress constant : 3.454MPa


Bolton and Whittle (1999) Loop 3 : Arm ave
95mm High Pressure Dilatometer
BH_STW_021 Test 3
12.00 Metres
16 Aug 21
RESULTS:
Gradient (beta) : 0.523
Intercept (n) : 7.152MPa
Shear stress constant : 3.743MPa
Ln[Radial stress]
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
Ln[shear strain]
-11
-10
-9
-8
-7
Source data - Loop 3
Total pressure (kPa)
1000
950
900
850
800
750
700
Radial Displacement (mm)
4.78
4.8
4.82
4.84


Bolton and Whittle (1999) Loop 4 : Arm ave
95mm High Pressure Dilatometer
BH_STW_021 Test 3
12.00 Metres
16 Aug 21
RESULTS:
Gradient (beta) : 0.525
Intercept (n) : 6.771MPa
Shear stress constant : 3.555MPa
Ln[Radial stress]
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
Ln[shear strain]
-10
-9
-8
-7
-6
Source data - Loop 4
Total pressure (kPa)
800
750
700
650
600
550
500
Radial Displacement (mm)
8.9
8.92
8.94
8.96
8.98
9


Variation of stiffness with strain, undrained analysis : Arm ave
POWER LAW PARAMETERS:
Cycle No. | Constant (MPa) | Gradient
1 | 4.830 | 0.605
2 | 3.454 | 0.530
3 | 3.743 | 0.523
4 | 3.555 | 0.525
95mm High Pressure Dilatometer
BH_STW_021 Test 3
12.00 Metres
16 Aug 21
Shear modulus (MPa)
520
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
Log plane shear strain
0.0001
0.001


Carter et al 1986 (adapted 2010) for c'-phi material : Arm ave
95mm High Pressure Dilatometer
BH_STW_021 Test 3
12.00 Metres
16 Aug 21
CURVE FIT PARAMETERS:
Origin : 2.910mm
Po : 199.0kPa
Cohesion : 28kPa
Phi peak : 28.2°
Dilation : 0.2°
Yield stress : 469kPa
Limit pressure : 2482kPa
Elastic exponent : 0.523
Gs at first yield : 43.5MPa
Janbu exponent : 0.163
Correlation : 0.640
Estimated PWP : 81.0kPa
Phi cv : 28.0°
Poisson's ratio : 0.25
Total pressure (kPa)
1,500
1,450
1,400
1,350
1,300
1,250
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
Cavity strain (%)
-1
0
1
2
3
4
5
6
7
8
9
10
11

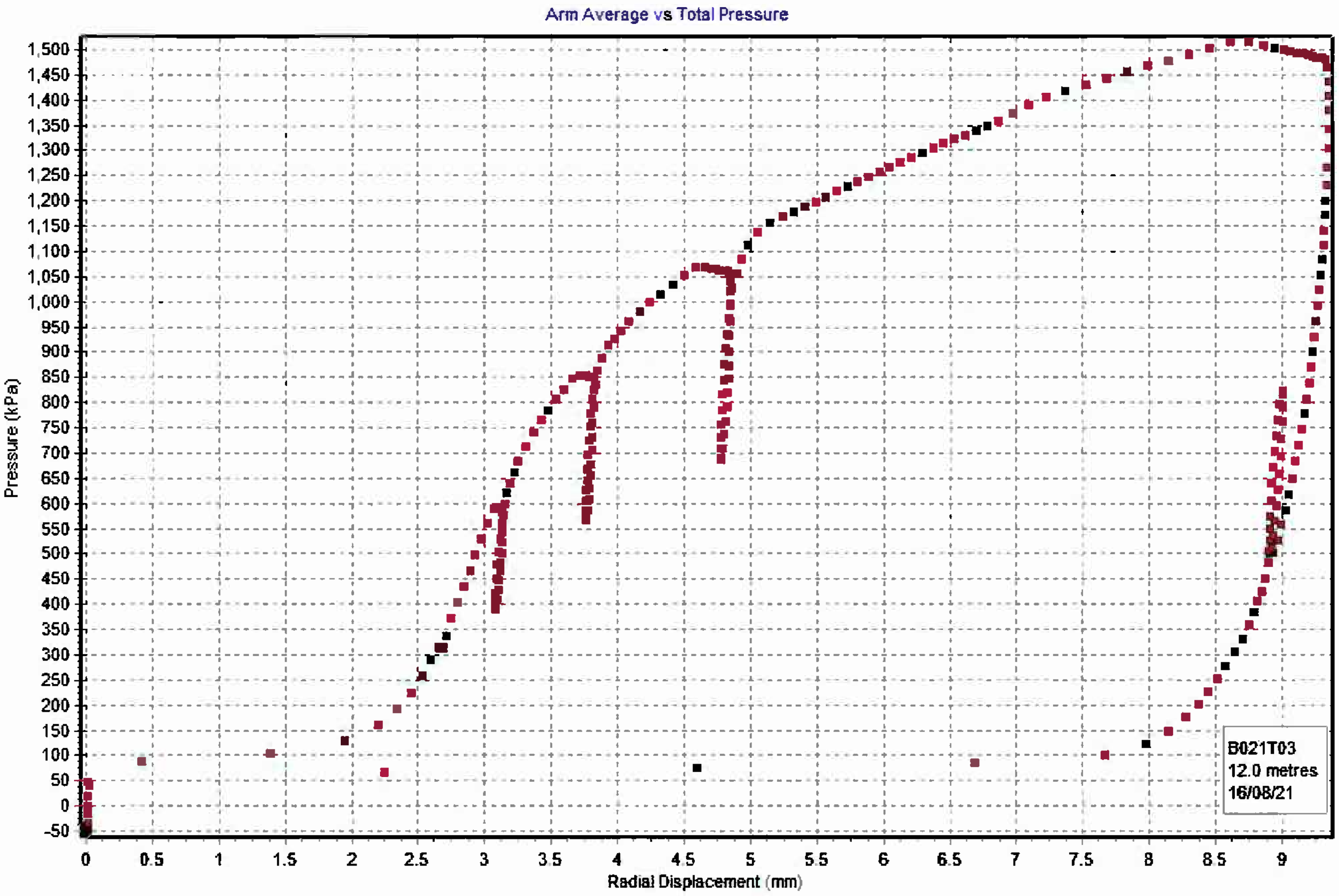


CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361

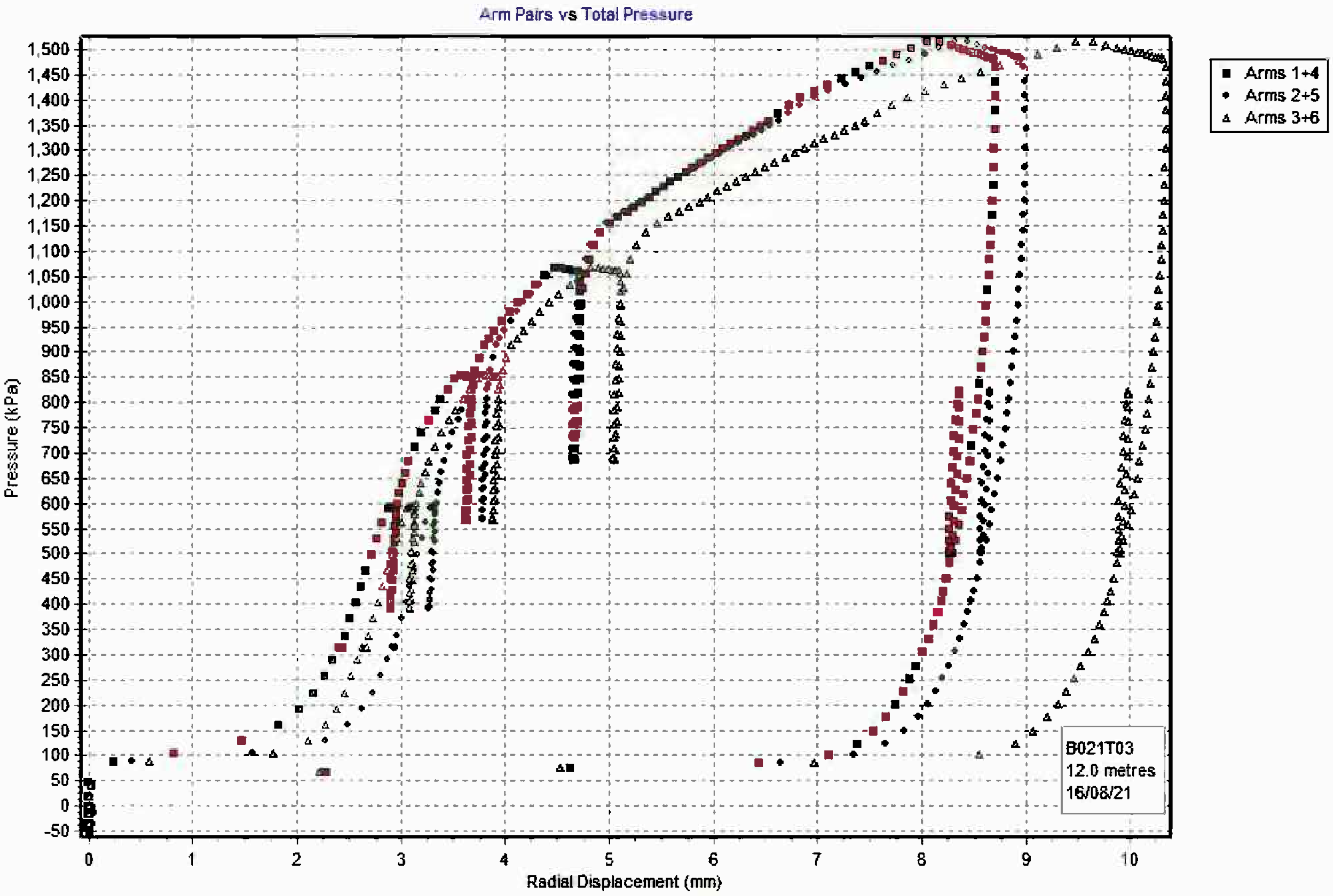
CIR1506/21

Cambridge WWTPR

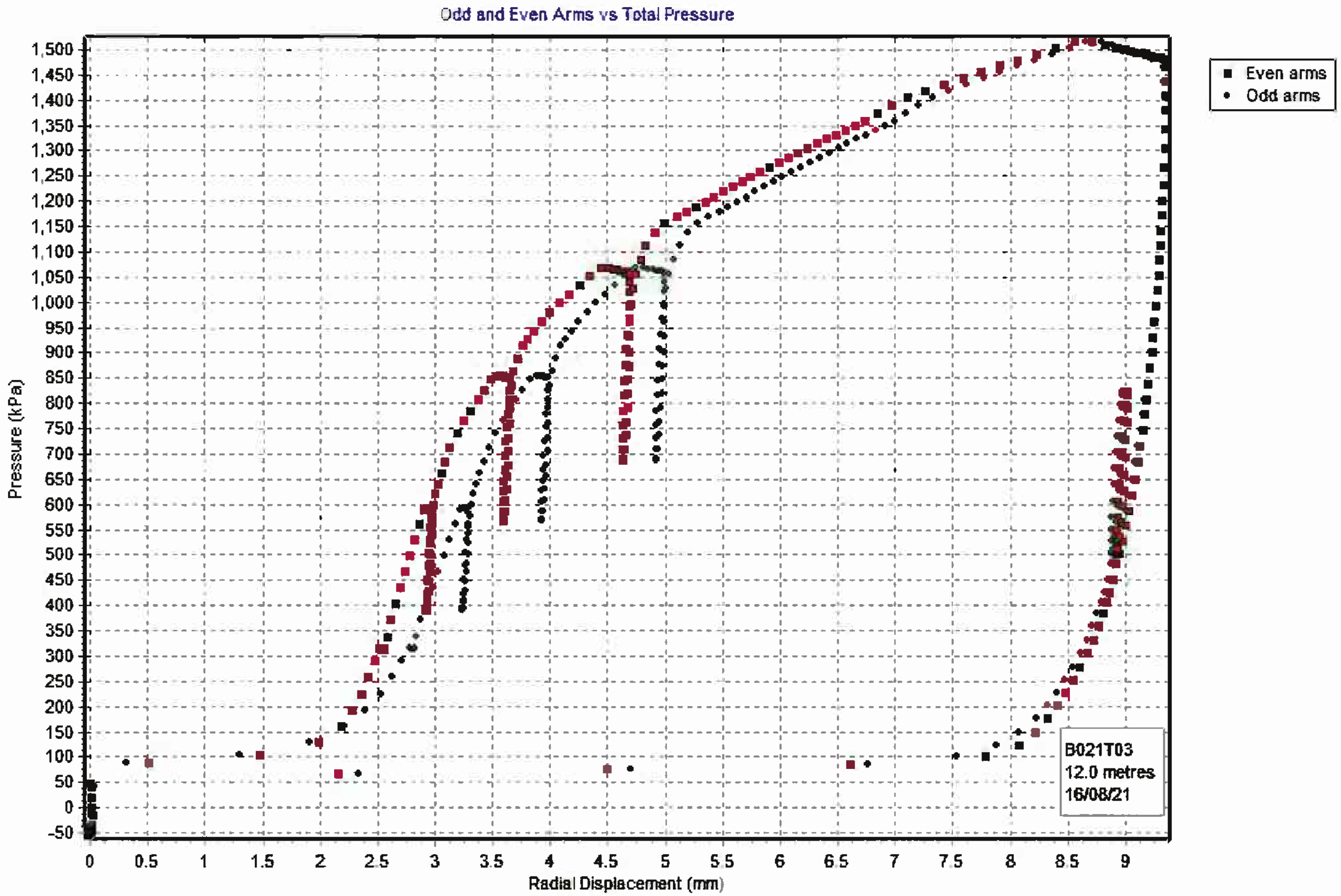
Pressuremeter Testing



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361



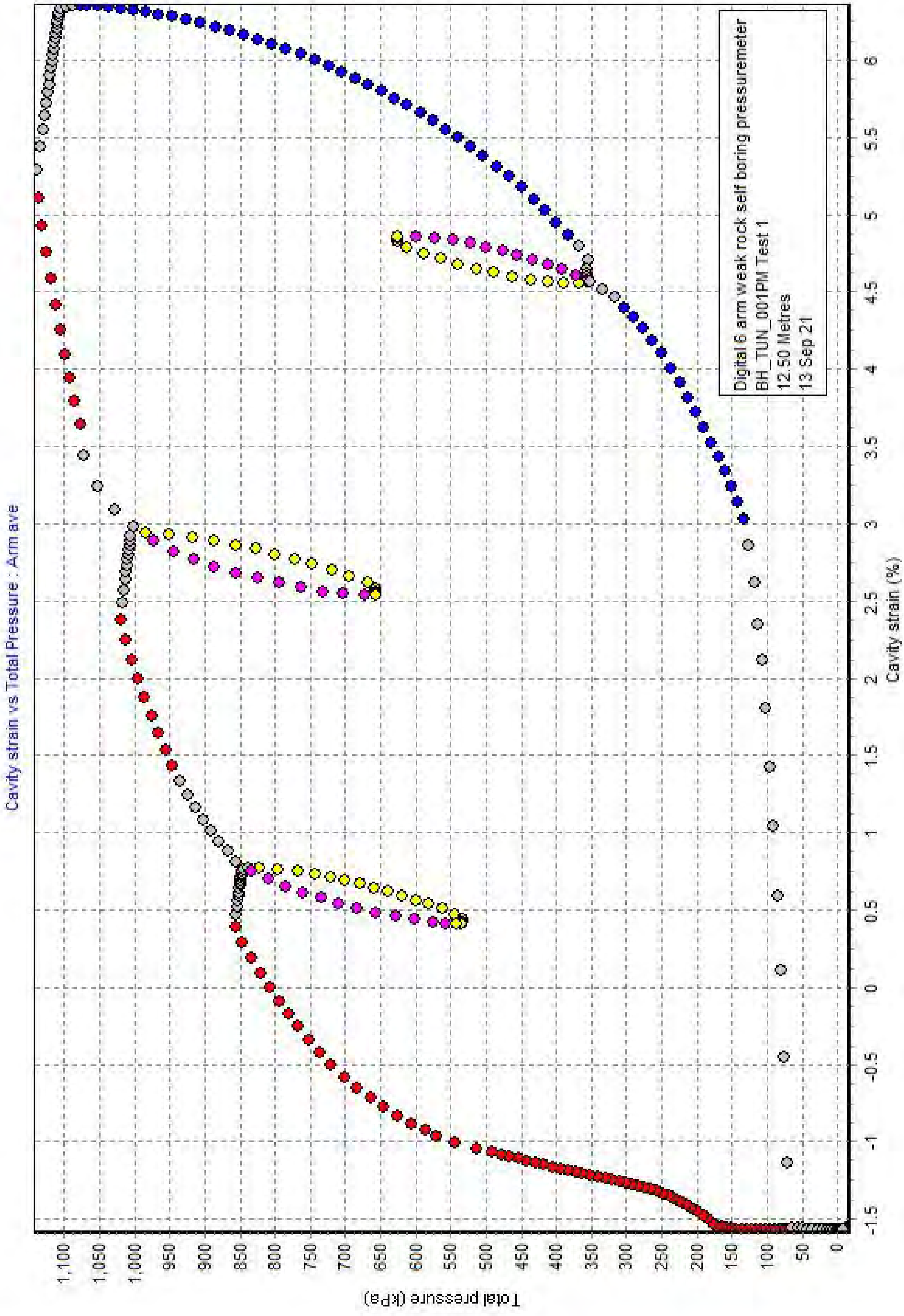
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel +44 (0)1223 262361

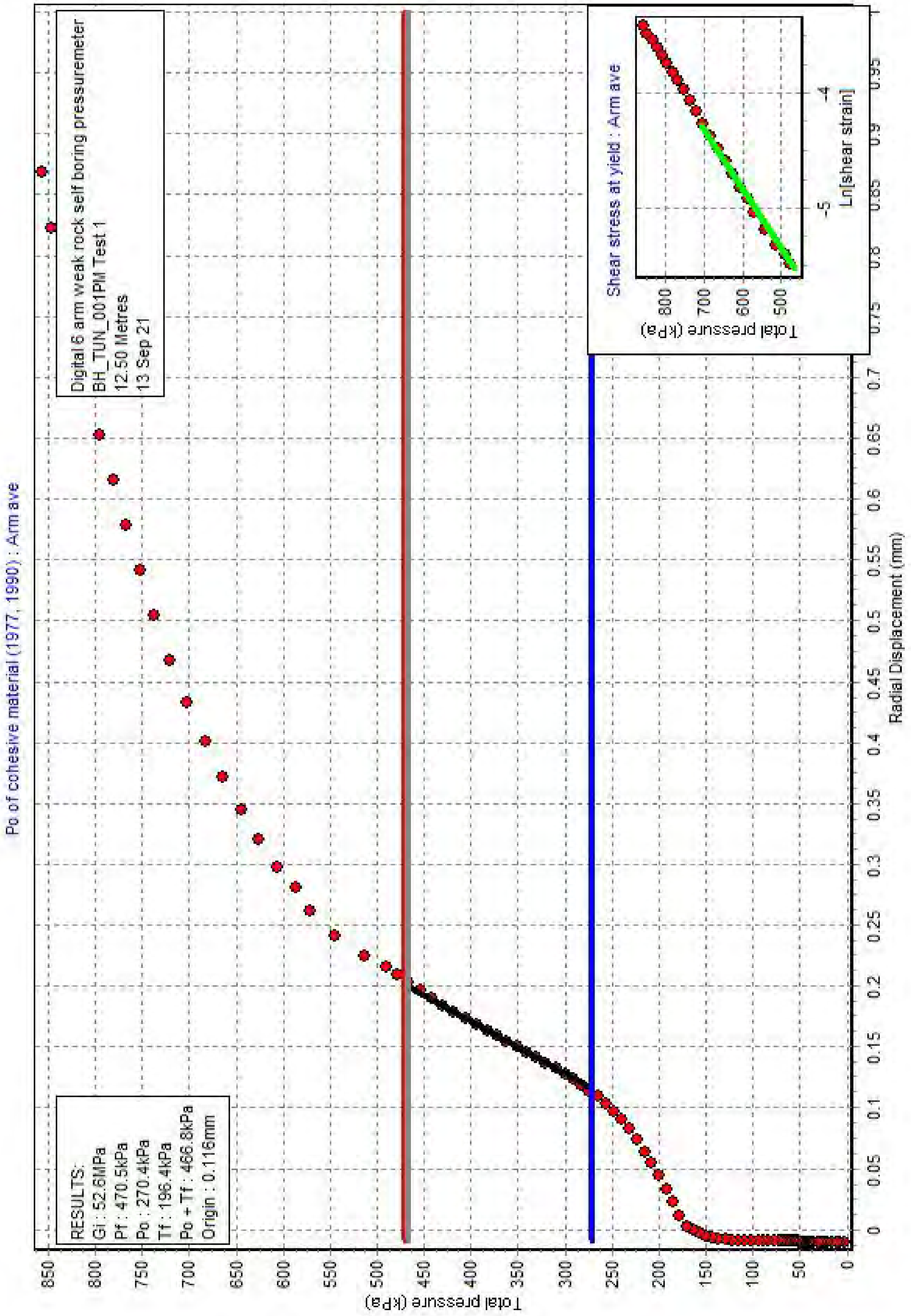


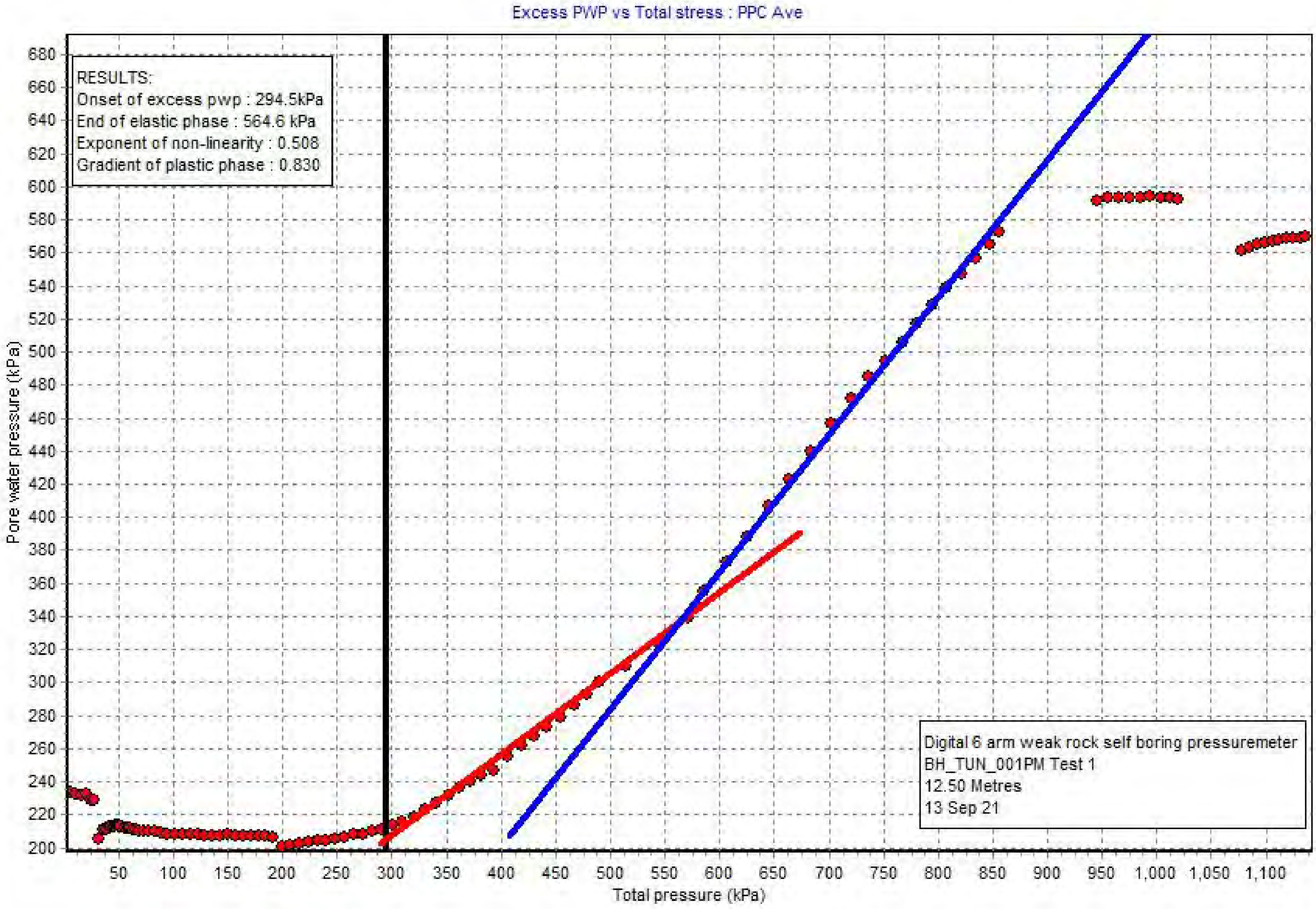
B021T03
12.0 metres
16/08/21

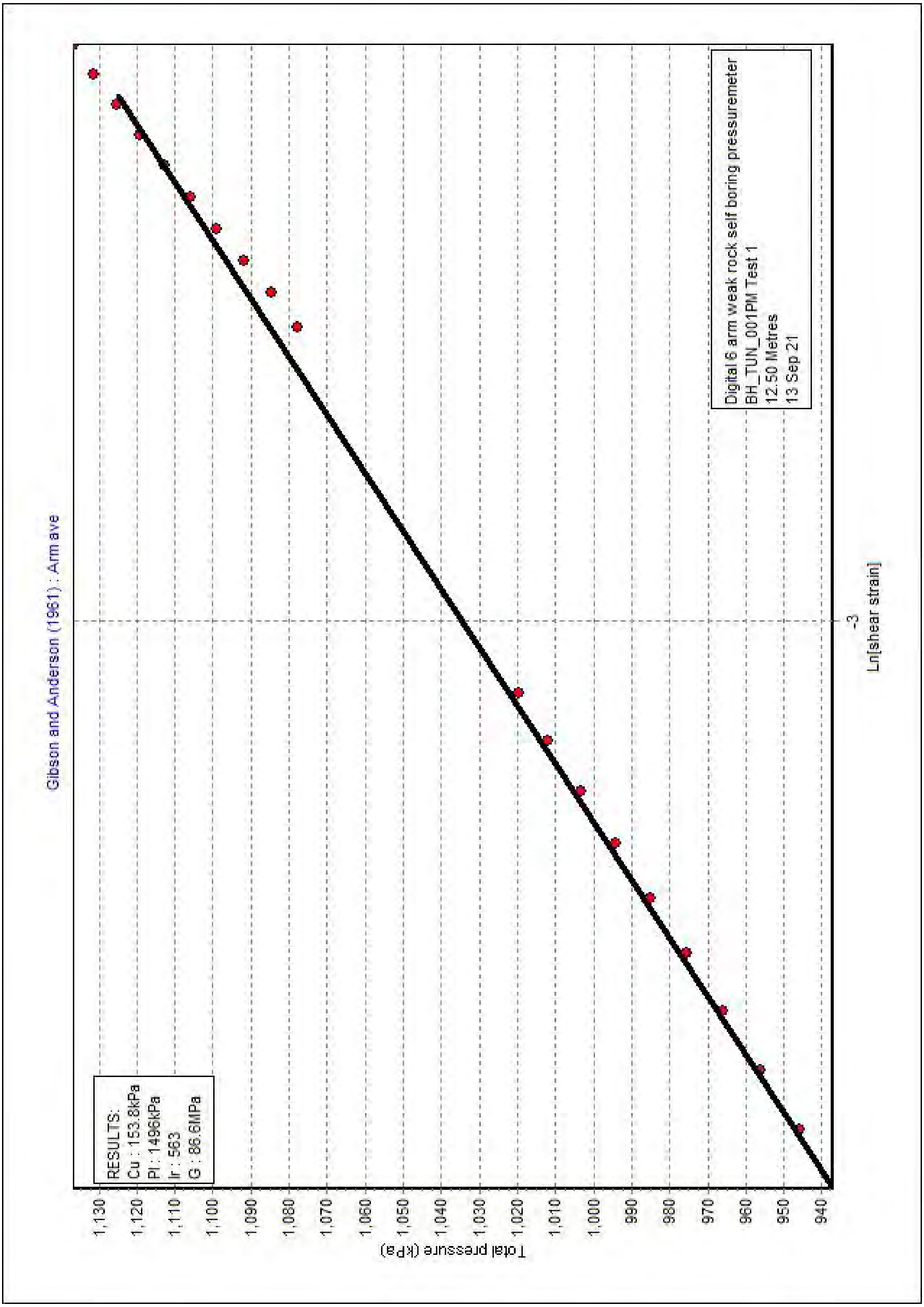
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel. +44 (0)1223 262361

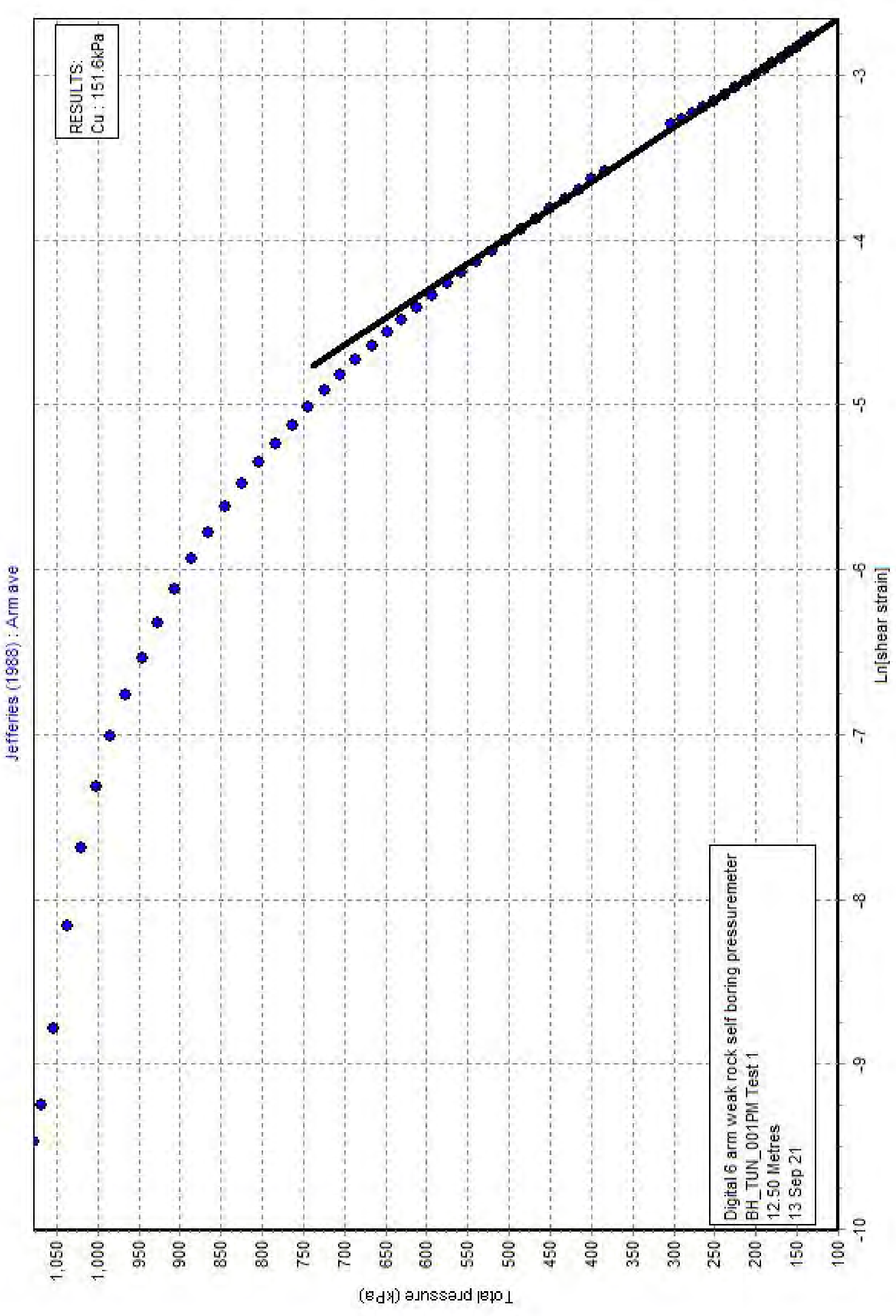
```
BH_TUN_001PM Test 1 - SUMMARY OF RESULTS
[File made with WinSitu ]

[DETAILS OF TEST]
Project        :   TE8364
Site           :   Cambridge Waste Water Treatment Plant Relocation Project
Borehole       :   BH_TUN_001PM
Test name      :   BH_TUN_001PM Test 1
Test date      :   13 Sep 21
Test depth     :   12.50 Metres
Water table    :   1.25 Metres
Ambient PWP    :   110.0 kPa
Material       :   Gault Clay
Probe          :   Digital 6 arm weak rock self boring pressuremeter
Diameter       :   88.1 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out
The file includes results from a curve fitting analysis

Analysed by YB / ES / RW on 14 Sep 21

Remarks:  Cutting shoe caught on casing, caused damange to cutting shoe
and resulted in a disturbed pocket.

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm)                  :   "Arm ave=0.69"
Po from Marsland & Randolph (kPa)   :   "Arm ave=270.4"
PWP versus Total Stress (kPa)       :   "PPC Ave=294.5"
Best estimate of Po (kPa)           :   "Arm ave=368.0"

[UNDRAINED STRENGTH PARAMETERS]
Gibson & Anderson 1961 - Cu (kPa)   :   "Arm ave=153.8"
Limit pressure (kPa)                :   "Arm ave=1496"
Jefferies 1988 - Cu (kPa)           :   "Arm ave=151.6"
Undrained yield stress (kPa)        :   "Arm ave=470.5"
PWP derived yield stress (kPa)      :   "PPC Ave=564.6"

[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=52.6"
Axis       Loop   Value    Mean Strain  Mean Pc  dE      dPc
           No     (MPa)    (%)          (kPa)    (%)     (kPa)
Arm ave    1      42.6     0.599        686      0.696   297
Arm ave    2      43.2     2.742        819      0.749   325
Arm ave    3      45.5     4.716        495      0.567   259

[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]
Axis       Loop   Intercept  Alpha      Gradient
           No     (MPa)      (MPa)
Arm ave    1      6.333      3.848      0.608
Arm ave    2      5.474      3.112      0.568
Arm ave    3      5.308      3.029      0.571

Non-linear exponent from PWP response :   "PPC Ave=0.508"

[PARAMETERS USED FOR UNDRAINED CURVE MODELLING]
{Axis is  Arm ave}
Strain Origin (mm)                  :   0.69
Po (kPa)                            :   368
Cu (kPa)                            :   153.8
Limit pressure (kPa)                :   1496
Non-linear exponent                 :   0.571
Calculated alpha (MPa)              :   3.726
G at yield (MPa)                    :   40.9
```

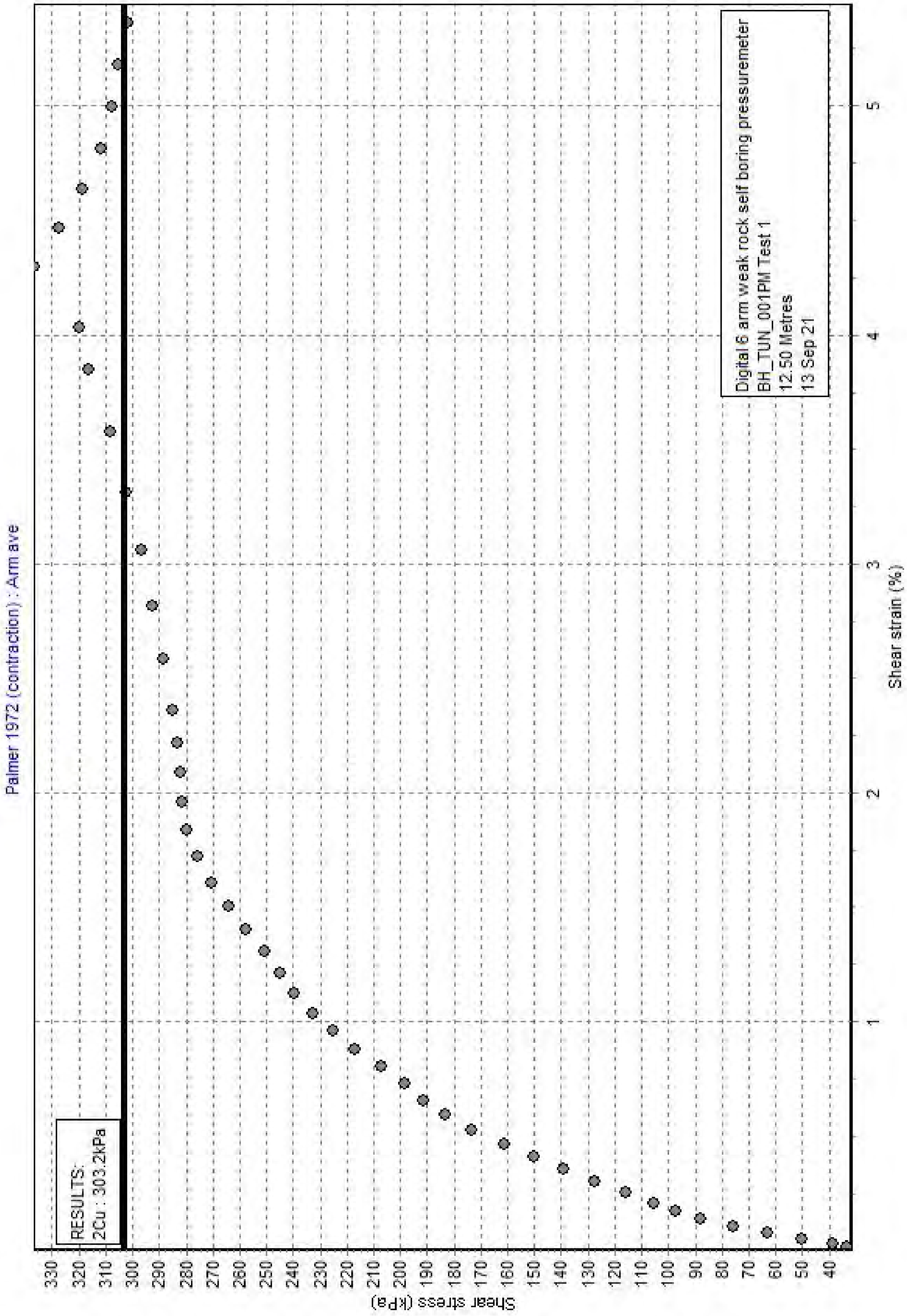

Cavity strain vs Total Pressure : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 1
12.50 Metres
13 Sep 21
Total pressure (kPa)
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Cavity strain (%)
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6

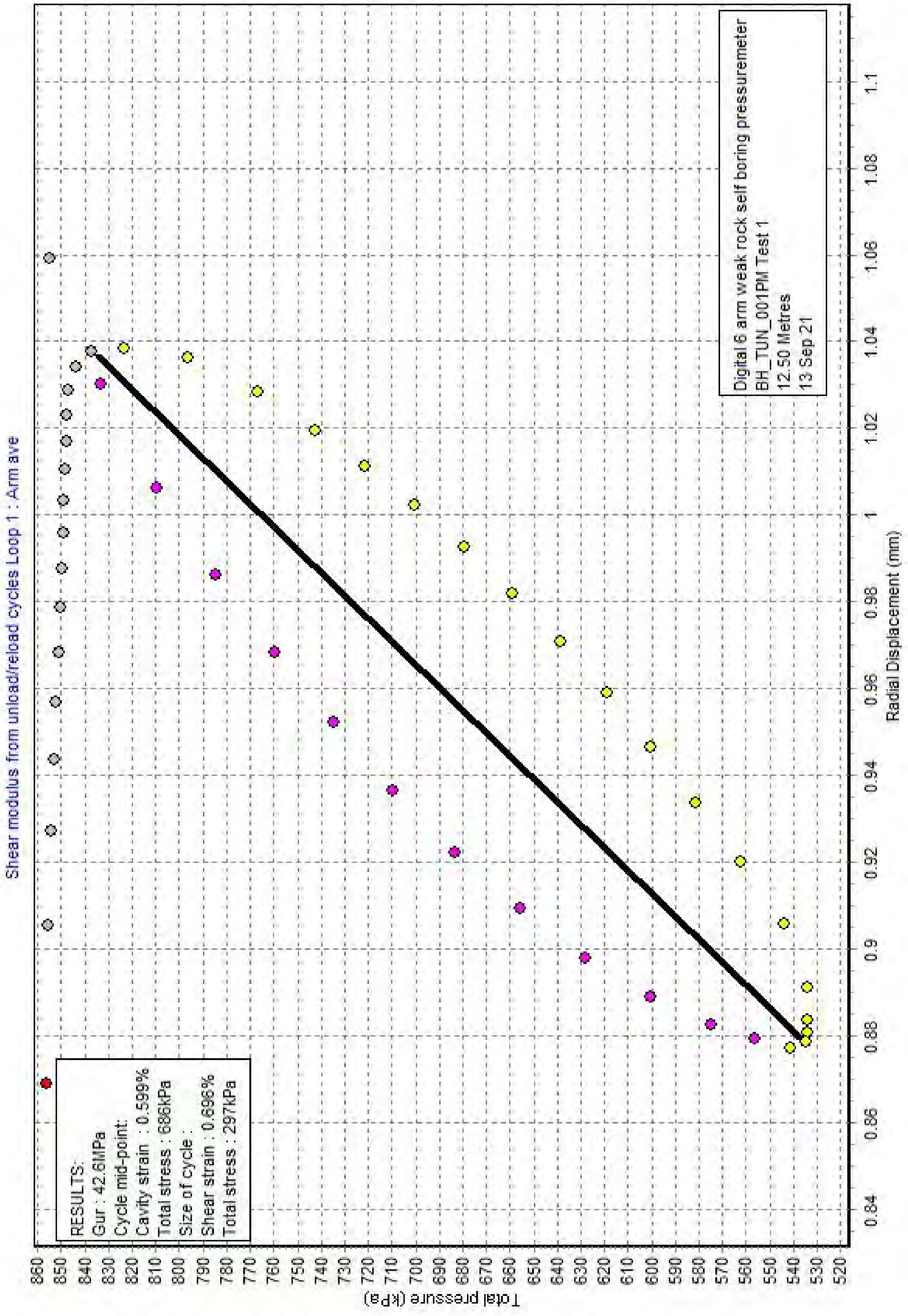

Po of cohesive material (1977, 1990) : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 1
12.50 Metres
13 Sep 21
RESULTS:
Gi : 52.6MPa
Pf : 470.5kPa
Po : 270.4kPa
Tf : 196.4kPa
Po + Tf : 466.8kPa
Origin : 0.116mm
Total pressure (kPa)
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Radial Displacement (mm)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0.75
0.8
0.85
0.9
0.95
Shear stress at yield : Arm ave
Total pressure (kPa)
800
700
600
500
Ln[shear strain]
-5
-4


Excess PWP vs Total stress : PPC Ave
RESULTS:
Onset of excess pwp : 294.5kPa
End of elastic phase : 564.6 kPa
Exponent of non-linearity : 0.508
Gradient of plastic phase : 0.830
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 1
12.50 Metres
13 Sep 21
Pore water pressure (kPa)
680
660
640
620
600
580
560
540
520
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
Total pressure (kPa)
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1,000
1,050
1,100


Gibson and Anderson (1961) : Arm ave
RESULTS:
Cu : 153.8kPa
Pl : 1496kPa
Ir : 563
G : 86.6MPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 1
12.50 Metres
13 Sep 21
Total pressure (kPa)
1,130
1,120
1,110
1,100
1,090
1,080
1,070
1,060
1,050
1,040
1,030
1,020
1,010
1,000
990
980
970
960
950
940
-3
Ln[shear strain]


Jefferies (1988) : Arm ave
RESULTS:
Cu : 151.6kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 1
12.50 Metres
13 Sep 21
Total pressure (kPa)
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
Ln[shear strain]
-3
-4
-5
-6
-7
-8
-9
-10

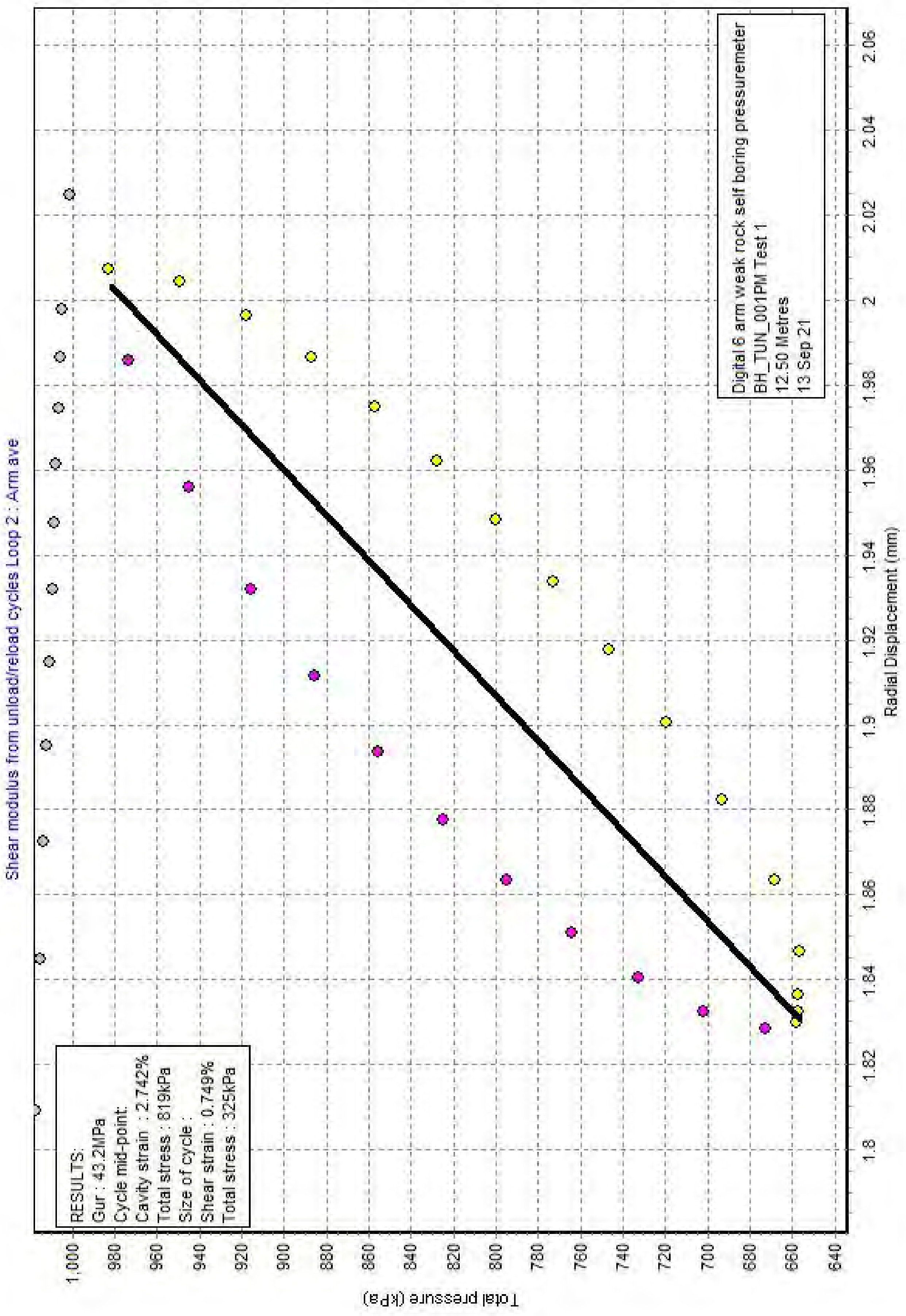

Palmer 1972 (contraction) : Arm ave
RESULTS:
2Cu : 303.2kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 1
12.50 Metres
13 Sep 21
Shear stress (kPa)
330
320
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
Shear strain (%)
1
2
3
4
5

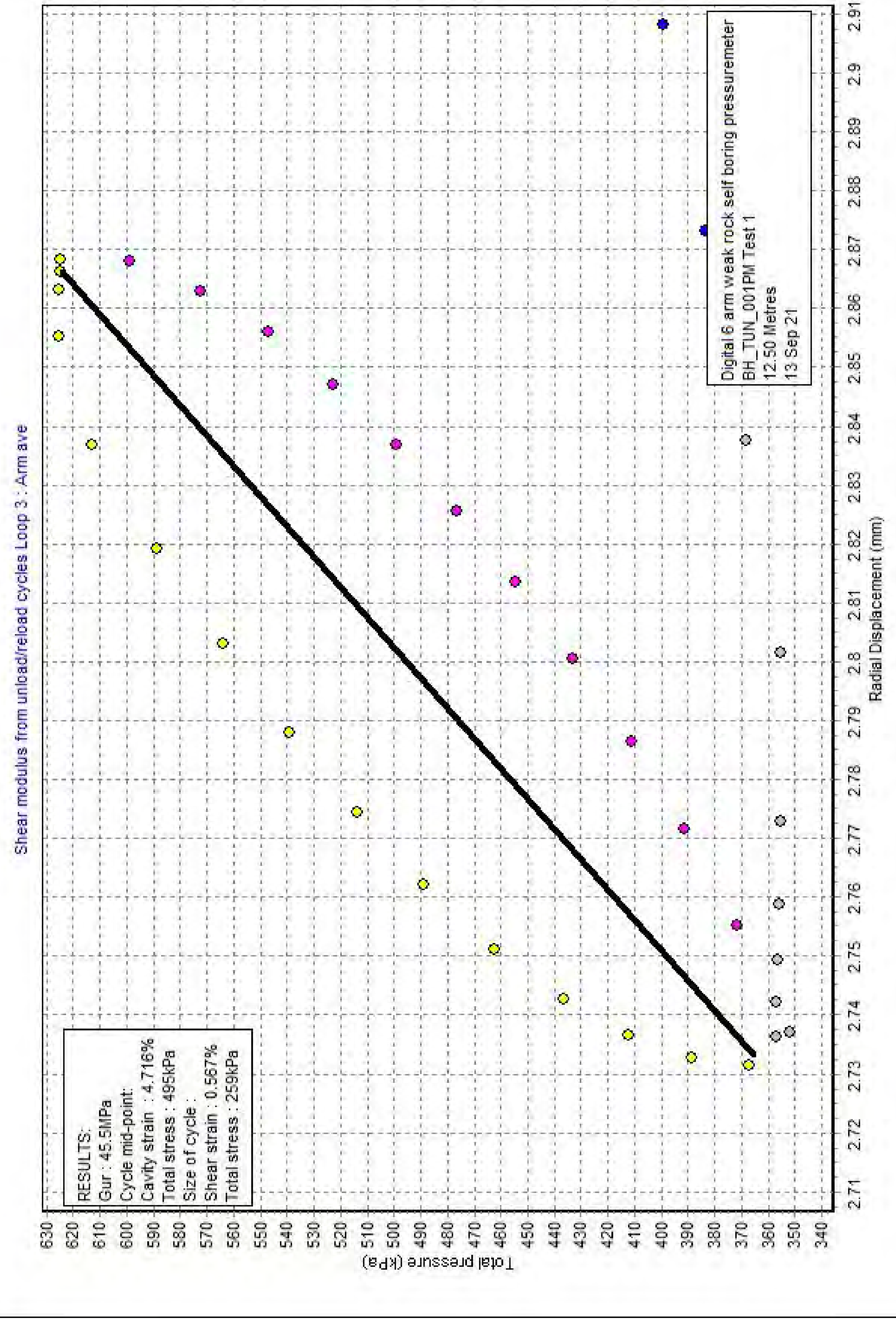


Shear modulus from unload/reload cycles Loop 1 : Arm ave

RESULTS:
Gur : 42.6MPa
Cycle mid-point:
Cavity strain : 0.599%
Total stress : 686kPa
Size of cycle :
Shear strain : 0.696%
Total stress : 297kPa

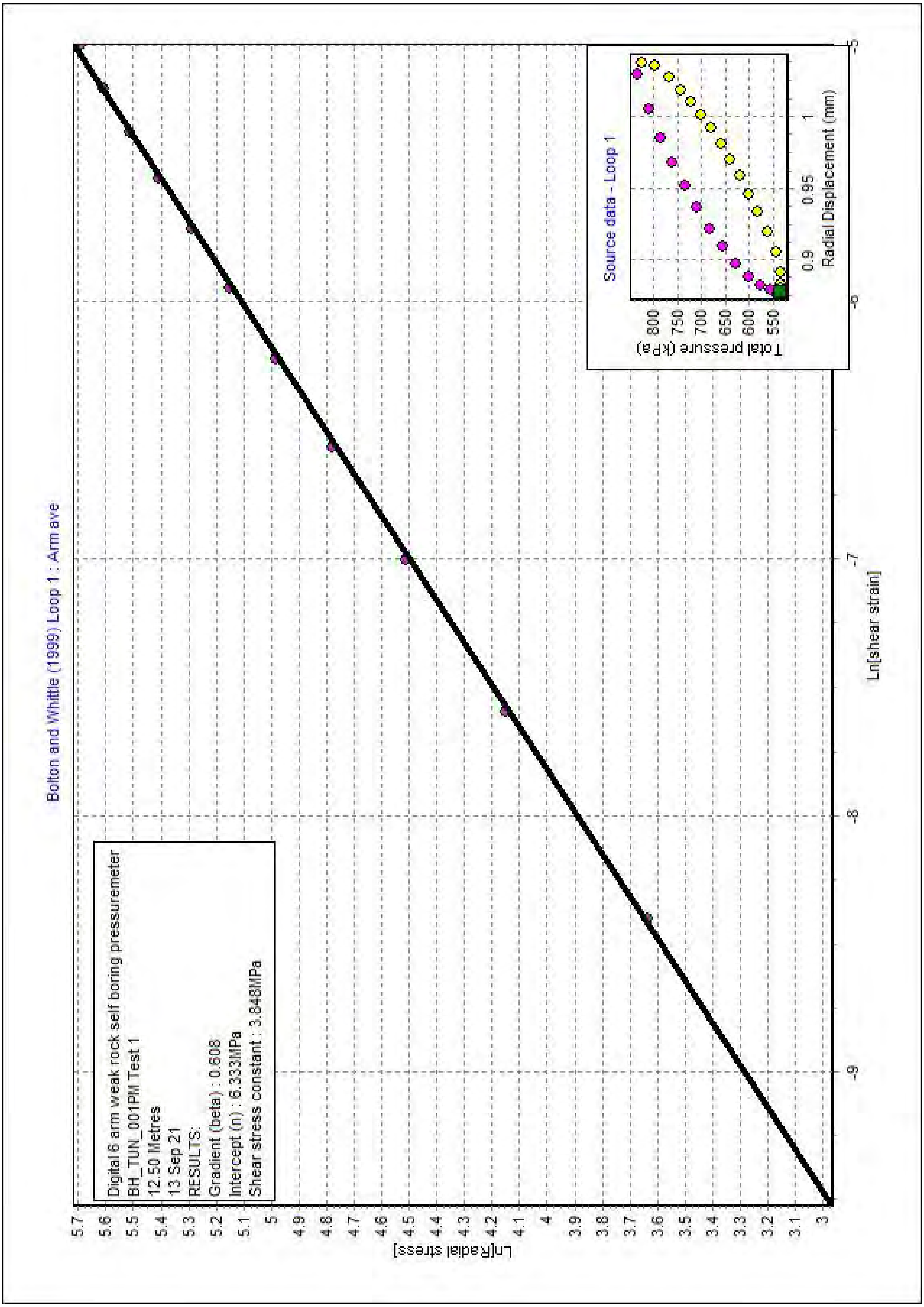
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 1
12.50 Metres
13 Sep 21

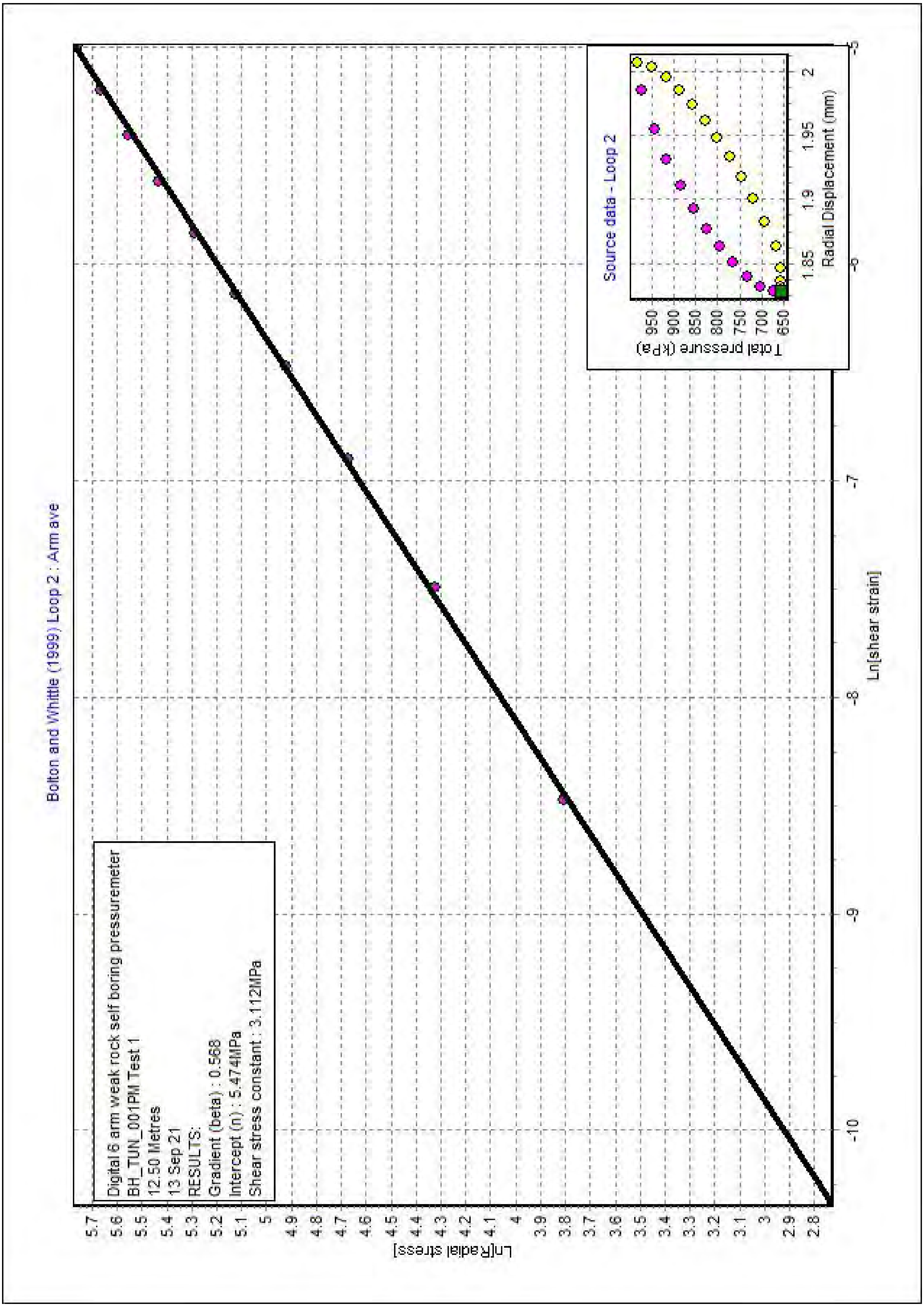

Shear modulus from unload/reload cycles Loop 2 : Arm ave
RESULTS:
Gur : 43.2MPa
Cycle mid-point:
Cavity strain : 2.742%
Total stress : 819kPa
Size of cycle :
Shear strain : 0.749%
Total stress : 325kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 1
12.50 Metres
13 Sep 21
Total pressure (kPa)
1,000
980
960
940
920
900
880
860
840
820
800
780
760
740
720
700
680
660
640
Radial Displacement (mm)
1.8
1.82
1.84
1.86
1.88
1.9
1.92
1.94
1.96
1.98
2
2.02
2.04
2.06

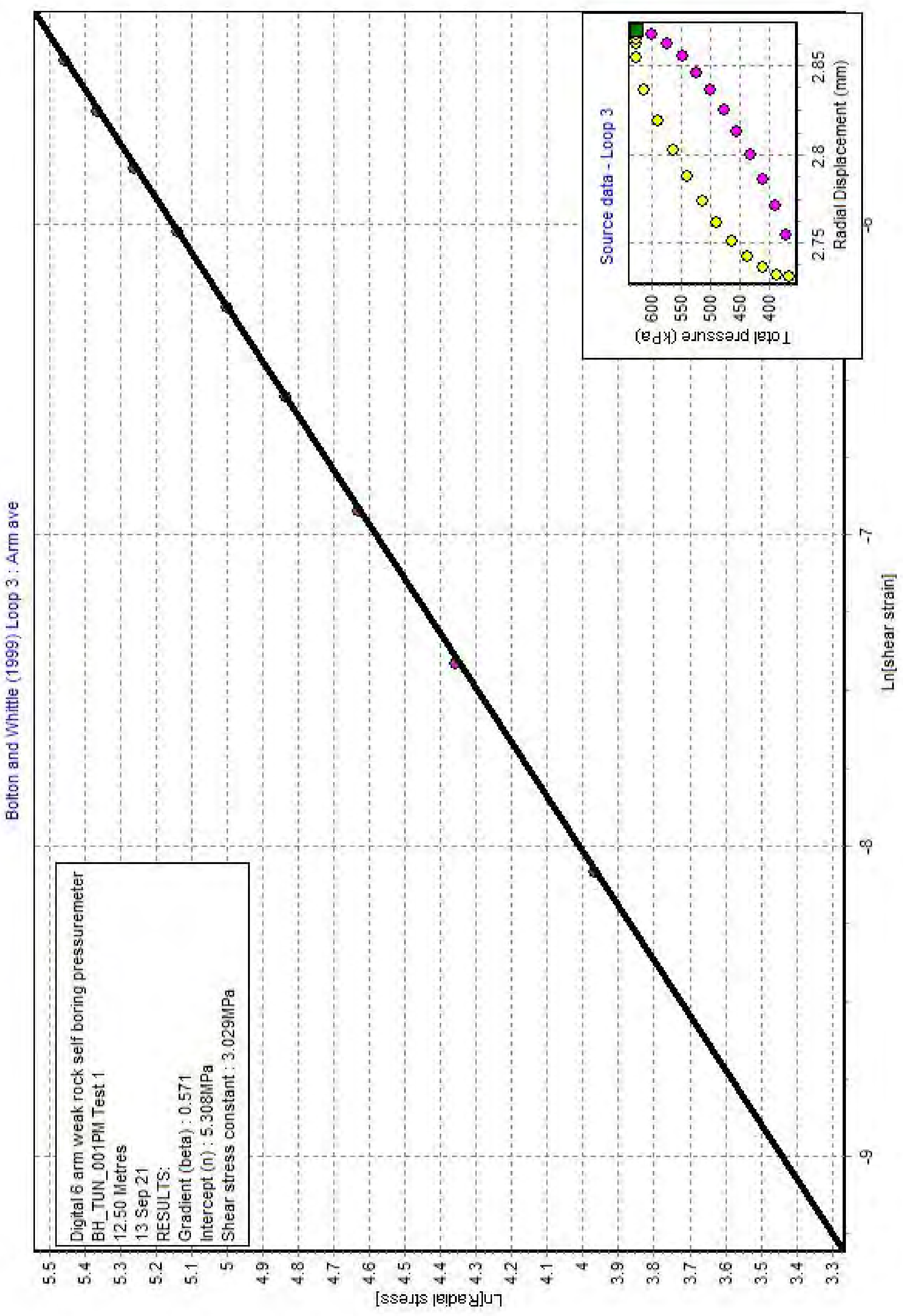


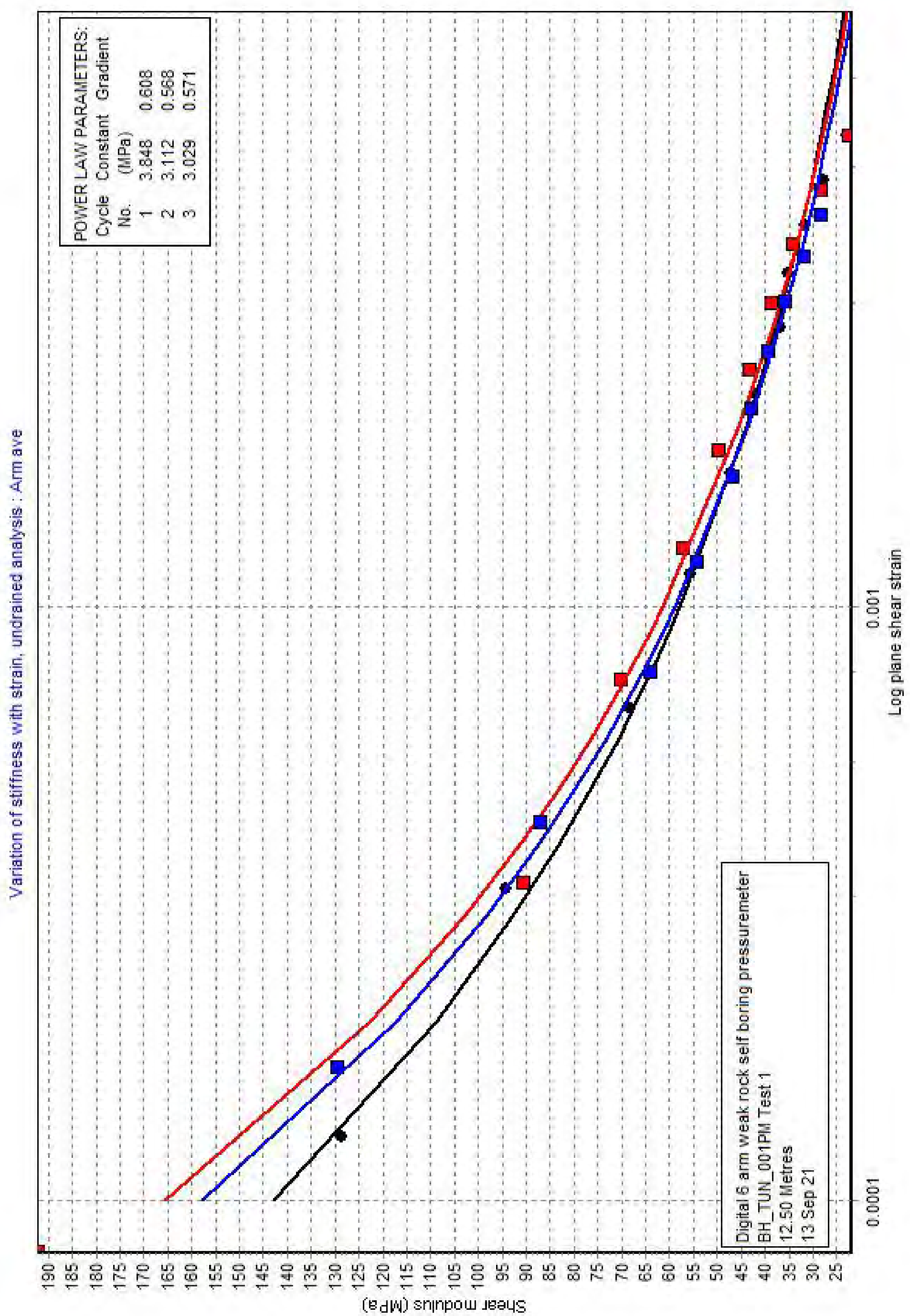
RESULTS:
Gur : 45.5MPa
Cycle mid-point:
Cavity strain : 4.716%
Total stress : 495kPa
Size of cycle :
Shear strain : 0.567%
Total stress : 259kPa

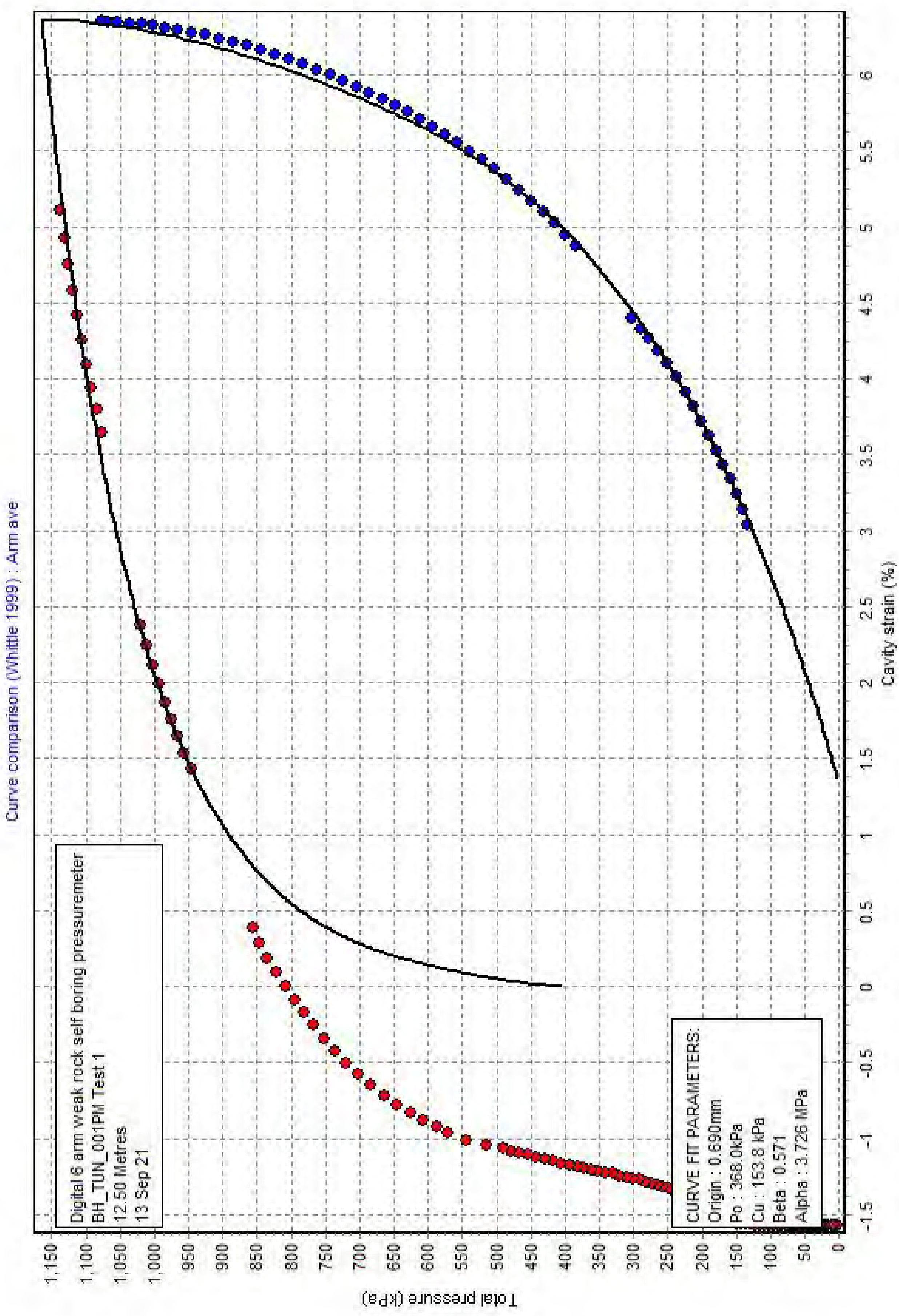
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 1
12.50 Metres
13 Sep 21

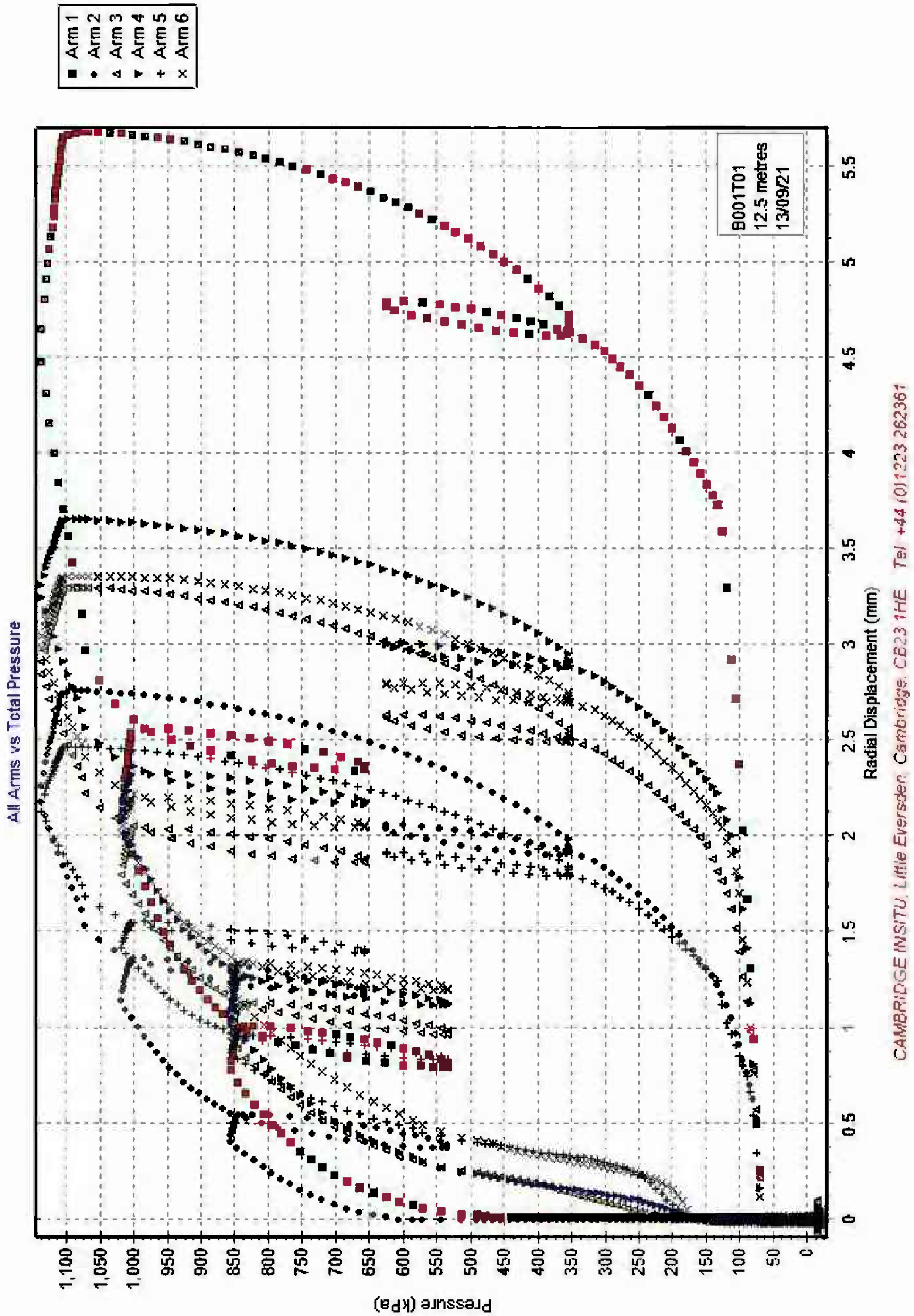

Bolton and Whittle (1999) Loop 1 : Arm ave
Ln[Radial stress]
Ln[shear strain]
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
-9
-8
-7
-6
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 1
12.50 Metres
13 Sep 21
RESULTS:
Gradient (beta) : 0.608
Intercept (n) : 6.333MPa
Shear stress constant : 3.848MPa
Source data - Loop 1
Total pressure (kPa)
Radial Displacement (mm)
800
750
700
650
600
550
0.9
0.95
1


Bolton and Whittle (1999) Loop 2 : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 1
12.50 Metres
13 Sep 21
RESULTS:
Gradient (beta) : 0.568
Intercept (n) : 5.474MPa
Shear stress constant : 3.112MPa
Ln[Radial stress]
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
2.9
2.8
Ln[shear strain]
-10
-9
-8
-7
-6
-5
Source data - Loop 2
Total pressure (kPa)
950
900
850
800
750
700
650
Radial Displacement (mm)
1.85
1.9
1.95
2


Bolton and Whittle (1999) Loop 3 : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 1
12.50 Metres
13 Sep 21
RESULTS:
Gradient (beta) : 0.571
Intercept (n) : 5.308MPa
Shear stress constant : 3.029MPa
Ln[Radial stress]
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
Ln[shear strain]
-9
-8
-7
-6
Source data - Loop 3
Total pressure (kPa)
600
550
500
450
400
Radial Displacement (mm)
2.75
2.8
2.85


Variation of stiffness with strain, undrained analysis : Arm ave
POWER LAW PARAMETERS:
Cycle Constant Gradient
No. (MPa)
1 3.848 0.608
2 3.112 0.568
3 3.029 0.571
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 1
12.50 Metres
13 Sep 21
Shear modulus (MPa)
190
185
180
175
170
165
160
155
150
145
140
135
130
125
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
0.0001
0.001
Log plane shear strain

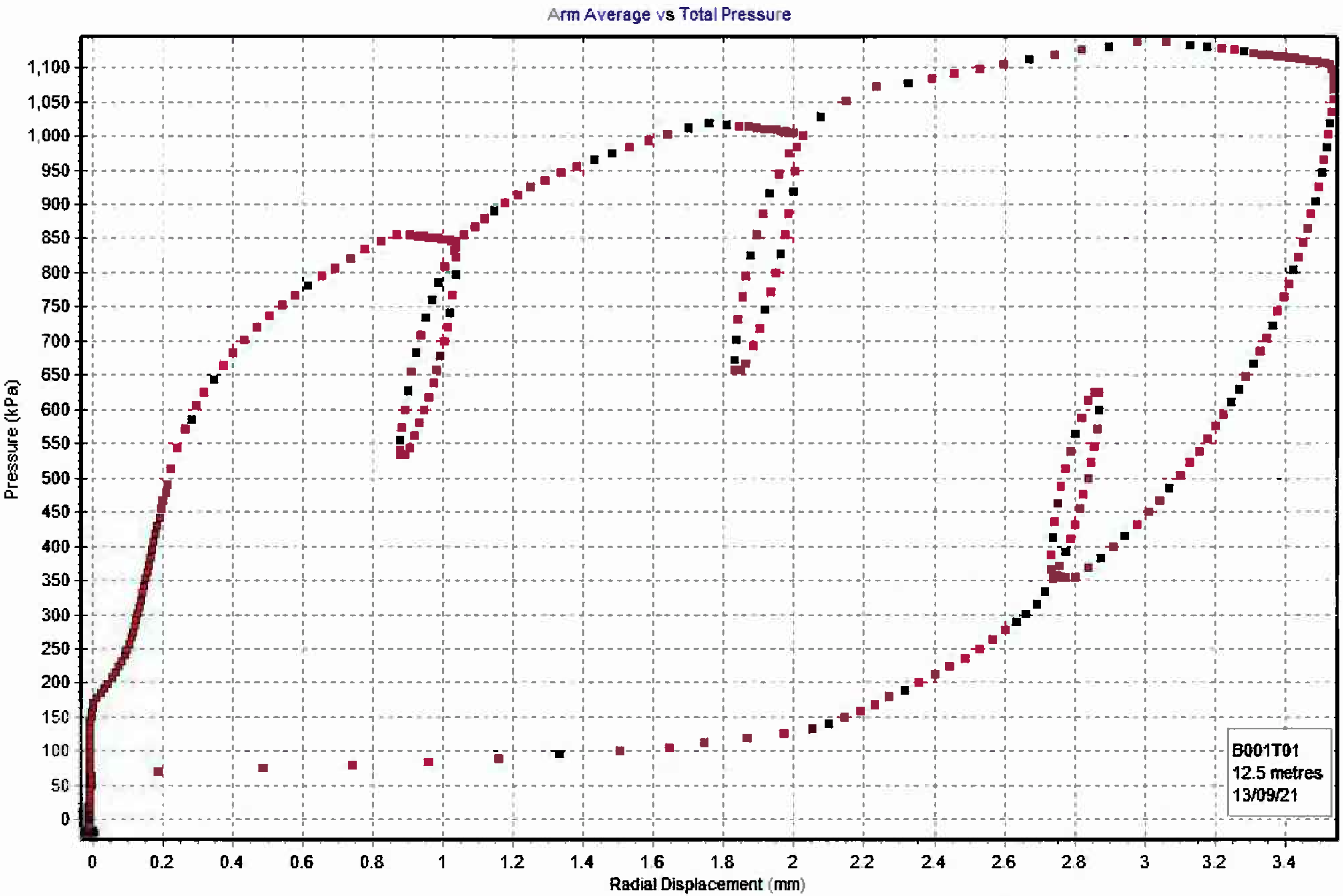

Curve comparison (Whittle 1999) : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 1
12.50 Metres
13 Sep 21
CURVE FIT PARAMETERS:
Origin : 0.690mm
Po : 368.0kPa
Cu : 153.8 kPa
Beta : 0.571
Alpha : 3.726 MPa
Total pressure (kPa)
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Cavity strain (%)
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6


All Arms vs Total Pressure
■ Arm 1
● Arm 2
△ Arm 3
▼ Arm 4
+ Arm 5
× Arm 6
B001T01
12.5 metres
13/09/21
Radial Displacement (mm)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
Pressure (kPa)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1,000
1,050
1,100
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel +44 (0)1223 262361

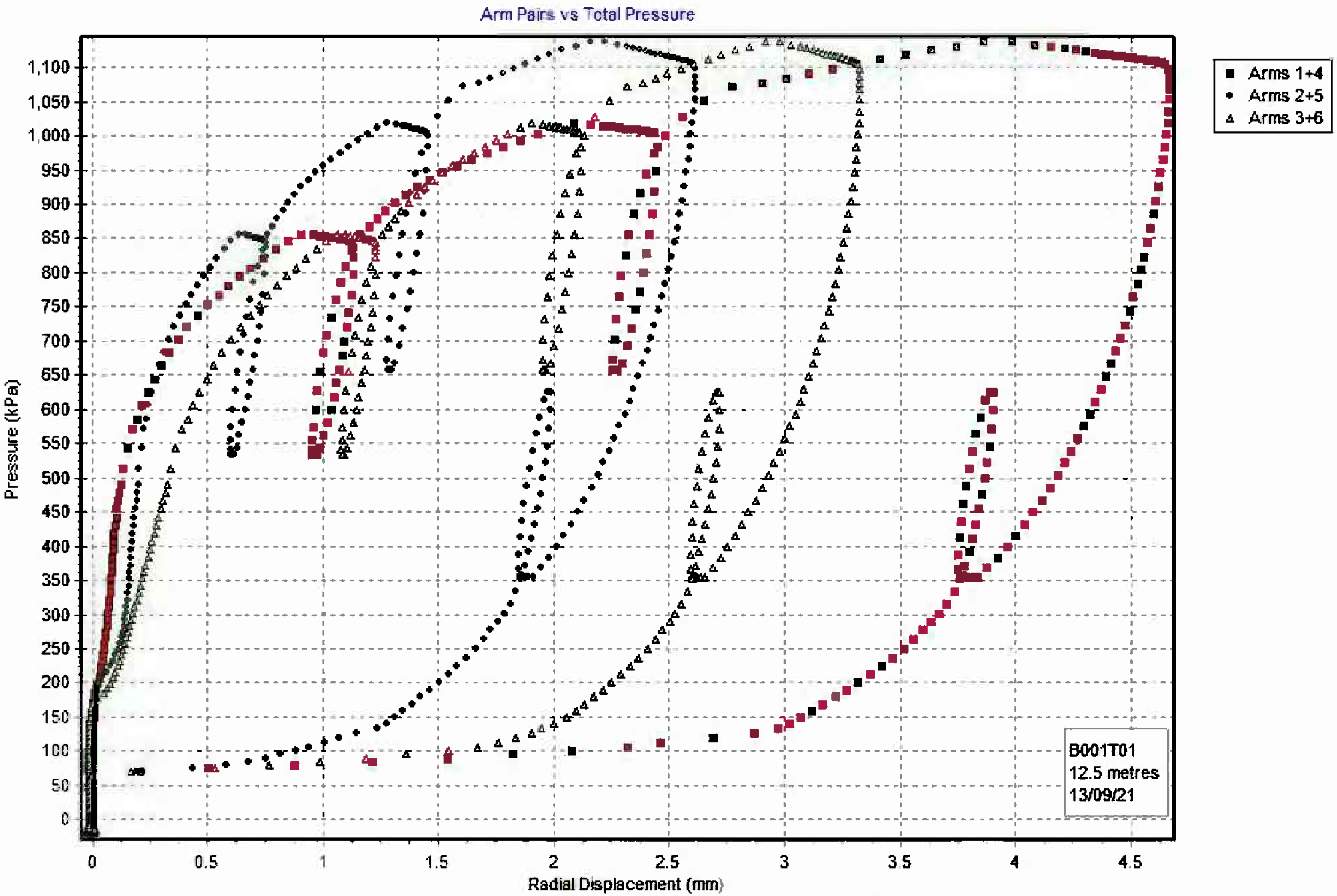
CIR1506/21

Cambridge WWTPR

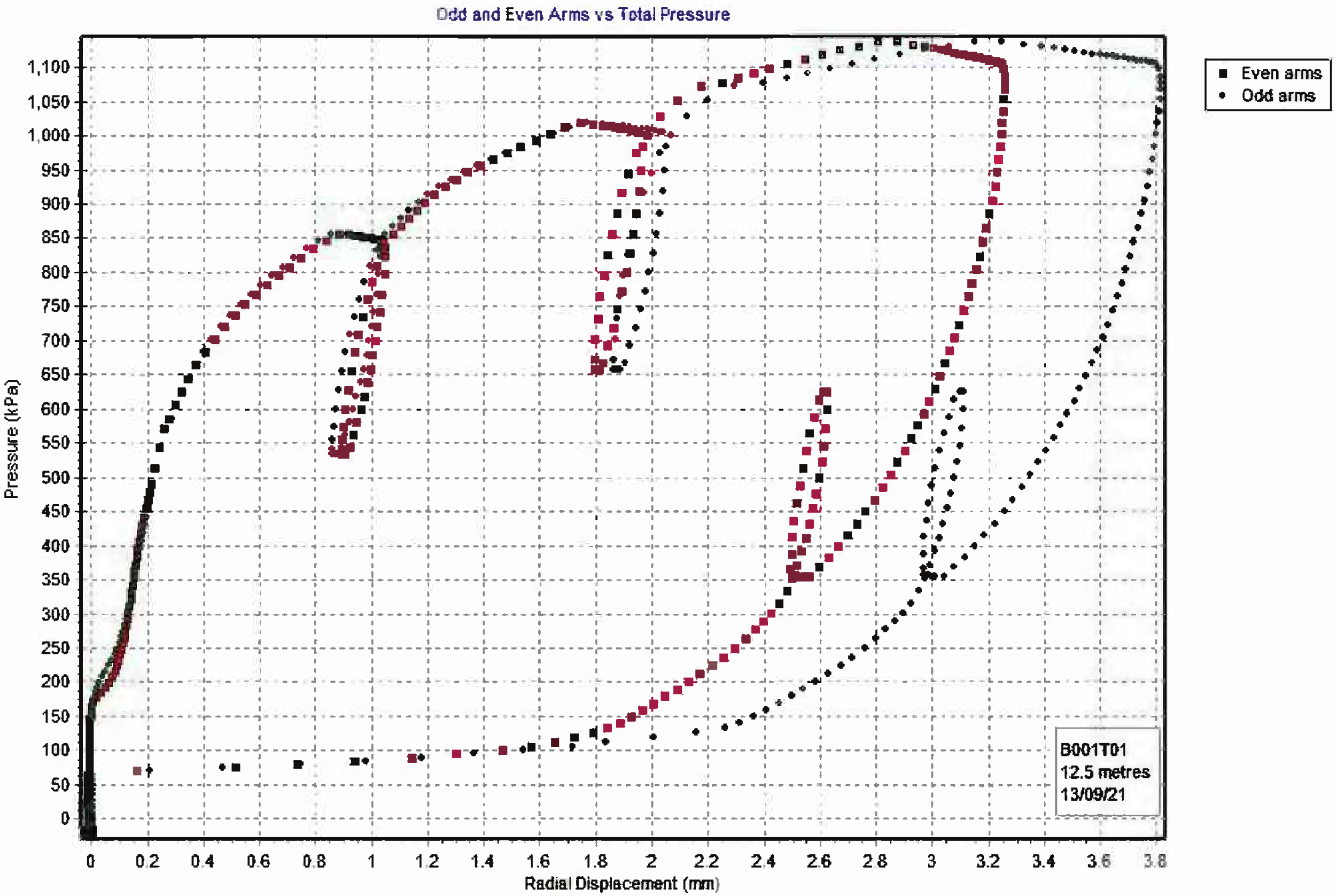
Pressuremeter Testing



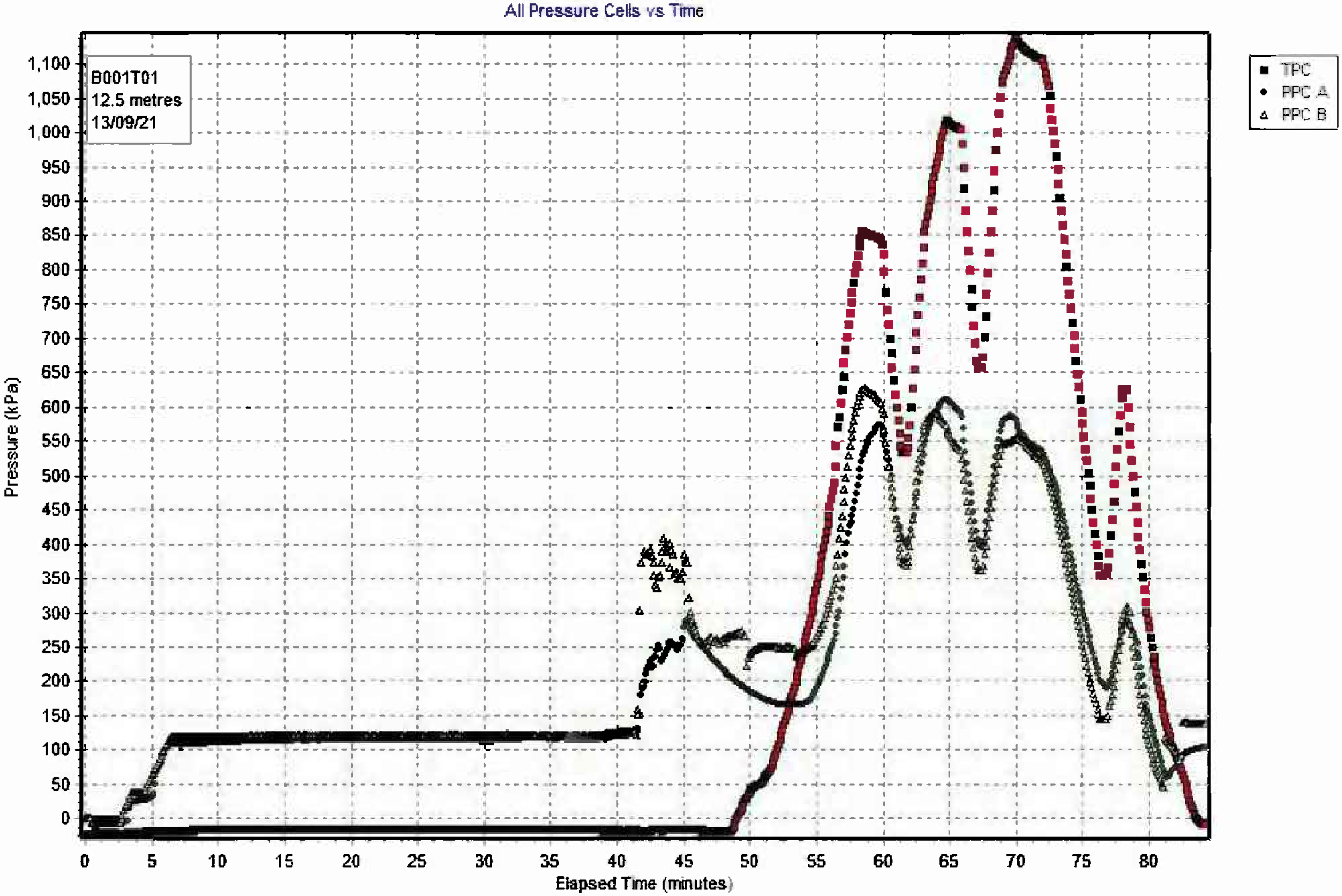
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel +44 (0)1223 262361



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361

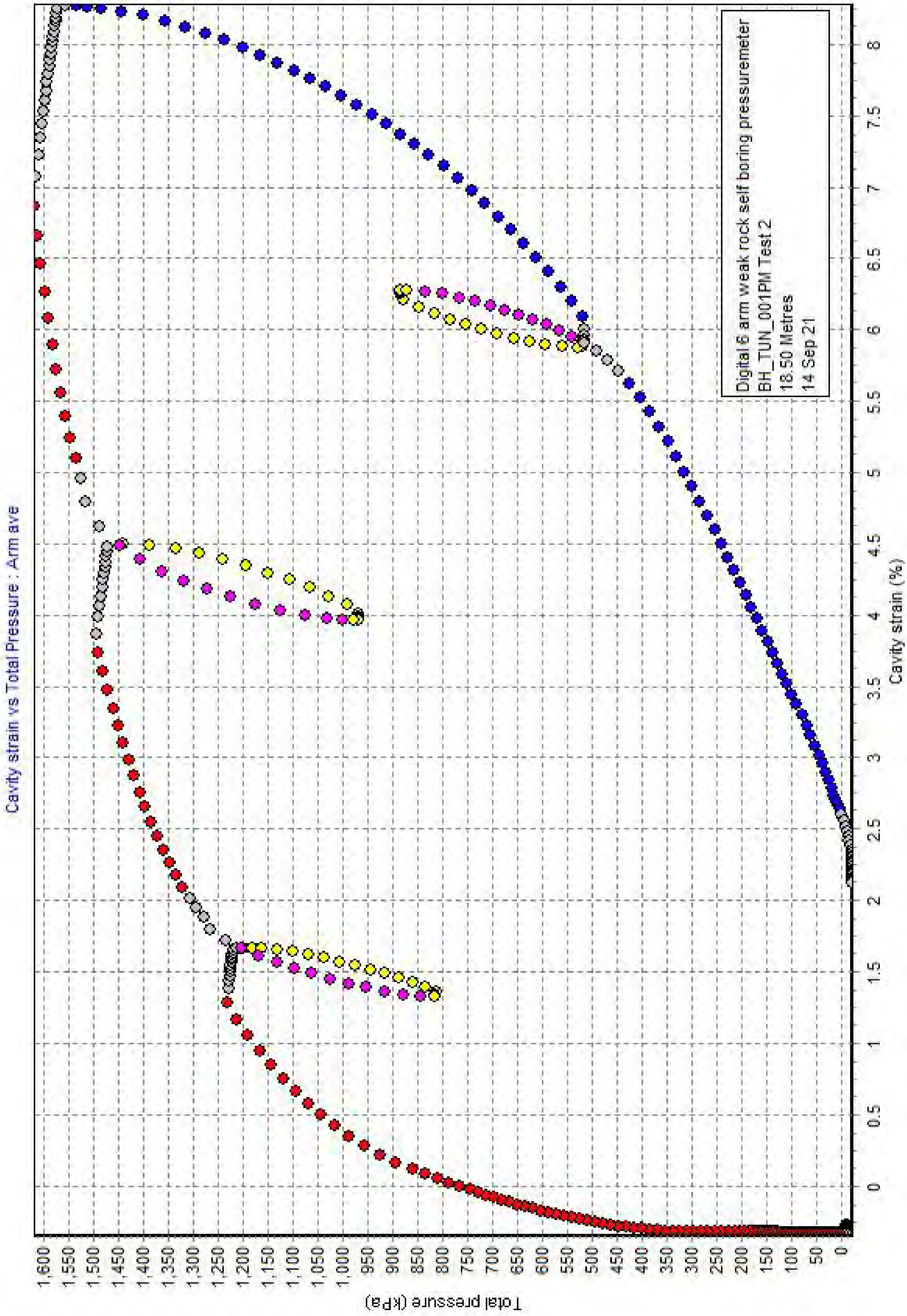


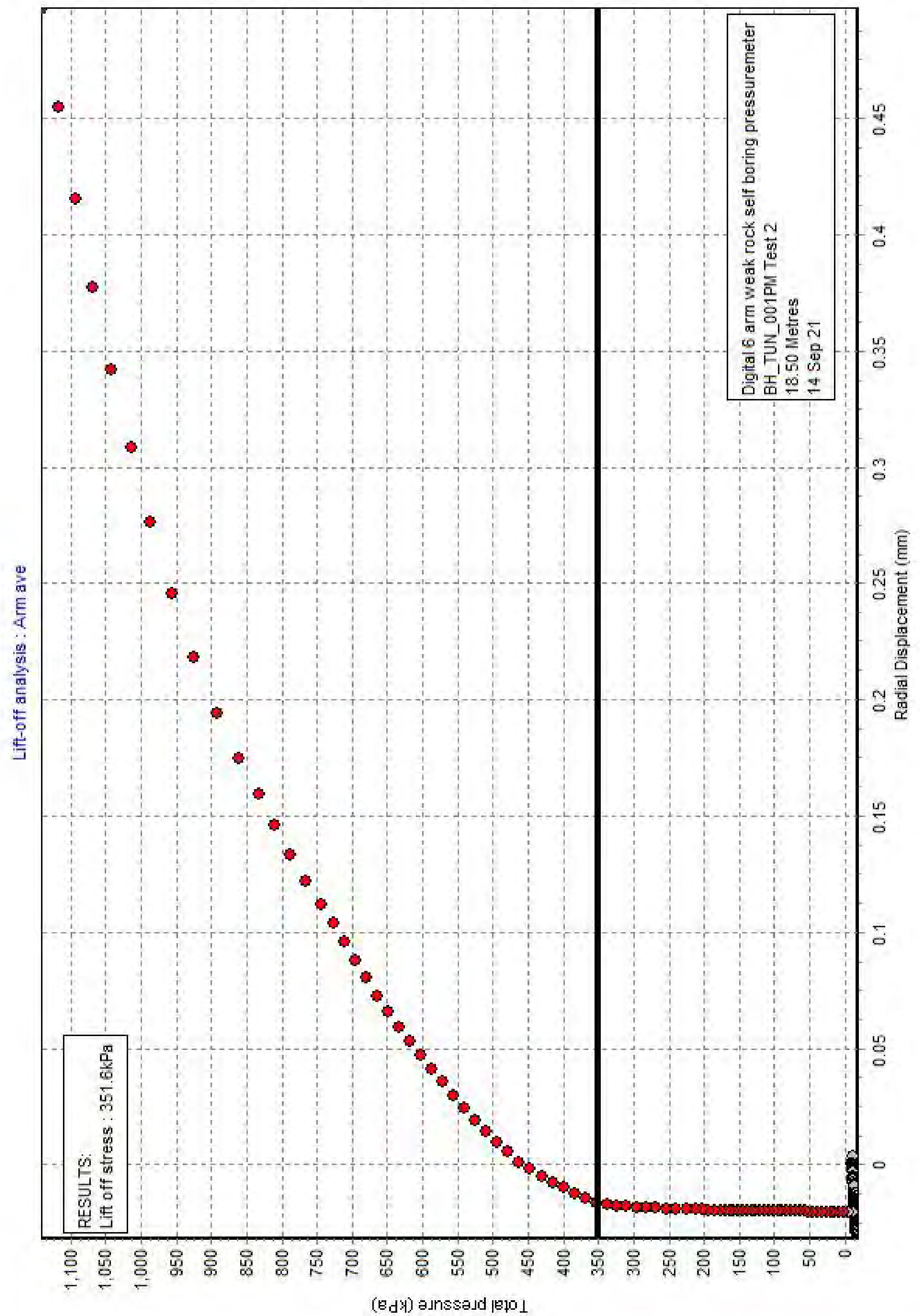
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361

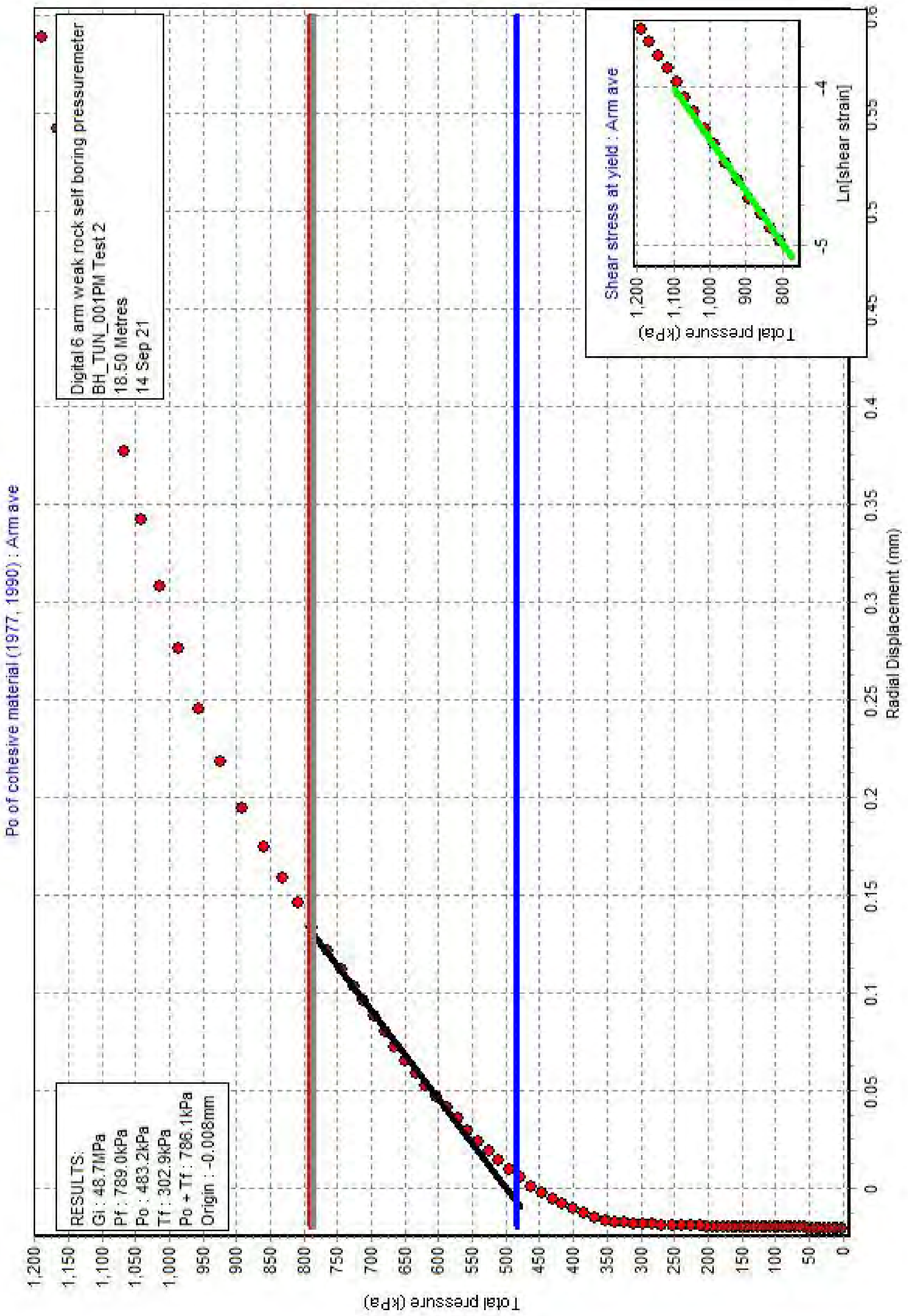


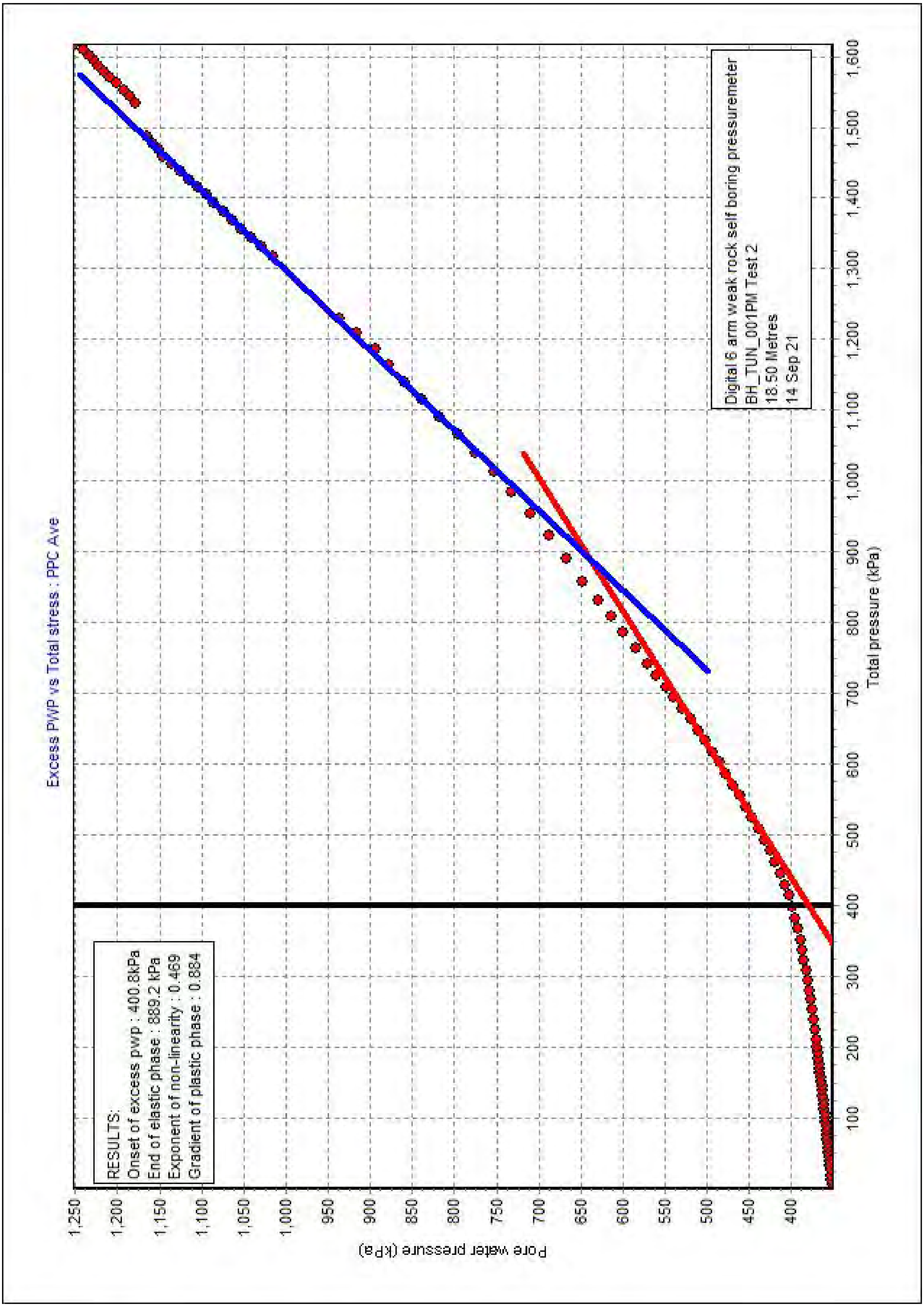
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361

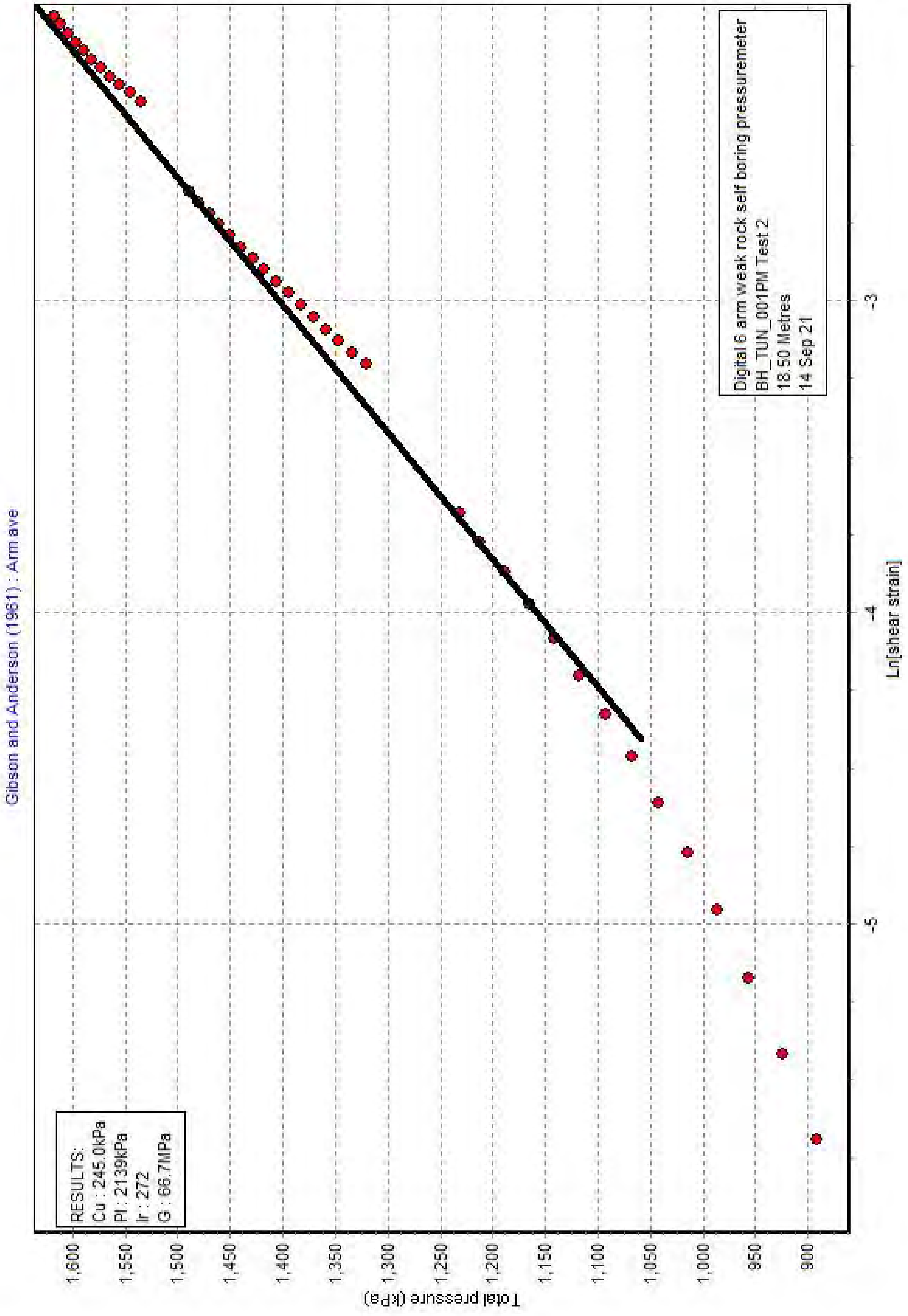
```
BH_TUN_001PM Test 2 - SUMMARY OF RESULTS
[File made with WinSitu ]

[DETAILS OF TEST]
Project        :   TE8364
Site           :   Cambridge Waste Water Treatment Plant Relocation Project
Borehole       :   BH_TUN_001PM
Test name      :   BH_TUN_001PM Test 2
Test date      :   14 Sep 21
Test depth     :   18.50 Metres
Water table    :   1.25 Metres
Ambient PWP    :   169.0 kPa
Material       :   Gault Clay
Probe          :   Digital 6 arm weak rock self boring pressuremeter
Diameter       :   88.1 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out
The file includes results from a curve fitting analysis

Analysed by YB / ES / RW on 14 Sep 21

Remarks:  SBPM caught on casing shoe resulting in some drilling
issues.

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm)                  :   "Arm ave=0.12"
Po from Marsland & Randolph (kPa)   :   "Arm ave=483.2"
Po from Lift off (kPa)              :   "Arm ave=351.6"
PWP versus Total Stress (kPa)       :   "PPC Ave=400.8"
Best estimate of Po (kPa)           :   "Arm ave=520.0"

[UNDRAINED STRENGTH PARAMETERS]
Gibson & Anderson 1961 - Cu (kPa)   :   "Arm ave=245.0"
Limit pressure (kPa)                :   "Arm ave=2139"
Jefferies 1988 - Cu (kPa)           :   "Arm ave=246.7"
Undrained yield stress (kPa)        :   "Arm ave=789.0"
PWP derived yield stress (kPa)      :   "PPC Ave=889.2"

[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=48.7"
Axis       Loop   Value    Mean Strain  Mean Pc  dE      dPc
           No     (MPa)    (%)          (kPa)    (%)     (kPa)
Arm ave    1      57.6     1.505        1008     0.670   387
Arm ave    2      47.1     4.243        1207     1.005   476
Arm ave    3      49.6     6.090        706      0.719   358

[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]
Axis       Loop   Intercept  Alpha      Gradient
           No     (MPa)      (MPa)
Arm ave    1      10.722     7.073      0.660
Arm ave    2      7.216      4.180      0.579
Arm ave    3      7.821      4.790      0.612

Non-linear exponent from PWP response :   "PPC Ave=0.469"

[PARAMETERS USED FOR UNDRAINED CURVE MODELLING]
{Axis is  Arm ave}
Strain Origin (mm)                  :   0.12
Po (kPa)                            :   520
Cu (kPa)                            :   245.0
Limit pressure (kPa)                :   2139
Non-linear exponent                 :   0.660
Calculated alpha (MPa)              :   7.055
G at yield (MPa)                    :   39.8
```


Cavity strain vs Total Pressure : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 2
18.50 Metres
14 Sep 21
Total pressure (kPa)
1,600
1,550
1,500
1,450
1,400
1,350
1,300
1,250
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Cavity strain (%)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8


Lift-off analysis : Arm ave
RESULTS:
Lift off stress : 351.6kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 2
18.50 Metres
14 Sep 21
Total pressure (kPa)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1,000
1,050
1,100
Radial Displacement (mm)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45

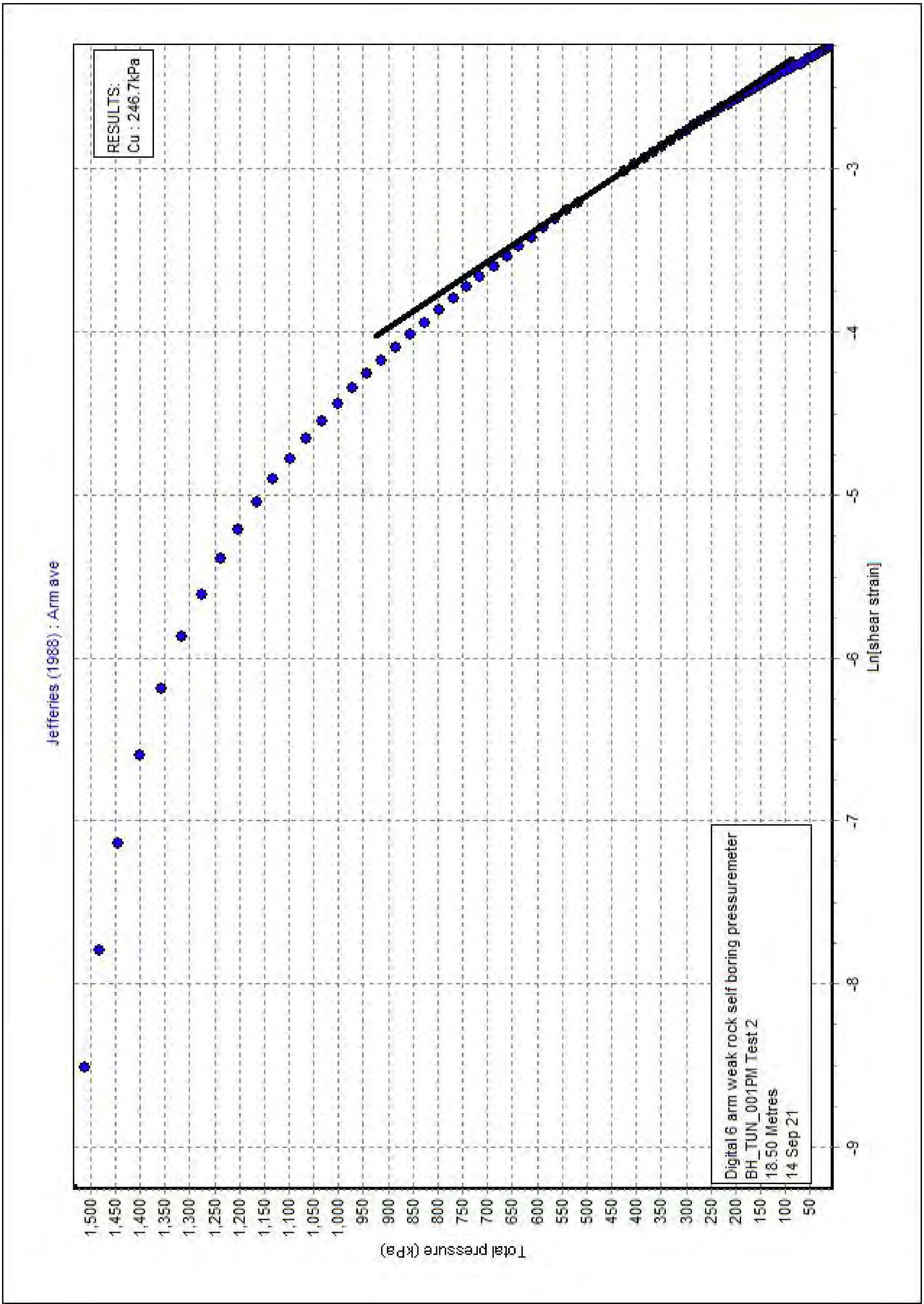

Po of cohesive material (1977, 1990) : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 2
18.50 Metres
14 Sep 21
RESULTS:
Gi : 48.7MPa
Pf : 789.0kPa
Po : 483.2kPa
Tf : 302.9kPa
Po + Tf : 786.1kPa
Origin : -0.008mm
Total pressure (kPa)
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Radial Displacement (mm)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
Shear stress at yield : Arm ave
Total pressure (kPa)
1,200
1,100
1,000
900
800
Ln[shear strain]
-5
-4

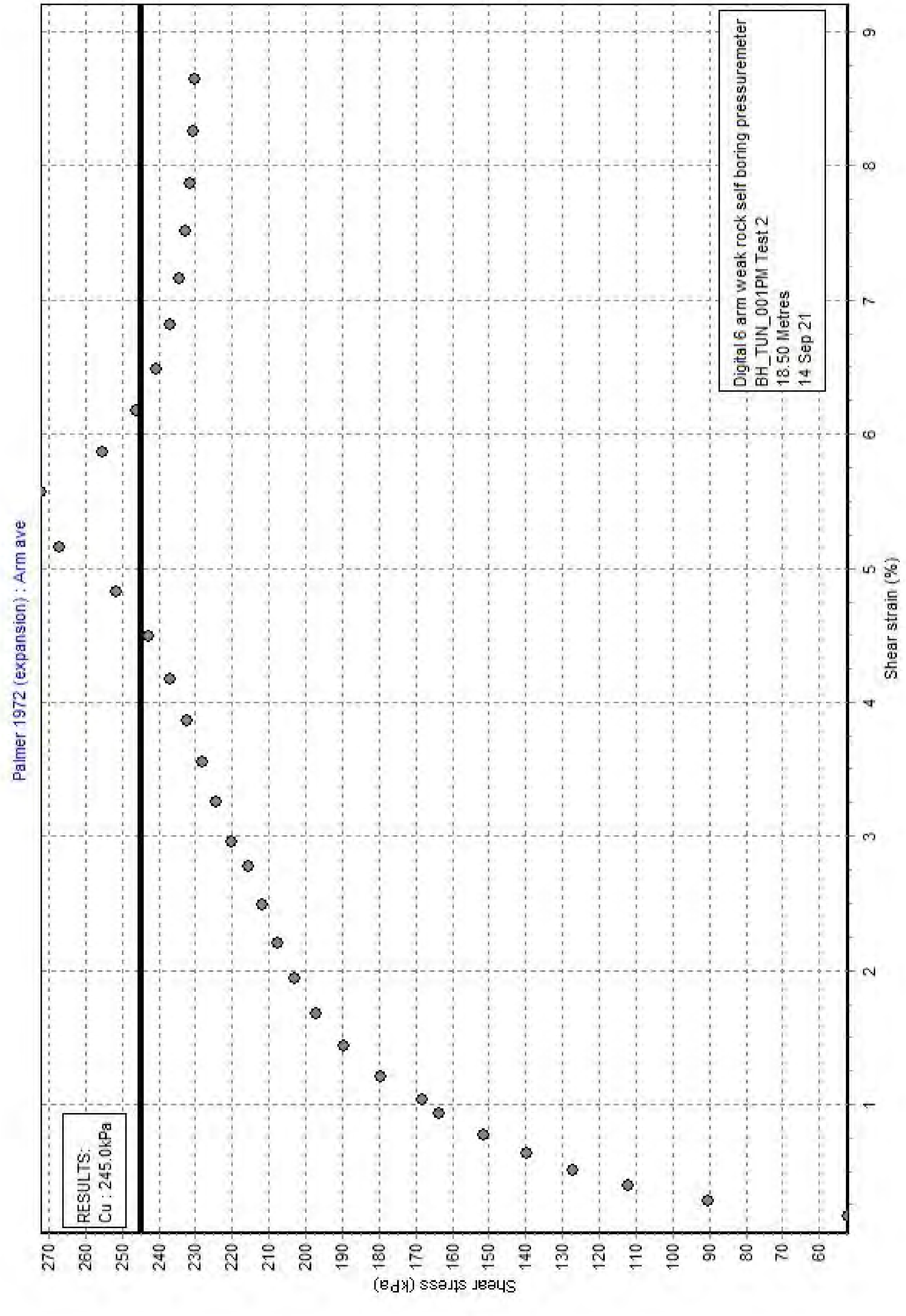

Excess PWP vs Total stress : PPC Ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 2
18.50 Metres
14 Sep 21
RESULTS:
Onset of excess pwp : 400.8kPa
End of elastic phase : 889.2 kPa
Exponent of non-linearity : 0.469
Gradient of plastic phase : 0.884
Total pressure (kPa)
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
1,300
1,400
1,500
1,600
Pore water pressure (kPa)
400
450
500
550
600
650
700
750
800
850
900
950
1,000
1,050
1,100
1,150
1,200
1,250

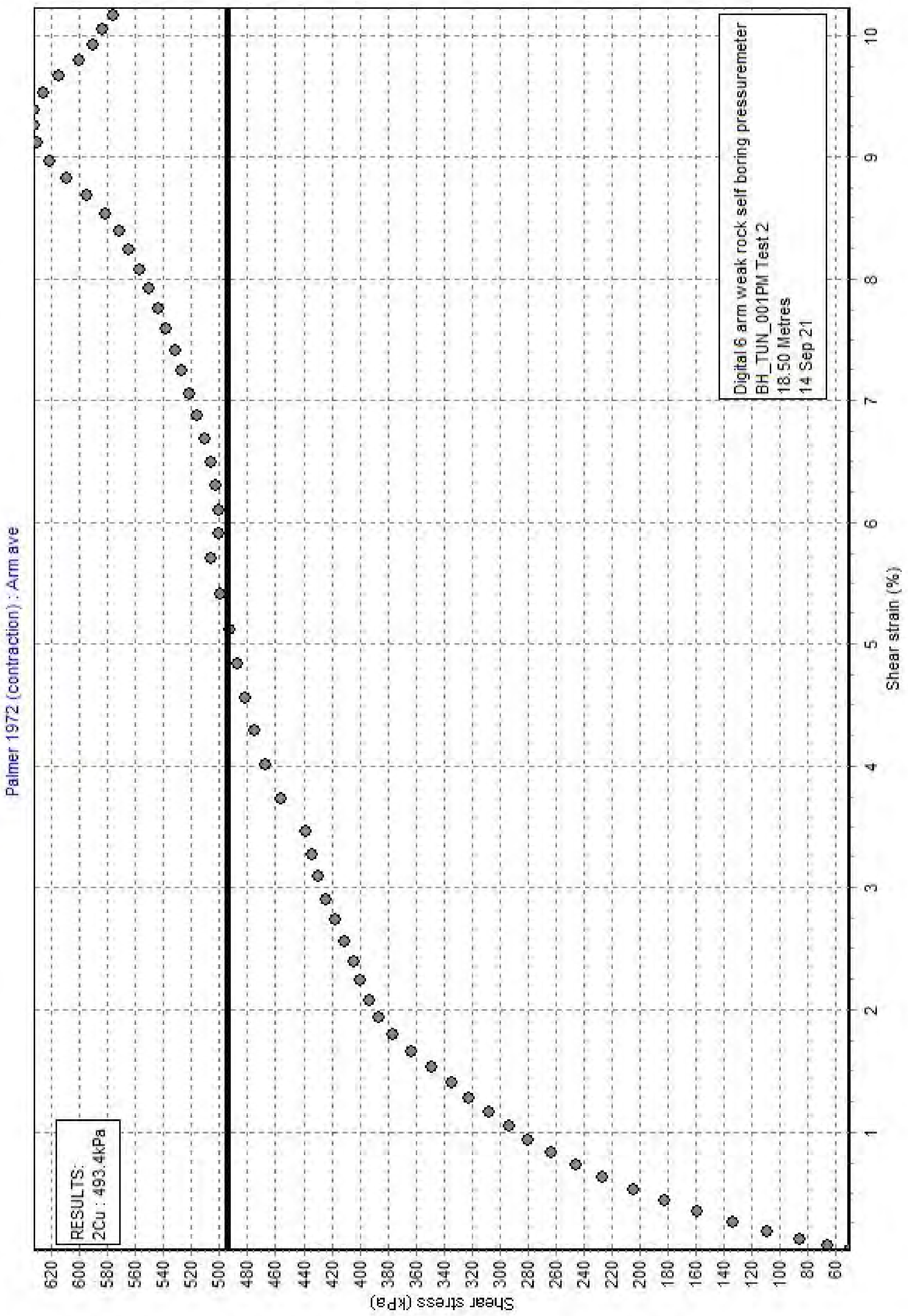


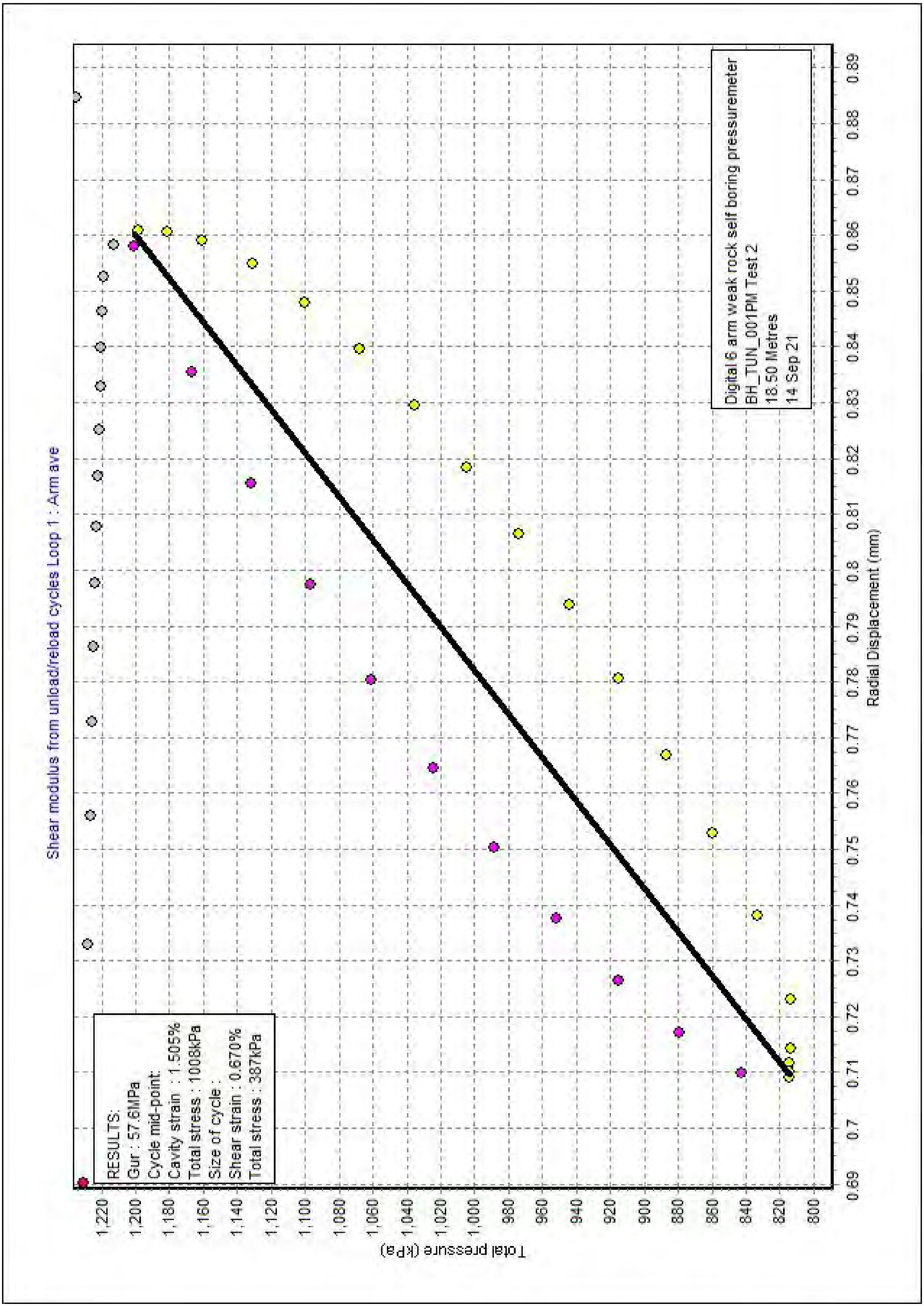
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 2
18.50 Metres
14 Sep 21

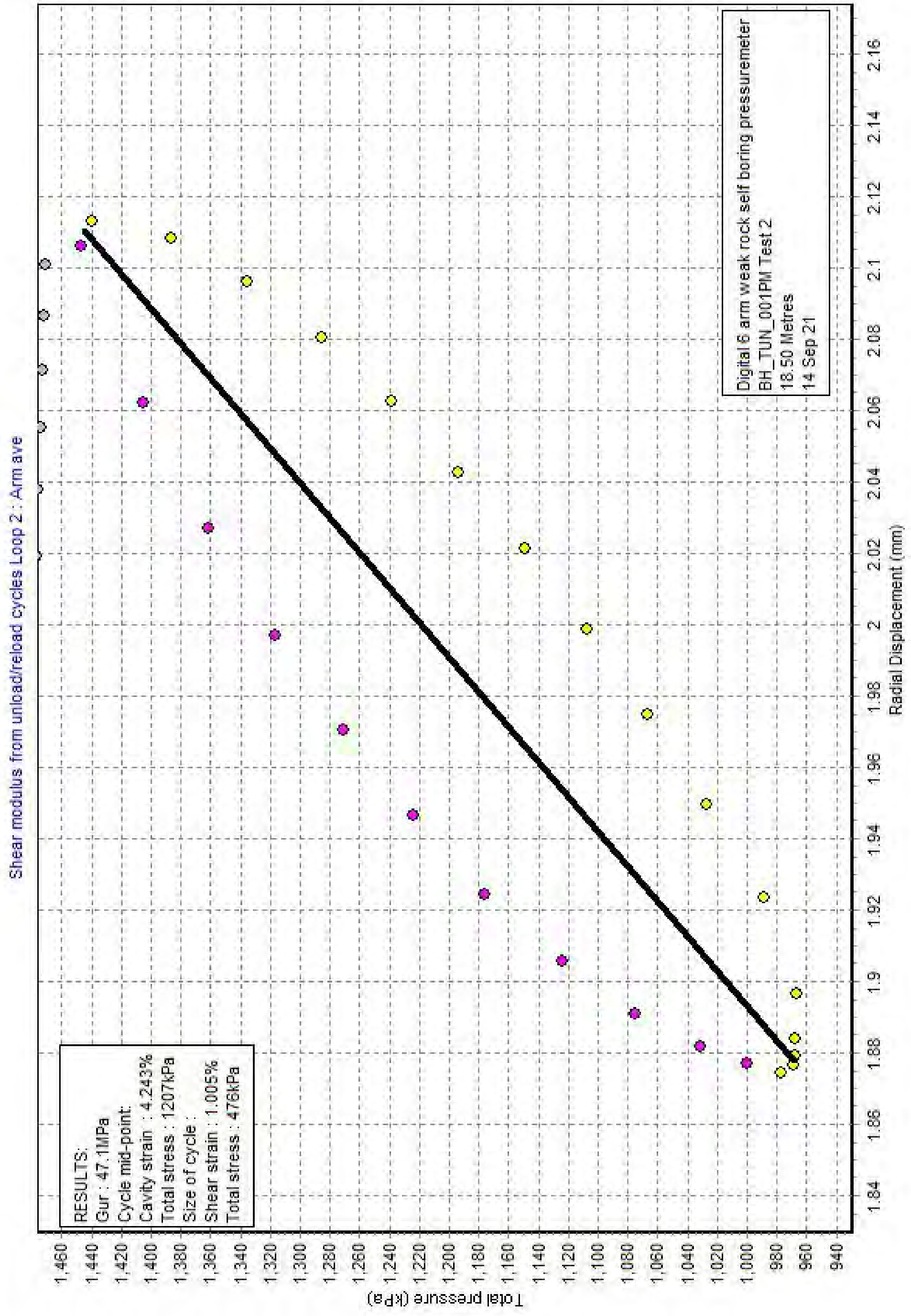
RESULTS:
Cu : 245.0kPa
Pl : 2139kPa
Ir : 272
G : 66.7MPa

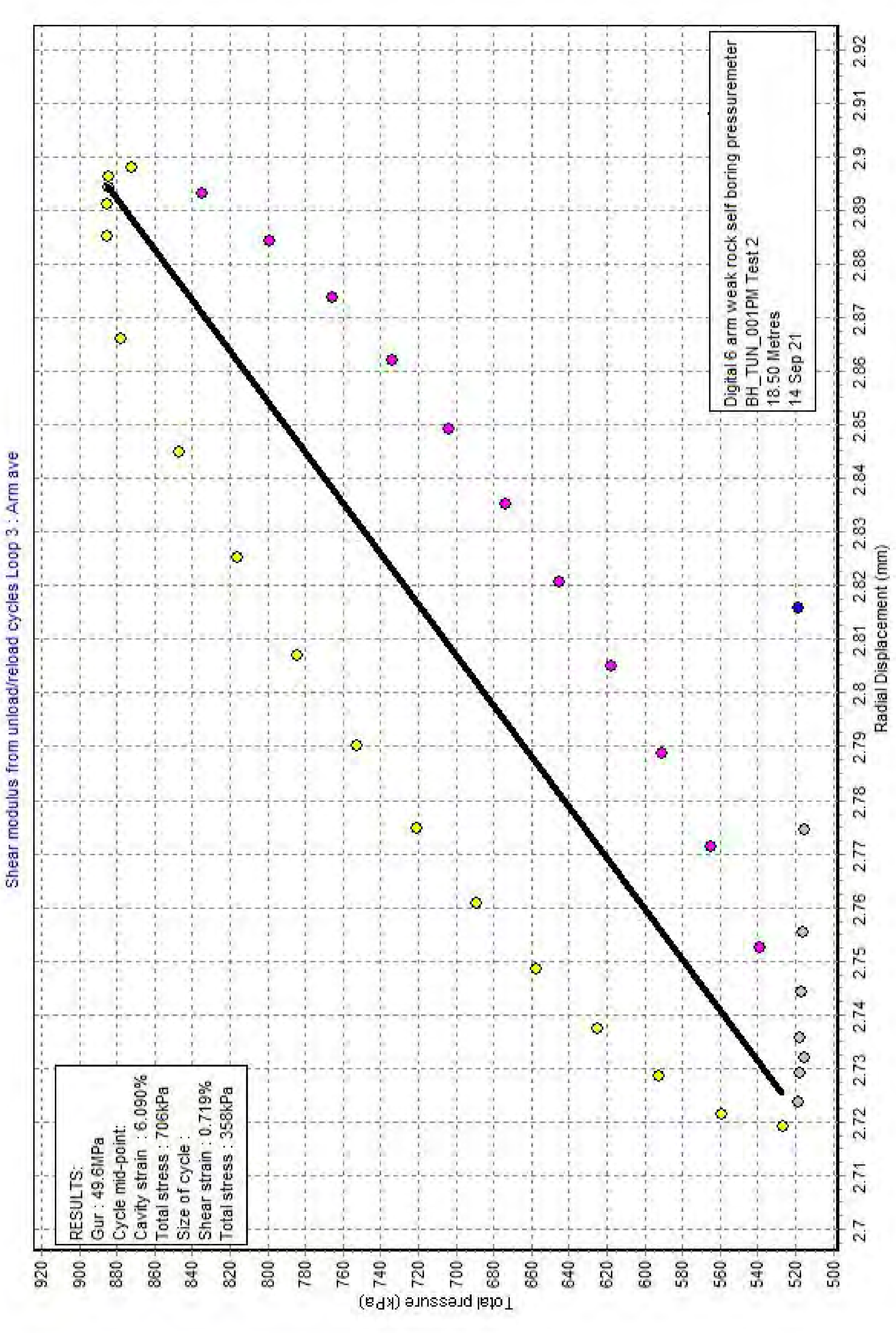

Jefferies (1988) : Arm ave
RESULTS:
Cu : 246.7kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 2
18.50 Metres
14 Sep 21
Total pressure (kPa)
1,500
1,450
1,400
1,350
1,300
1,250
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
Ln[shear strain]
-9
-8
-7
-6
-5
-4
-3

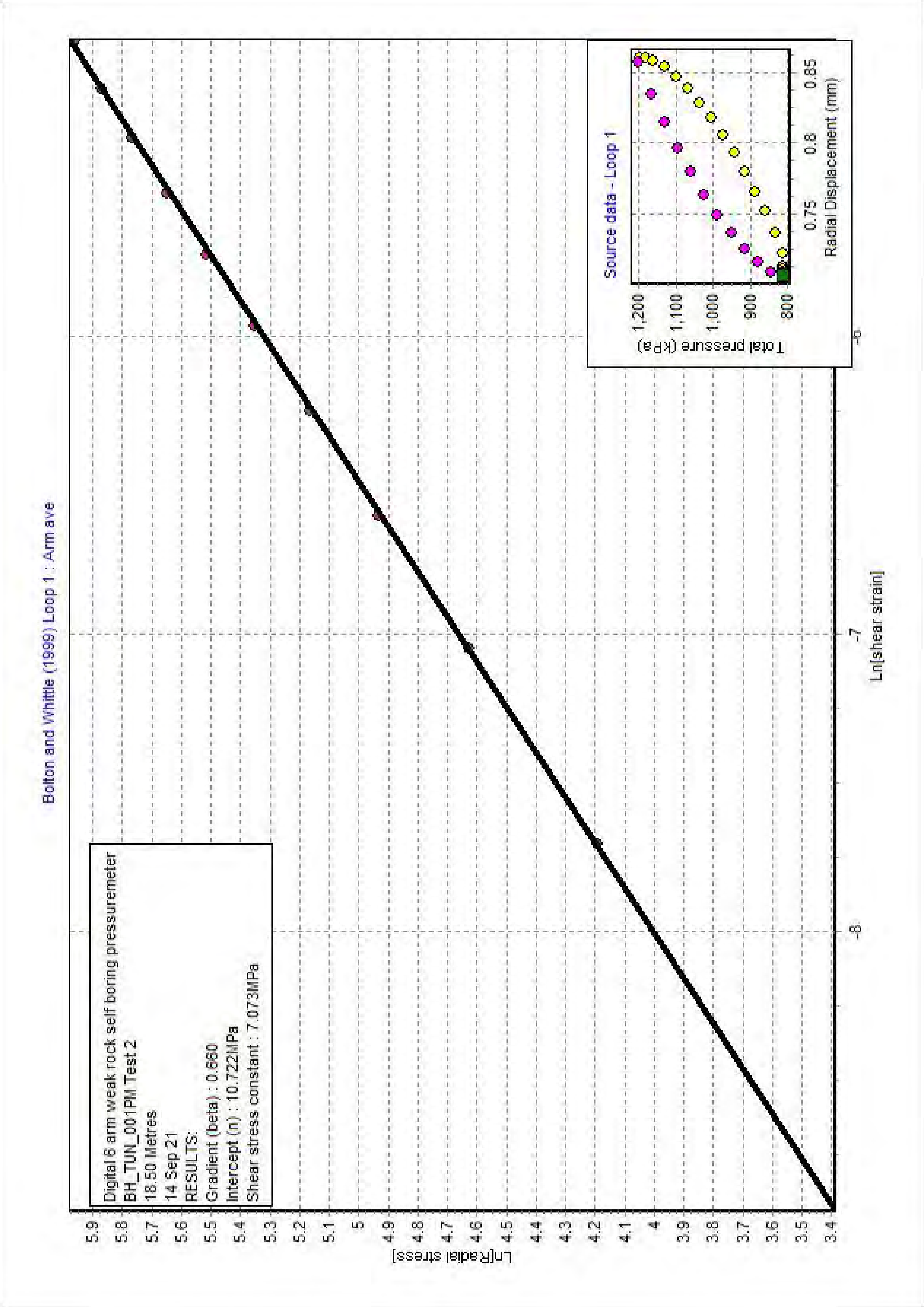

Palmer 1972 (expansion) : Arm ave
RESULTS:
Cu : 245.0kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 2
18.50 Metres
14 Sep 21
Shear stress (kPa)
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
Shear strain (%)
1
2
3
4
5
6
7
8
9


Palmer 1972 (contraction) : Arm ave
RESULTS:
2Cu : 493.4kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 2
18.50 Metres
14 Sep 21
Shear stress (kPa)
620
600
580
560
540
520
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
Shear strain (%)
1
2
3
4
5
6
7
8
9
10

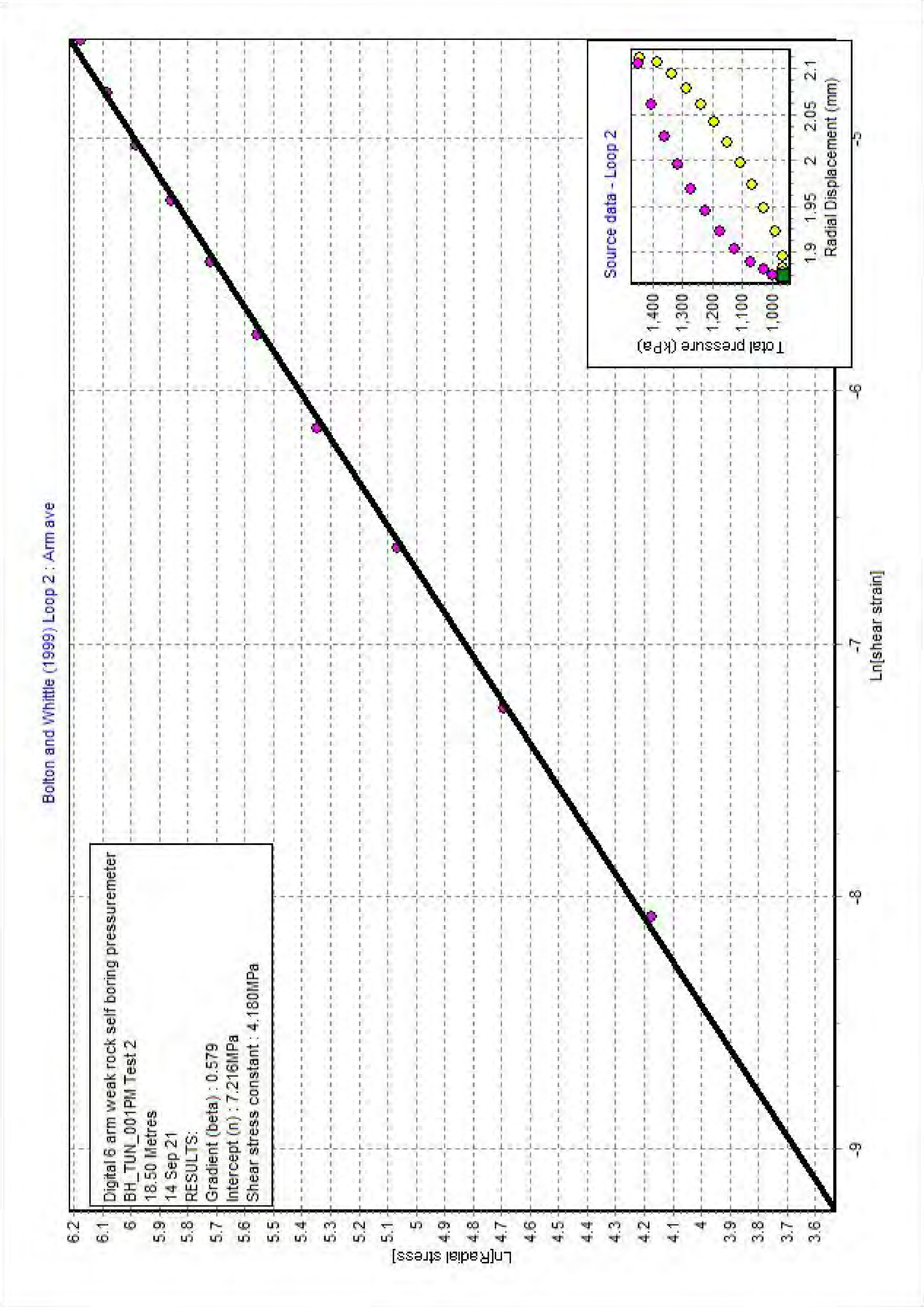

Shear modulus from unload/reload cycles Loop 1 : Arm ave
RESULTS:
Gur : 57.6MPa
Cycle mid-point:
Cavity strain : 1.505%
Total stress : 1008kPa
Size of cycle :
Shear strain : 0.670%
Total stress : 387kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 2
18.50 Metres
14 Sep 21
Total pressure (kPa)
1,220
1,200
1,180
1,160
1,140
1,120
1,100
1,080
1,060
1,040
1,020
1,000
980
960
940
920
900
880
860
840
820
800
Radial Displacement (mm)
0.69
0.7
0.71
0.72
0.73
0.74
0.75
0.76
0.77
0.78
0.79
0.8
0.81
0.82
0.83
0.84
0.85
0.86
0.87
0.88
0.89

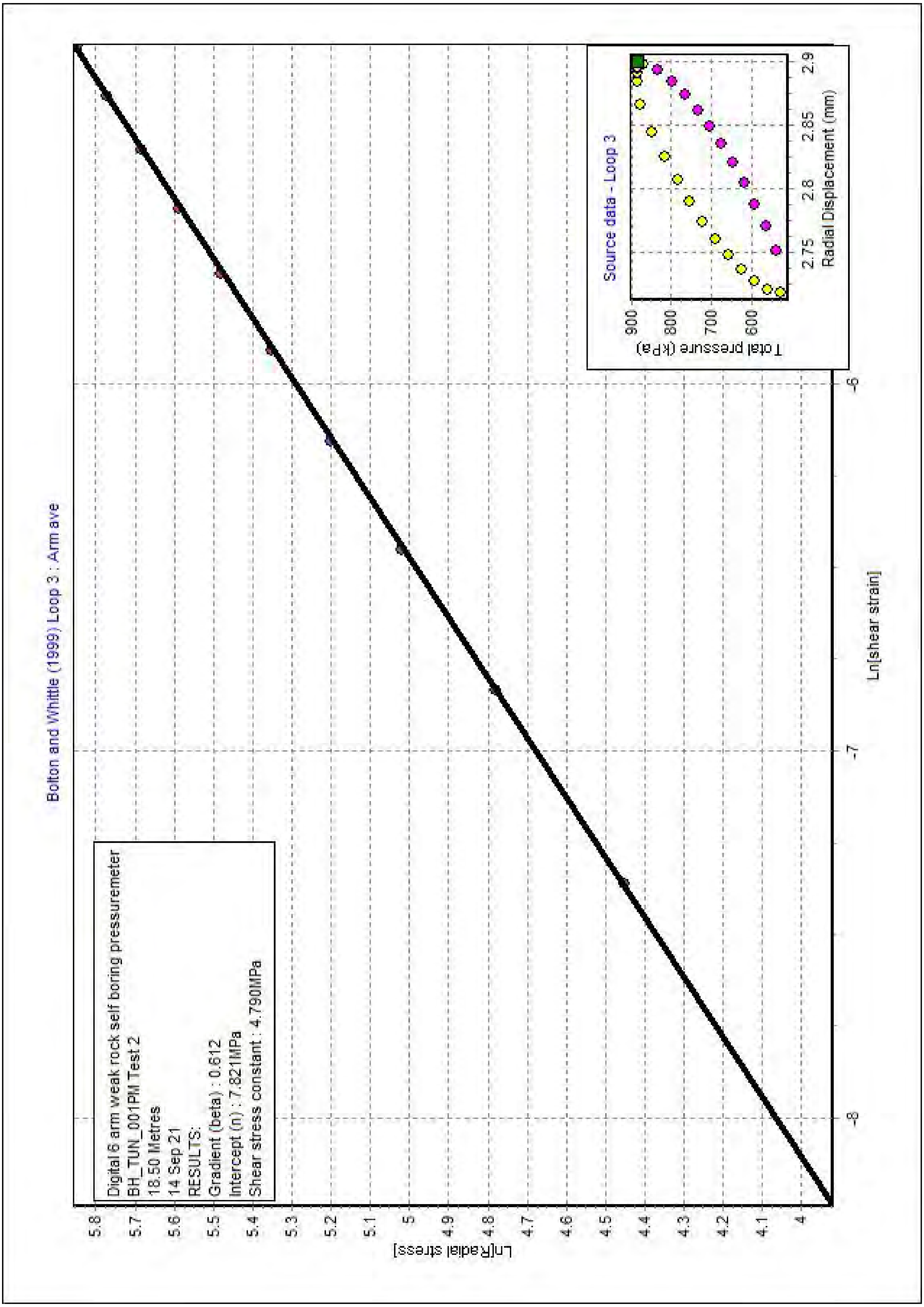

Shear modulus from unload/reload cycles Loop 2 : Arm ave
RESULTS:
Gur : 47.1MPa
Cycle mid-point:
Cavity strain : 4.243%
Total stress : 1207kPa
Size of cycle :
Shear strain : 1.005%
Total stress : 476kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 2
18.50 Metres
14 Sep 21
Total pressure (kPa)
1,460
1,440
1,420
1,400
1,380
1,360
1,340
1,320
1,300
1,280
1,260
1,240
1,220
1,200
1,180
1,160
1,140
1,120
1,100
1,080
1,060
1,040
1,020
1,000
980
960
940
Radial Displacement (mm)
1.84
1.86
1.88
1.9
1.92
1.94
1.96
1.98
2
2.02
2.04
2.06
2.08
2.1
2.12
2.14
2.16

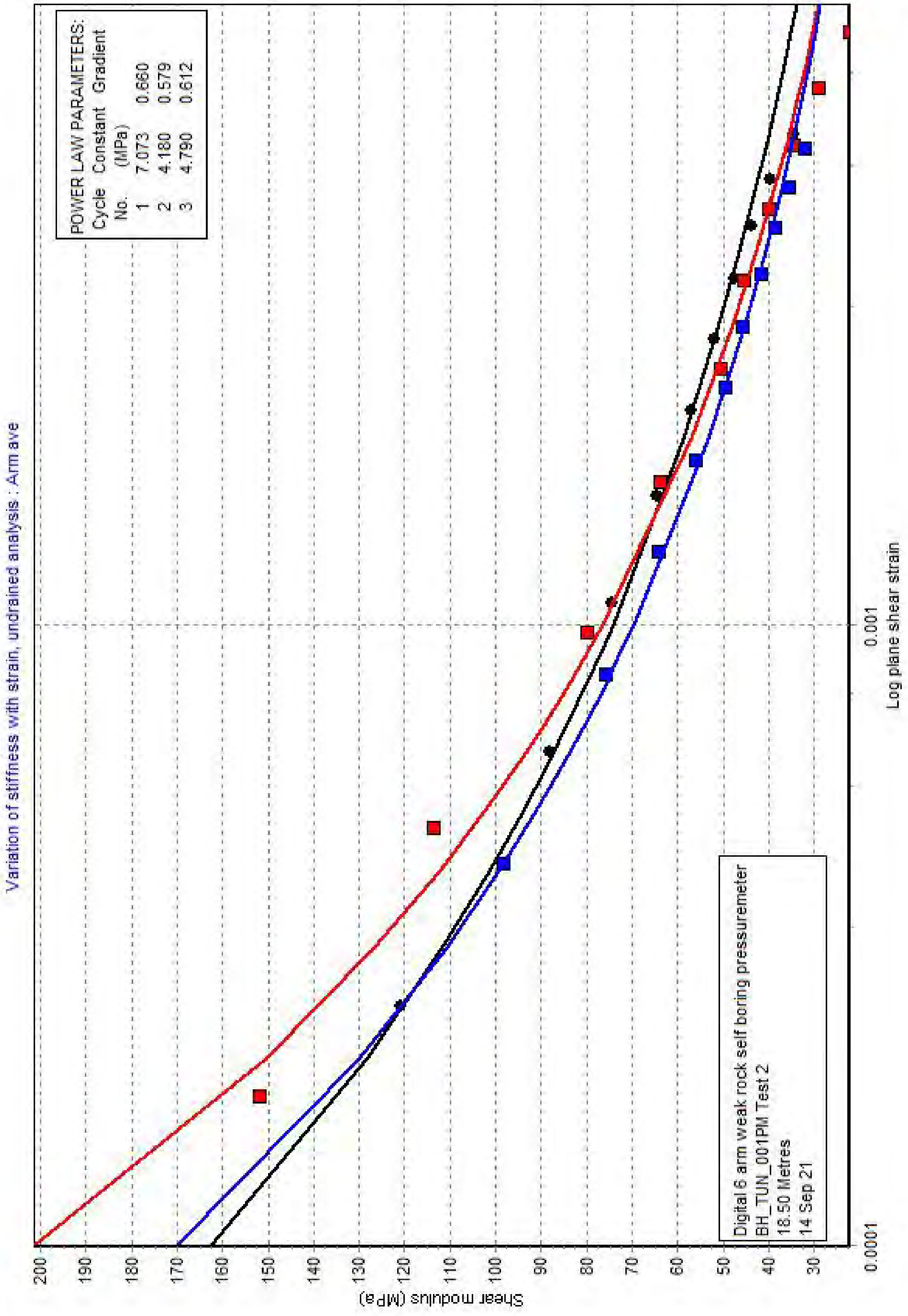

Shear modulus from unload/reload cycles Loop 3 : Arm ave
RESULTS:
Gur : 49.6MPa
Cycle mid-point:
Cavity strain : 6.090%
Total stress : 706kPa
Size of cycle :
Shear strain : 0.719%
Total stress : 358kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 2
18.50 Metres
14 Sep 21
Radial Displacement (mm)
2.7
2.71
2.72
2.73
2.74
2.75
2.76
2.77
2.78
2.79
2.8
2.81
2.82
2.83
2.84
2.85
2.86
2.87
2.88
2.89
2.9
2.91
2.92
Total pressure (kPa)
920
900
880
860
840
820
800
780
760
740
720
700
680
660
640
620
600
580
560
540
520
500

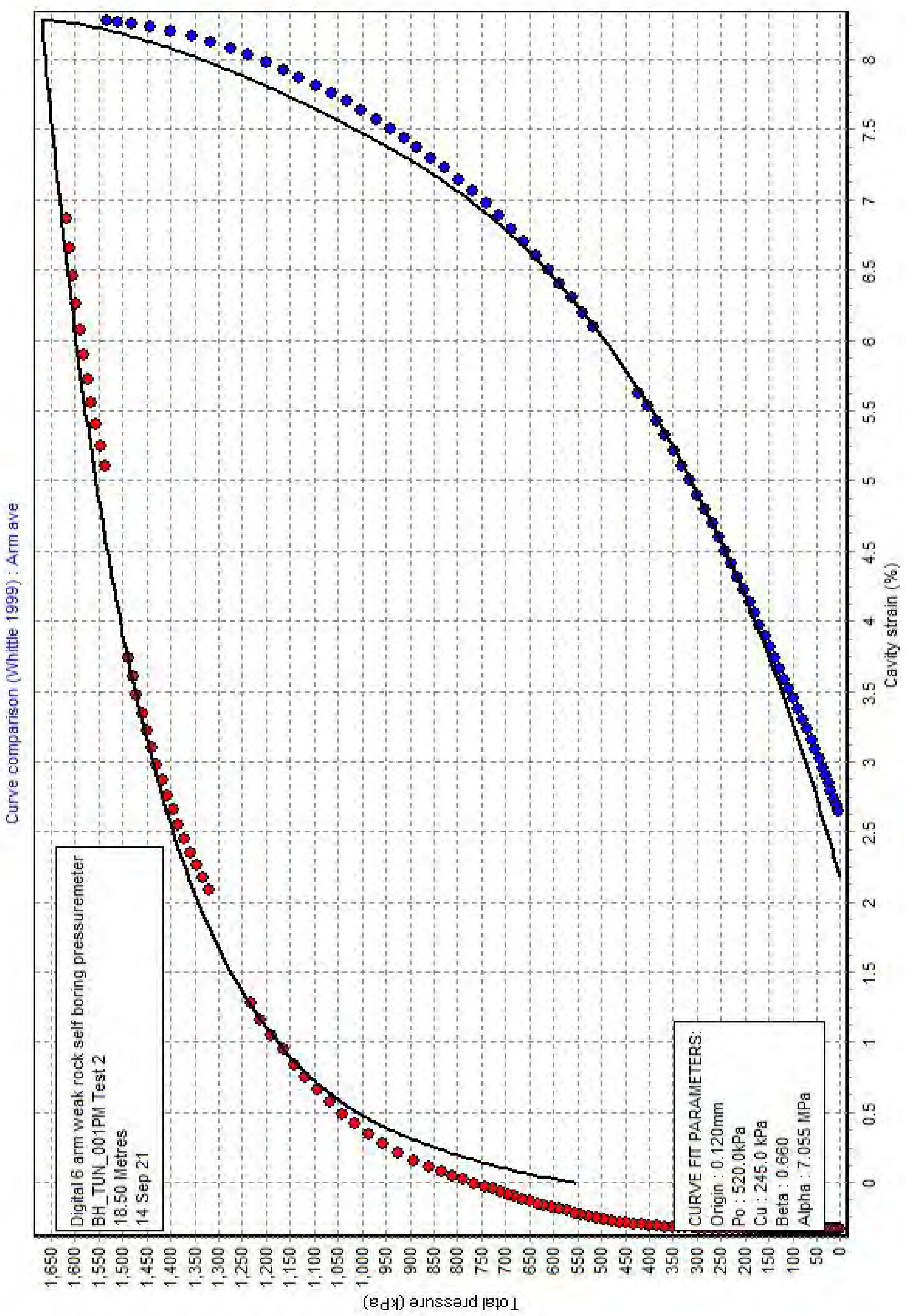


Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 2
18.50 Metres
14 Sep 21
RESULTS:
Gradient (beta) : 0.660
Intercept (n) : 10.722MPa
Shear stress constant : 7.073MPa

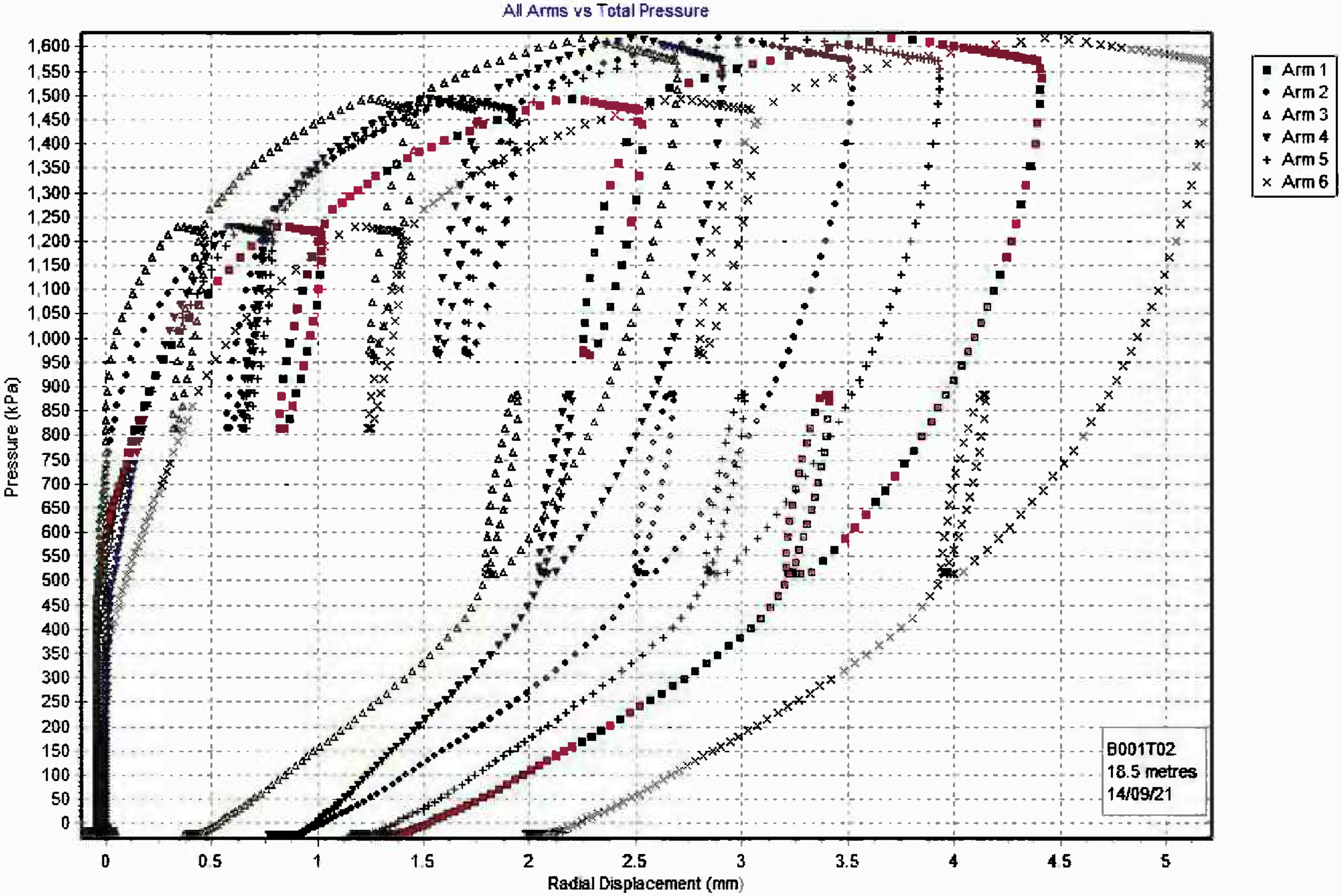

Bolton and Whittle (1999) Loop 2 : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 2
18.50 Metres
14 Sep 21
RESULTS:
Gradient (beta) : 0.579
Intercept (n) : 7.216MPa
Shear stress constant : 4.180MPa
Ln[Radial stress]
6.2
6.1
6
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
Ln[shear strain]
-9
-8
-7
-6
-5
Source data - Loop 2
Total pressure (kPa)
1,400
1,300
1,200
1,100
1,000
Radial Displacement (mm)
1.9
1.95
2
2.05
2.1


Bolton and Whittle (1999) Loop 3 : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 2
18.50 Metres
14 Sep 21
RESULTS:
Gradient (beta) : 0.612
Intercept (n) : 7.821MPa
Shear stress constant : 4.790MPa
Ln[Radial stress]
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
Ln[shear strain]
-8
-7
-6
Source data - Loop 3
Total pressure (kPa)
900
800
700
600
Radial Displacement (mm)
2.75
2.8
2.85
2.9


Variation of stiffness with strain, undrained analysis : Arm ave
POWER LAW PARAMETERS:
Cycle No. | Constant (MPa) | Gradient
1 | 7.073 | 0.660
2 | 4.180 | 0.579
3 | 4.790 | 0.612
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 2
18.50 Metres
14 Sep 21
Shear modulus (MPa)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
Log plane shear strain
0.0001
0.001

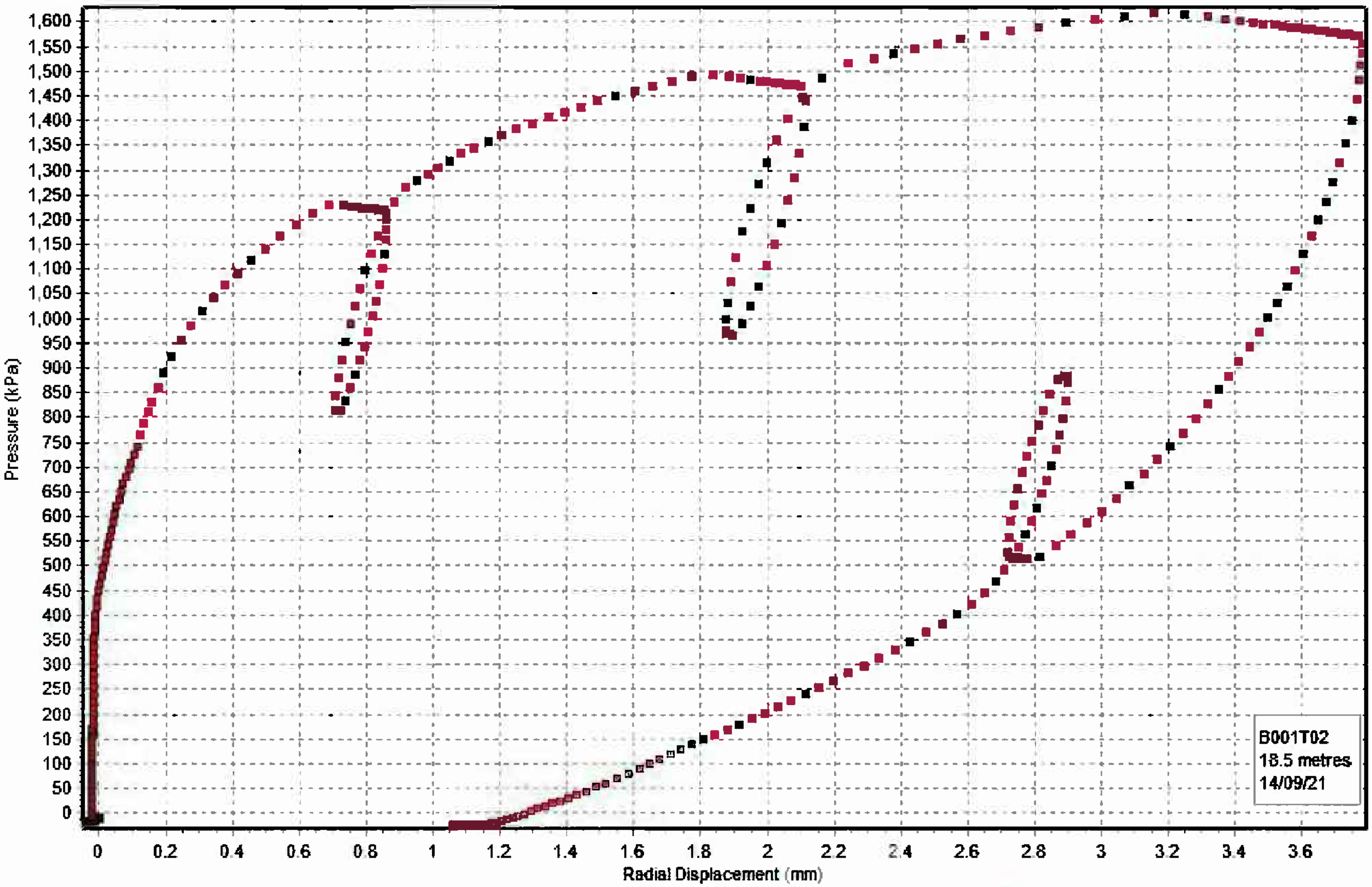

Curve comparison (Whittle 1999) : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_001PM Test 2
18.50 Metres
14 Sep 21
CURVE FIT PARAMETERS:
Origin : 0.120mm
Po : 520.0kPa
Cu : 245.0 kPa
Beta : 0.660
Alpha : 7.055 MPa
Total pressure (kPa)
1,650
1,600
1,550
1,500
1,450
1,400
1,350
1,300
1,250
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Cavity strain (%)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8

All Arms vs Total Pressure



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361

Arm Average vs Total Pressure

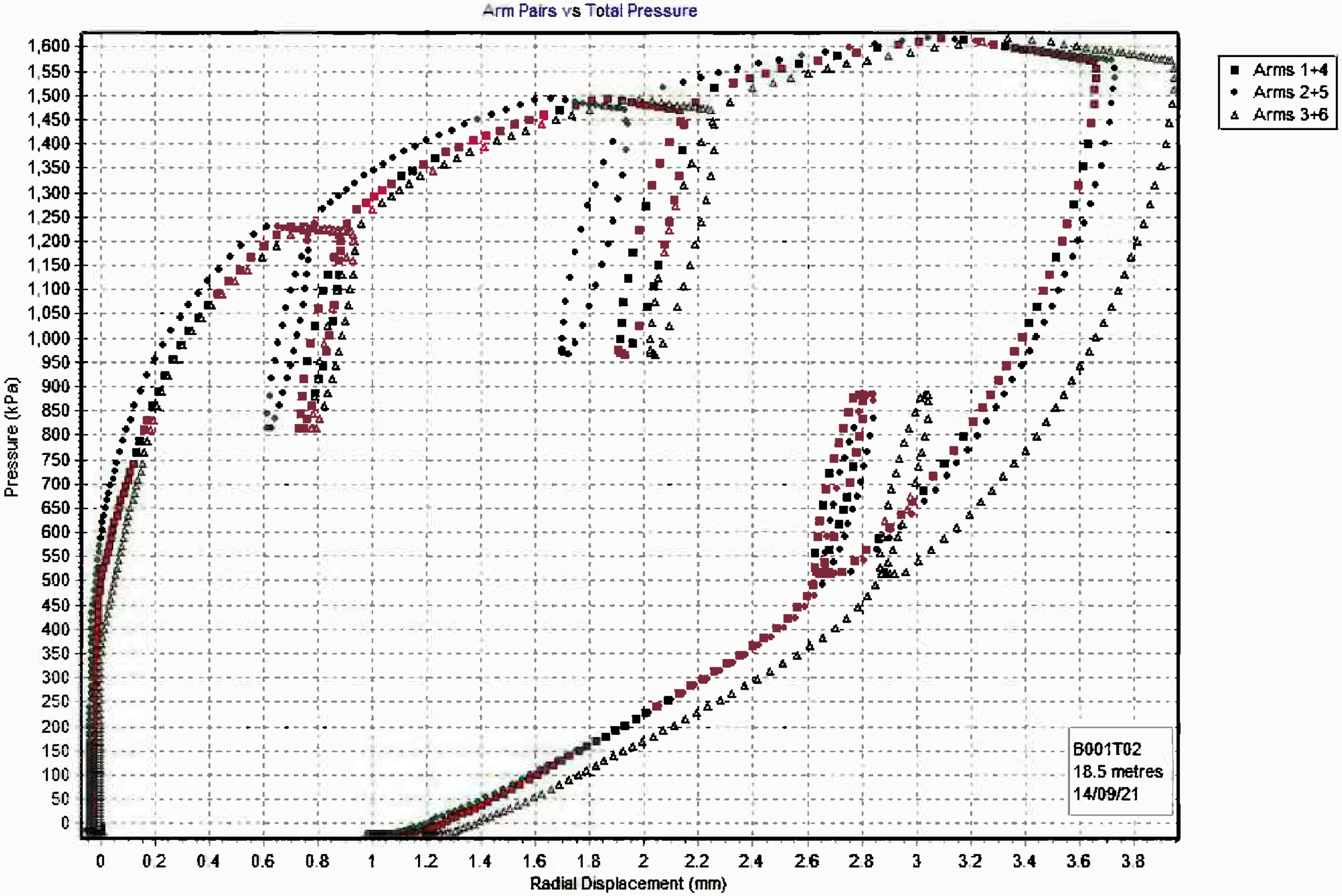


CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361

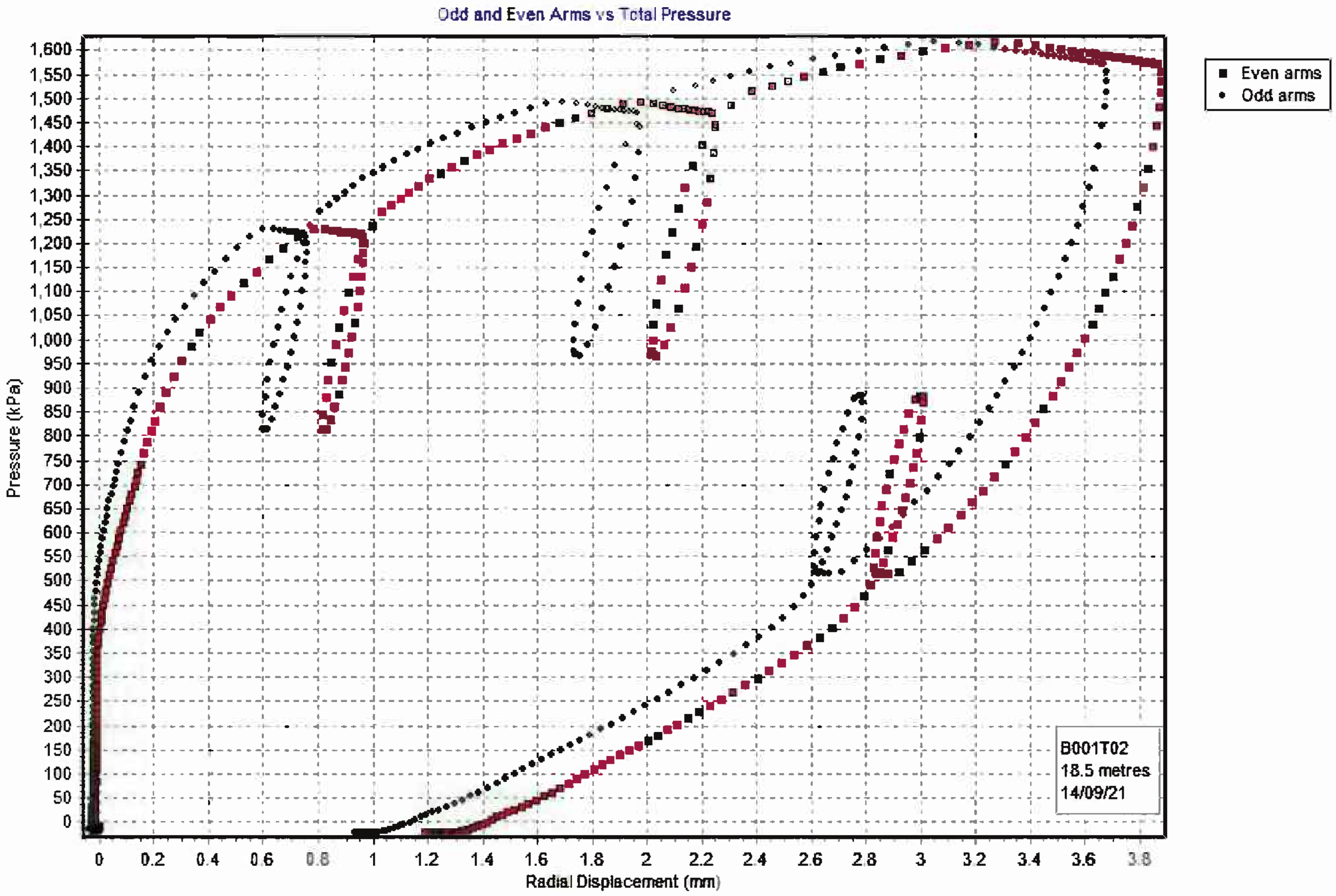
CIR1506/21

Cambridge WWTPR

Pressuremeter Testing

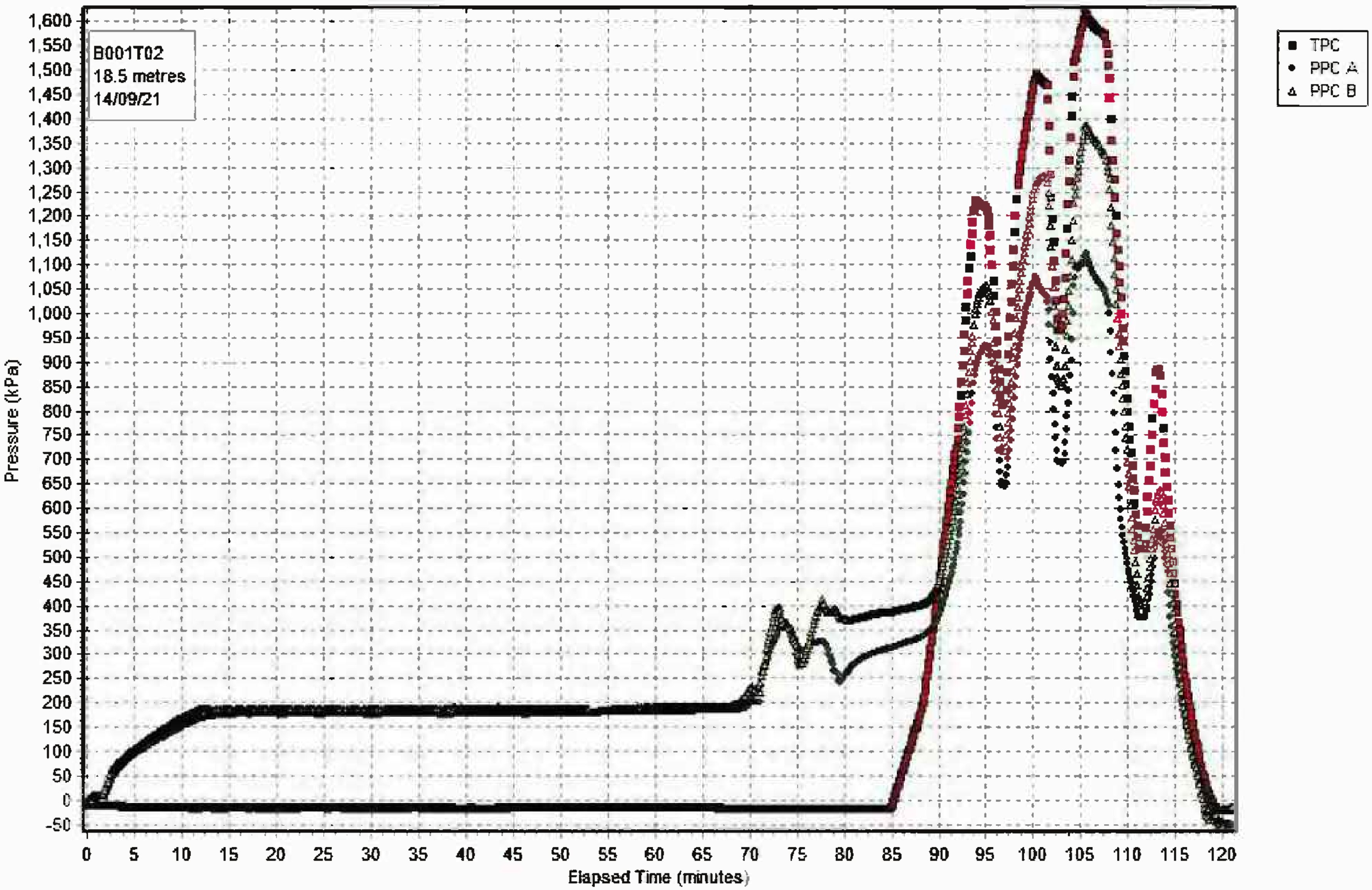


CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361

All Pressure Cells vs Time



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361

B6PMT01 - TEST & CALIBRATION DETAILS

[PROJECT DETAILS]
Contract name : CWWTPR

[BOREHOLE DETAILS]
Borehole : BH_TUN_006PM

[TEST DETAILS]
Test name : B6PMT01
Test date : 29/09/21
Depth (M) : 12.20
Material: : Gault Clay
Heading (deg) : n/a
Data Rate (secs) : 6
Start Line : 1
Stop Line : 425

[COMMENTS]
Very quick drilling. Likely washed out pocket. No data suitable for analysis.

[PROBE DETAILS]
Type : Digital 6 Arm Self Boring Pressuremeter
Diameter over probe : 88.10mm
Diameter under membrane : 79.15mm
CHL strip thickness : 0.5000mm

[CALIBRATION FACTORS]

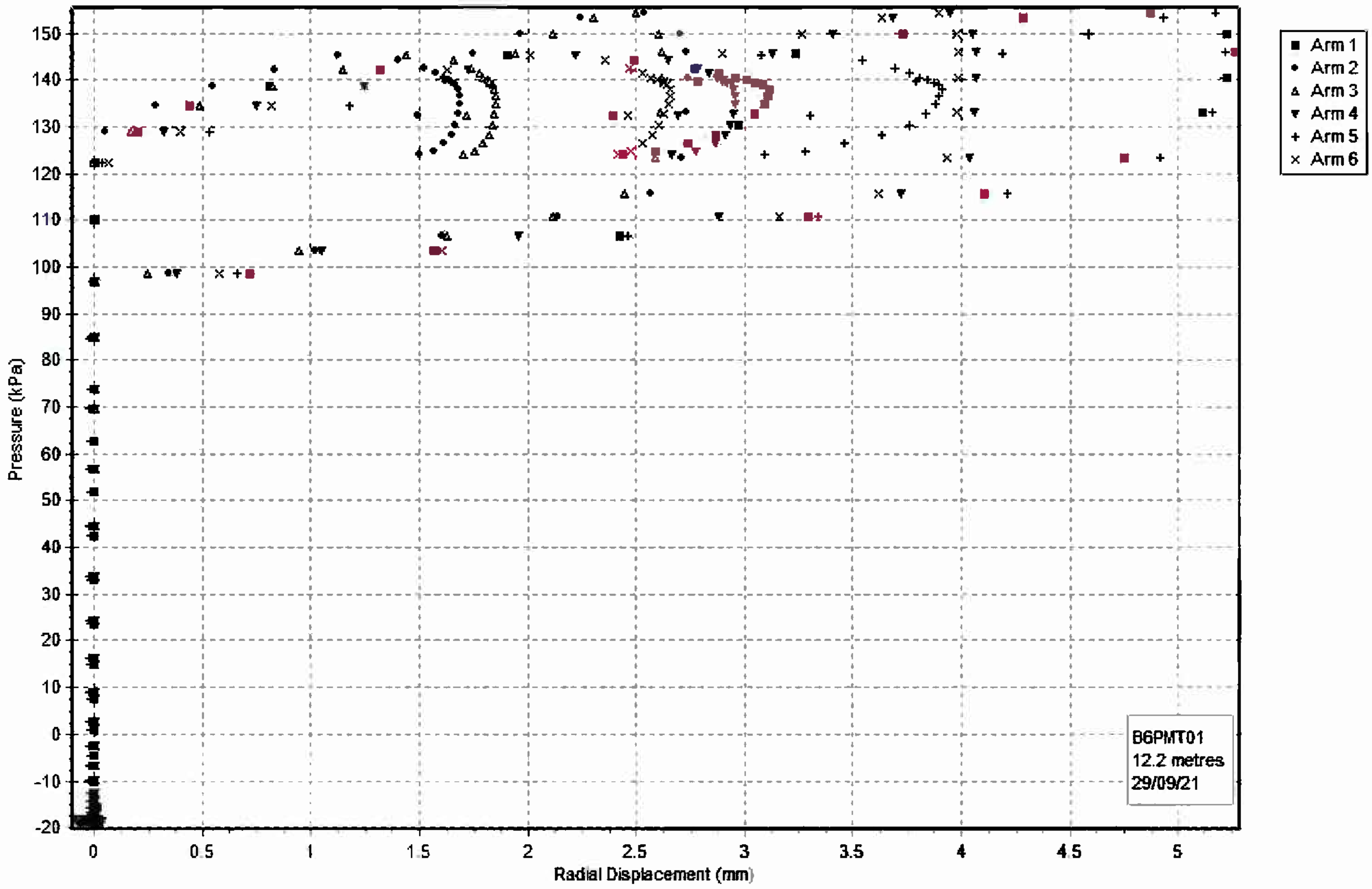
	TRANSDUCERS	MEMBRANE	COMPLIANCE
ARM 1	-85.0 mV and 306.3 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
ARM 2	-933.4 mV and 326.5 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
ARM 3	-326.0 mV and 326.9 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
ARM 4	75.7 mV and 330.0 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
ARM 5	78.5 mV and 330.4 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
ARM 6	-140.9 mV and 329.0 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
PPC A	-2564.0 mV and 402.4 mV/MPa		
PPC B	-2393.6 mV and 388.5 mV/MPa		
TPC	-2379.3 mV and 457.3 mV/MPa		

CIR1506/21

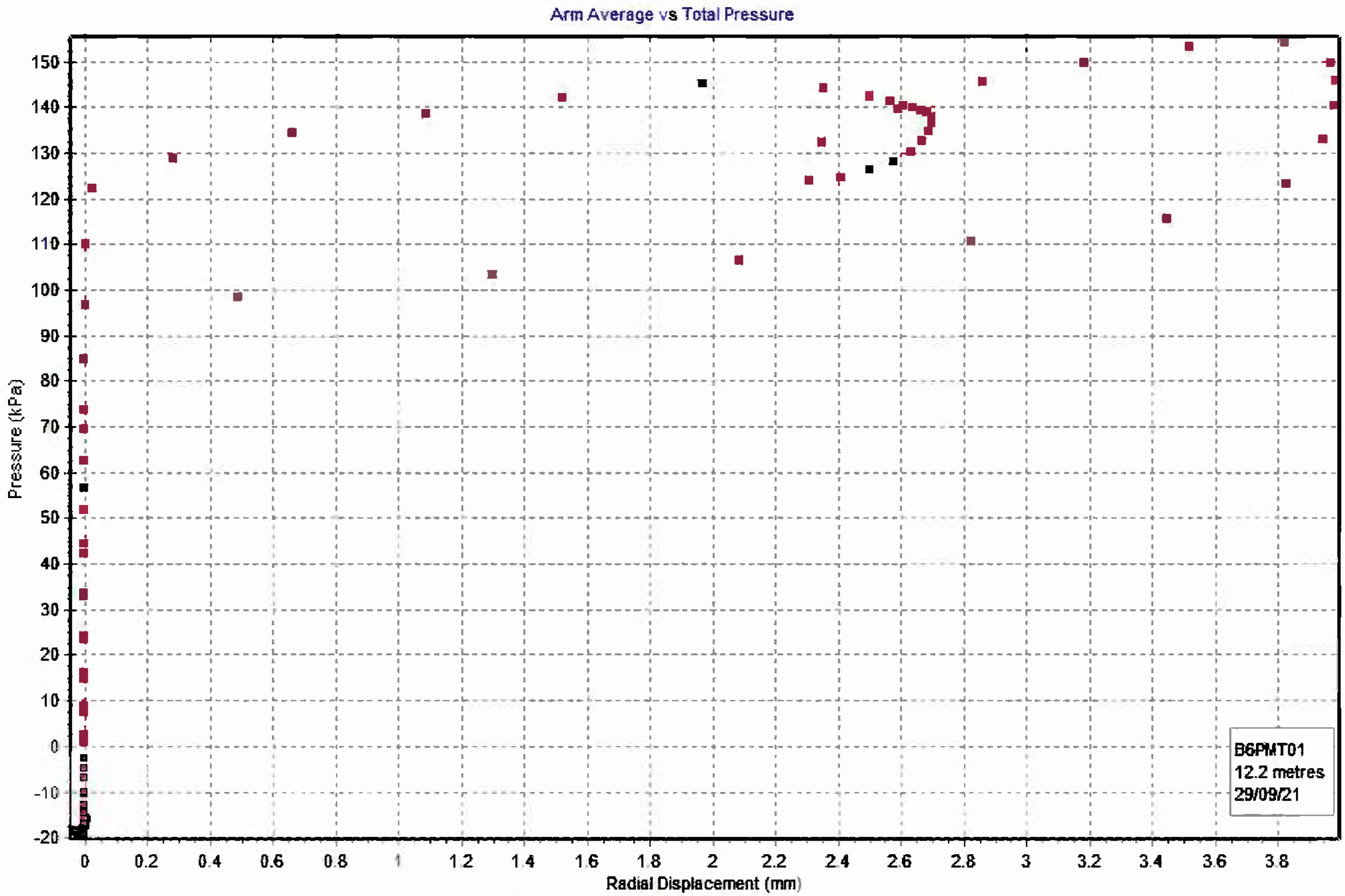
Cambridge WWTPR

Pressuremeter Testing

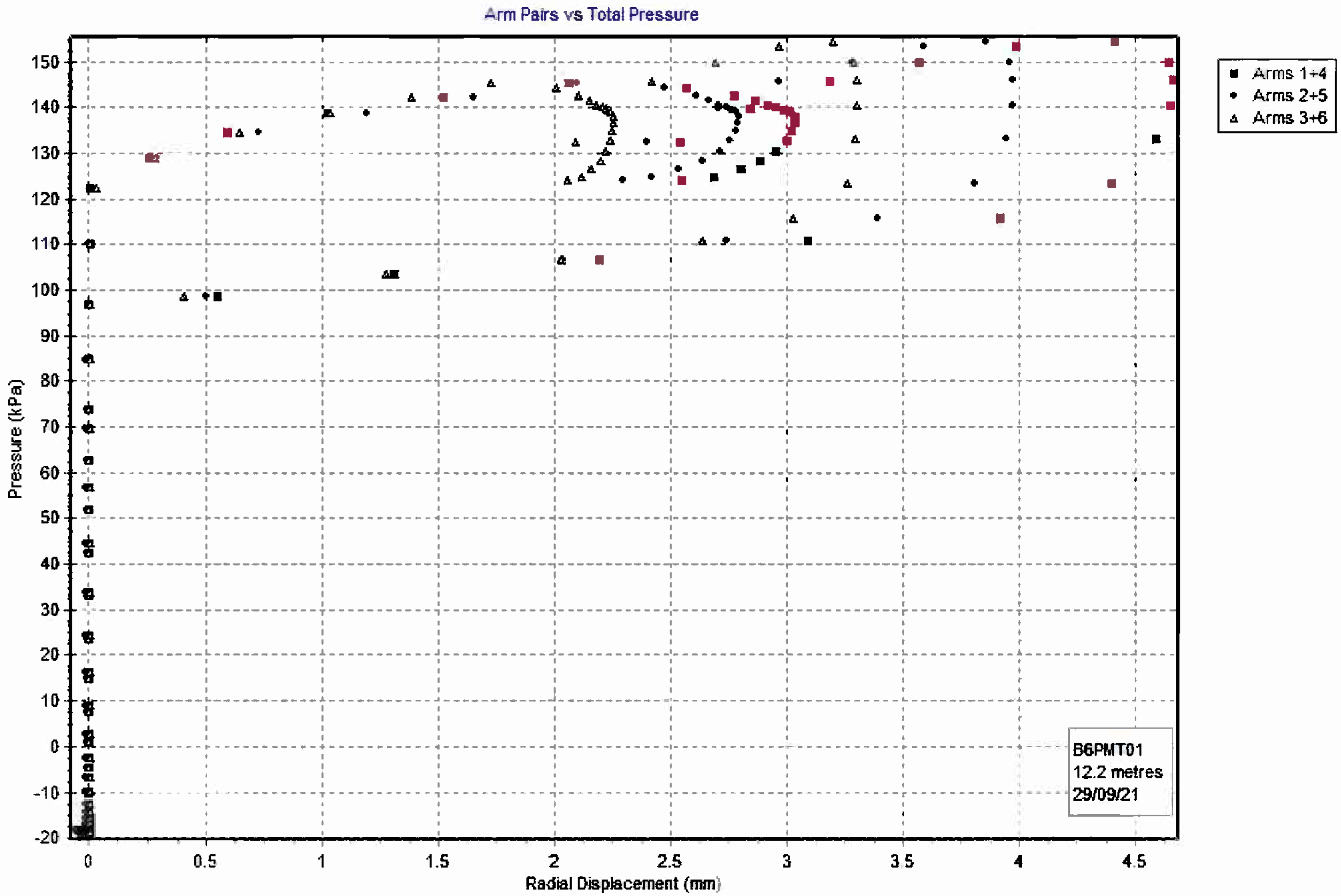
All Arms vs Total Pressure



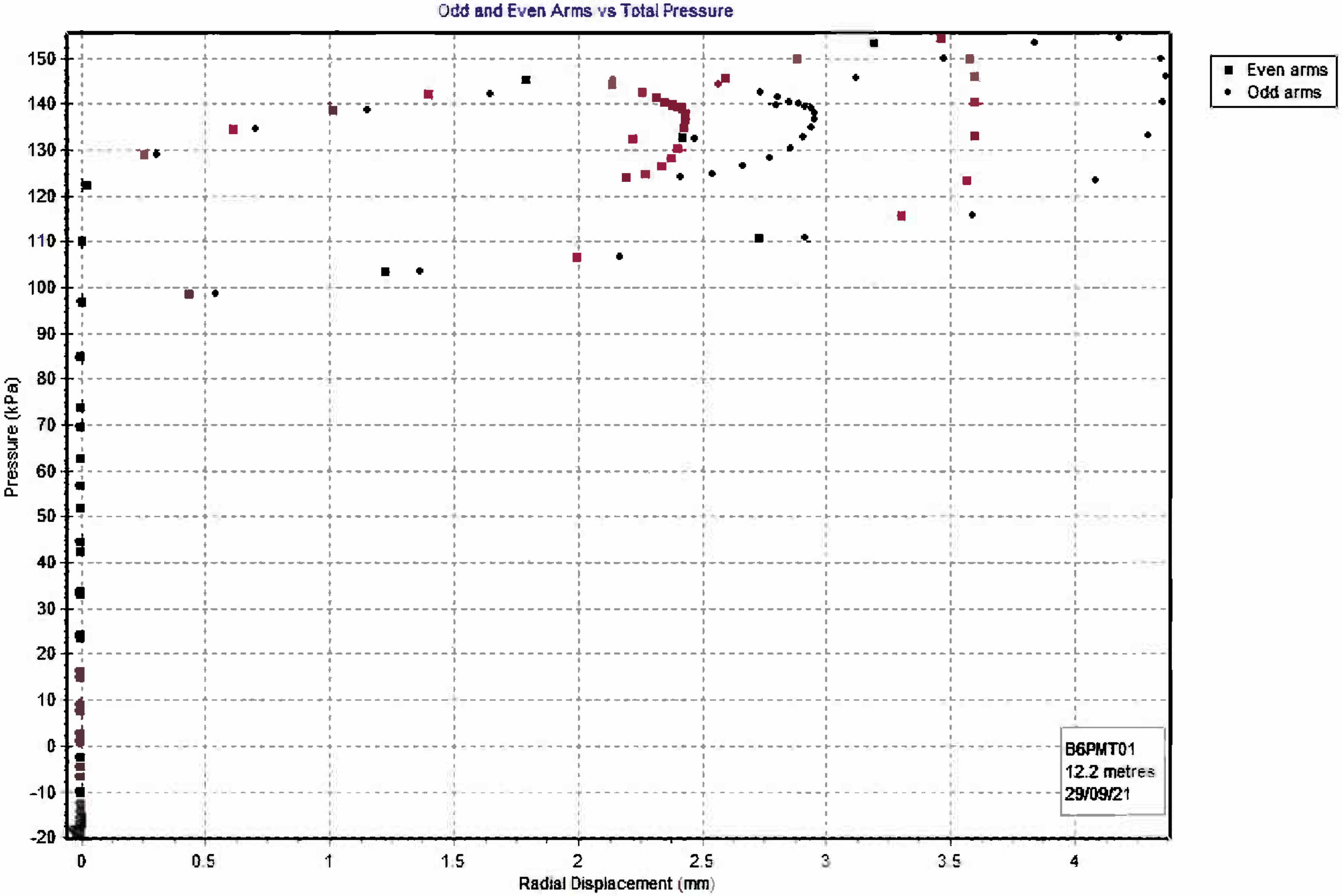
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel: +44 (0)1223 262361



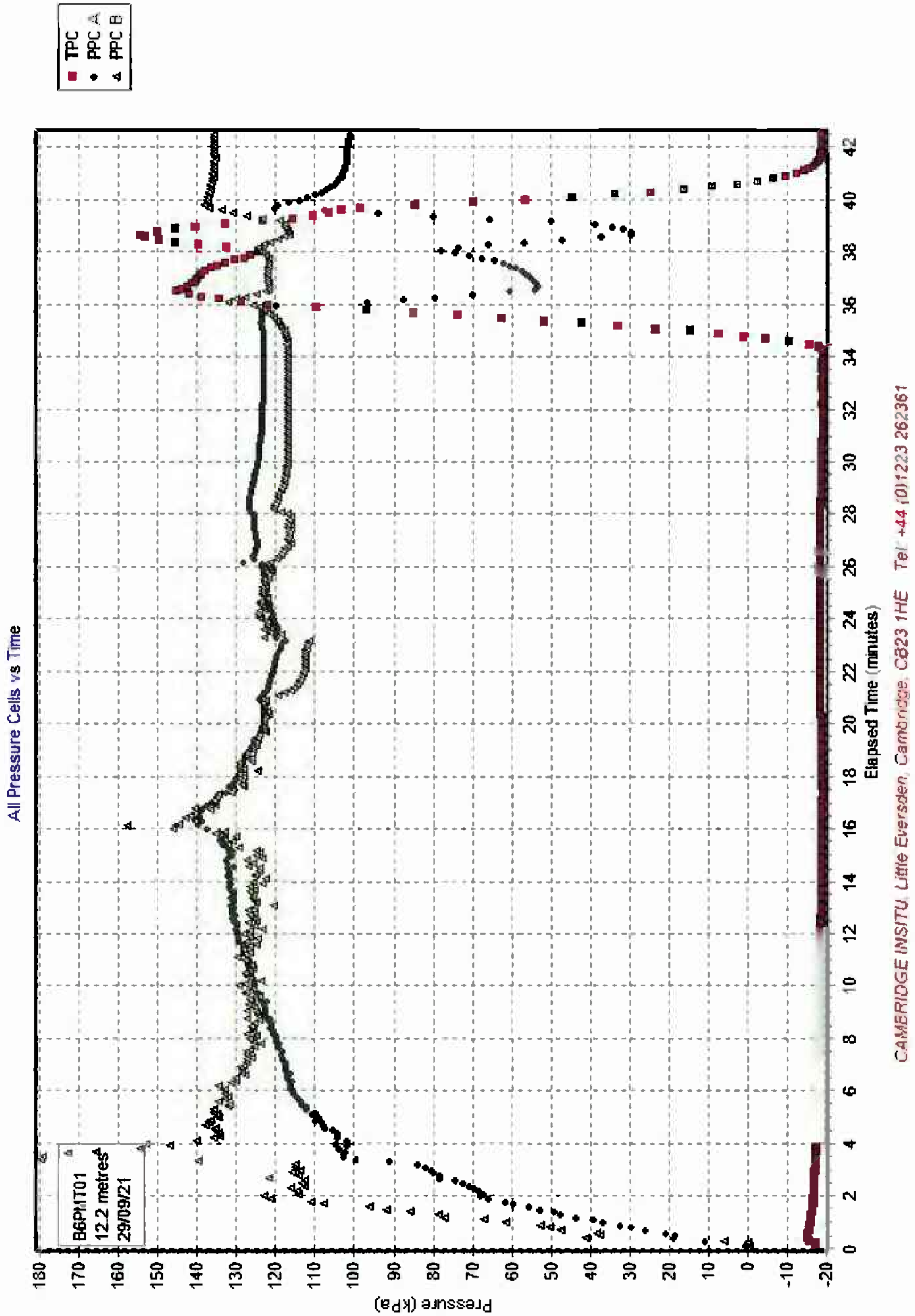
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel: +44 (0)1223 262361



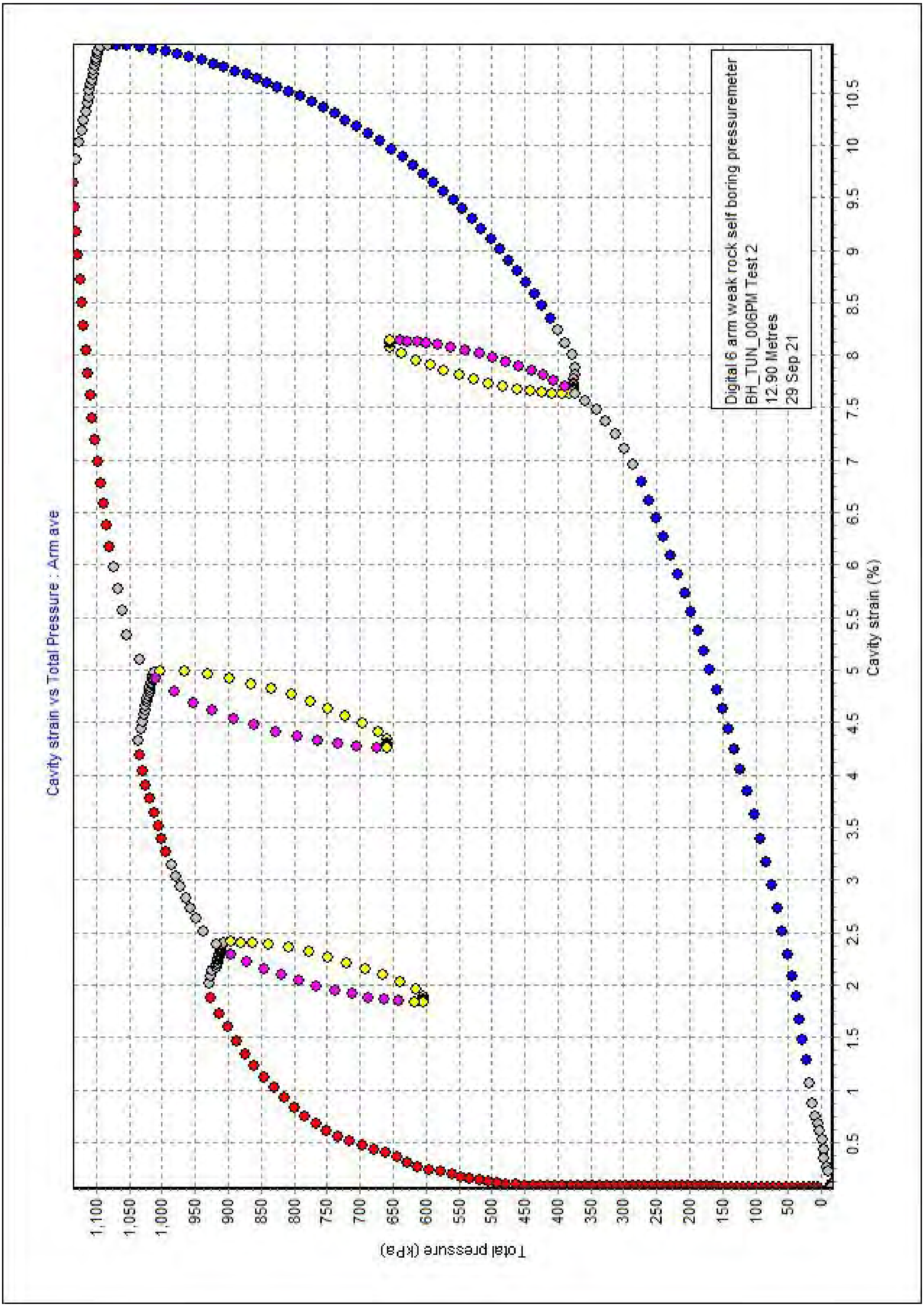
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361

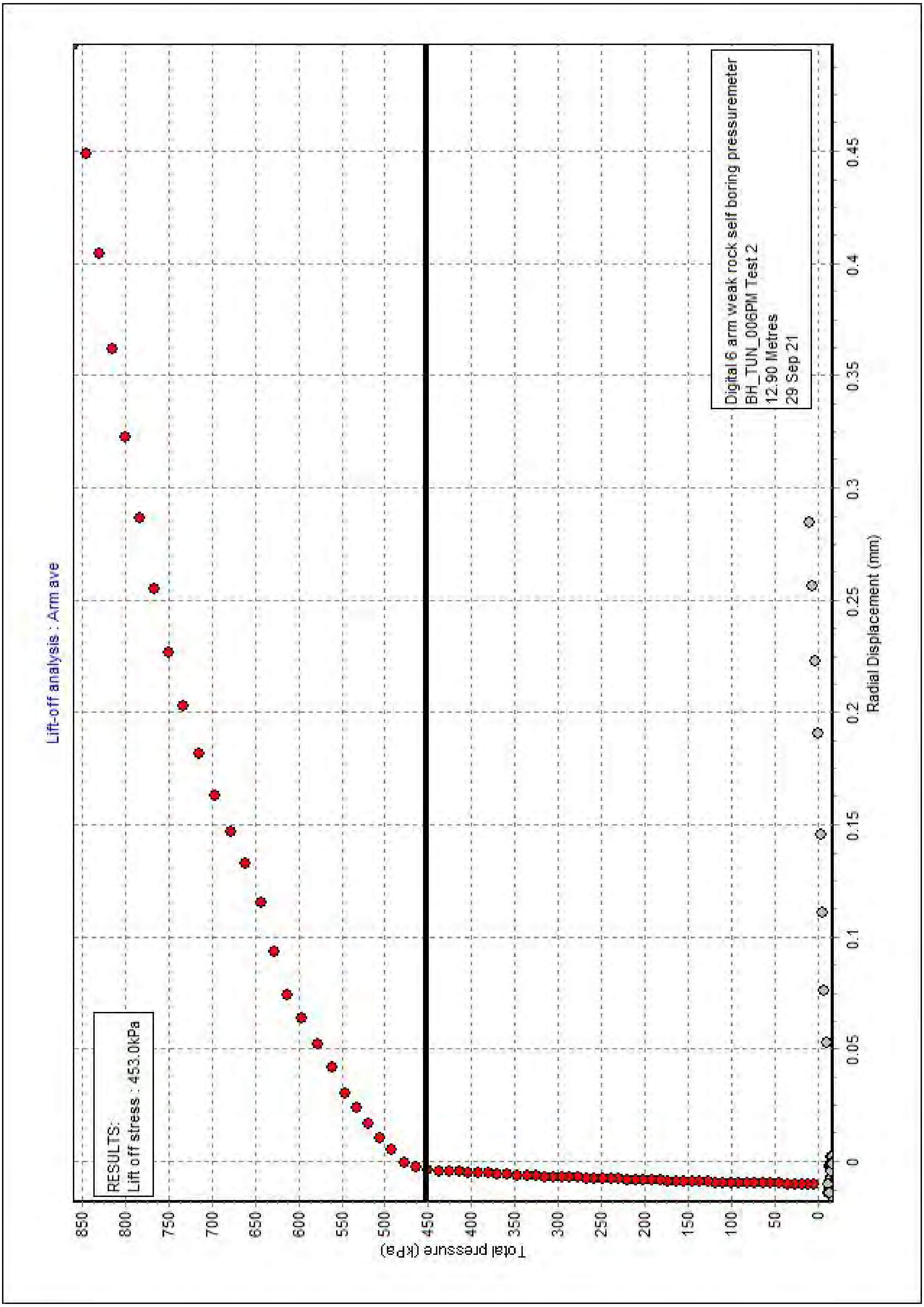


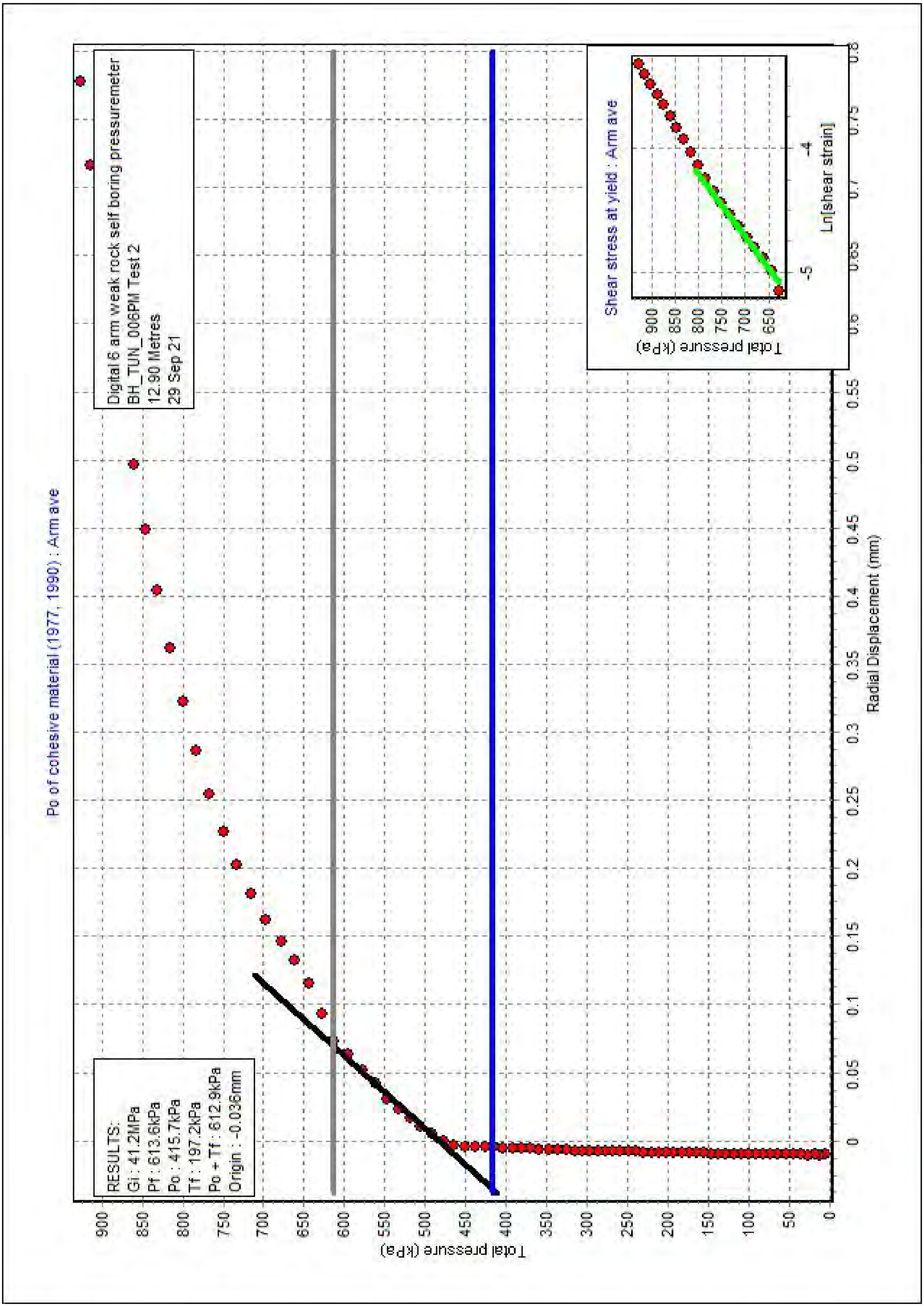
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361

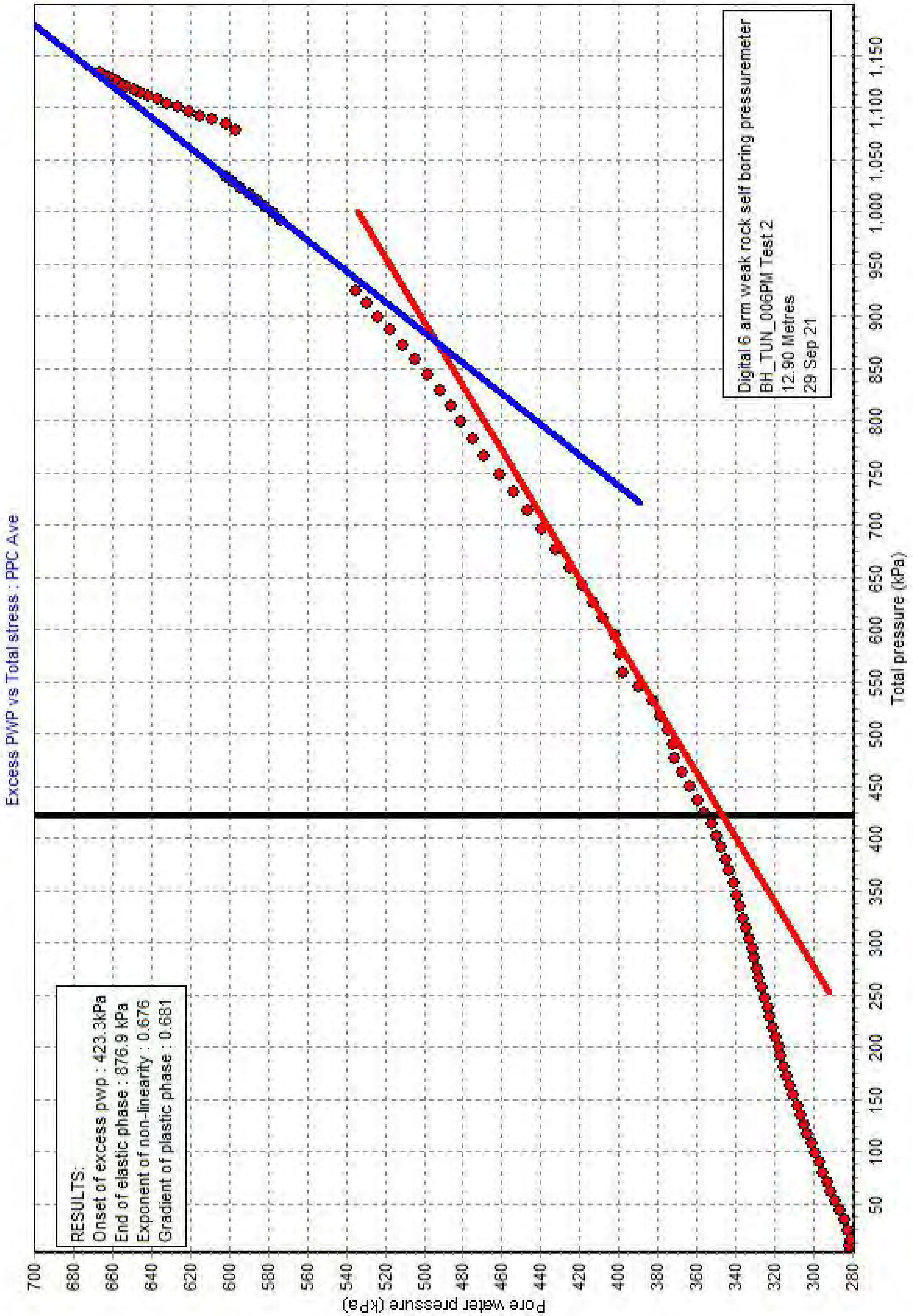

All Pressure Cells vs Time
TPC
PPC A
PPC B
BGPMT01
12.2 metres
29/09/21
Pressure (kPa)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
Elapsed Time (minutes)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel +44 (0)1223 262361

```
BH_TUN_006PM Test 2 - SUMMARY OF RESULTS
[File made with WinSitu ]

[DETAILS OF TEST]
Project        :   TE8364
Site           :   Cambridge Waste Water Treatment Plant Relocation Project
Borehole       :   BH_TUN_006PM
Test name      :   BH_TUN_006PM Test 2
Test date      :   29 Sep 21
Test depth     :   12.90 Metres
Water table    :   4.5 Metres
Ambient PWP    :   82.0 kPa
Material       :   Gault Clay
Probe          :   Digital 6 arm weak rock self boring pressuremeter
Diameter       :   88.1 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out
The file includes results from a curve fitting analysis

Analysed by YB / ES / RW on 30 Sep 21

Remarks:  Test has been slightly pushed. Test has been slightly pushed.
Initial stiffness is over estimated due to this disturbance and
should be treated with caution

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm)                  :   "Arm ave=-0.05"
Po from Marsland & Randolph (kPa)   :   "Arm ave=415.7"
Po from Lift off (kPa)              :   "Arm ave=453.0"
PWP versus Total Stress (kPa)       :   "PPC Ave=423.3"
Best estimate of Po (kPa)           :   "Arm ave=410.0"

[UNDRAINED STRENGTH PARAMETERS]
Gibson & Anderson 1961 - Cu (kPa)   :   "Arm ave=143.1"
Limit pressure (kPa)                :   "Arm ave=1392"
Jefferies 1988 - Cu (kPa)           :   "Arm ave=140.8"
Undrained yield stress (kPa)        :   "Arm ave=613.6"
PWP derived yield stress (kPa)      :   "PPC Ave=876.9"

[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=41.2"
Axis       Loop   Value    Mean Strain   Mean Pc  dE      dPc
           No     (MPa)    (%)           (kPa)    (%)     (kPa)
Arm ave    1      27.5     2.133         757      1.099   303
Arm ave    2      25.9     4.631         835      1.343   350
Arm ave    3      29.1     7.897         518      0.943   275

[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]
Axis       Loop   Intercept  Alpha      Gradient
           No     (MPa)      (MPa)
Arm ave    1      4.824      2.845      0.590
Arm ave    2      4.732      2.745      0.580
Arm ave    3      5.407      3.334      0.617

Non-linear exponent from PWP response :   "PPC Ave=0.676"

[PARAMETERS USED FOR UNDRAINED CURVE MODELLING]
{Axis is  Arm ave}
Strain Origin (mm)                  :   -0.05
Po (kPa)                            :   410
Cu (kPa)                            :   143.1
Limit pressure (kPa)                :   1392
Non-linear exponent                 :   0.580
Calculated alpha (MPa)              :   2.813
G at yield (MPa)                    :   24.3
```


Cavity strain vs Total Pressure : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_006PM Test 2
12.90 Metres
29 Sep 21
Cavity strain (%)
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
Total pressure (kPa)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1,000
1,050
1,100

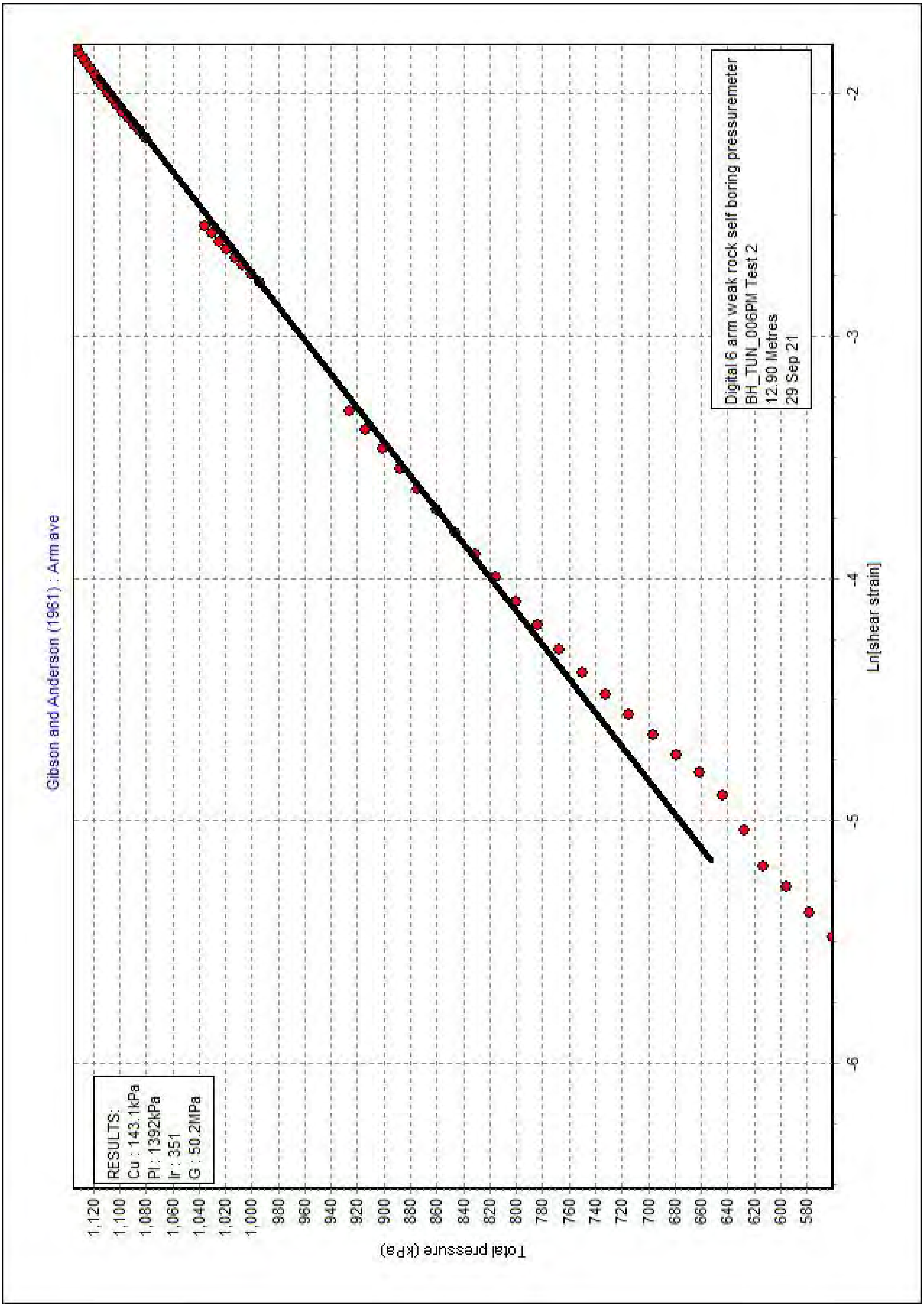

Lift-off analysis : Arm ave
RESULTS:
Lift off stress : 453.0kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_006PM Test 2
12.90 Metres
29 Sep 21
Total pressure (kPa)
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Radial Displacement (mm)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45

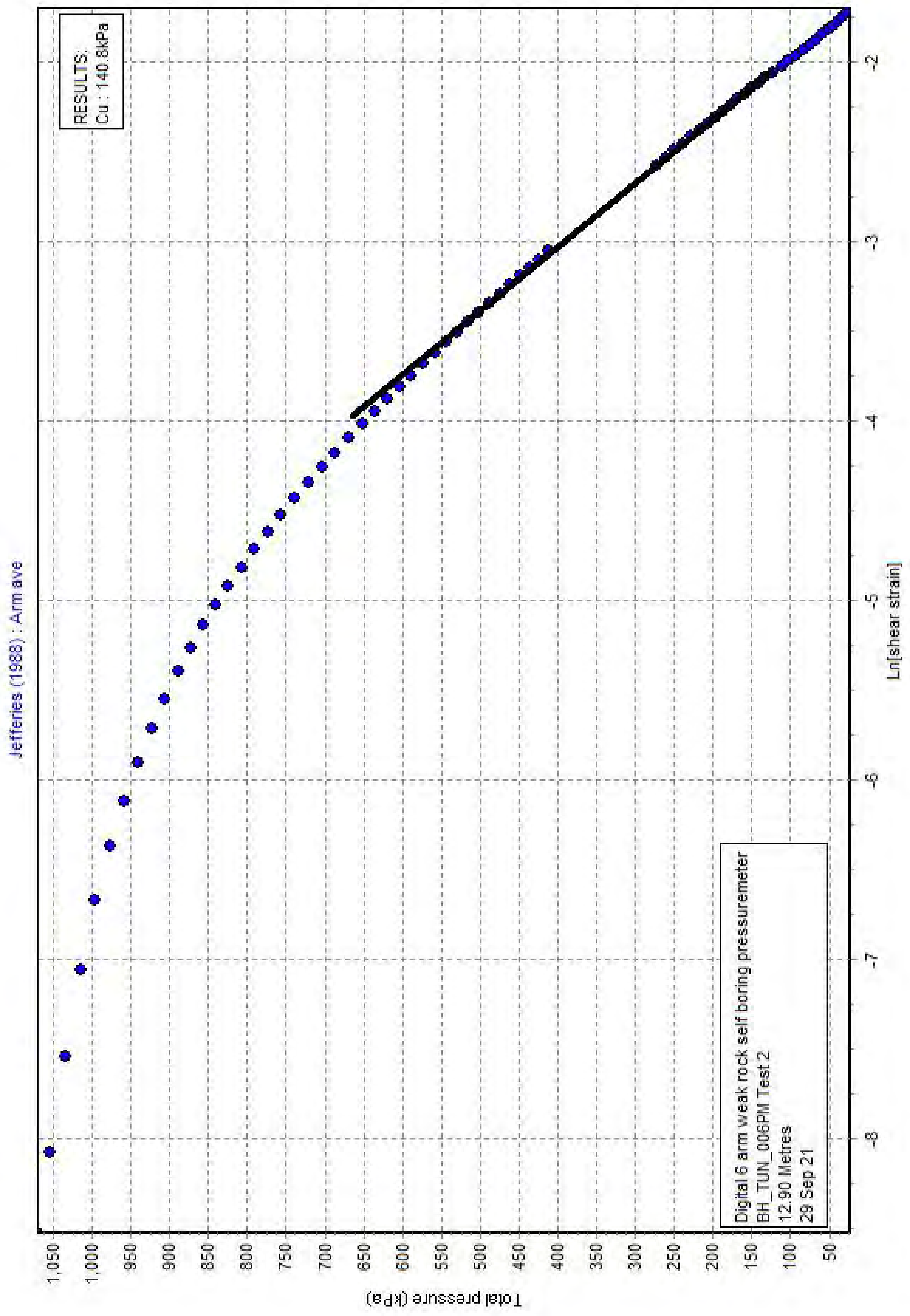

Po of cohesive material (1977, 1990) : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_006PM Test 2
12.90 Metres
29 Sep 21
RESULTS:
Gi : 41.2MPa
Pf : 613.6kPa
Po : 415.7kPa
Tf : 197.2kPa
Po + Tf : 612.9kPa
Origin : -0.036mm
Total pressure (kPa)
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Radial Displacement (mm)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0.75
0.8
Shear stress at yield : Arm ave
Total pressure (kPa)
900
850
800
750
700
650
Ln[shear strain]
-5
-4

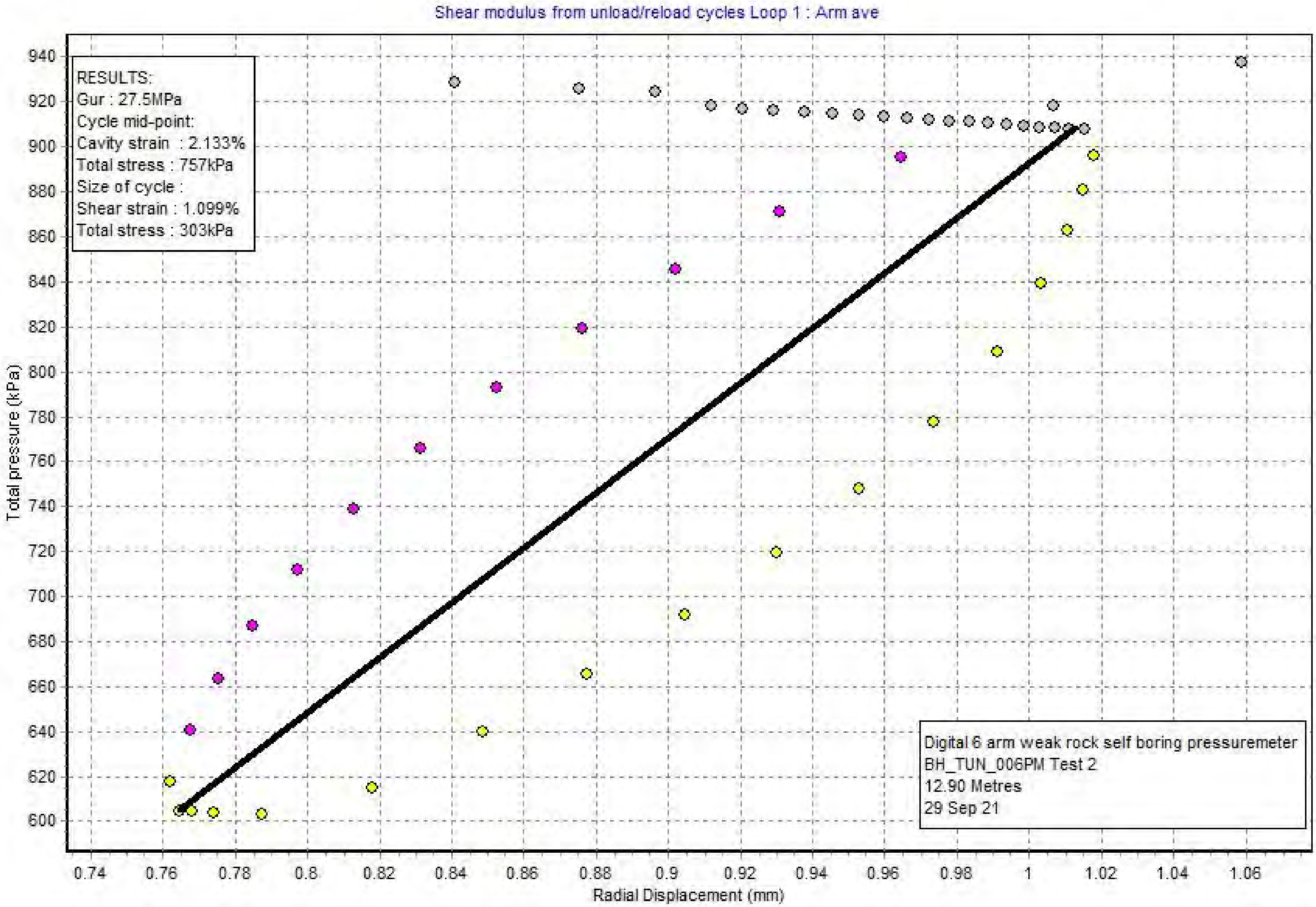


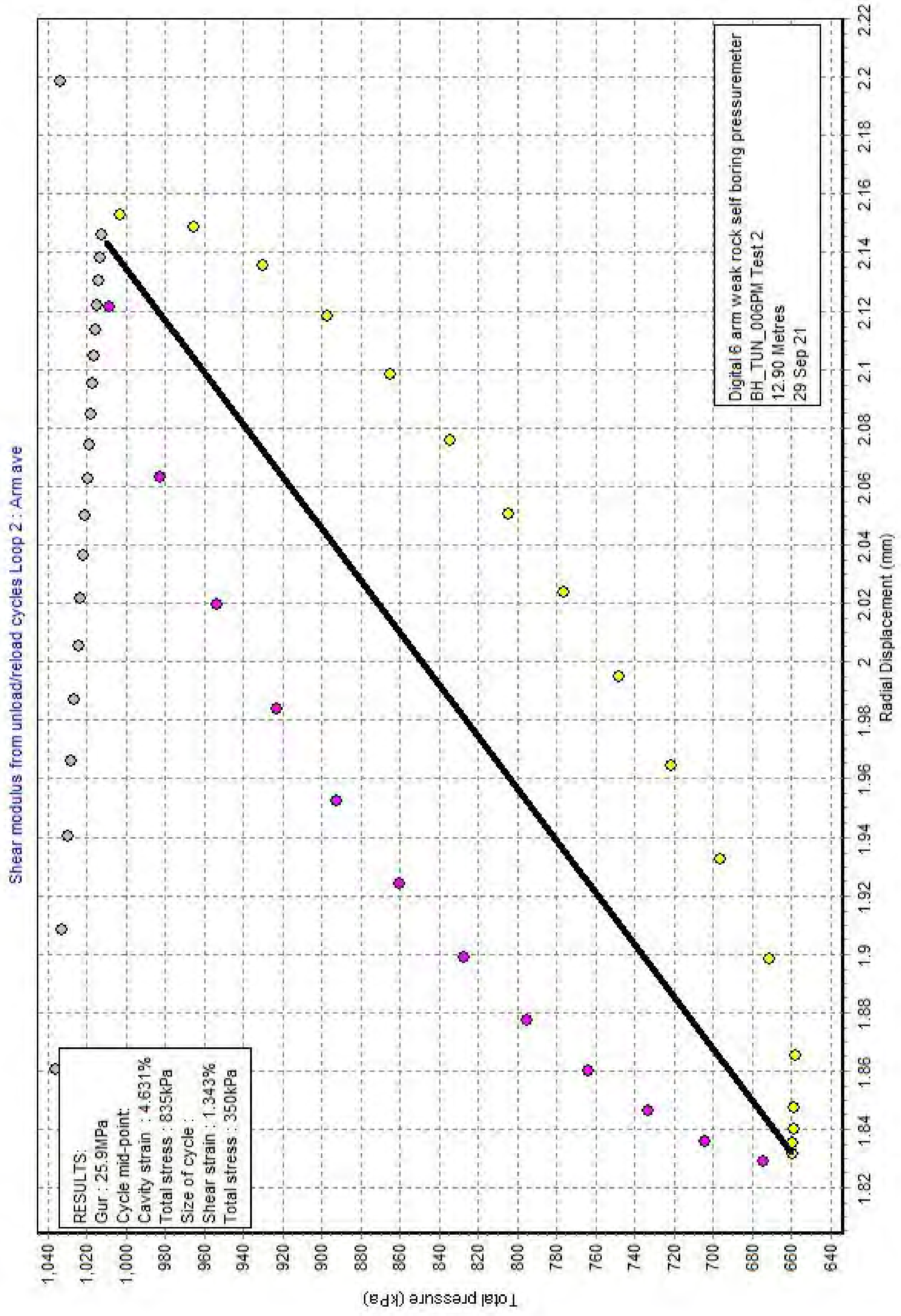
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_006PM Test 2
12.90 Metres
29 Sep 21

RESULTS:
Onset of excess pwp : 423.3kPa
End of elastic phase : 876.9 kPa
Exponent of non-linearity : 0.676
Gradient of plastic phase : 0.681

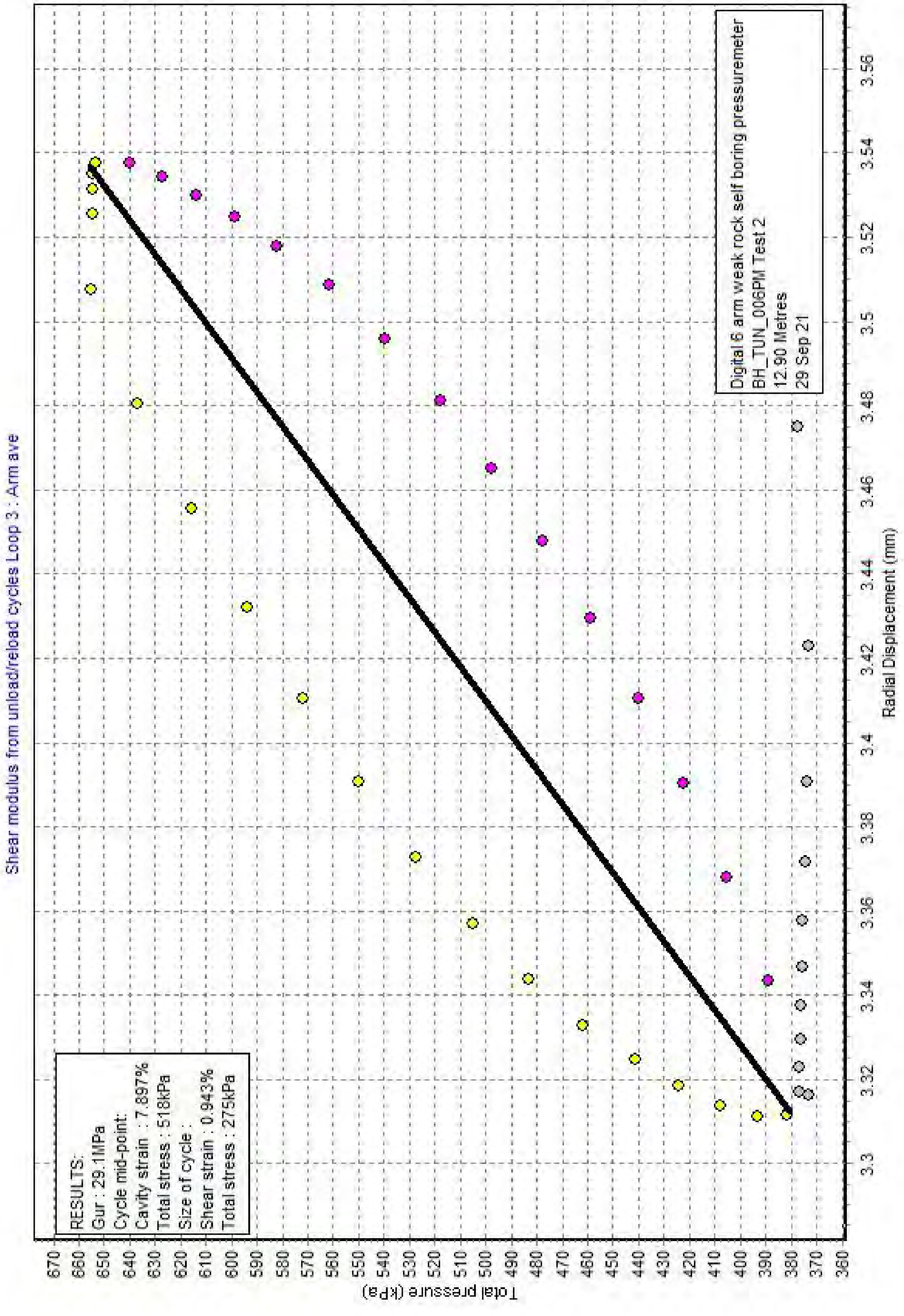

Gibson and Anderson (1961) : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_006PM Test 2
12.90 Metres
29 Sep 21
RESULTS:
Cu : 143.1kPa
Pl : 1392kPa
Ir : 351
G : 50.2MPa
Total pressure (kPa)
1,120
1,100
1,080
1,060
1,040
1,020
1,000
980
960
940
920
900
880
860
840
820
800
780
760
740
720
700
680
660
640
620
600
580
Ln[shear strain]
-2
-3
-4
-5
-6

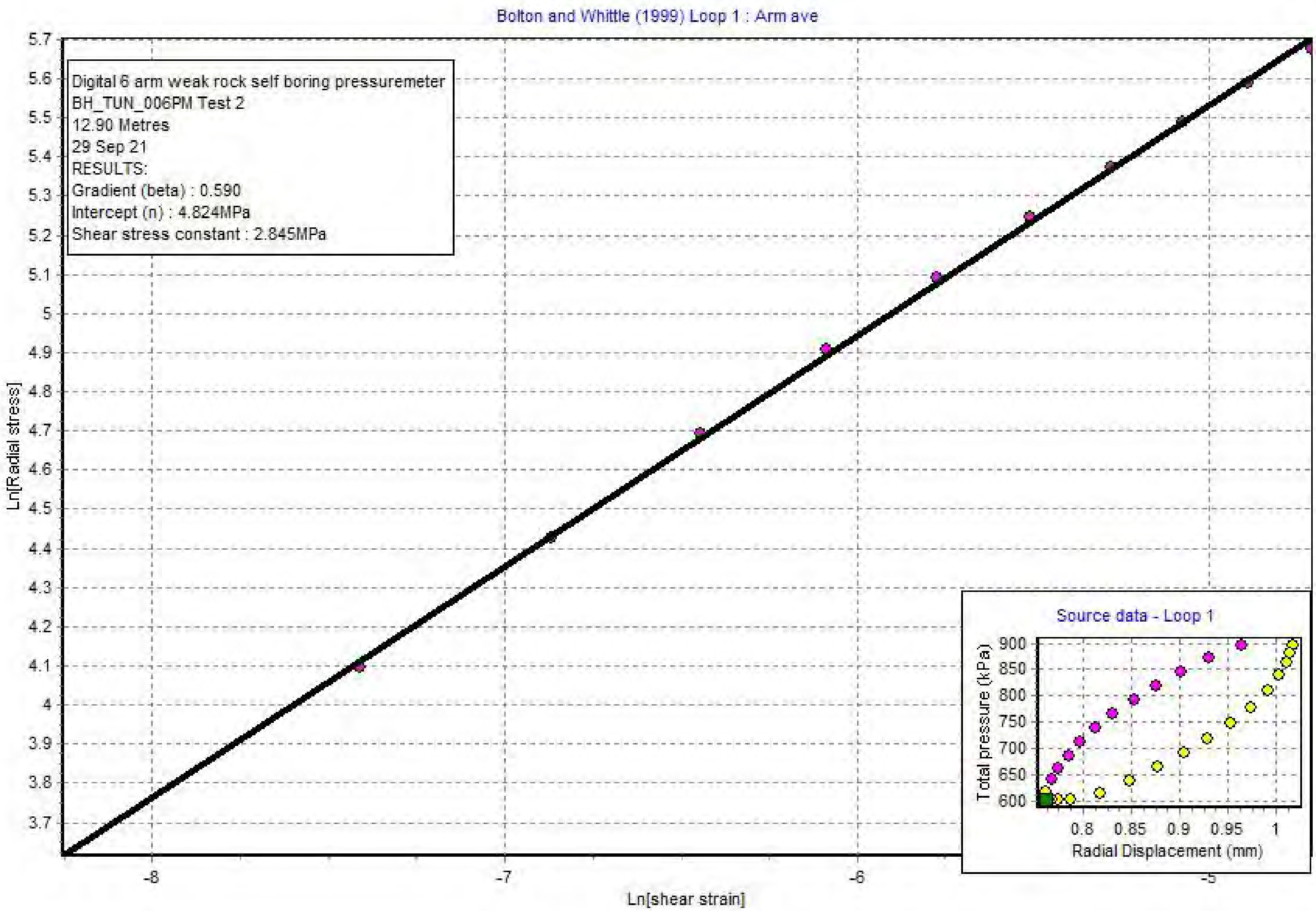

Jefferies (1988) : Arm ave
RESULTS:
Cu : 140.8kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_006PM Test 2
12.90 Metres
29 Sep 21
Total pressure (kPa)
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
Ln[shear strain]
-2
-3
-4
-5
-6
-7
-8


Shear modulus from unload/reload cycles Loop 1 : Arm ave
RESULTS:
Gur : 27.5MPa
Cycle mid-point:
Cavity strain : 2.133%
Total stress : 757kPa
Size of cycle :
Shear strain : 1.099%
Total stress : 303kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_006PM Test 2
12.90 Metres
29 Sep 21
Total pressure (kPa)
940
920
900
880
860
840
820
800
780
760
740
720
700
680
660
640
620
600
Radial Displacement (mm)
0.74
0.76
0.78
0.8
0.82
0.84
0.86
0.88
0.9
0.92
0.94
0.96
0.98
1
1.02
1.04
1.06

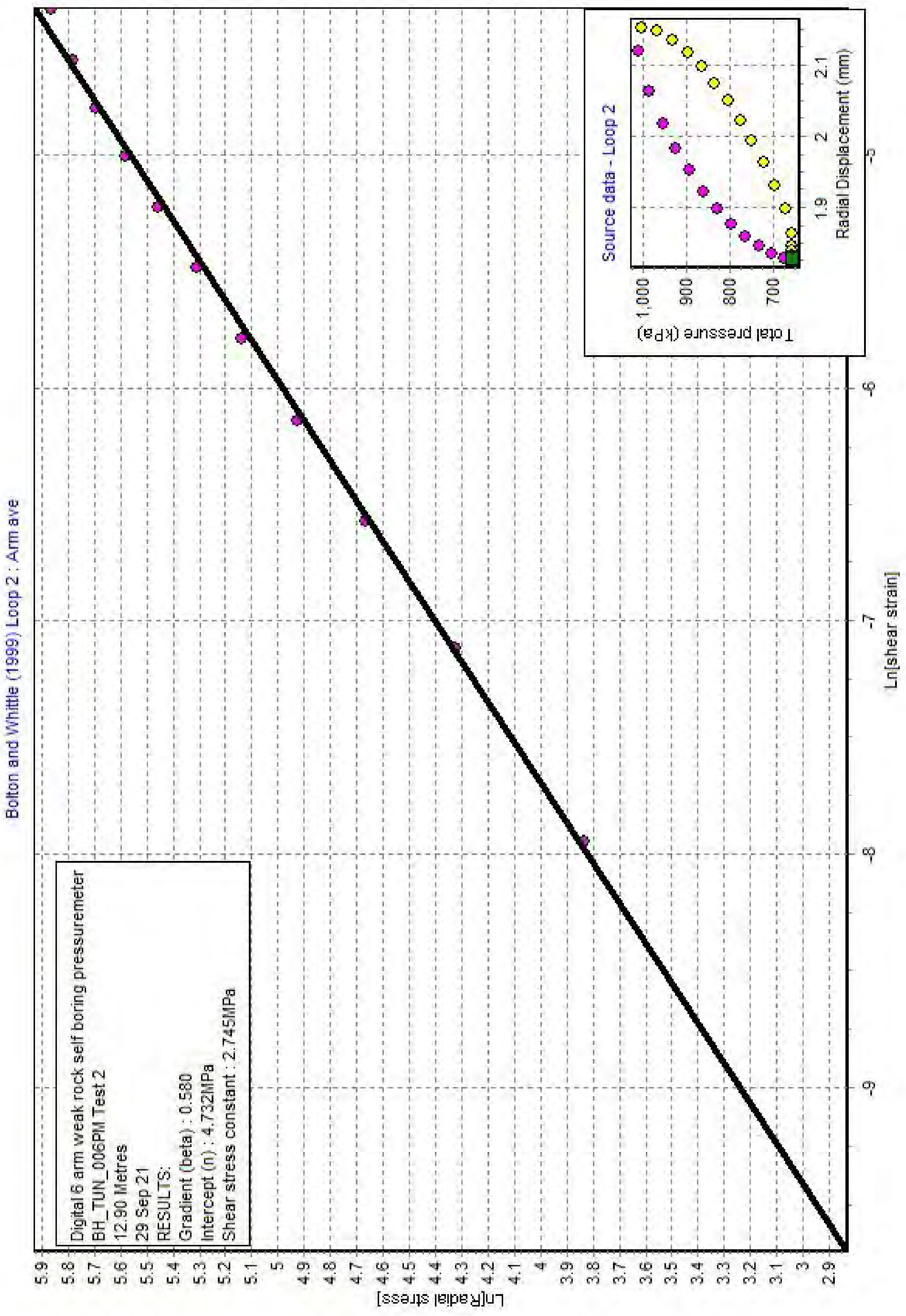


RESULTS:
Gur : 25.9MPa
Cycle mid-point:
Cavity strain : 4.631%
Total stress : 835kPa
Size of cycle :
Shear strain : 1.343%
Total stress : 350kPa

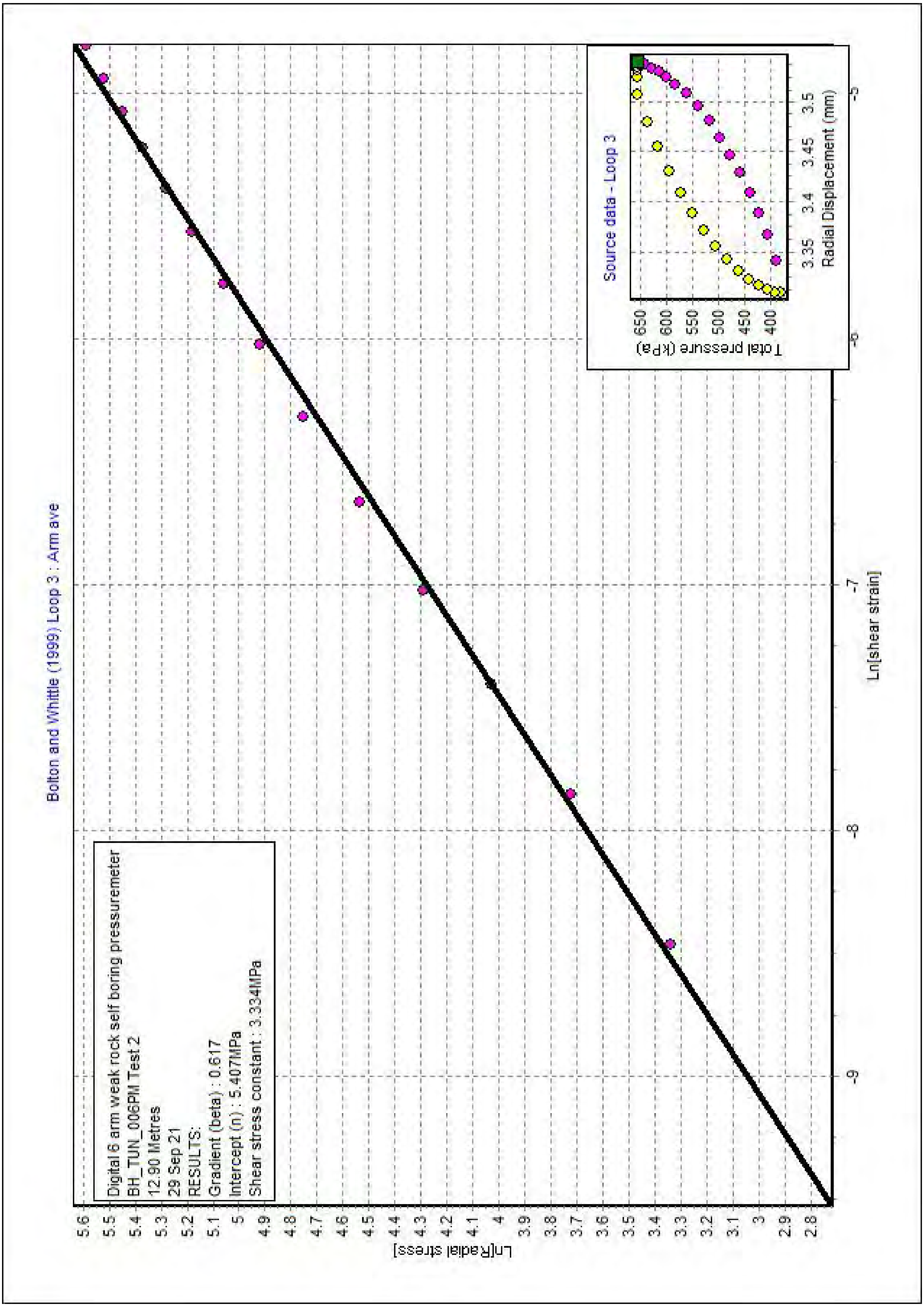

Shear modulus from unload/reload cycles Loop 3 : Arm ave
RESULTS:
Gur : 29.1MPa
Cycle mid-point:
Cavity strain : 7.897%
Total stress : 518kPa
Size of cycle :
Shear strain : 0.943%
Total stress : 275kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_006PM Test 2
12.90 Metres
29 Sep 21
Total pressure (kPa)
670
660
650
640
630
620
610
600
590
580
570
560
550
540
530
520
510
500
490
480
470
460
450
440
430
420
410
400
390
380
370
360
Radial Displacement (mm)
3.3
3.32
3.34
3.36
3.38
3.4
3.42
3.44
3.46
3.48
3.5
3.52
3.54
3.56



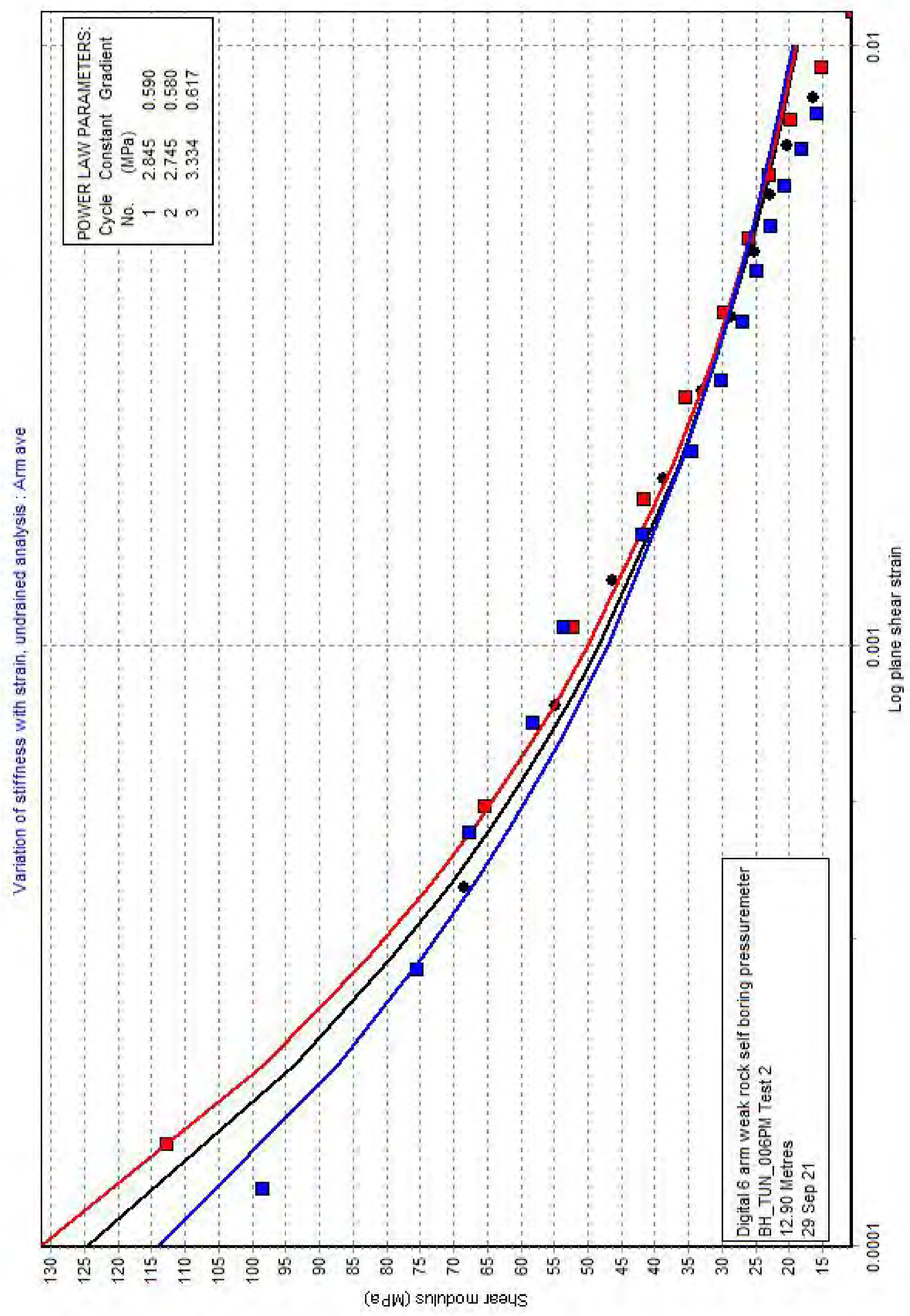
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_006PM Test 2
12.90 Metres
29 Sep 21
RESULTS:
Gradient (beta) : 0.590
Intercept (n) : 4.824MPa
Shear stress constant : 2.845MPa

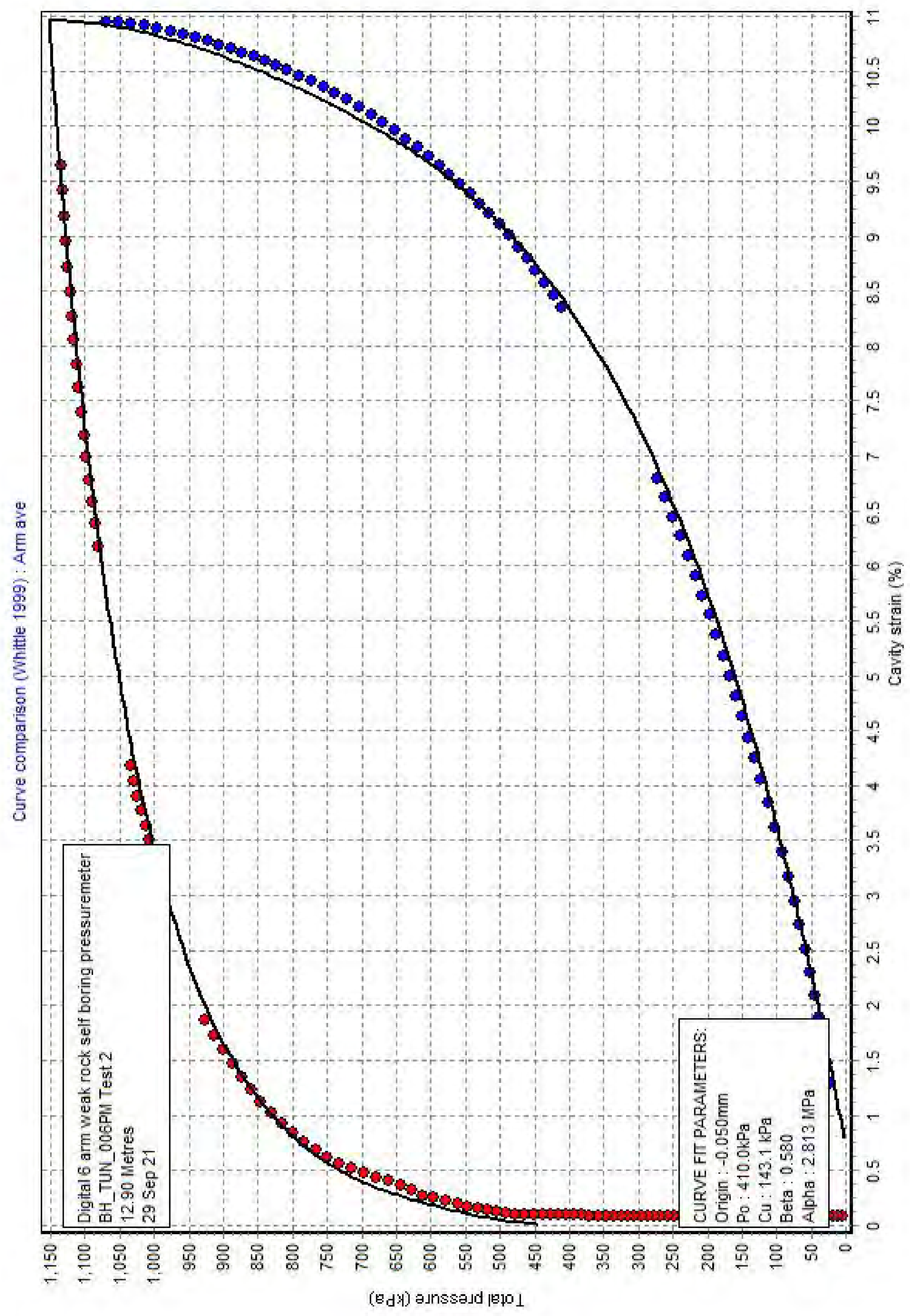


Digital 6 arm weak rock self boring pressuremeter
BH_TUN_006PM Test 2
12.90 Metres
29 Sep 21
RESULTS:
Gradient (beta) : 0.580
Intercept (n) : 4.732MPa
Shear stress constant : 2.745MPa



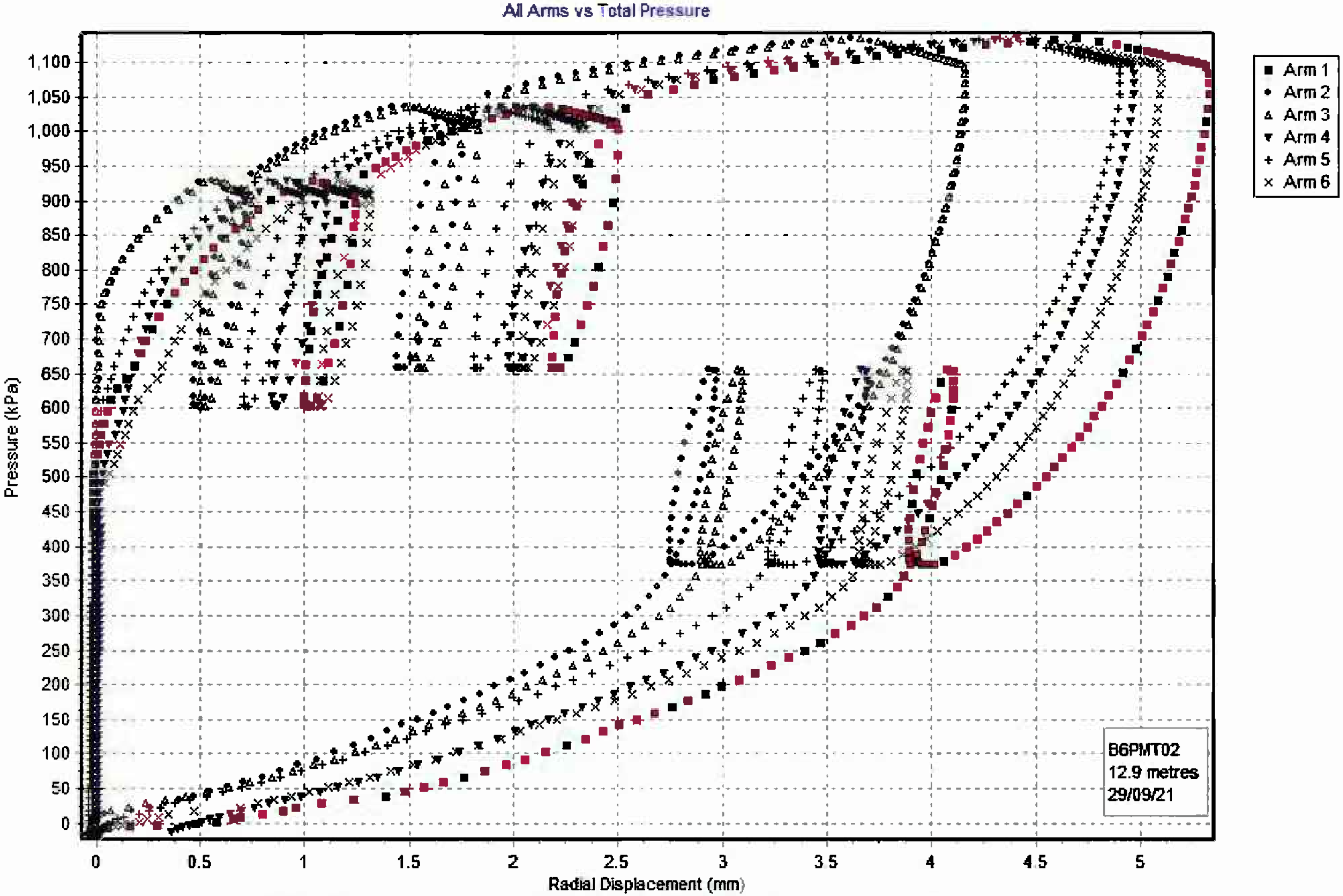
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_006PM Test 2
12.90 Metres
29 Sep 21
RESULTS:
Gradient (beta) : 0.617
Intercept (n) : 5.407MPa
Shear stress constant : 3.334MPa


Variation of stiffness with strain, undrained analysis : Arm ave
POWER LAW PARAMETERS:
Cycle No. | Constant (MPa) | Gradient
1 | 2.845 | 0.590
2 | 2.745 | 0.580
3 | 3.334 | 0.617
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_006PM Test 2
12.90 Metres
29 Sep 21
Shear modulus (MPa)
130
125
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
Log plane shear strain
0.0001
0.001
0.01

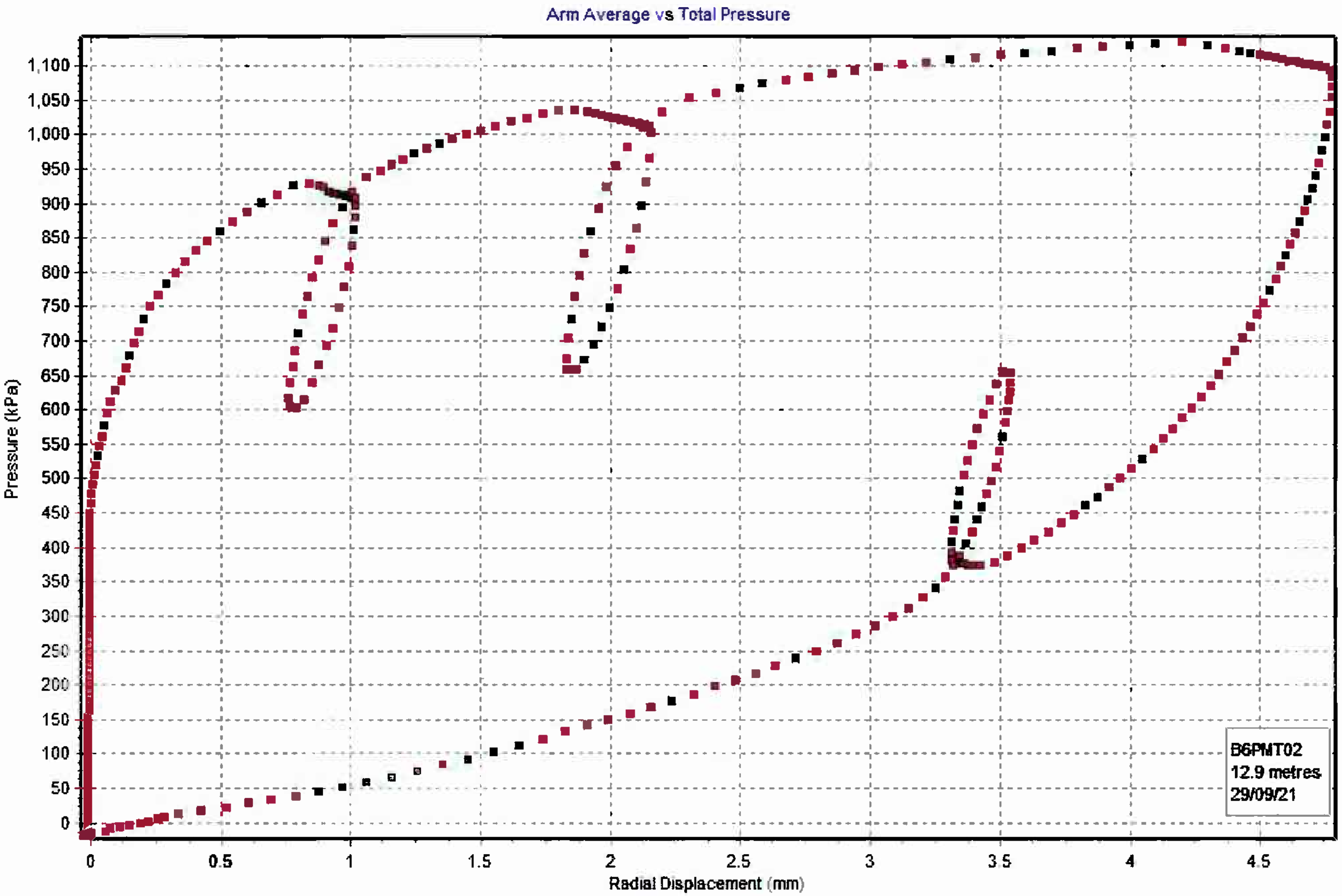


Digital 6 arm weak rock self boring pressuremeter
BH_TUN_006PM Test 2
12.90 Metres
29 Sep 21

CURVE FIT PARAMETERS:
Origin : -0.050mm
Po : 410.0kPa
Cu : 143.1 kPa
Beta : 0.580
Alpha : 2.813 MPa



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel +44 (0)1223 262361

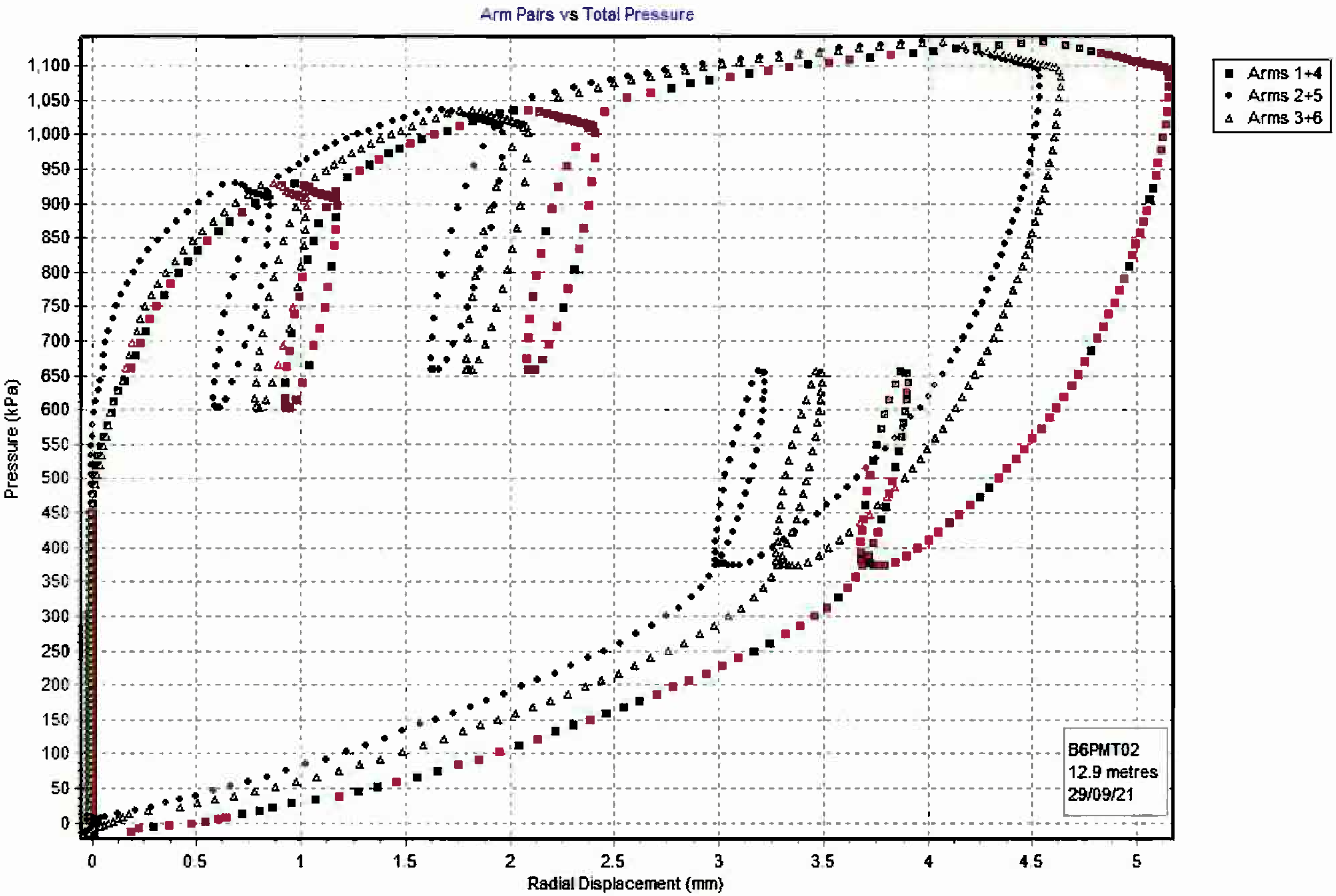


CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361

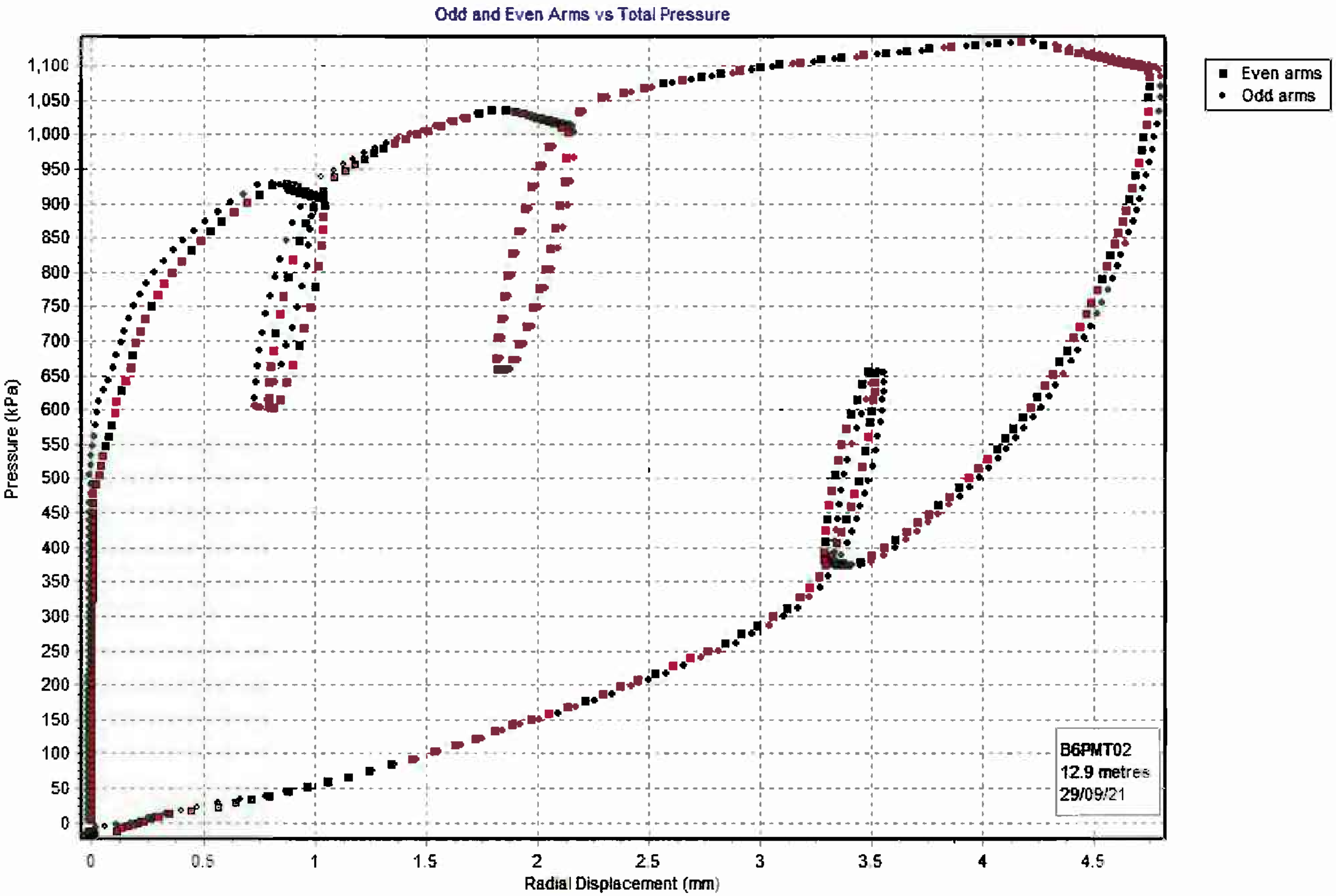
CIR1506/21

Cambridge WWTPR

Pressuremeter Testing



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361



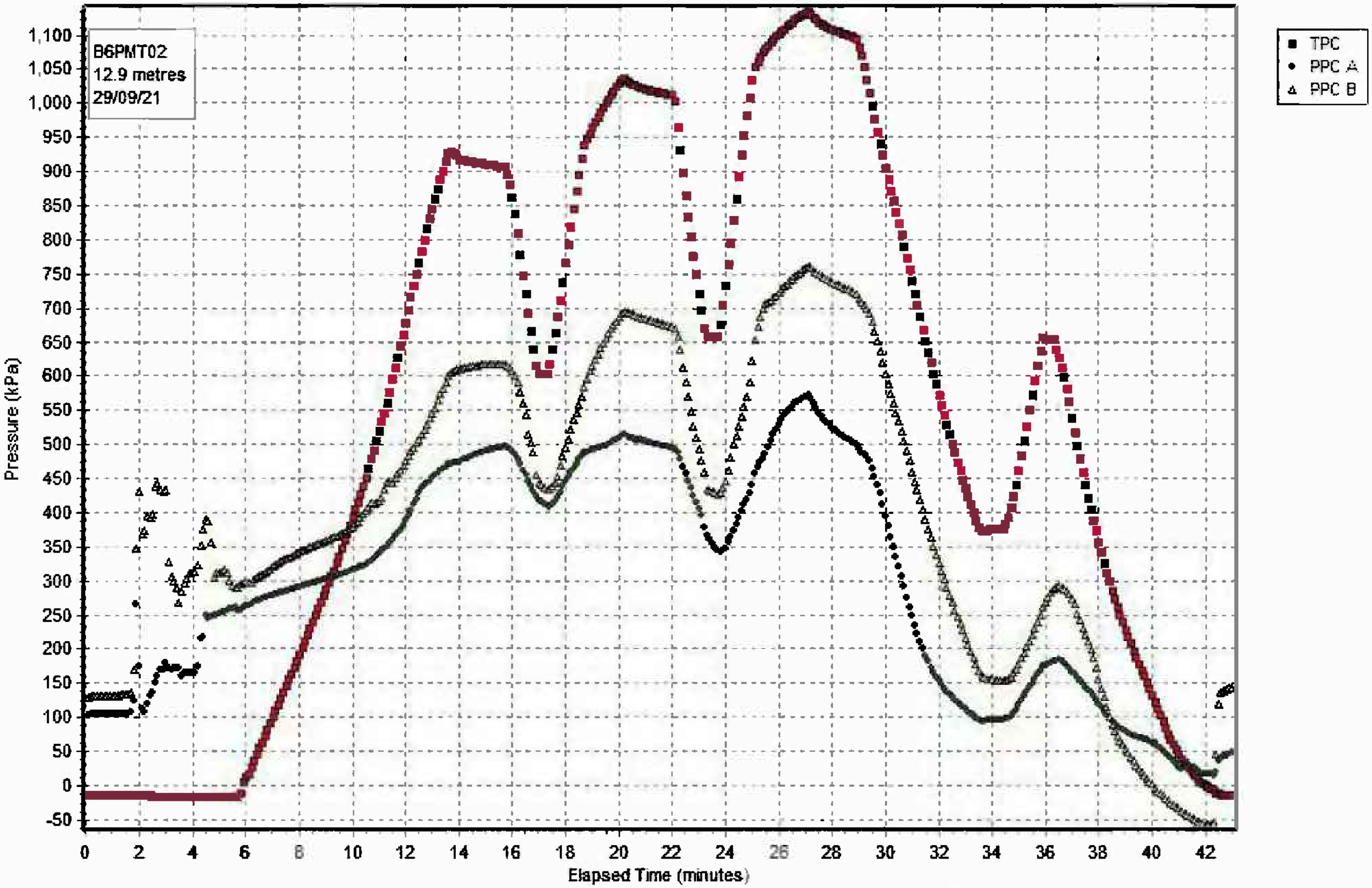
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361

CIR1506/21

Cambridge WWTPR

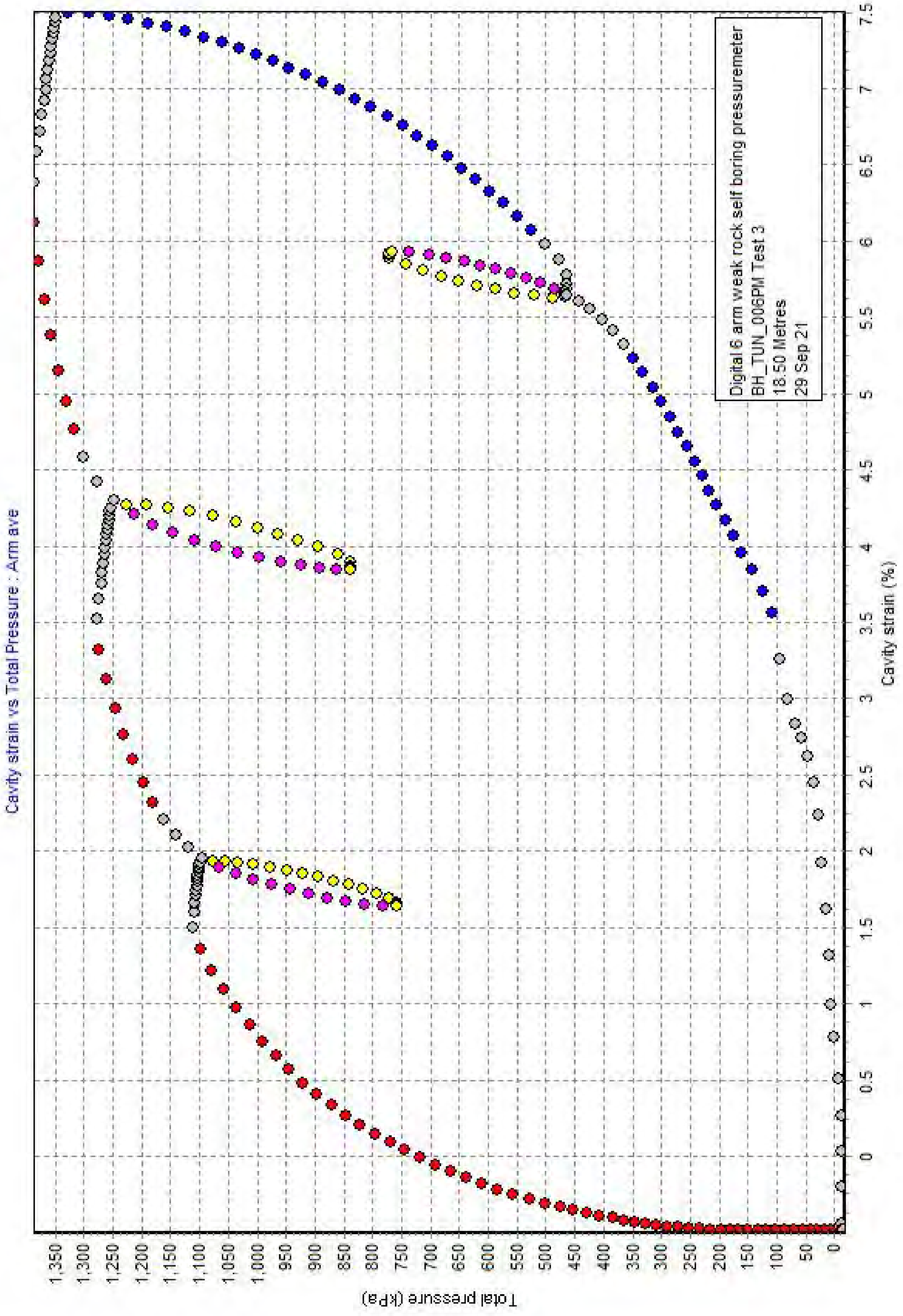
Pressuremeter Testing

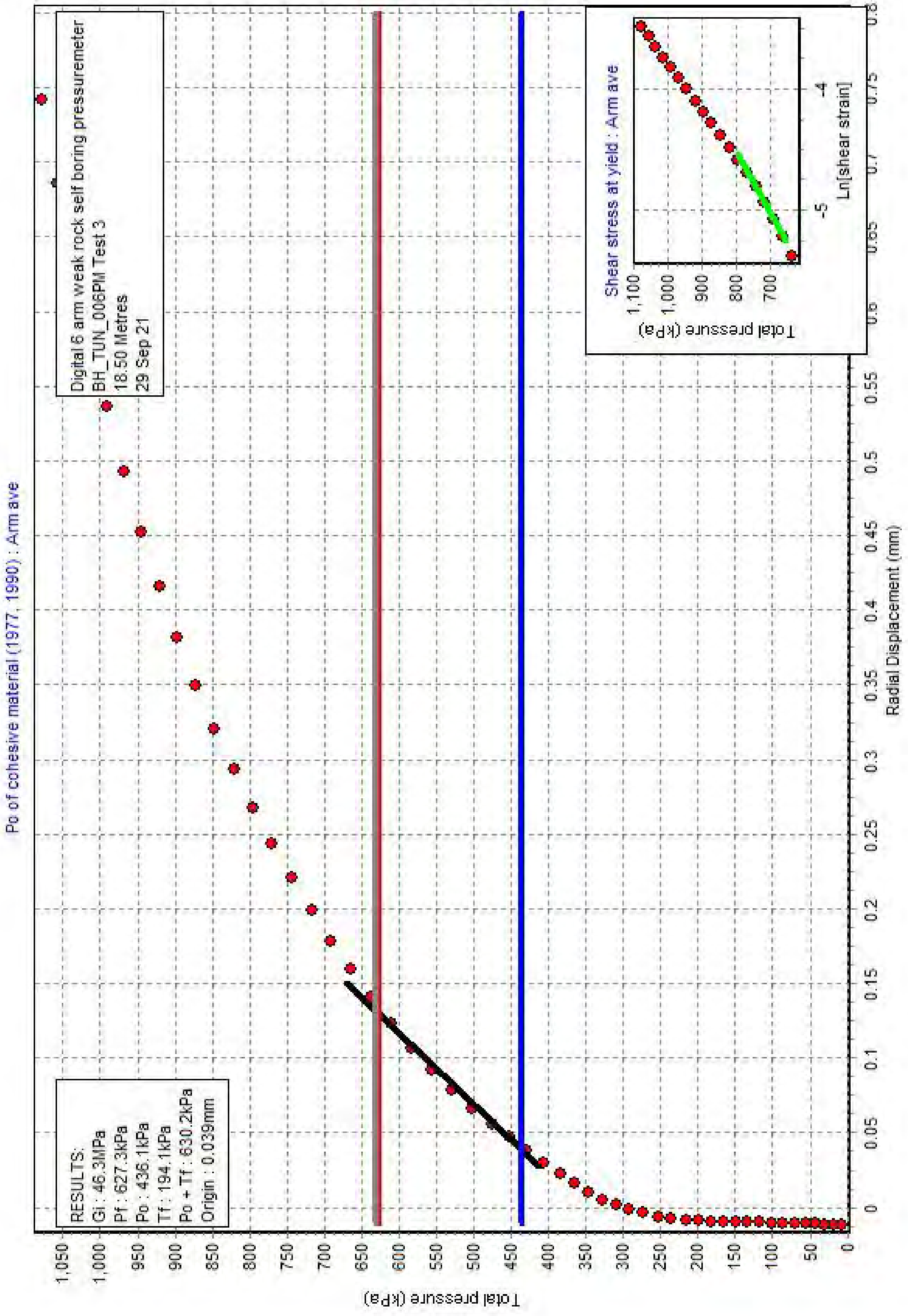
All Pressure Cells vs Time

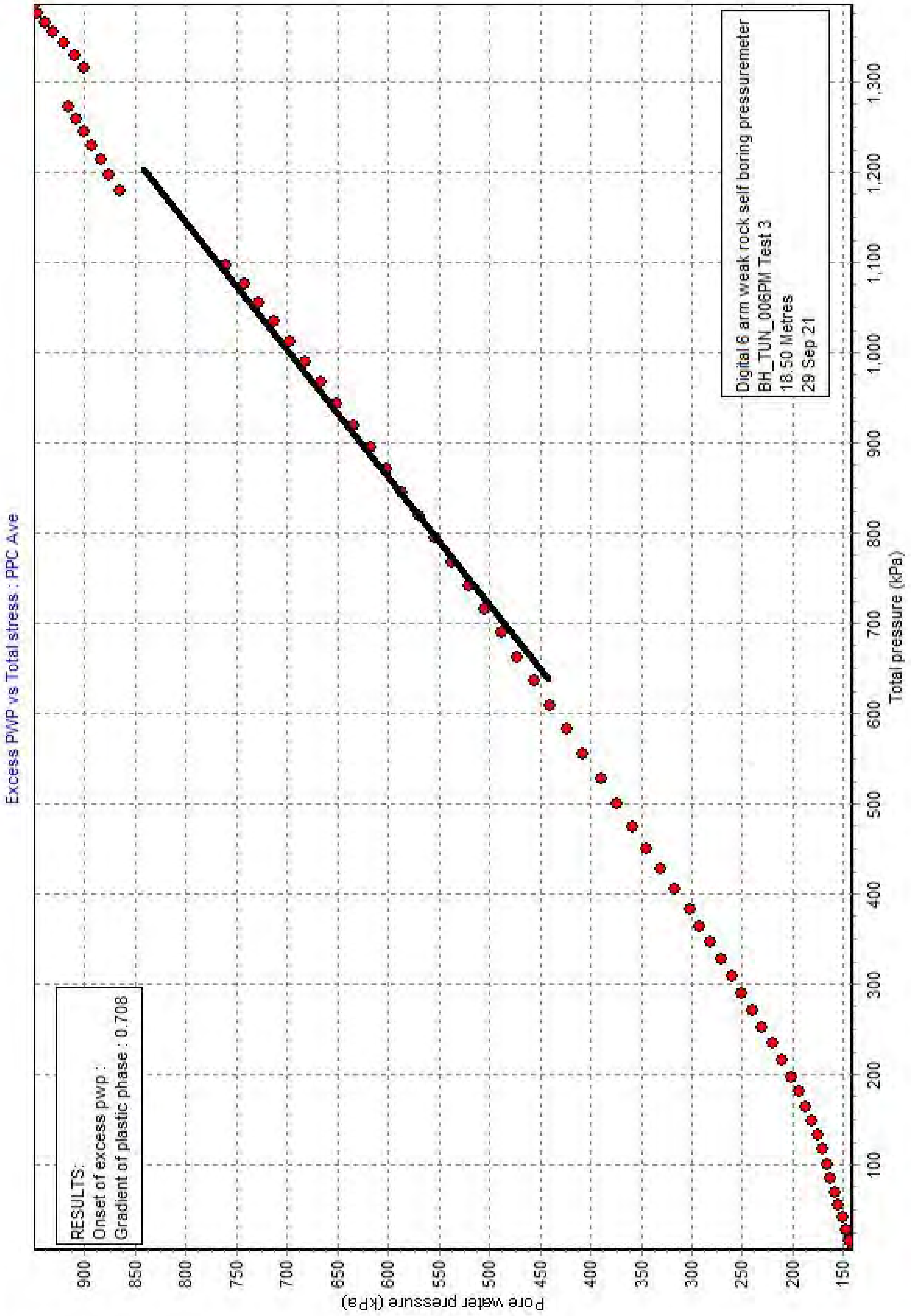


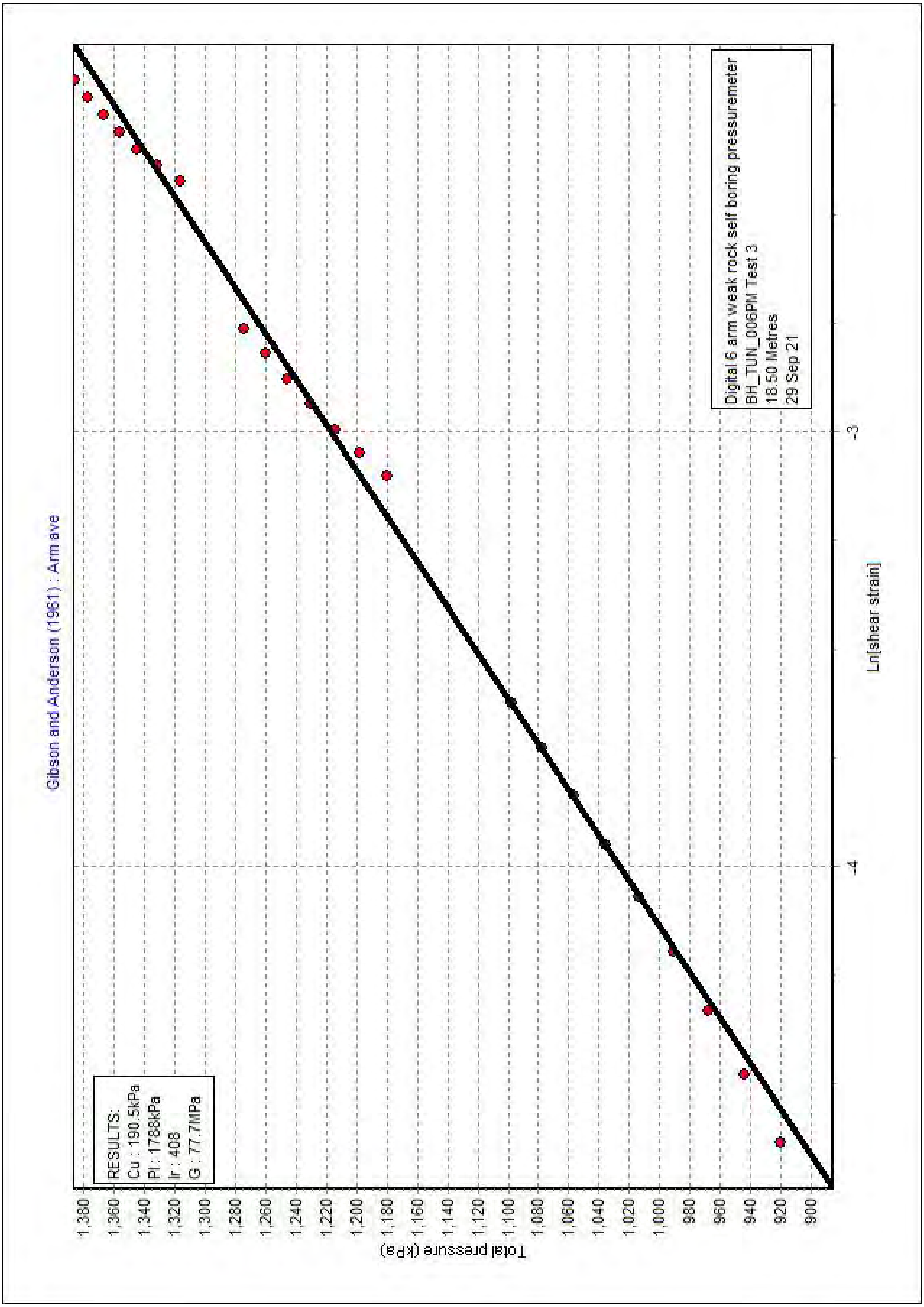
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361

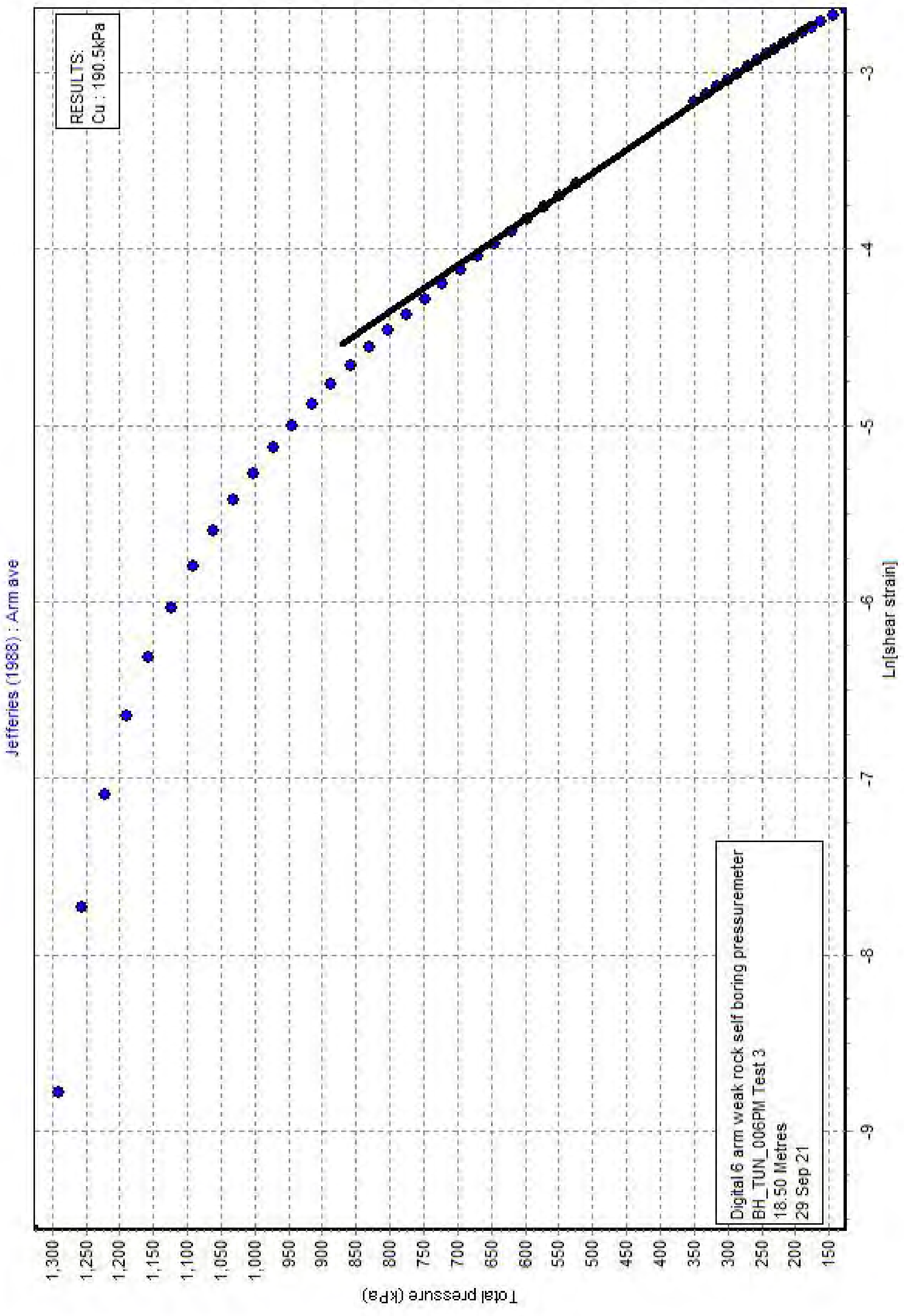
```
BH_TUN_006PM Test 3 - SUMMARY OF RESULTS
[File made with WinSitu ]

[DETAILS OF TEST]
Project        :   TE8364
Site           :   Cambridge Waste Water Treatment Plant Relocation Project
Borehole       :   BH_TUN_006PM
Test name      :   BH_TUN_006PM Test 3
Test date      :   29 Sep 21
Test depth     :   18.50 Metres
Water table    :   4.5 Metres
Ambient PWP    :   137.0 kPa
Material       :   Gault Clay
Probe          :   Digital 6 arm weak rock self boring pressuremeter
Diameter       :   88.1 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out
The file includes results from a curve fitting analysis

Analysed by YB / ES / RW on 30 Sep 21

Remarks:

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm)                   :   "Arm ave=0.20"
Po from Marsland & Randolph (kPa)    :   "Arm ave=436.1"
Best estimate of Po (kPa)            :   "Arm ave=453.0"

[UNDRAINED STRENGTH PARAMETERS]
Gibson & Anderson 1961 - Cu (kPa)    :   "Arm ave=190.5"
Limit pressure (kPa)                 :   "Arm ave=1788"
Jefferies 1988 - Cu (kPa)            :   "Arm ave=190.5"
Undrained yield stress (kPa)         :   "Arm ave=627.3"

[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=46.3"
Axis       Loop   Value    Mean Strain  Mean Pc  dE      dPc
           No     (MPa)    (%)          (kPa)    (%)     (kPa)
Arm ave    1      54.9     1.797        919      0.581   320
Arm ave    2      47.9     4.066        1034     0.808   389
Arm ave    3      51.7     5.792        626      0.542   281

[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]
Axis       Loop   Intercept  Alpha      Gradient
           No     (MPa)      (MPa)
Arm ave    1      10.084     6.611      0.656
Arm ave    2      9.918      6.425      0.648
Arm ave    3      7.691      4.690      0.610


[PARAMETERS USED FOR UNDRAINED CURVE MODELLING]
{Axis is  Arm ave}
Strain Origin (mm)                   :   0.20
Po (kPa)                             :   453
Cu (kPa)                             :   190.5
Limit pressure (kPa)                 :   1788
Non-linear exponent                  :   0.648
Calculated alpha (MPa)               :   6.588
G at yield (MPa)                     :   45.2
```

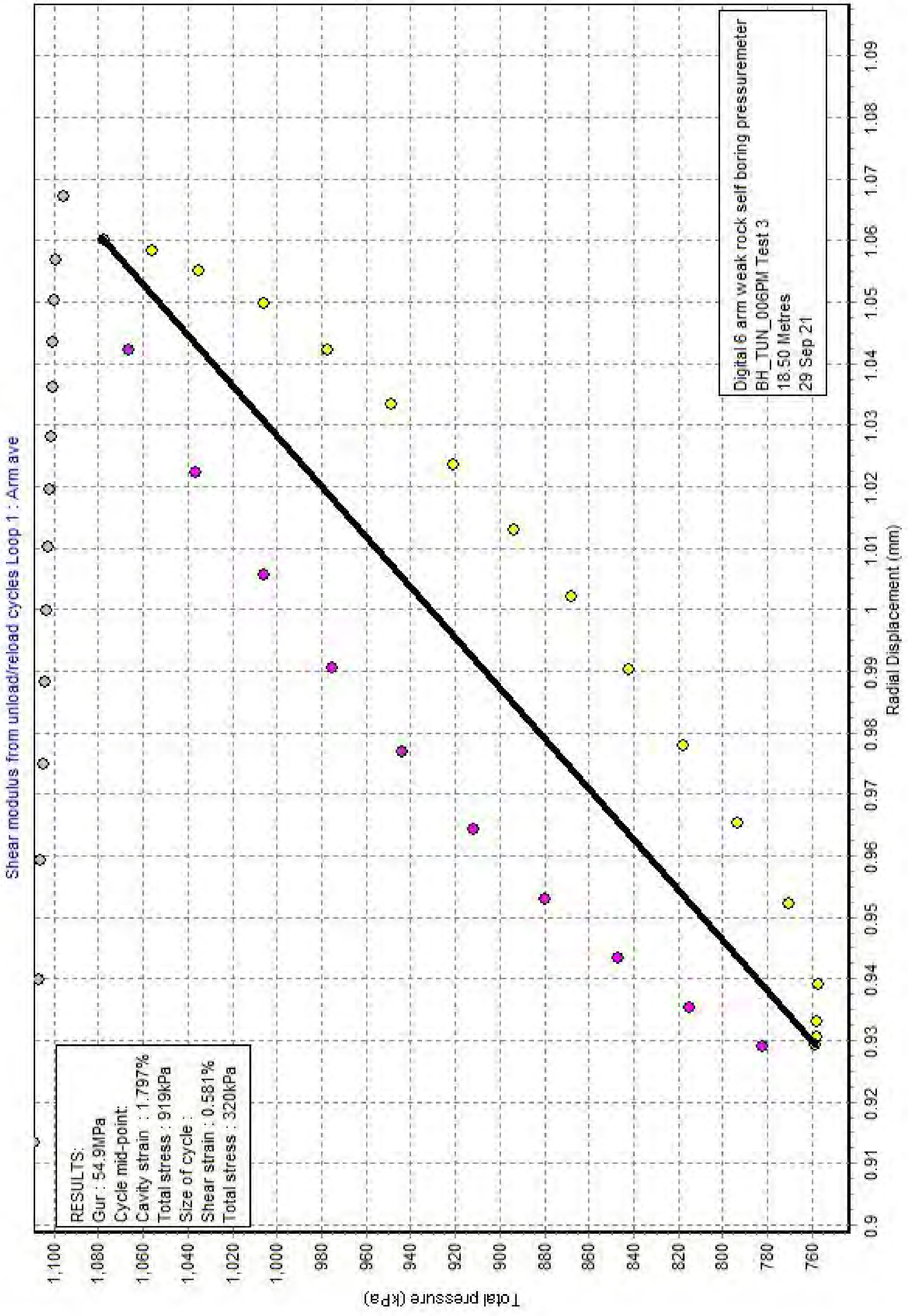

Cavity strain vs Total Pressure : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_006PM Test 3
18.50 Metres
29 Sep 21
Total pressure (kPa)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1,000
1,050
1,100
1,150
1,200
1,250
1,300
1,350
Cavity strain (%)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5


Po of cohesive material (1977, 1990) : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_006PM Test 3
18.50 Metres
29 Sep 21
RESULTS:
Gi : 46.3MPa
Pf : 627.3kPa
Po : 436.1kPa
Tf : 194.1kPa
Po + Tf : 630.2kPa
Origin : 0.039mm
Total pressure (kPa)
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Radial Displacement (mm)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0.75
0.8
Shear stress at yield : Arm ave
Total pressure (kPa)
1,100
1,000
900
800
700
Ln[shear strain]
-5
-4


Excess PWP vs Total stress : PPC Ave
RESULTS:
Onset of excess pwp :
Gradient of plastic phase : 0.708
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_006PM Test 3
18.50 Metres
29 Sep 21
Pore water pressure (kPa)
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
Total pressure (kPa)
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
1,300

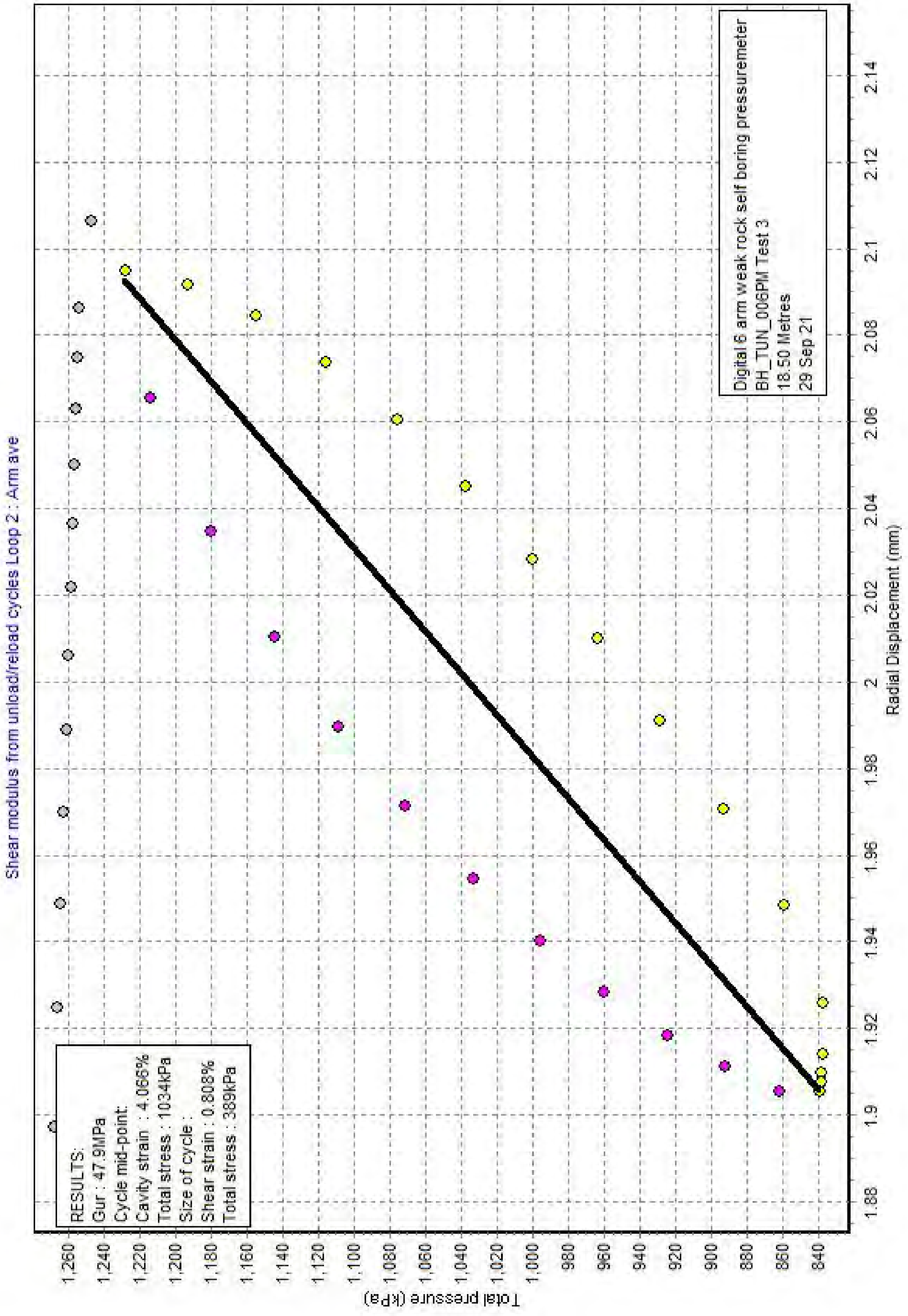

Gibson and Anderson (1961) : Arm ave
RESULTS:
Cu : 190.5kPa
Pl : 1788kPa
Ir : 408
G : 77.7MPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_006PM Test 3
18.50 Metres
29 Sep 21
Total pressure (kPa)
1,380
1,360
1,340
1,320
1,300
1,280
1,260
1,240
1,220
1,200
1,180
1,160
1,140
1,120
1,100
1,080
1,060
1,040
1,020
1,000
980
960
940
920
900
Ln[shear strain]
-4
-3

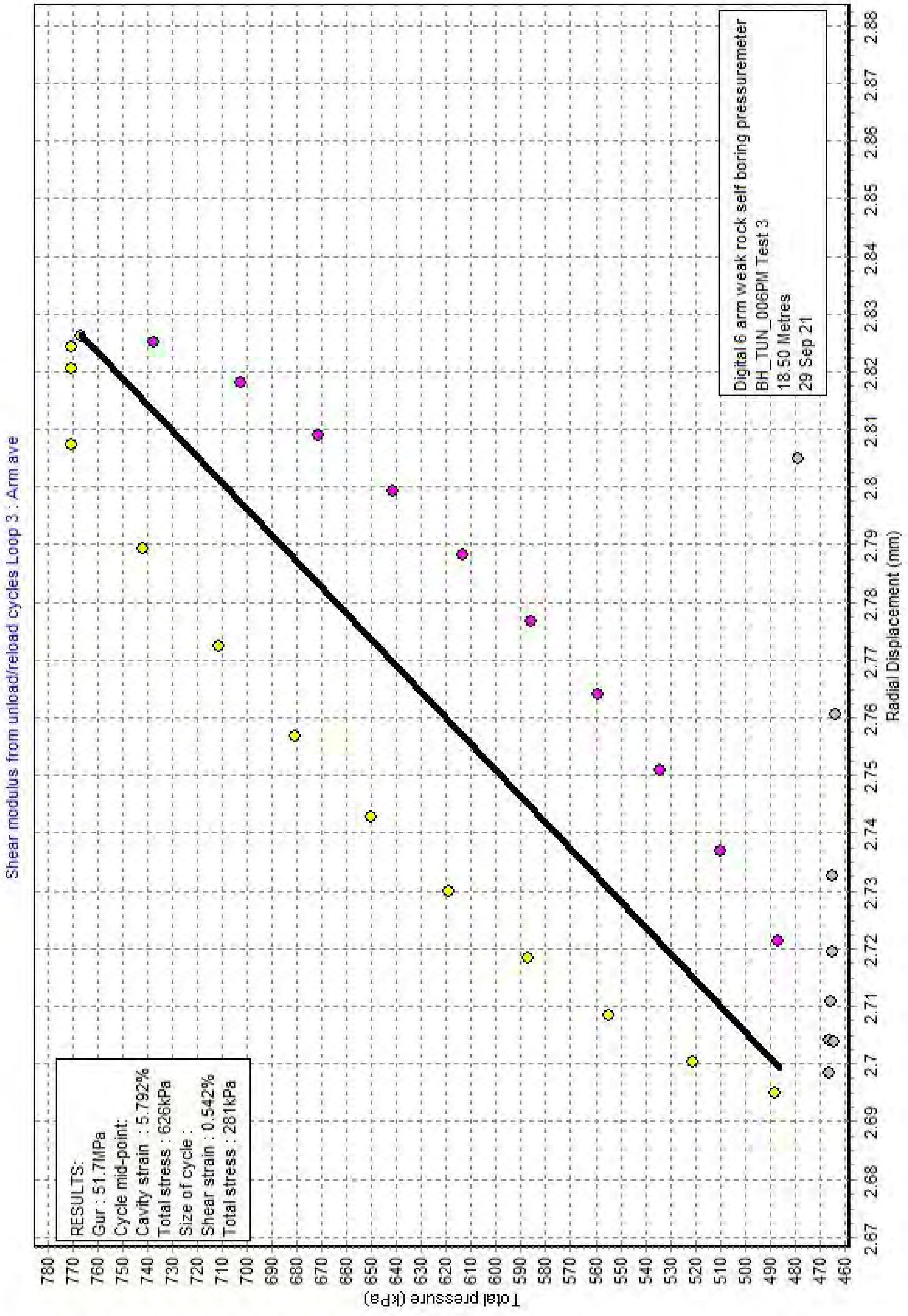

Jefferies (1988) : Arm ave
RESULTS:
Cu : 190.5kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_006PM Test 3
18.50 Metres
29 Sep 21
Total pressure (kPa)
1,300
1,250
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
Ln[shear strain]
-9
-8
-7
-6
-5
-4
-3

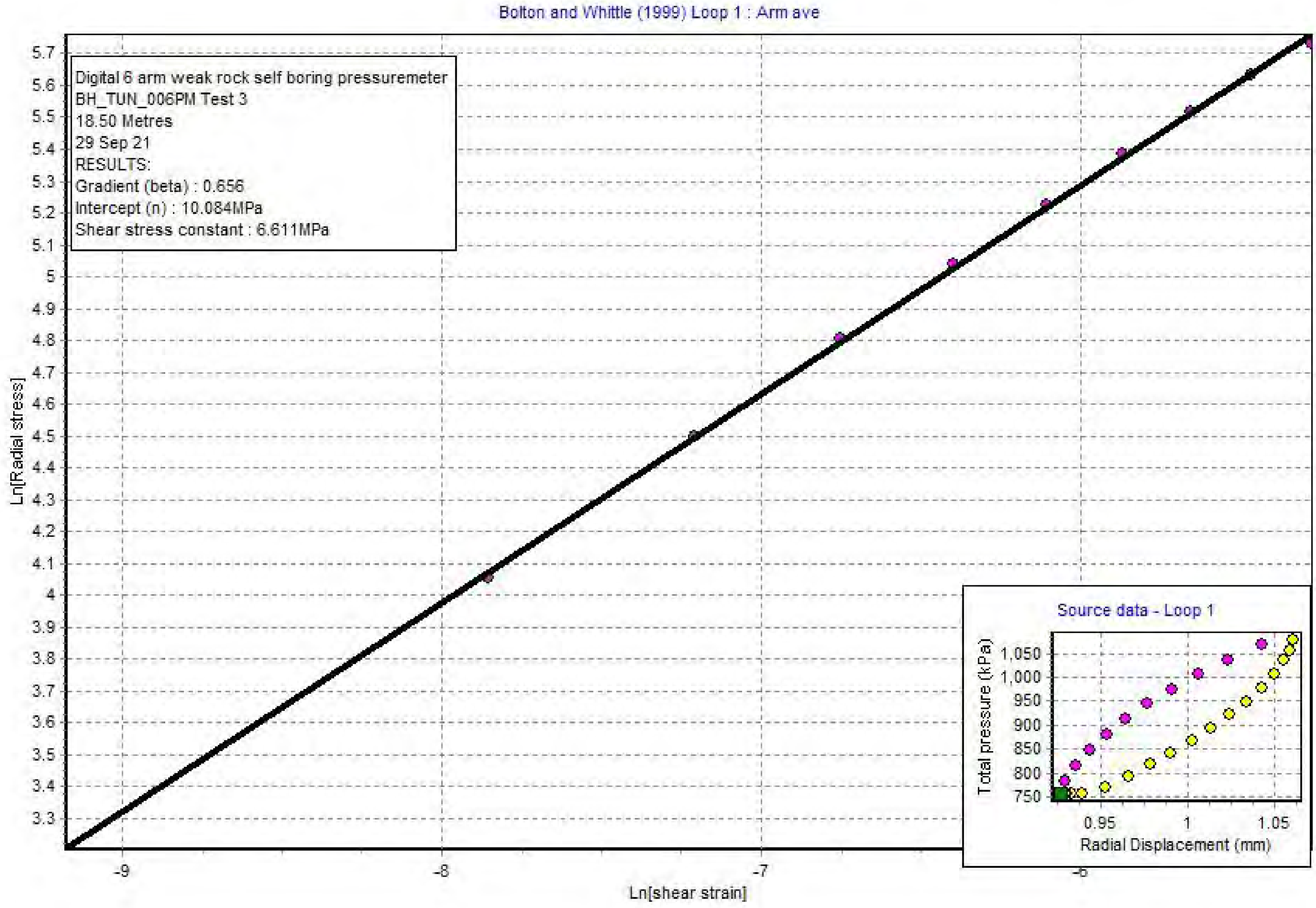


RESULTS:
Gur : 54.9MPa
Cycle mid-point:
Cavity strain : 1.797%
Total stress : 919kPa
Size of cycle :
Shear strain : 0.581%
Total stress : 320kPa

Digital 6 arm weak rock self boring pressuremeter
BH_TUN_006PM Test 3
18.50 Metres
29 Sep 21

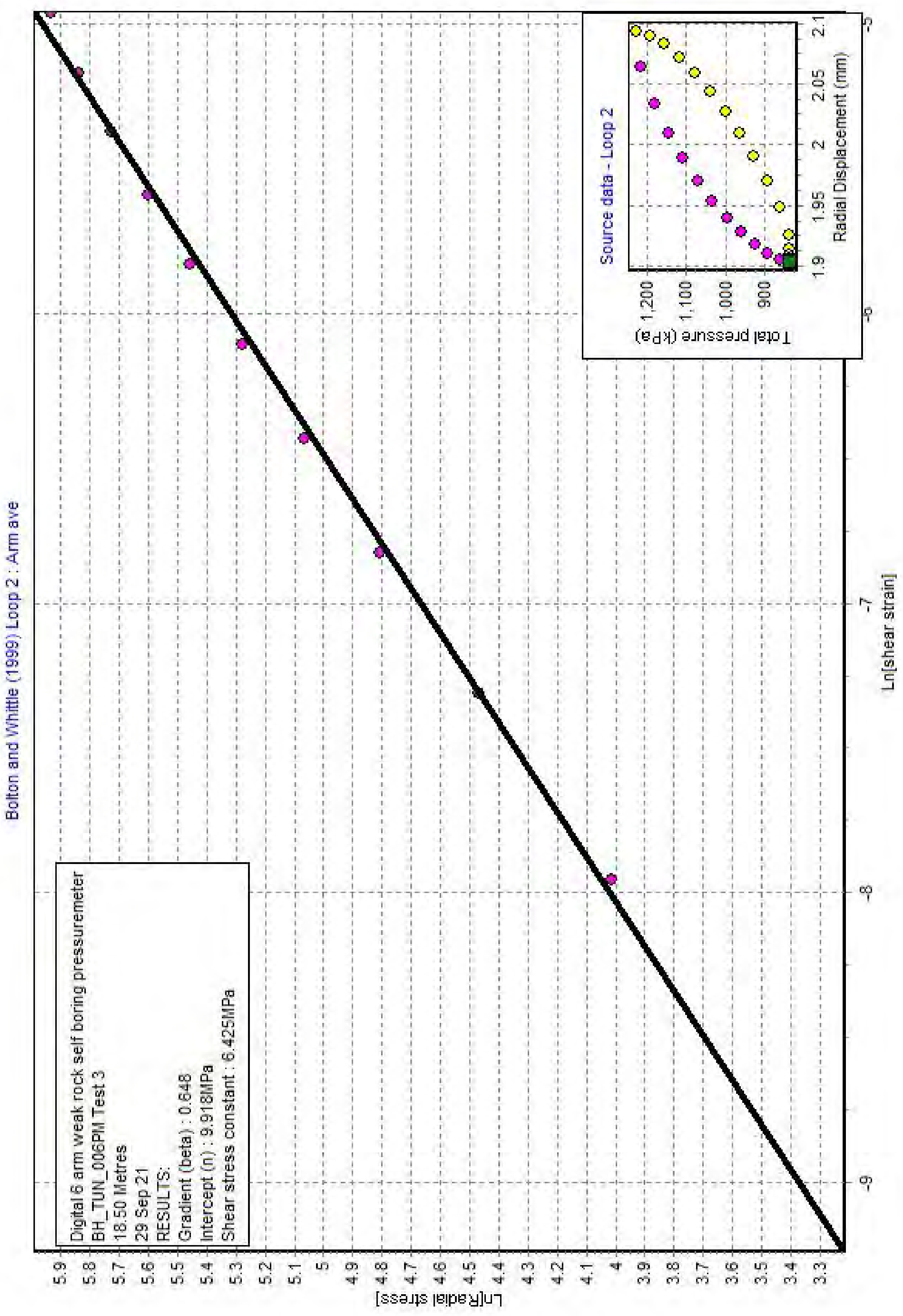

Shear modulus from unload/reload cycles Loop 2 : Arm ave
RESULTS:
Gur : 47.9MPa
Cycle mid-point:
Cavity strain : 4.066%
Total stress : 1034kPa
Size of cycle :
Shear strain : 0.808%
Total stress : 389kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_006PM Test 3
18.50 Metres
29 Sep 21
Total pressure (kPa)
1,260
1,240
1,220
1,200
1,180
1,160
1,140
1,120
1,100
1,080
1,060
1,040
1,020
1,000
980
960
940
920
900
880
860
840
Radial Displacement (mm)
1.88
1.9
1.92
1.94
1.96
1.98
2
2.02
2.04
2.06
2.08
2.1
2.12
2.14

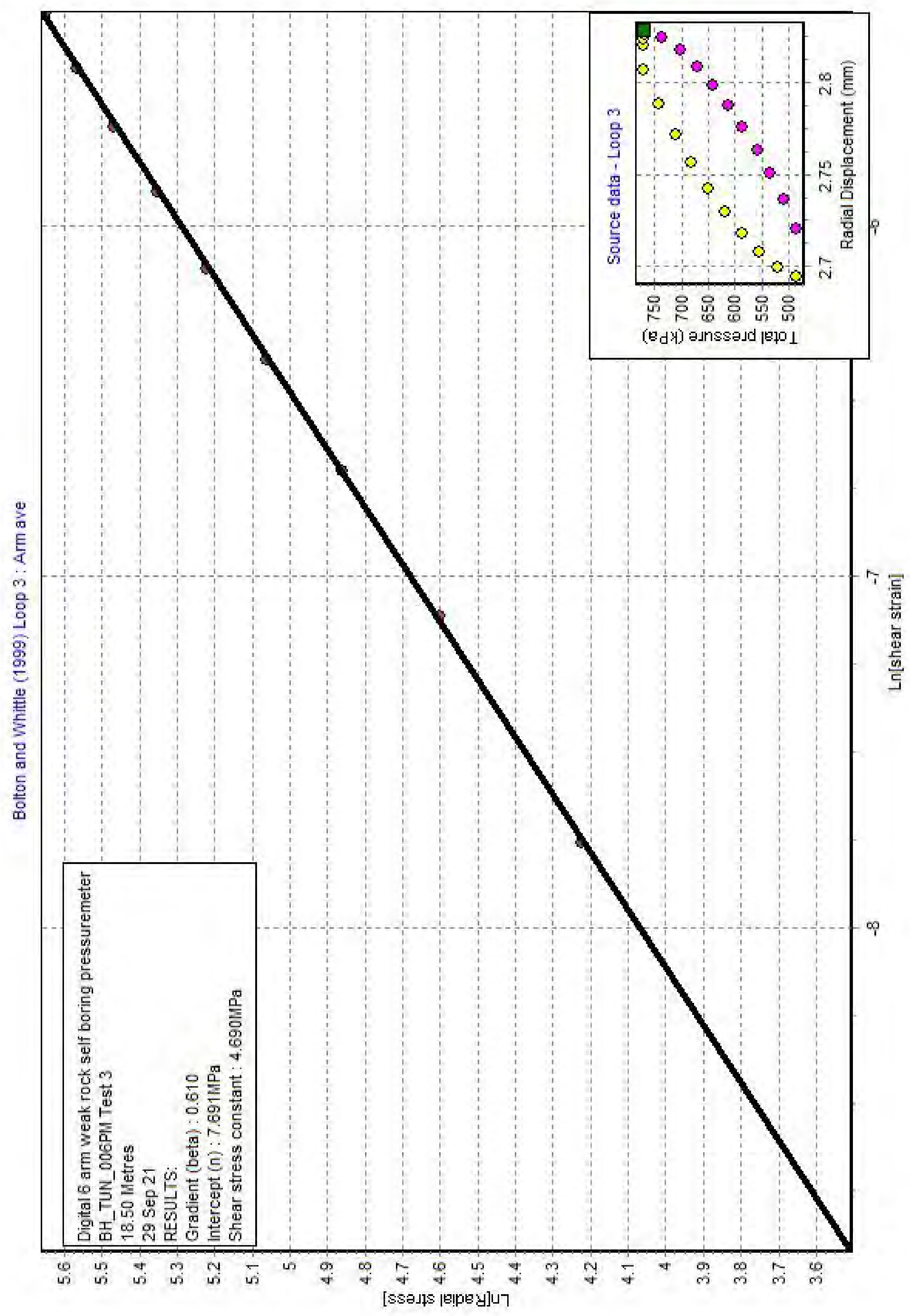

Shear modulus from unload/reload cycles Loop 3 : Arm ave
RESULTS:
Gur : 51.7MPa
Cycle mid-point:
Cavity strain : 5.792%
Total stress : 626kPa
Size of cycle :
Shear strain : 0.542%
Total stress : 281kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_006PM Test 3
18.50 Metres
29 Sep 21
Total pressure (kPa)
780
770
760
750
740
730
720
710
700
690
680
670
660
650
640
630
620
610
600
590
580
570
560
550
540
530
520
510
500
490
480
470
460
Radial Displacement (mm)
2.67
2.68
2.69
2.7
2.71
2.72
2.73
2.74
2.75
2.76
2.77
2.78
2.79
2.8
2.81
2.82
2.83
2.84
2.85
2.86
2.87
2.88



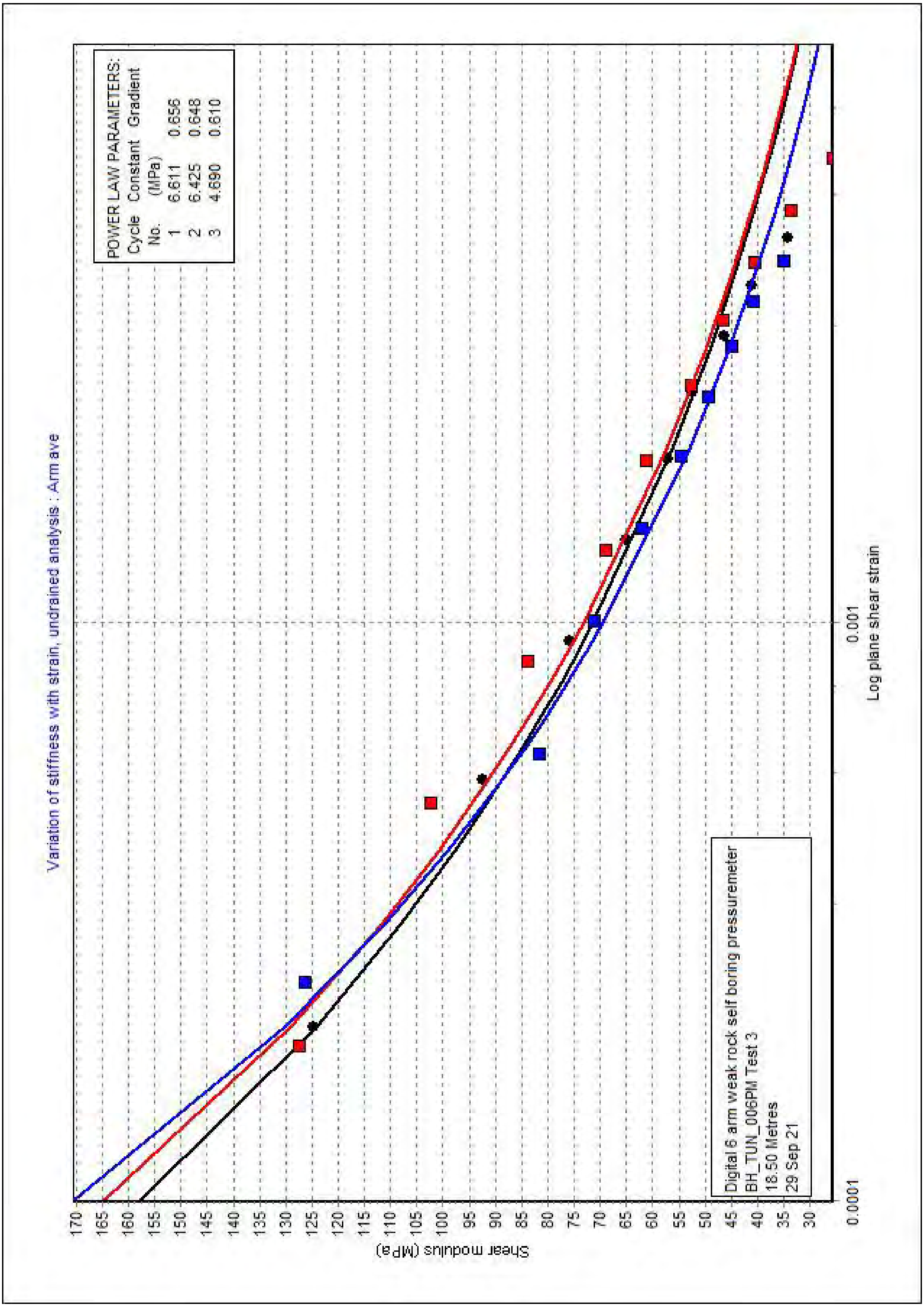
Bolton and Whittle (1999) Loop 1 : Arm ave

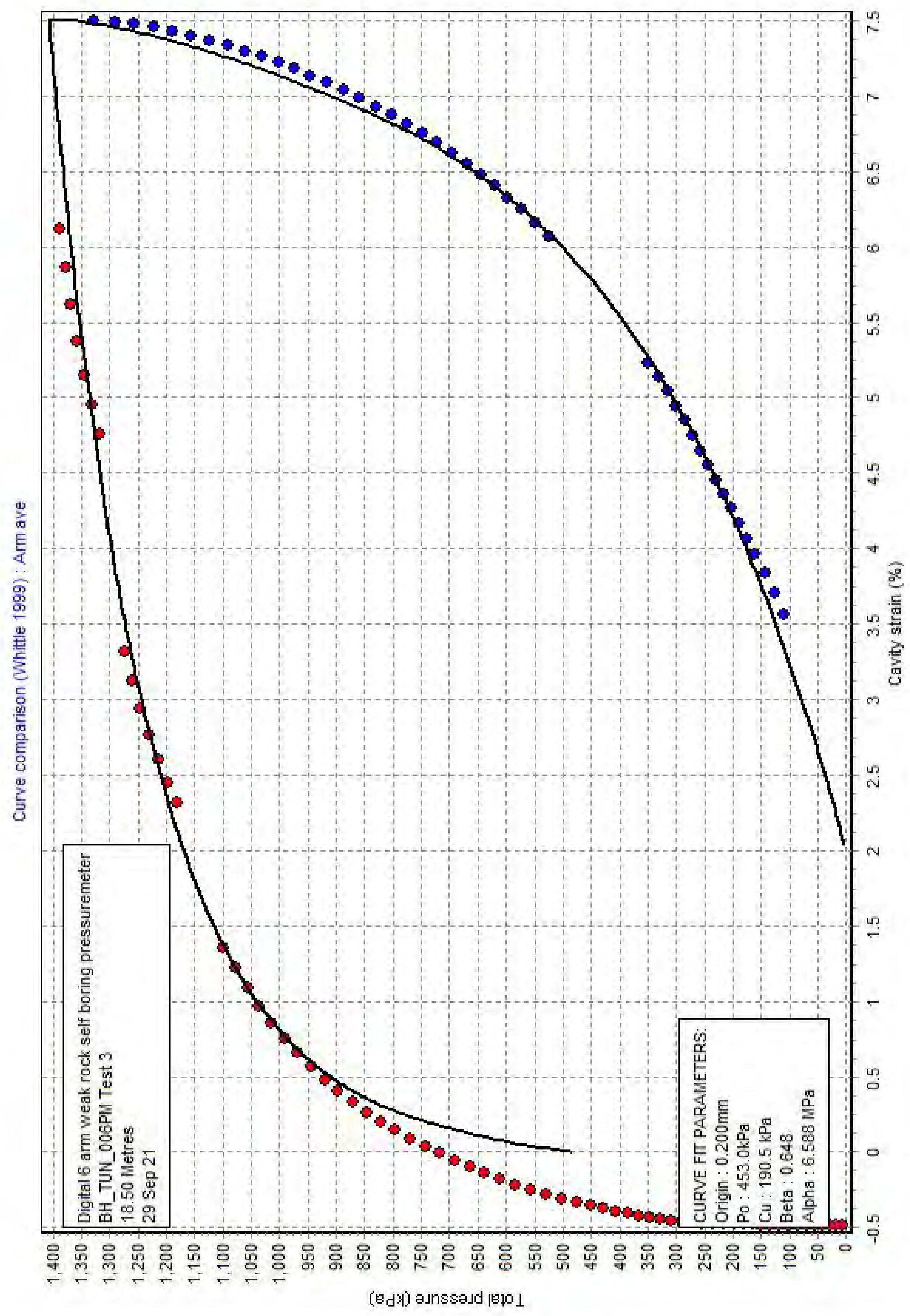
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_006PM Test 3
18.50 Metres
29 Sep 21
RESULTS:
Gradient (beta) : 0.656
Intercept (n) : 10.084MPa
Shear stress constant : 6.611MPa

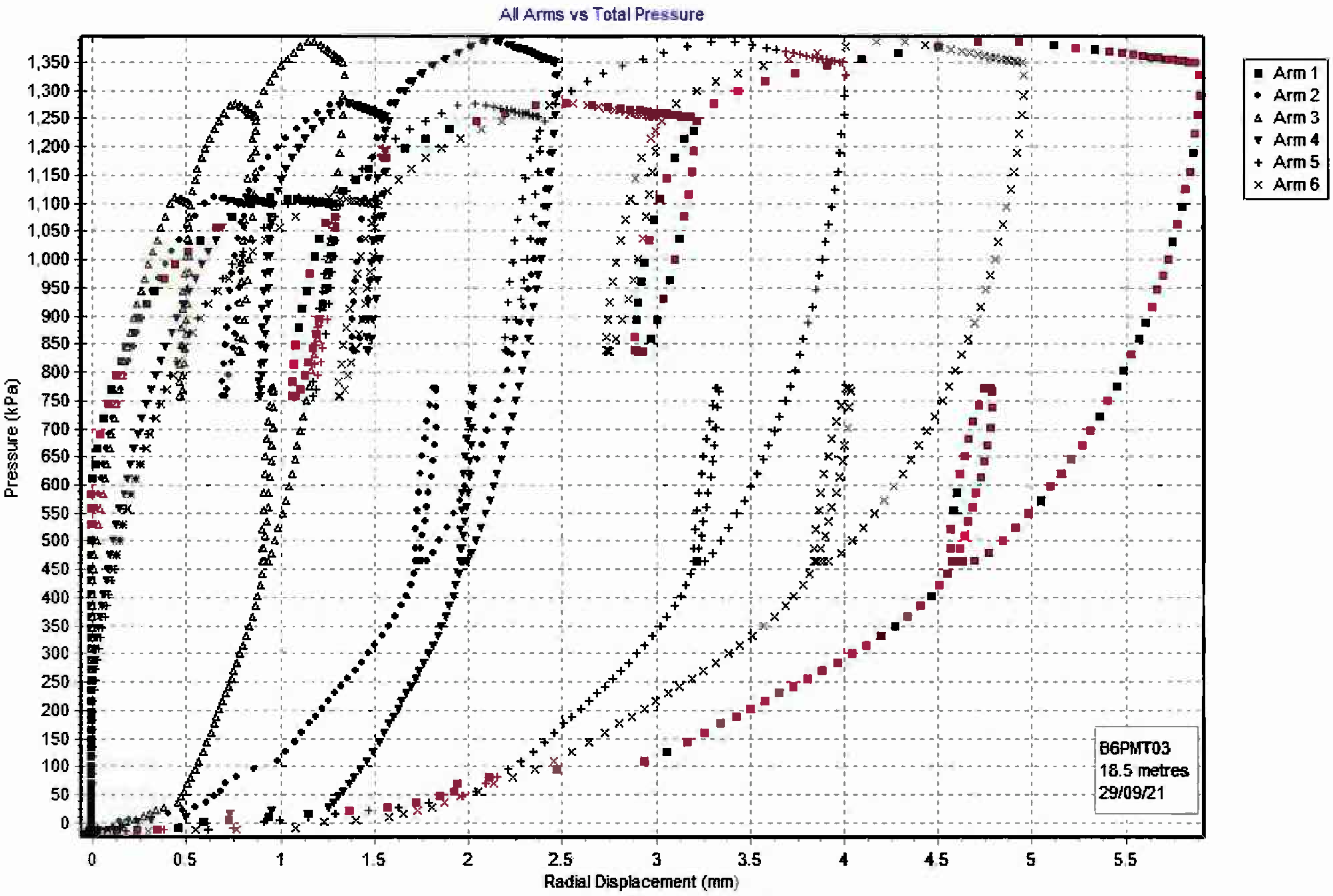

Bolton and Whittle (1999) Loop 2 : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_006PM Test 3
18.50 Metres
29 Sep 21
RESULTS:
Gradient (beta) : 0.648
Intercept (n) : 9.918MPa
Shear stress constant : 6.425MPa
Ln[Radial stress]
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
Ln[shear strain]
-9
-8
-7
-6
-5
Source data - Loop 2
Total pressure (kPa)
1,200
1,100
1,000
900
Radial Displacement (mm)
1.9
1.95
2
2.05
2.1



Digital 6 arm weak rock self boring pressuremeter
BH_TUN_006PM Test 3
18.50 Metres
29 Sep 21
RESULTS:
Gradient (beta) : 0.610
Intercept (n) : 7.691MPa
Shear stress constant : 4.690MPa


Variation of stiffness with strain, undrained analysis : Arm ave
POWER LAW PARAMETERS:
Cycle No. | Constant (MPa) | Gradient
1 | 6.611 | 0.656
2 | 6.425 | 0.648
3 | 4.690 | 0.610
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_006PM Test 3
18.50 Metres
29 Sep 21
Shear modulus (MPa)
170
165
160
155
150
145
140
135
130
125
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
Log plane shear strain
0.0001
0.001


Curve comparison (Whittle 1999) : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_006PM Test 3
18.50 Metres
29 Sep 21
CURVE FIT PARAMETERS:
Origin : 0.200mm
Po : 453.0kPa
Cu : 190.5 kPa
Beta : 0.648
Alpha : 6.588 MPa
Total pressure (kPa)
1,400
1,350
1,300
1,250
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Cavity strain (%)
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5

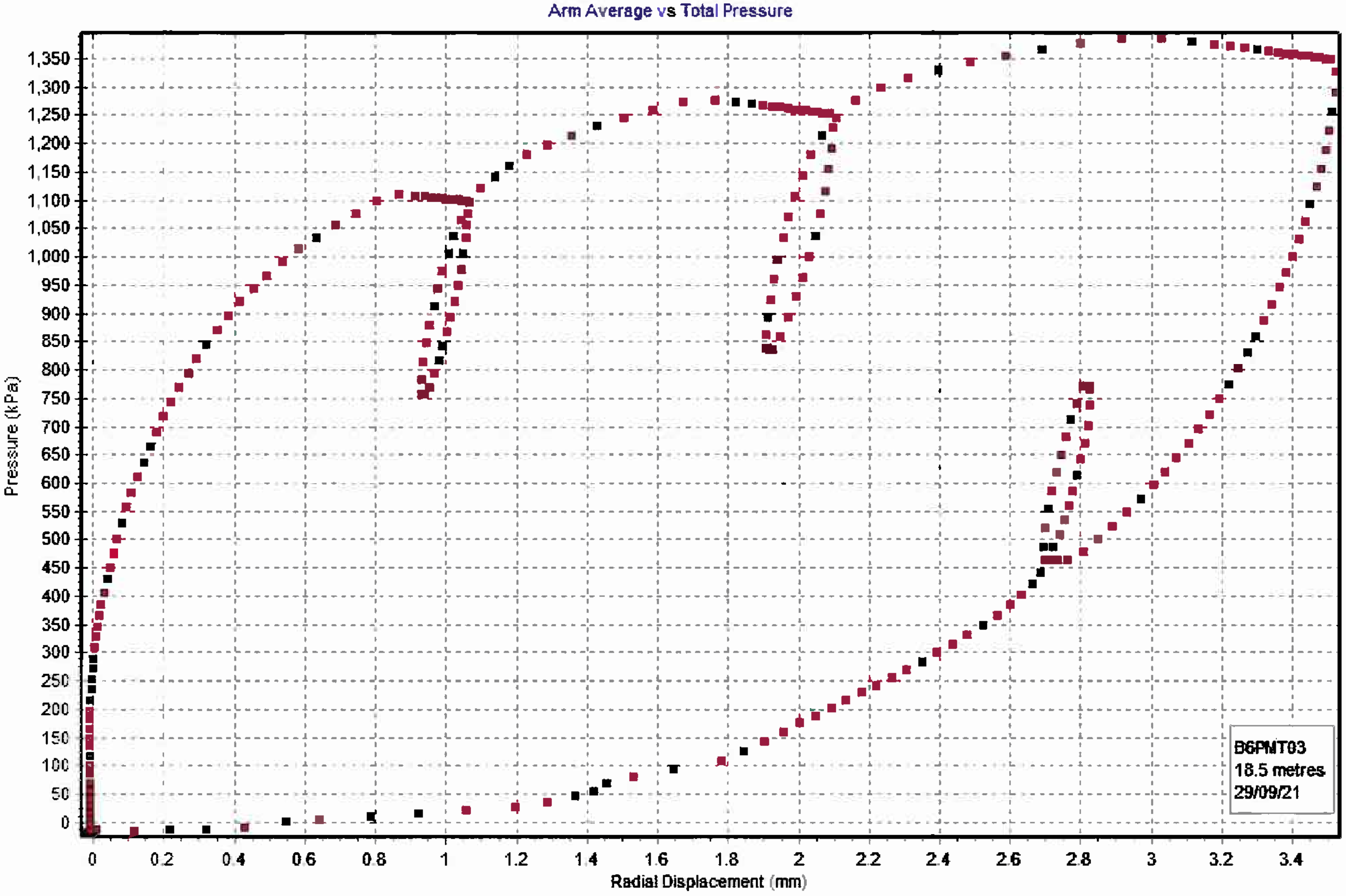


CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel +44 (0)1223 262361

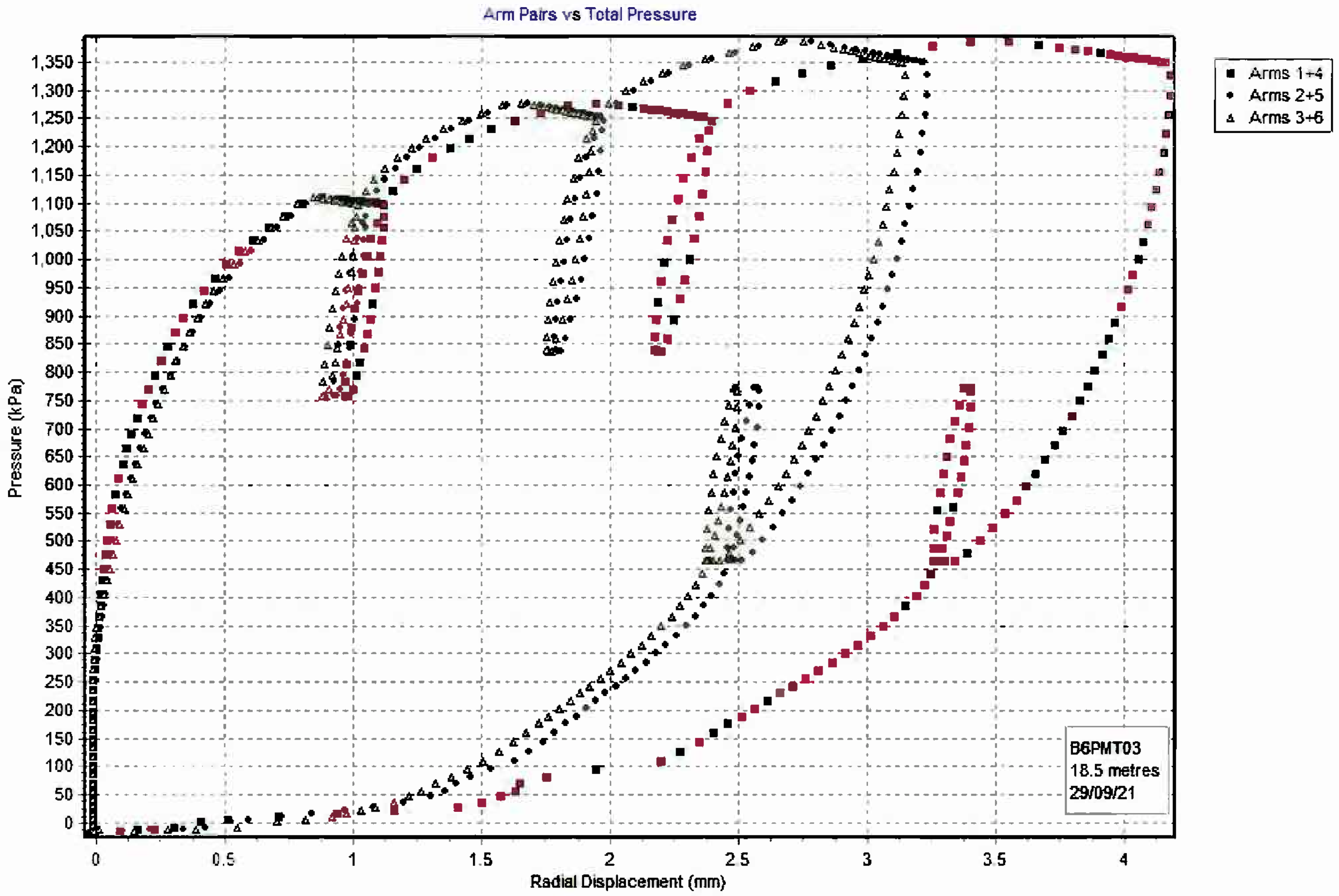
CIR1506/21

Cambridge WWTPR

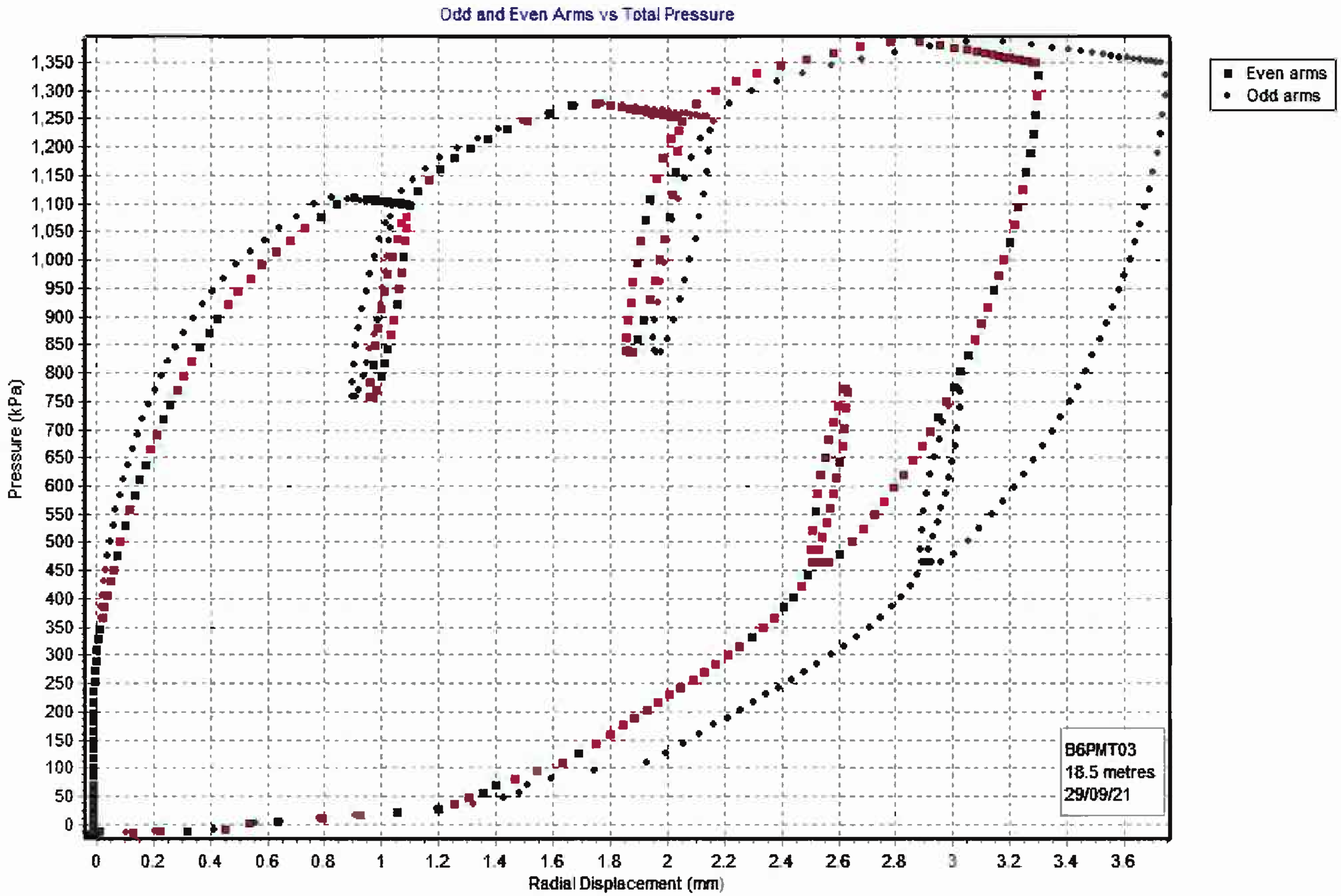
Pressuremeter Testing



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361

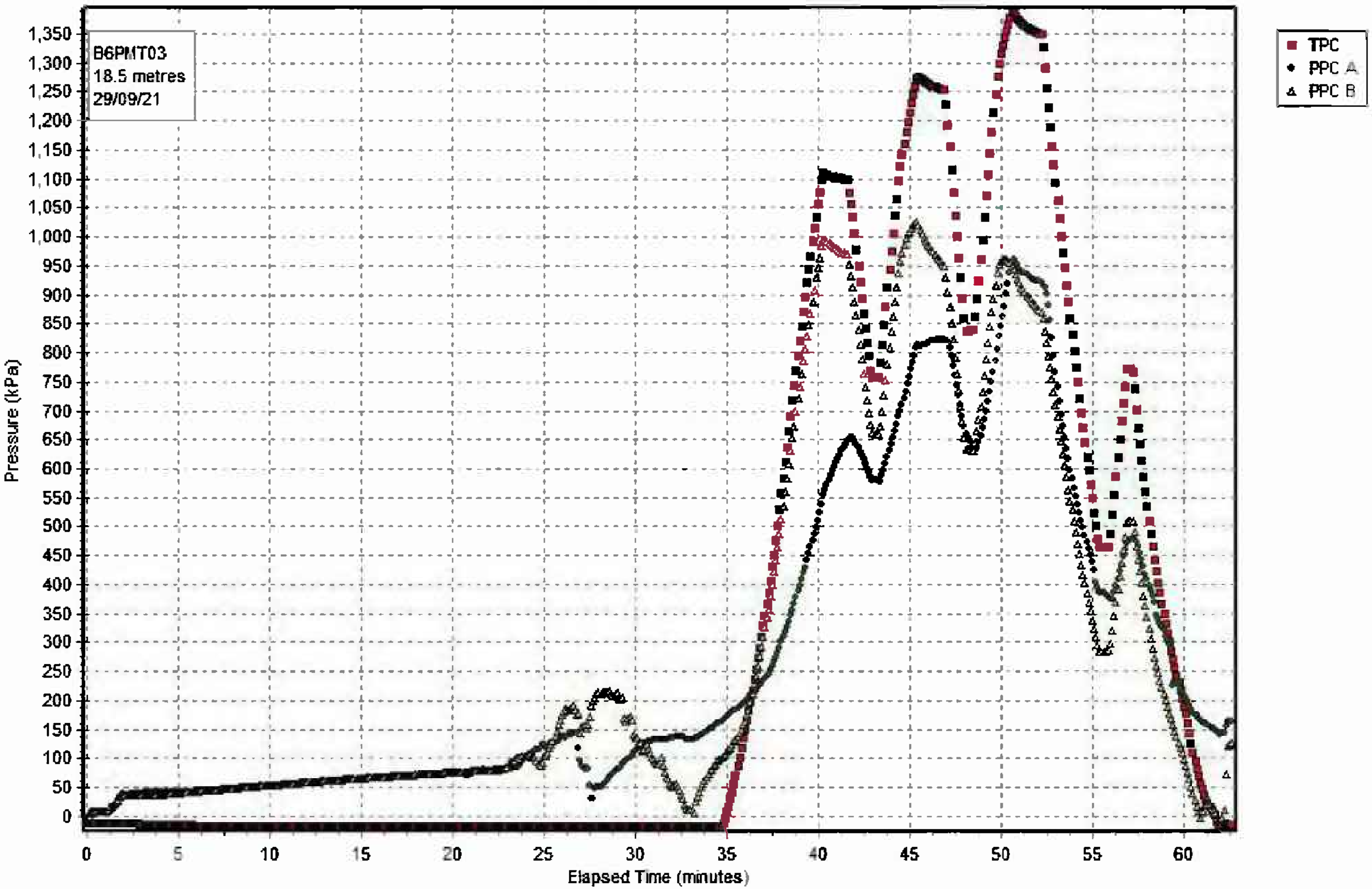


CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361



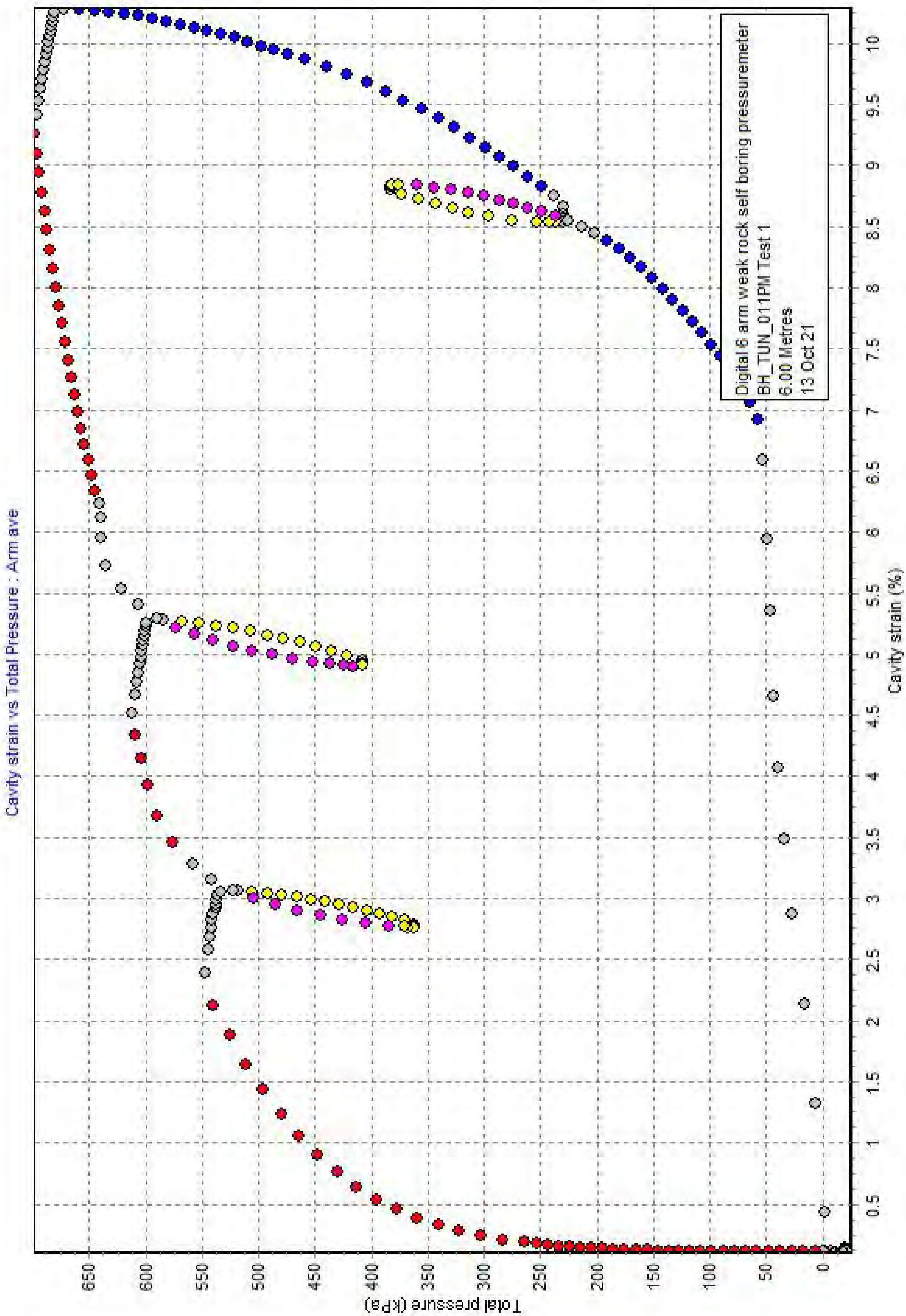
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361

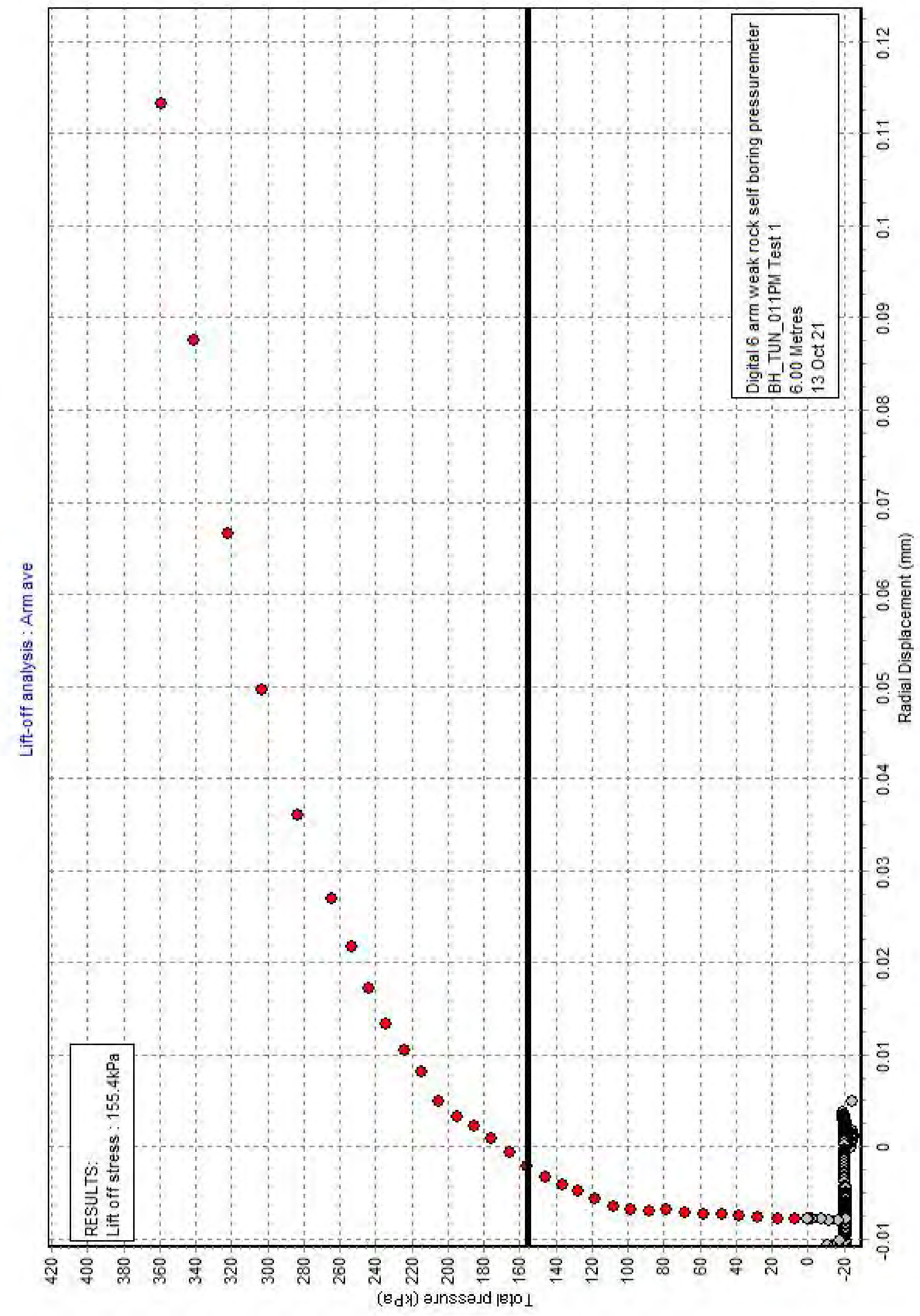
All Pressure Cells vs Time

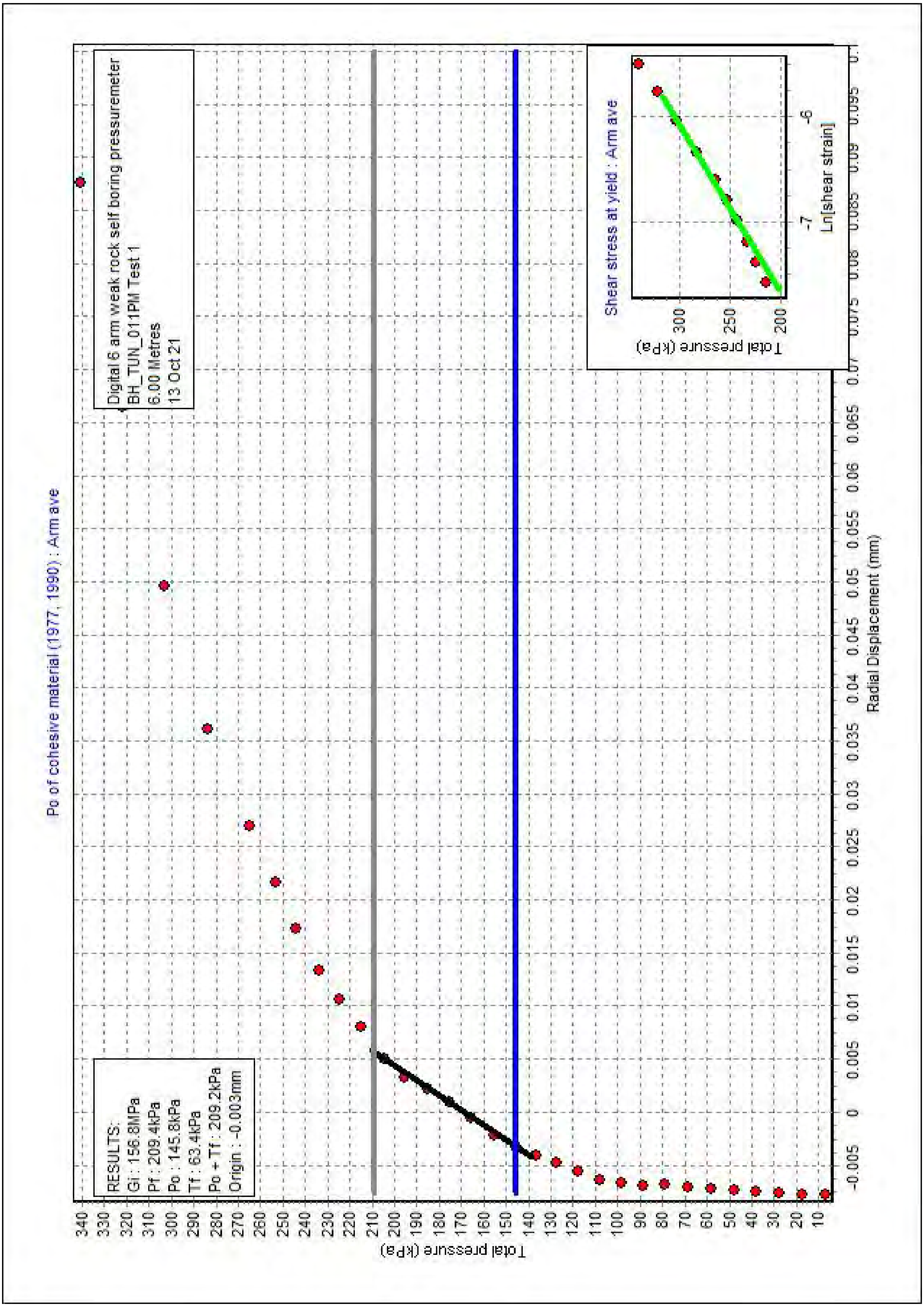


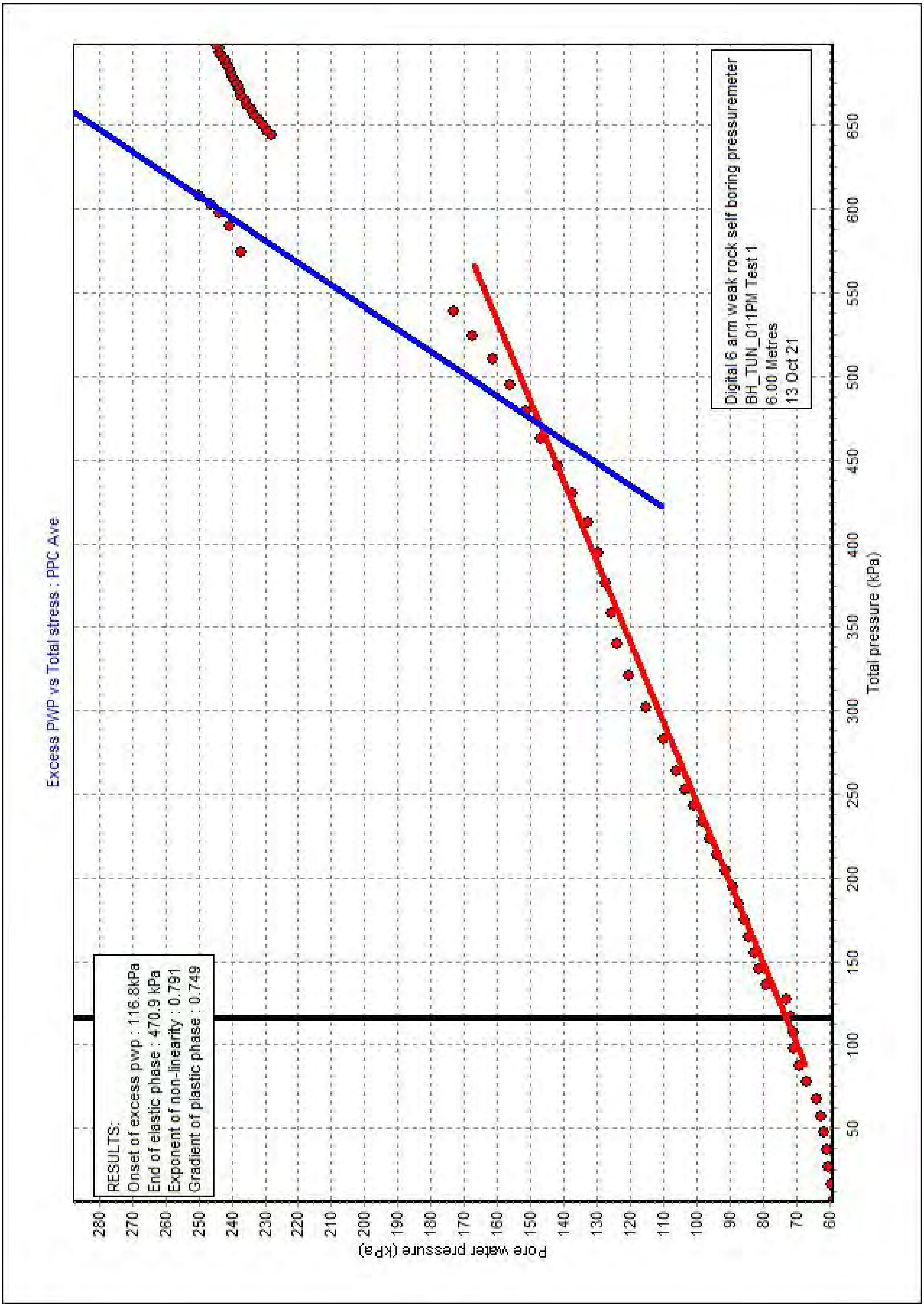
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel: +44 (0)1223 262361

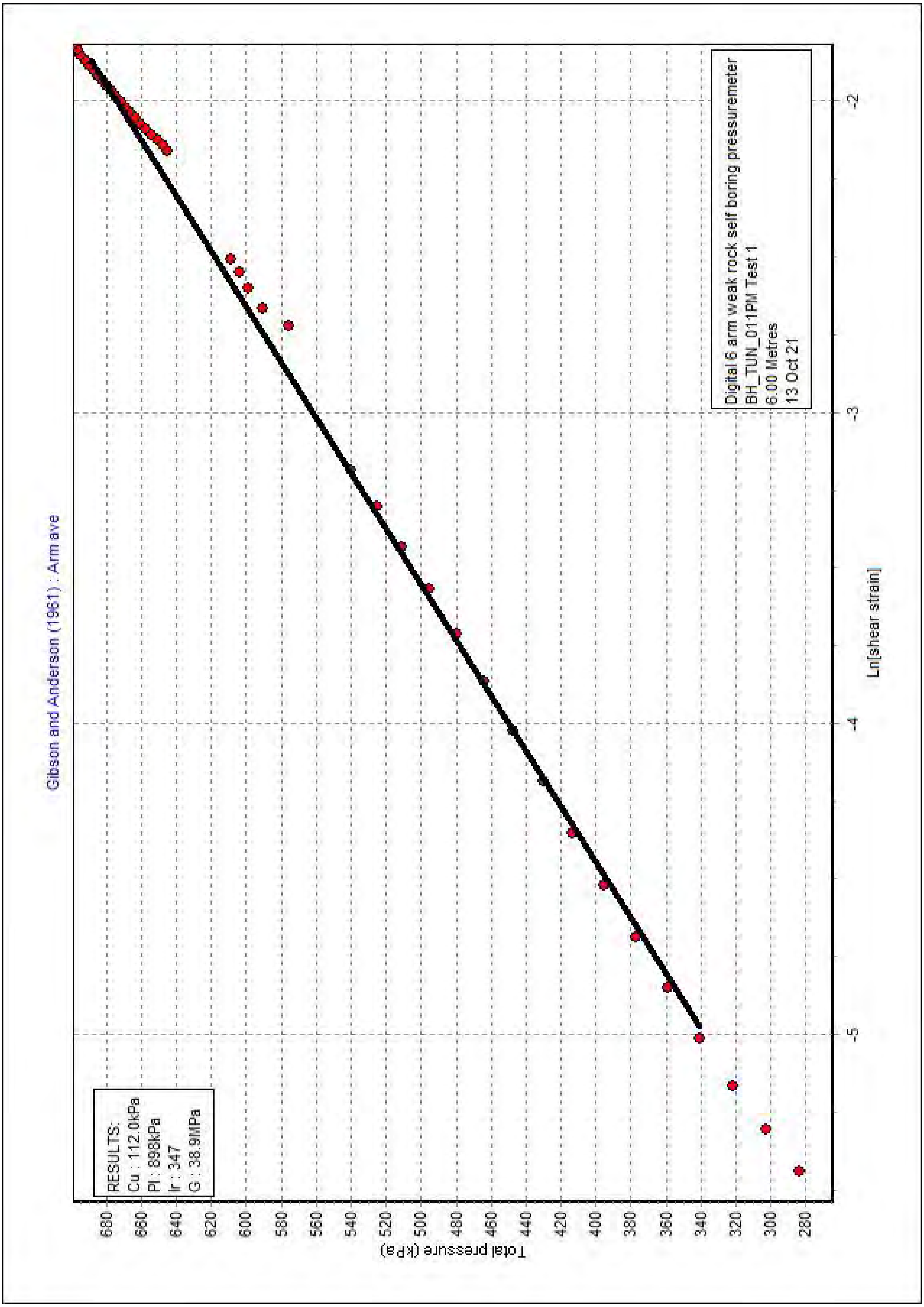
```
BH_TUN_011PM Test 1 - SUMMARY OF RESULTS
[File made with WinSitu ]

[DETAILS OF TEST]
Project        :   TE8364
Site           :   Cambridge Waste Water Treatment Plant Relocation Project
Borehole       :   BH_TUN_011PM
Test name      :   BH_TUN_011PM Test 1
Test date      :   13 Oct 21
Test depth     :   6.00 Metres
Water table    :   1.75 Metres
Ambient PWP    :   42.0 kPa
Material       :   Gault Clay
Probe          :   Digital 6 arm weak rock self boring pressuremeter
Diameter       :   88.1 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out
The file includes results from a curve fitting analysis

Analysed by YB / ES / RW on 13 Oct 21

Remarks:

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm)                  :   "Arm ave=-0.06"
Po from Marsland & Randolph (kPa)   :   "Arm ave=145.8"
Po from Lift off (kPa)              :   "Arm ave=155.4"
PWP versus Total Stress (kPa)       :   "PPC Ave=116.8"
Best estimate of Po (kPa)           :   "Arm ave=131.0"

[UNDRAINED STRENGTH PARAMETERS]
Gibson & Anderson 1961 - Cu (kPa)   :   "Arm ave=112.0"
Limit pressure (kPa)                :   "Arm ave=898"
Jefferies 1988 - Cu (kPa)           :   "Arm ave=113.5"
Undrained yield stress (kPa)        :   "Arm ave=209.4"
PWP derived yield stress (kPa)      :   "PPC Ave=470.9"

[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=156.8"
Axis       Loop   Value    Mean Strain  Mean Pc  dE      dPc
           No     (MPa)    (%)          (kPa)    (%)     (kPa)
Arm ave    1      27.1     2.924        441      0.575   156
Arm ave    2      25.0     5.100        496      0.699   175
Arm ave    3      25.8     8.701        309      0.558   145

[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]
Axis       Loop   Intercept  Alpha      Gradient
           No     (MPa)      (MPa)
Arm ave    1      3.831      2.351      0.614
Arm ave    2      3.626      2.170      0.599
Arm ave    3      3.380      2.000      0.592

Non-linear exponent from PWP response :   "PPC Ave=0.791"

[PARAMETERS USED FOR UNDRAINED CURVE MODELLING]
{Axis is  Arm ave}
Strain Origin (mm)                  :   -0.06
Po (kPa)                            :   131
Cu (kPa)                            :   112.0
Limit pressure (kPa)                :   898
Non-linear exponent                 :   0.592
Calculated alpha (MPa)              :   2.378
G at yield (MPa)                    :   19.5
```

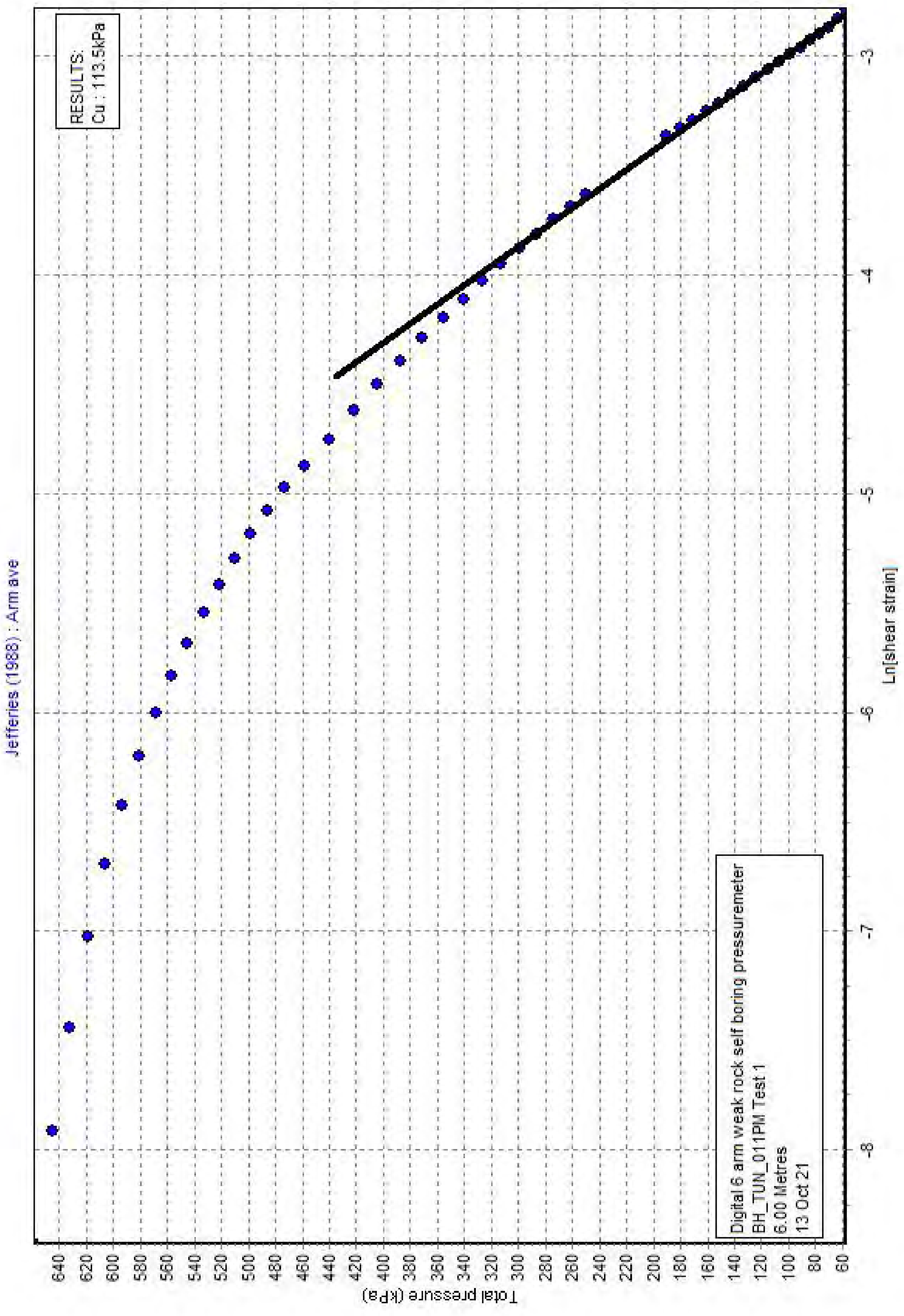

Cavity strain vs Total Pressure : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 1
6.00 Metres
13 Oct 21
Cavity strain (%)
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
Total pressure (kPa)
0
50
100
150
200
250
300
350
400
450
500
550
600
650

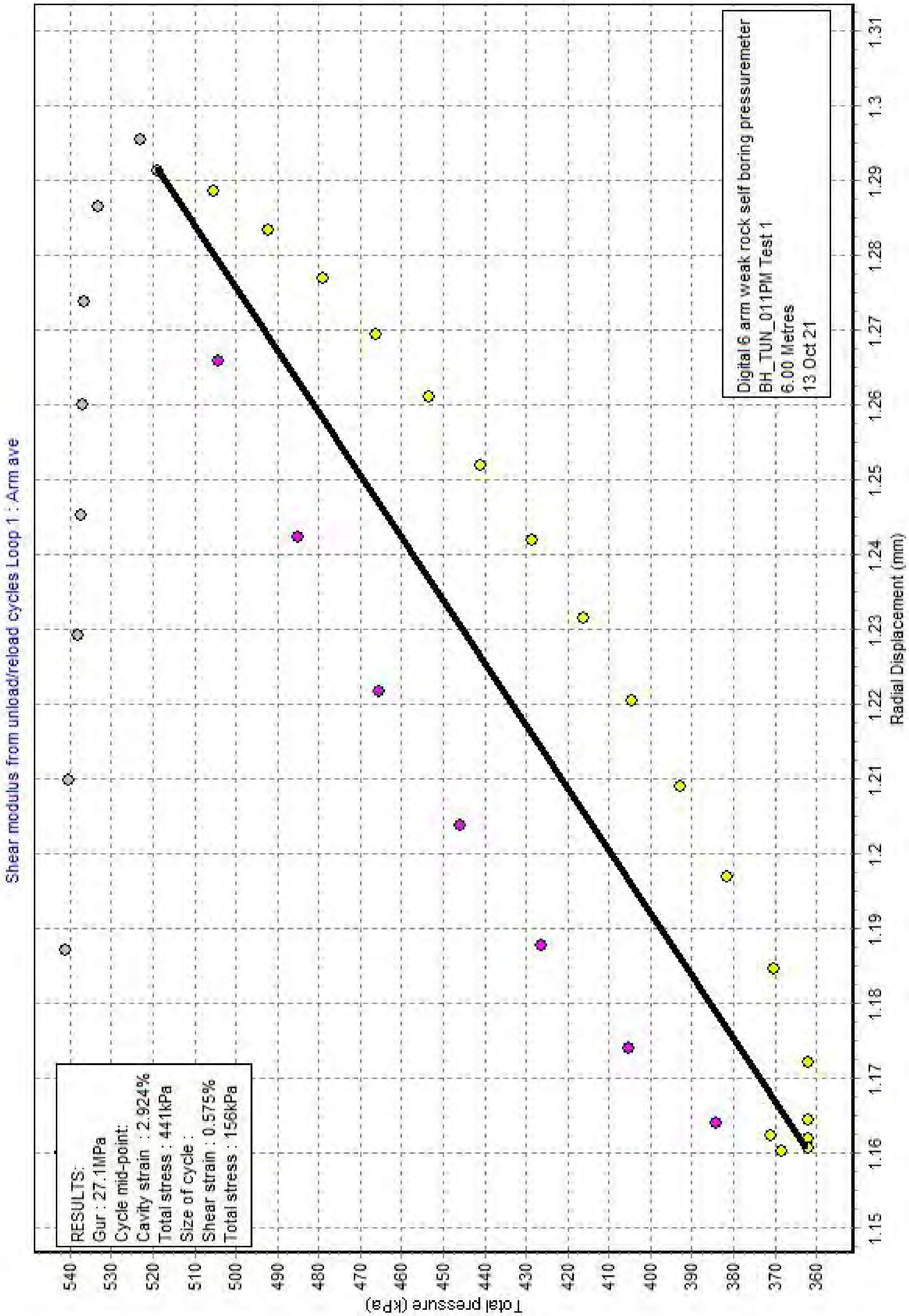

Lift-off analysis : Arm ave
RESULTS:
Lift off stress : 155.4kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 1
6.00 Metres
13 Oct 21
Total pressure (kPa)
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
-20
Radial Displacement (mm)
-0.01
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
0.11
0.12

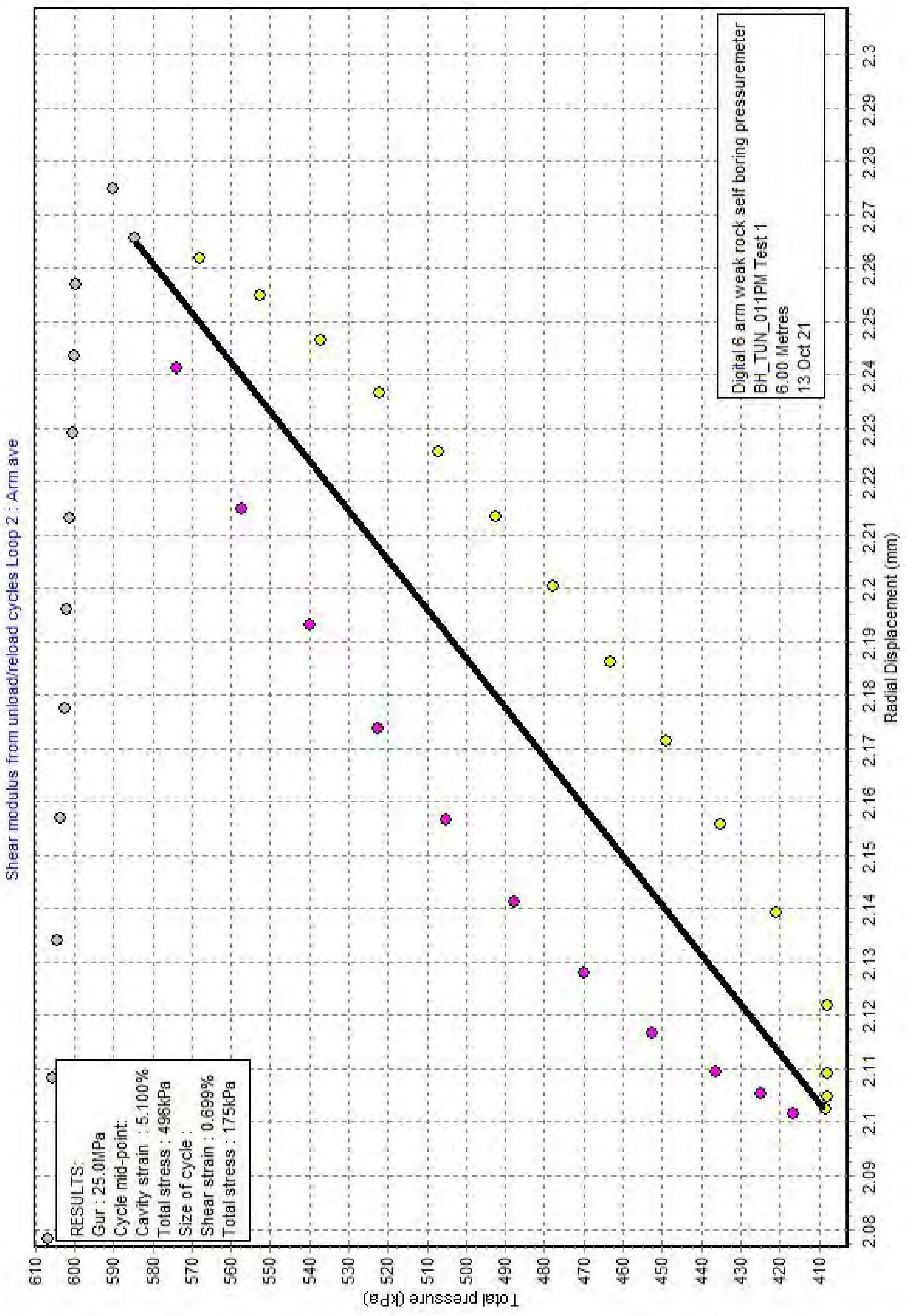

Po of cohesive material (1977, 1990) : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 1
6.00 Metres
13 Oct 21
RESULTS:
Gi : 156.8MPa
Pf : 209.4kPa
Po : 145.8kPa
Tf : 63.4kPa
Po + Tf : 209.2kPa
Origin : -0.003mm
Total pressure (kPa)
340 330 320 310 300 290 280 270 260 250 240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
Radial Displacement (mm)
-0.005 0 0.005 0.01 0.015 0.02 0.025 0.03 0.035 0.04 0.045 0.05 0.055 0.06 0.065 0.07 0.075 0.08 0.085 0.09 0.095 0.1
Shear stress at yield : Arm ave
Total pressure (kPa)
300 250 200
Ln[shear strain]
-7 -6

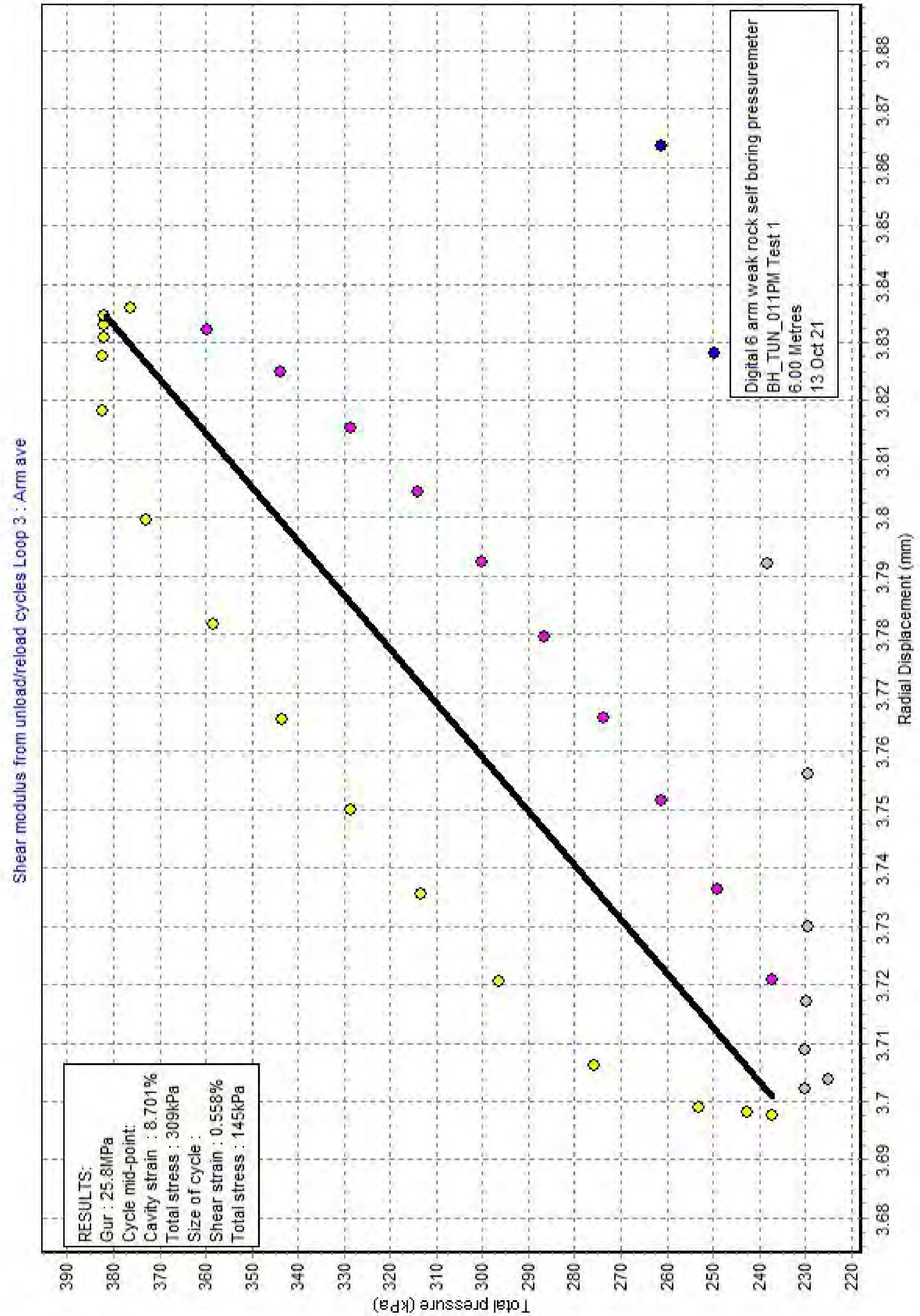

Excess PWP vs Total stress : PPC Ave
RESULTS:
Onset of excess pwp : 116.8kPa
End of elastic phase : 470.9 kPa
Exponent of non-linearity : 0.791
Gradient of plastic phase : 0.749
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 1
6.00 Metres
13 Oct 21
Pore water pressure (kPa)
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
Total pressure (kPa)
50
100
150
200
250
300
350
400
450
500
550
600
650

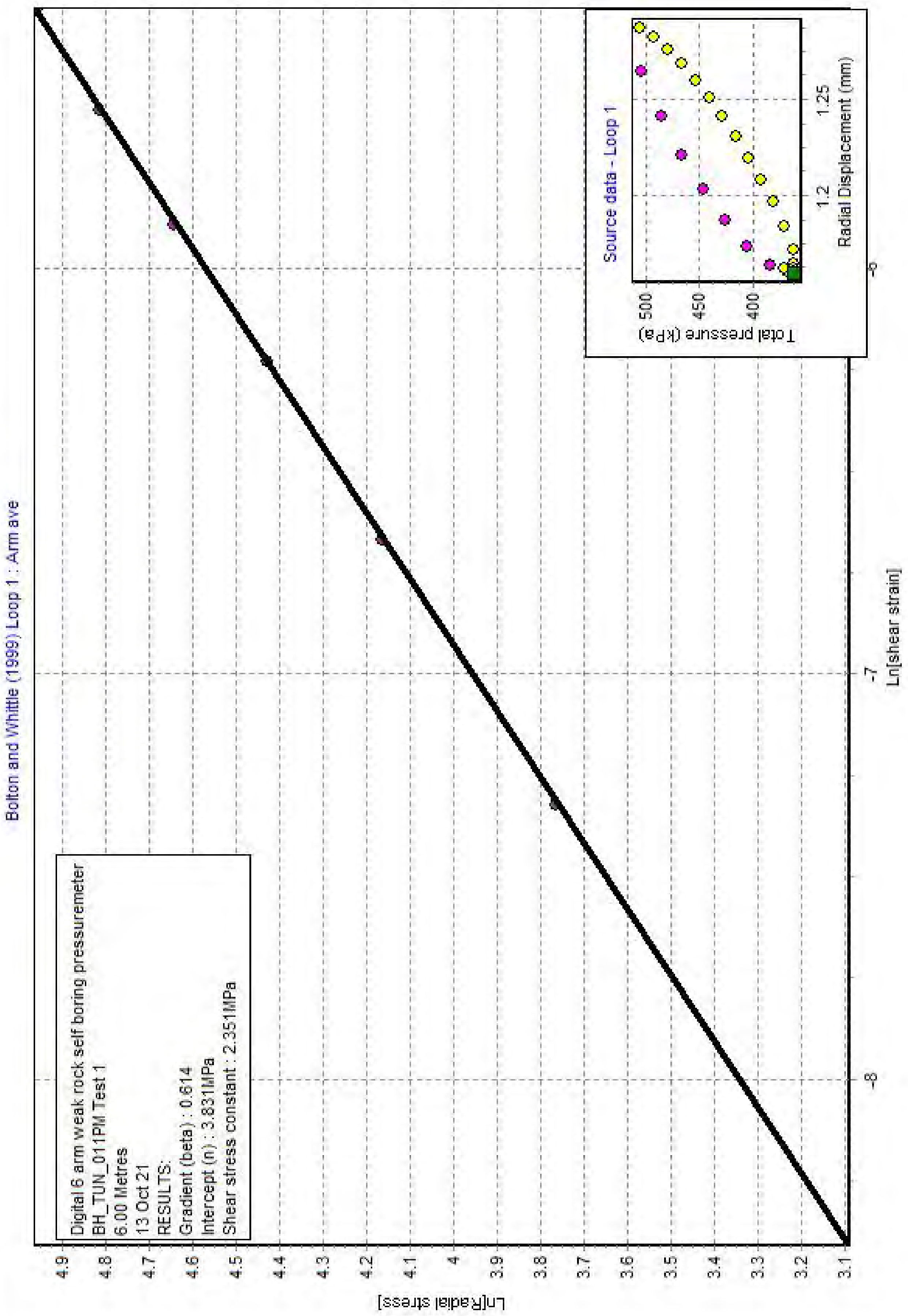

Gibson and Anderson (1961) : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 1
6.00 Metres
13 Oct 21
RESULTS:
Cu : 112.0kPa
Pl : 898kPa
Ir : 347
G : 38.9MPa
Ln[shear strain]
-2
-3
-4
-5
Total pressure (kPa)
680
660
640
620
600
580
560
540
520
500
480
460
440
420
400
380
360
340
320
300
280


Jefferies (1988) : Arm ave
RESULTS:
Cu : 113.5kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 1
6.00 Metres
13 Oct 21
Ln[shear strain]
-3
-4
-5
-6
-7
-8
Total pressure (kPa)
640
620
600
580
560
540
520
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60

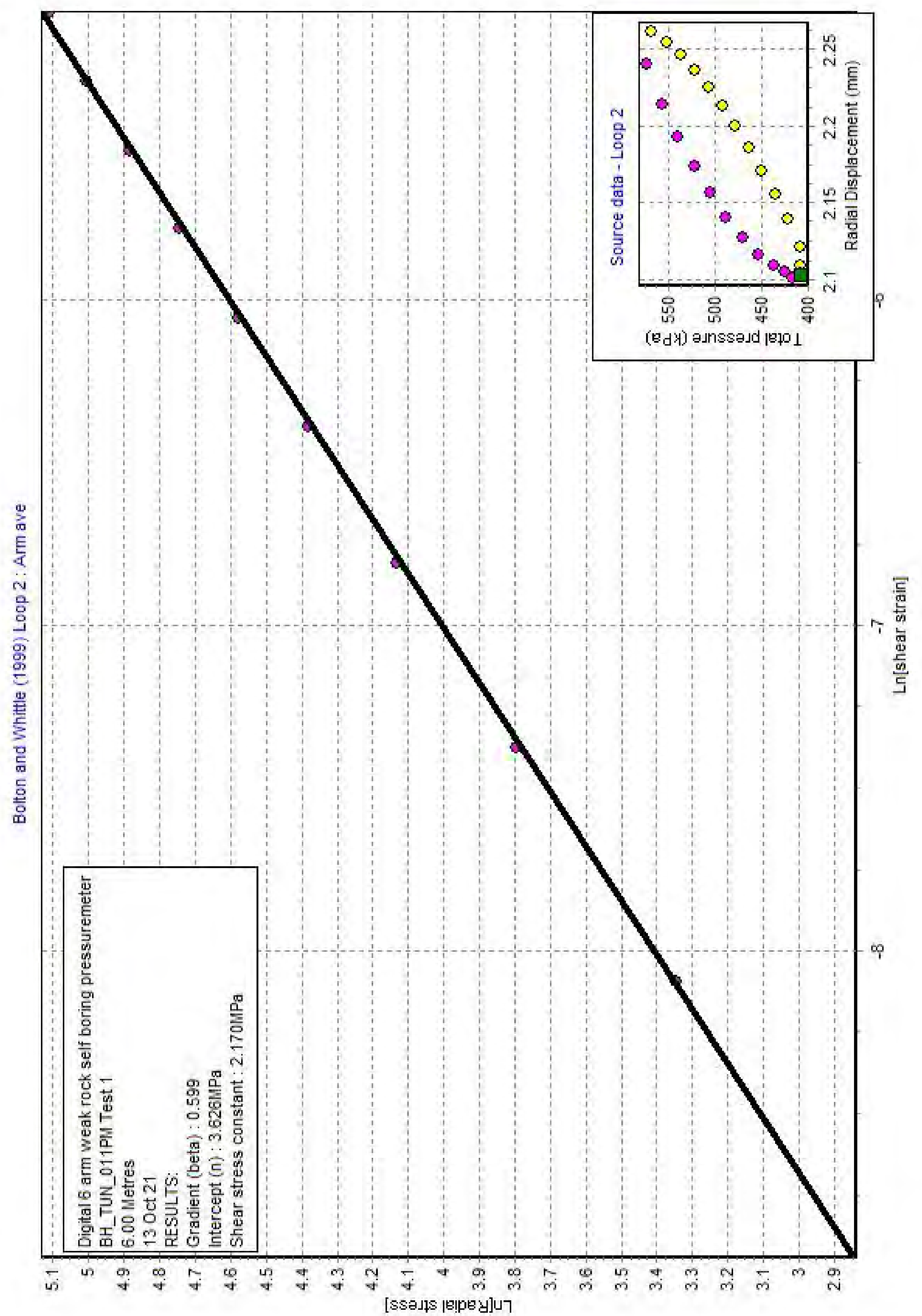

Shear modulus from unload/reload cycles Loop 1 : Arm ave
Total pressure (kPa)
540
530
520
510
500
490
480
470
460
450
440
430
420
410
400
390
380
370
360
Radial Displacement (mm)
1.15
1.16
1.17
1.18
1.19
1.2
1.21
1.22
1.23
1.24
1.25
1.26
1.27
1.28
1.29
1.3
1.31
RESULTS:
Gur : 27.1MPa
Cycle mid-point:
Cavity strain : 2.924%
Total stress : 441kPa
Size of cycle :
Shear strain : 0.575%
Total stress : 156kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 1
6.00 Metres
13 Oct 21

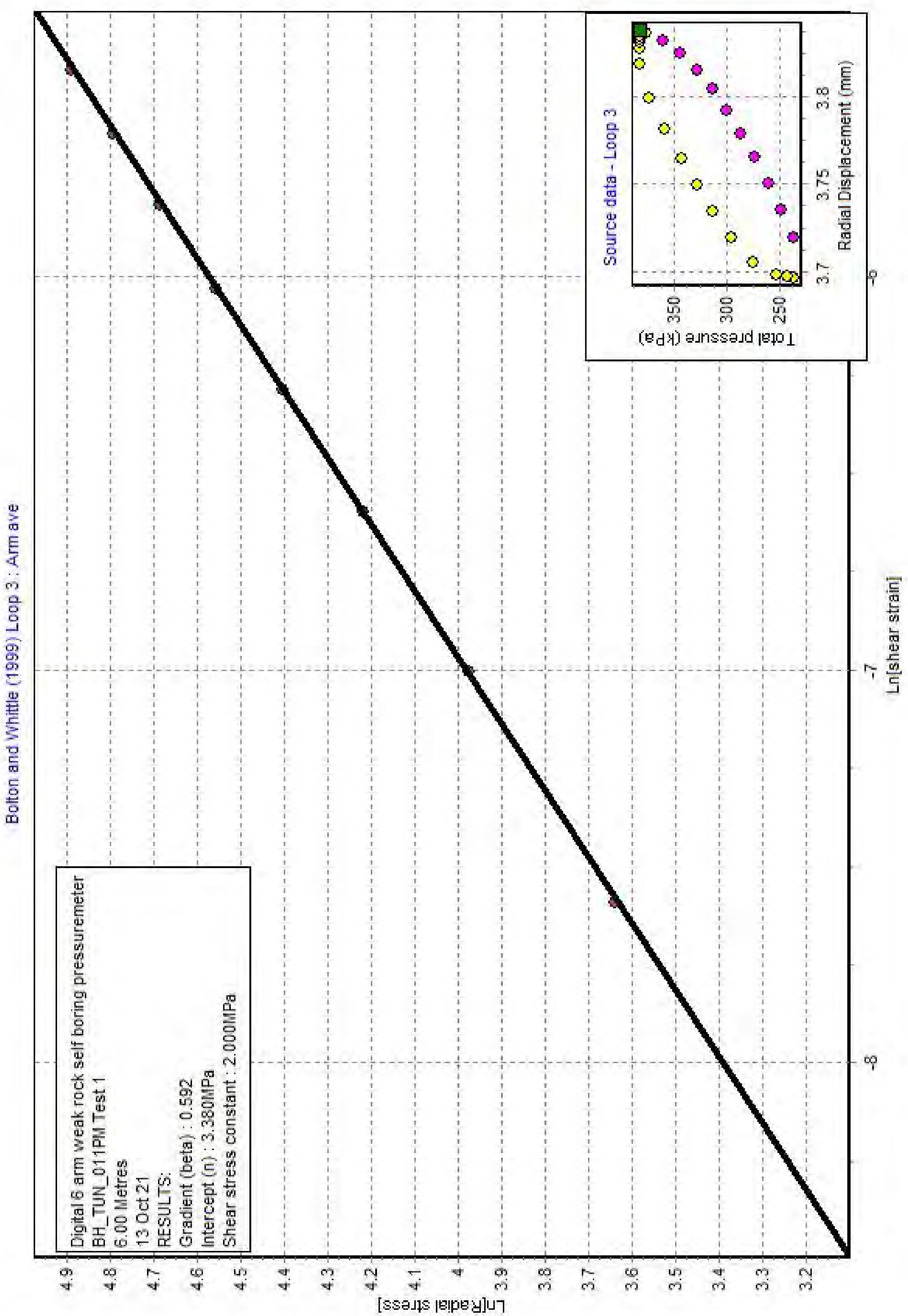

Shear modulus from unload/reload cycles Loop 2 : Arm ave
RESULTS:
Gur : 25.0MPa
Cycle mid-point:
Cavity strain : 5.100%
Total stress : 496kPa
Size of cycle :
Shear strain : 0.699%
Total stress : 175kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 1
6.00 Metres
13 Oct 21
Total pressure (kPa)
610
600
590
580
570
560
550
540
530
520
510
500
490
480
470
460
450
440
430
420
410
Radial Displacement (mm)
2.08
2.09
2.1
2.11
2.12
2.13
2.14
2.15
2.16
2.17
2.18
2.19
2.2
2.21
2.22
2.23
2.24
2.25
2.26
2.27
2.28
2.29
2.3

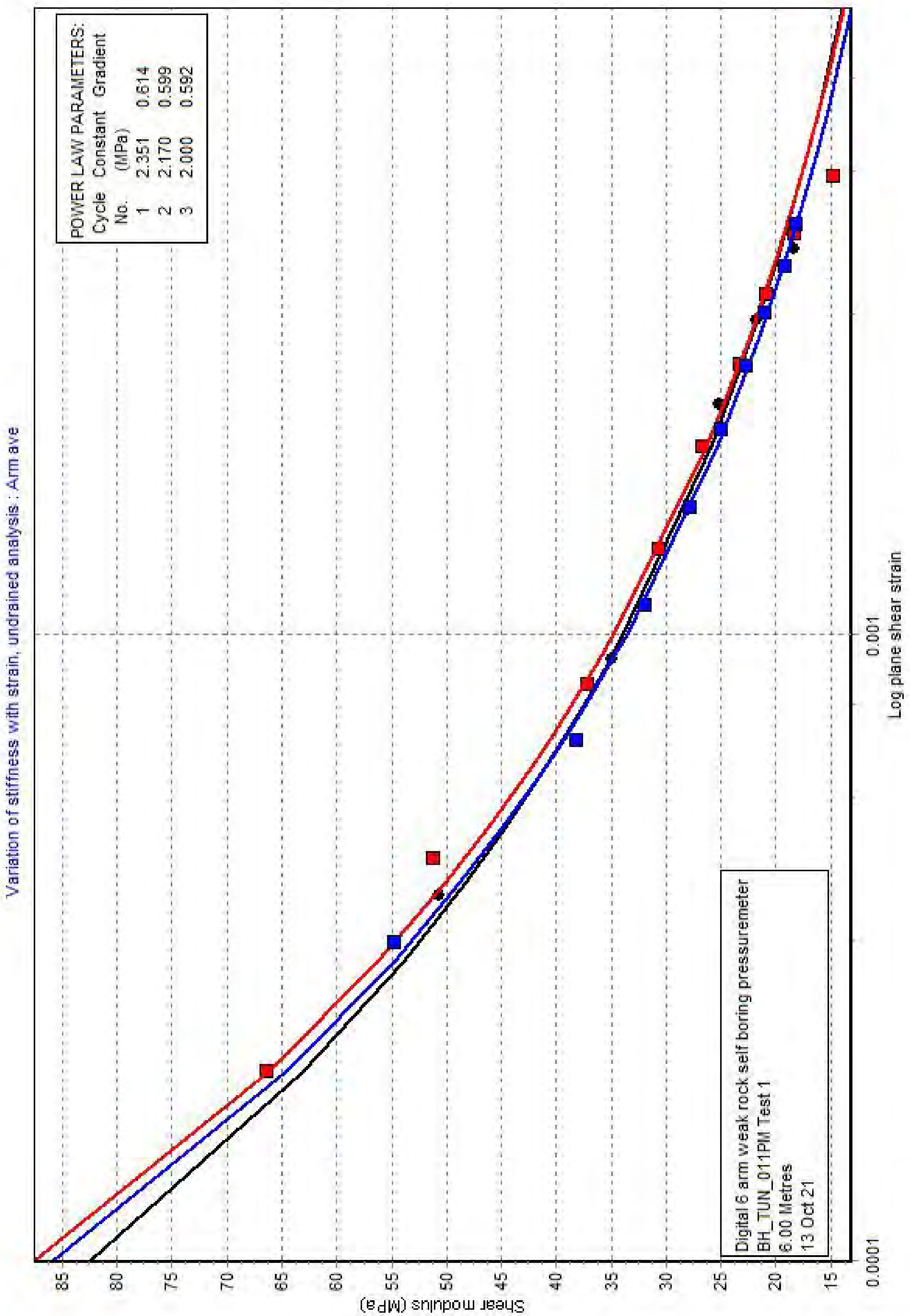

Shear modulus from unload/reload cycles Loop 3 : Arm ave
Total pressure (kPa)
390
380
370
360
350
340
330
320
310
300
290
280
270
260
250
240
230
220
Radial Displacement (mm)
3.68
3.69
3.7
3.71
3.72
3.73
3.74
3.75
3.76
3.77
3.78
3.79
3.8
3.81
3.82
3.83
3.84
3.85
3.86
3.87
3.88
RESULTS:
Gur : 25.8MPa
Cycle mid-point:
Cavity strain : 8.701%
Total stress : 309kPa
Size of cycle :
Shear strain : 0.558%
Total stress : 145kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 1
6.00 Metres
13 Oct 21

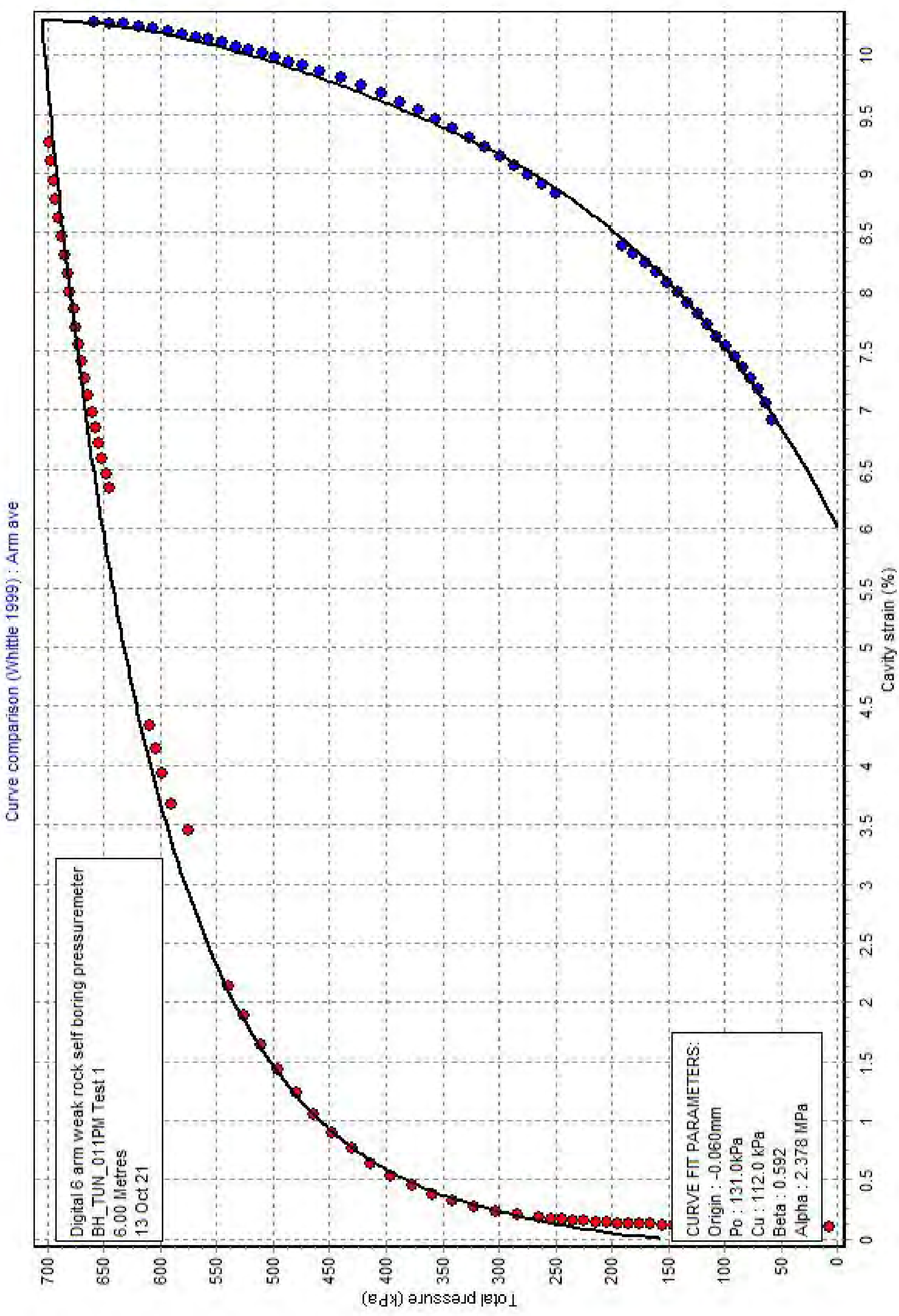


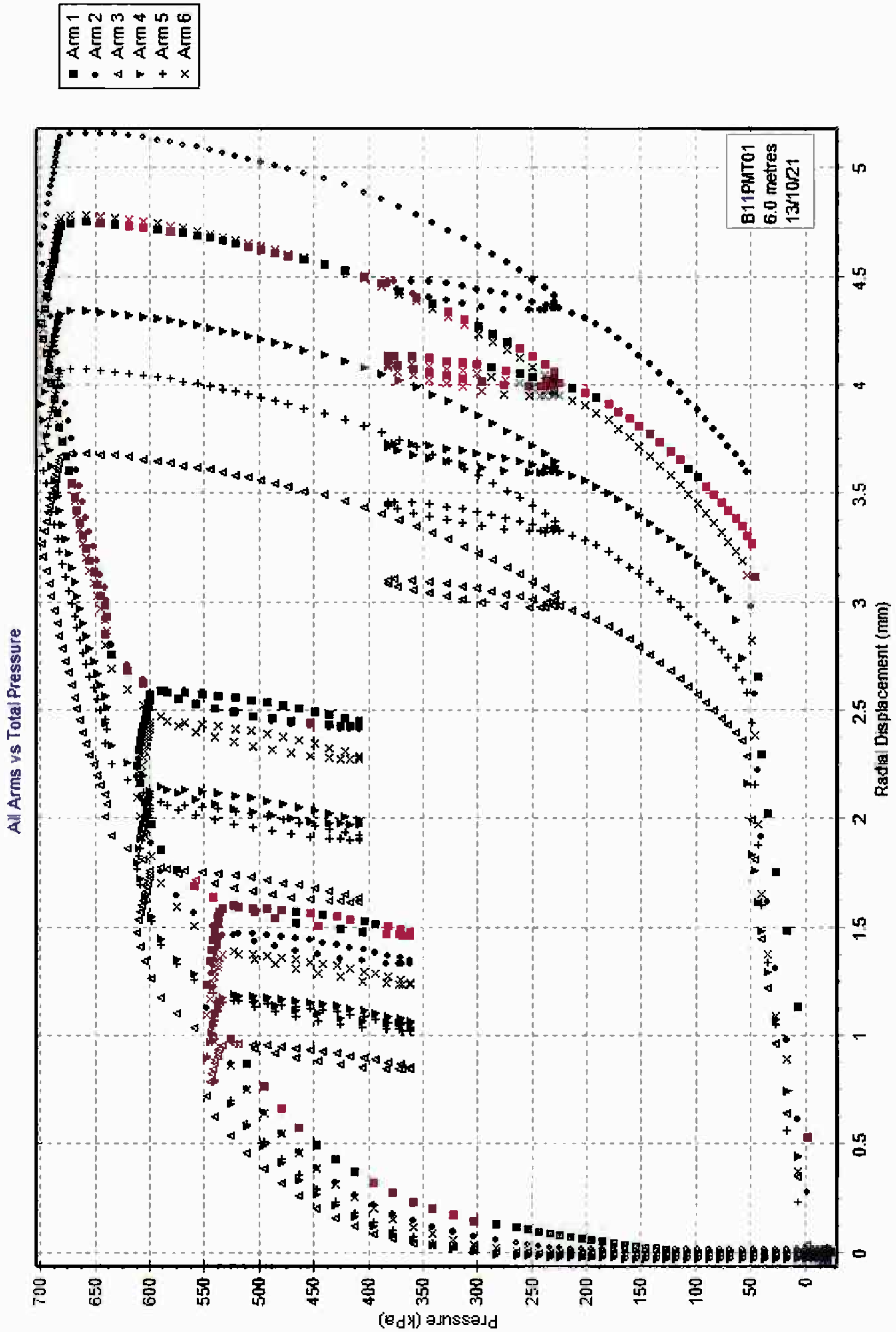
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 1
6.00 Metres
13 Oct 21
RESULTS:
Gradient (beta) : 0.614
Intercept (n) : 3.831MPa
Shear stress constant : 2.351MPa

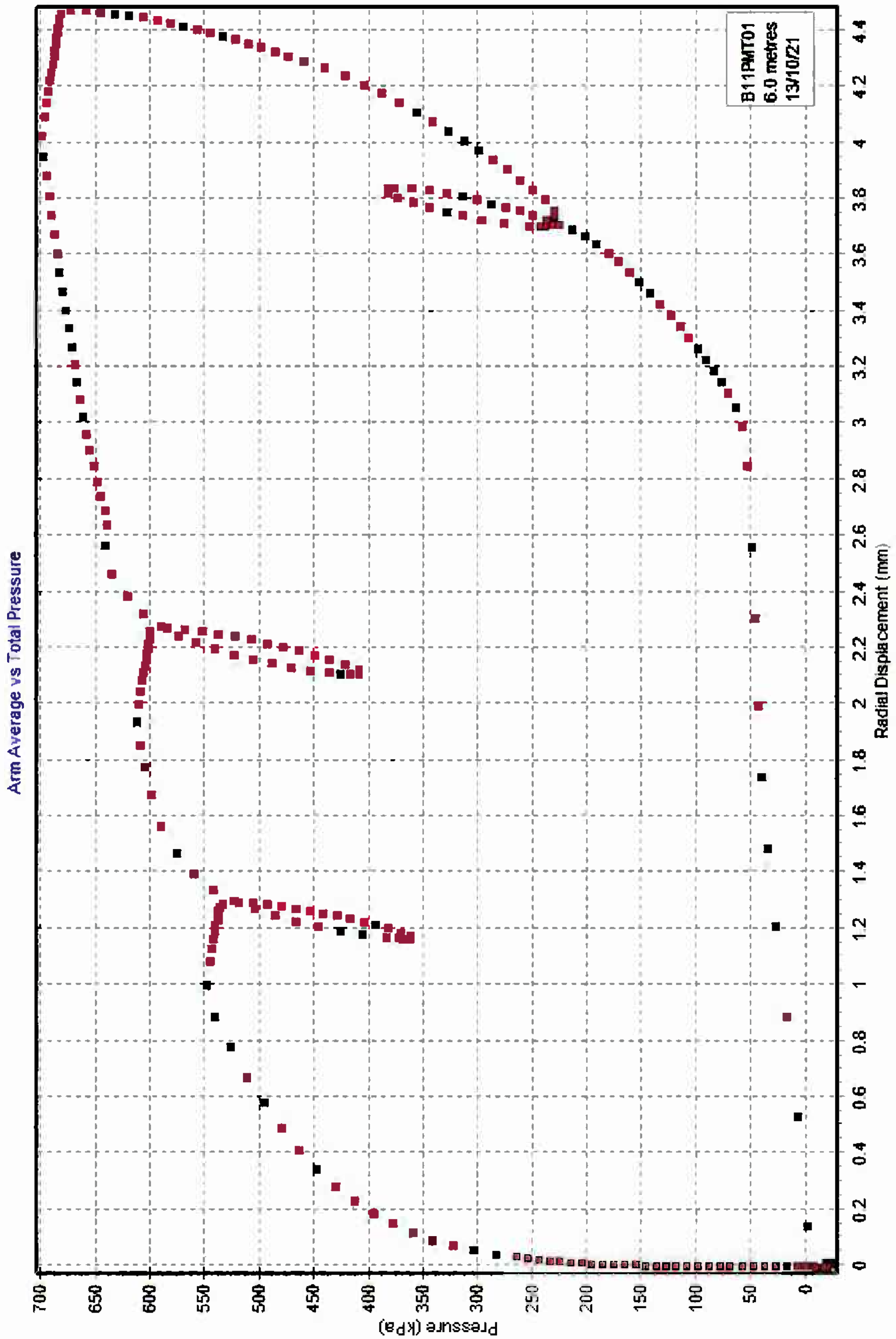

Bolton and Whittle (1999) Loop 2 : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 1
6.00 Metres
13 Oct 21
RESULTS:
Gradient (beta) : 0.599
Intercept (n) : 3.626MPa
Shear stress constant : 2.170MPa
Ln[Radial stress]
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3
2.9
Ln[shear strain]
-8
-7
-6
Source data - Loop 2
Total pressure (kPa)
550
500
450
400
Radial Displacement (mm)
2.1
2.15
2.2
2.25

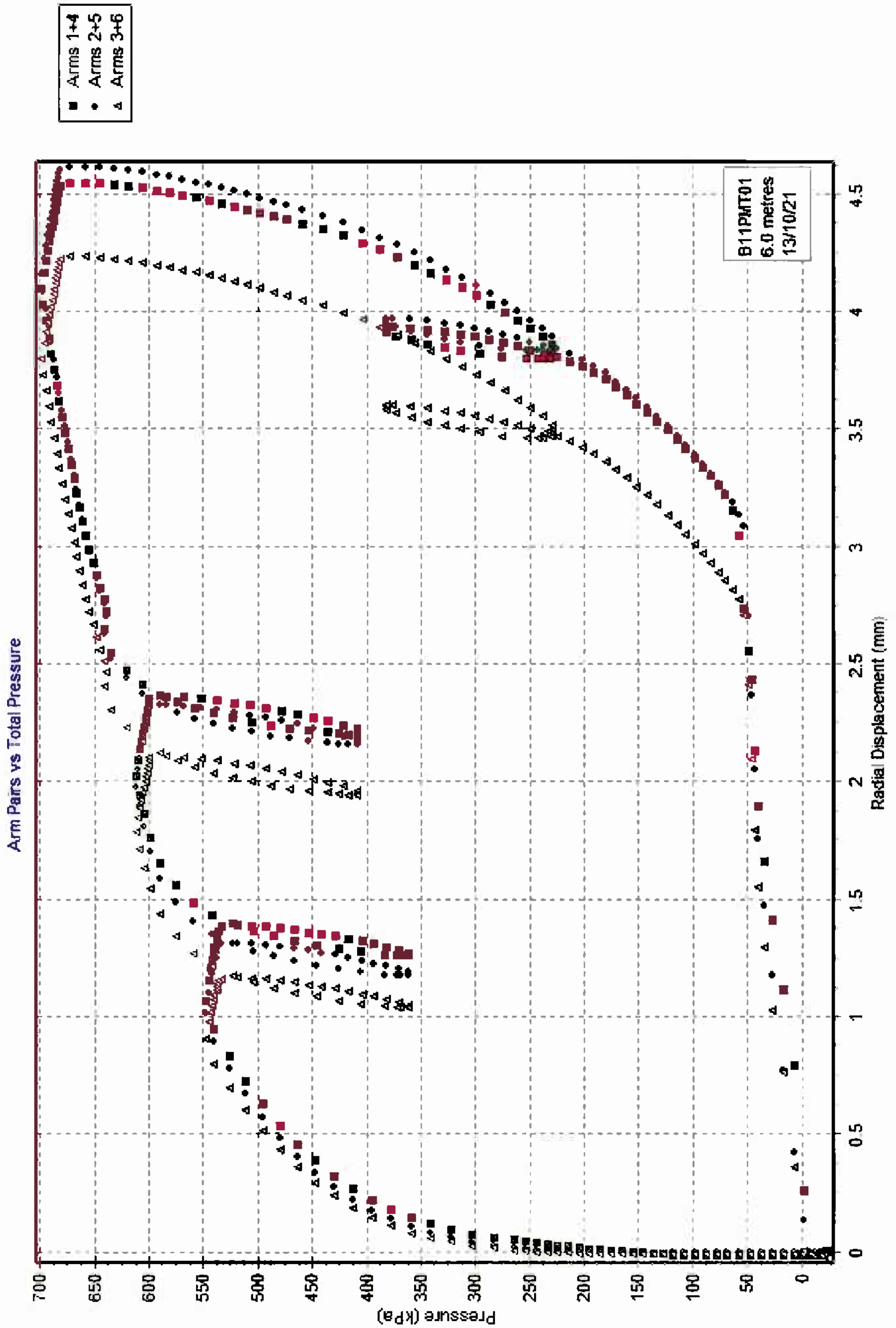

Bolton and Whittle (1999) Loop 3 : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 1
6.00 Metres
13 Oct 21
RESULTS:
Gradient (beta) : 0.592
Intercept (n) : 3.380MPa
Shear stress constant : 2.000MPa
Ln[Radial stress]
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
Ln[shear strain]
-8
-7
-6
Source data - Loop 3
Total pressure (kPa)
350
300
250
Radial Displacement (mm)
3.7
3.75
3.8

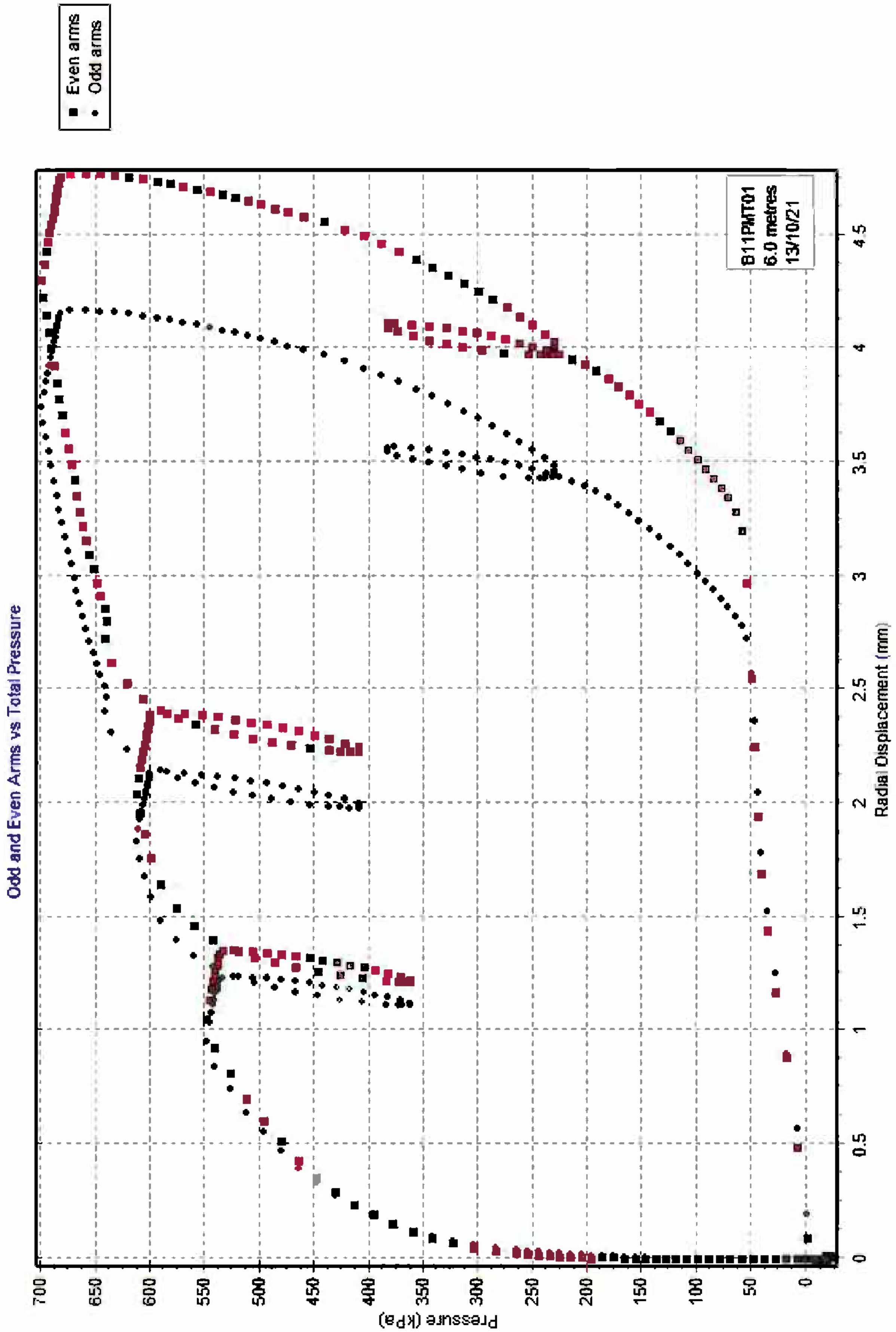

Variation of stiffness with strain, undrained analysis : Arm ave
POWER LAW PARAMETERS:
Cycle Constant Gradient
No. (MPa)
1 2.351 0.614
2 2.170 0.599
3 2.000 0.592
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 1
6.00 Metres
13 Oct 21
Shear modulus (MPa)
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
0.0001
0.001
Log plane shear strain

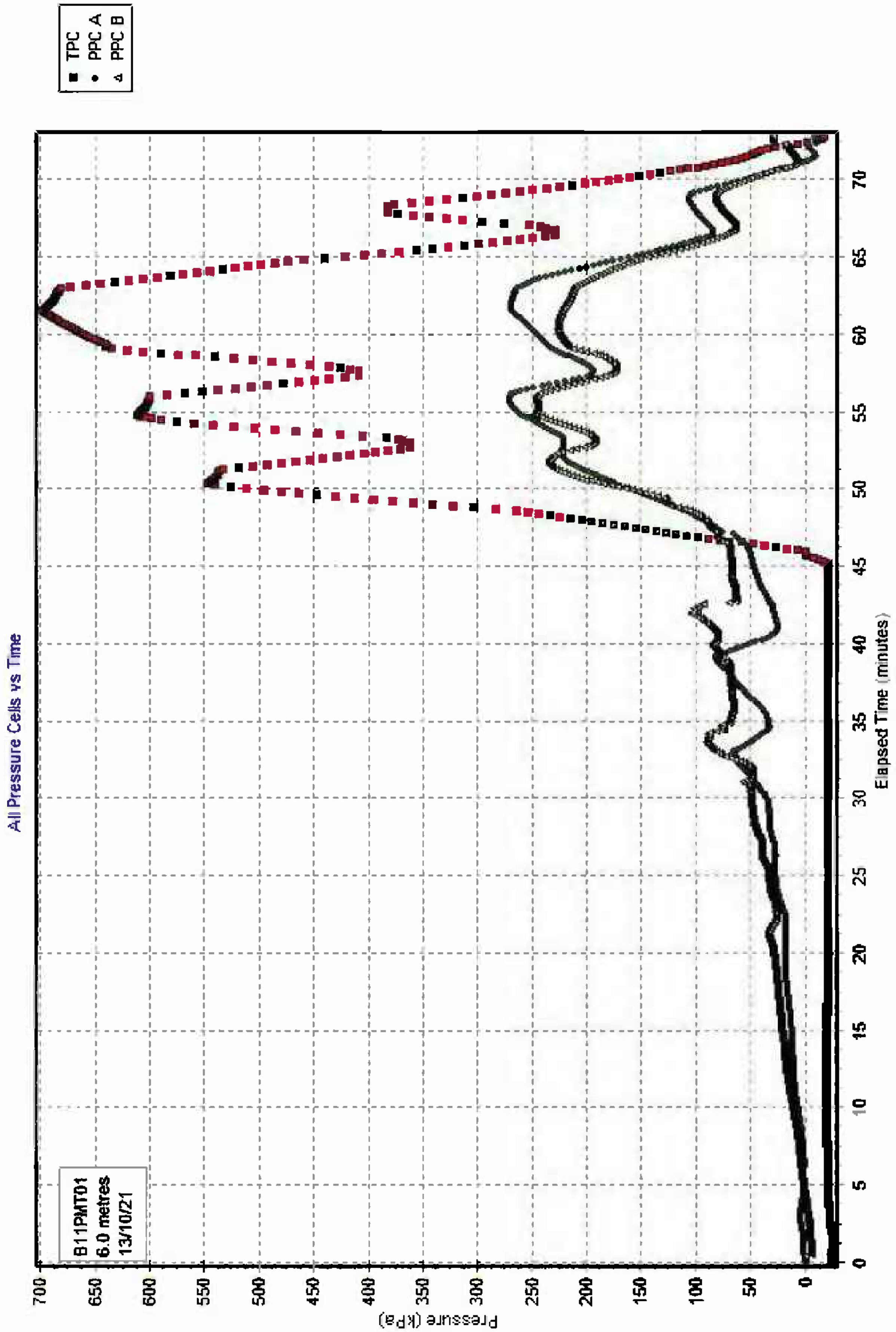

Curve comparison (Whittle 1999) : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 1
6.00 Metres
13 Oct 21
CURVE FIT PARAMETERS:
Origin : -0.060mm
Po : 131.0kPa
Cu : 112.0 kPa
Beta : 0.592
Alpha : 2.378 MPa
Total pressure (kPa)
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Cavity strain (%)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10


All Arms vs Total Pressure
■ Arm 1
● Arm 2
▵ Arm 3
▾ Arm 4
+ Arm 5
× Arm 6
B11PMT01
6.0 metres
13/10/21
Pressure (kPa)
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Radial Displacement (mm)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

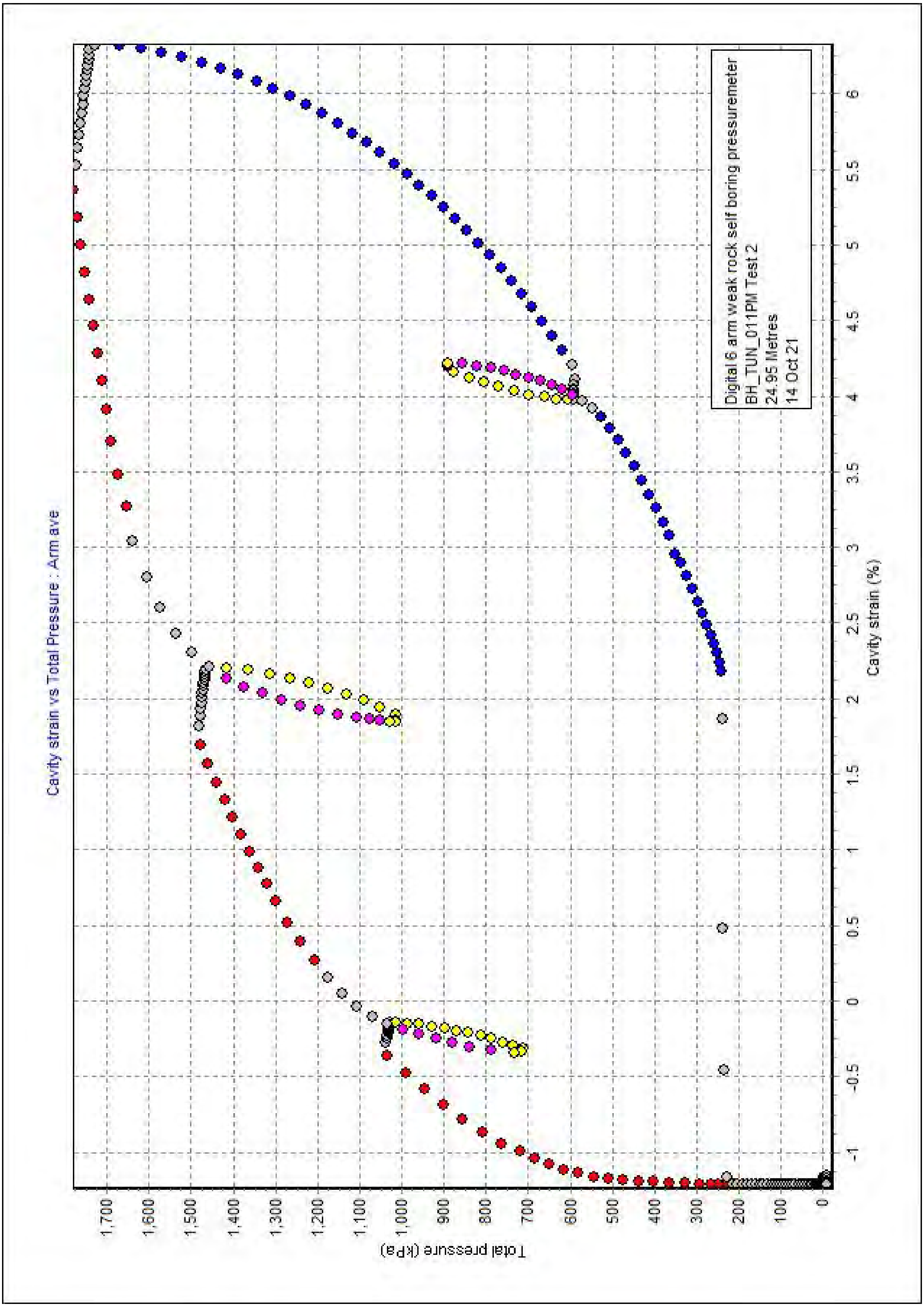

Arm Average vs Total Pressure
B11PMT01
6.0 metres
13/10/21
Radial Displacement (mm)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
3.6
3.8
4
4.2
4.4
Pressure (kPa)
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0

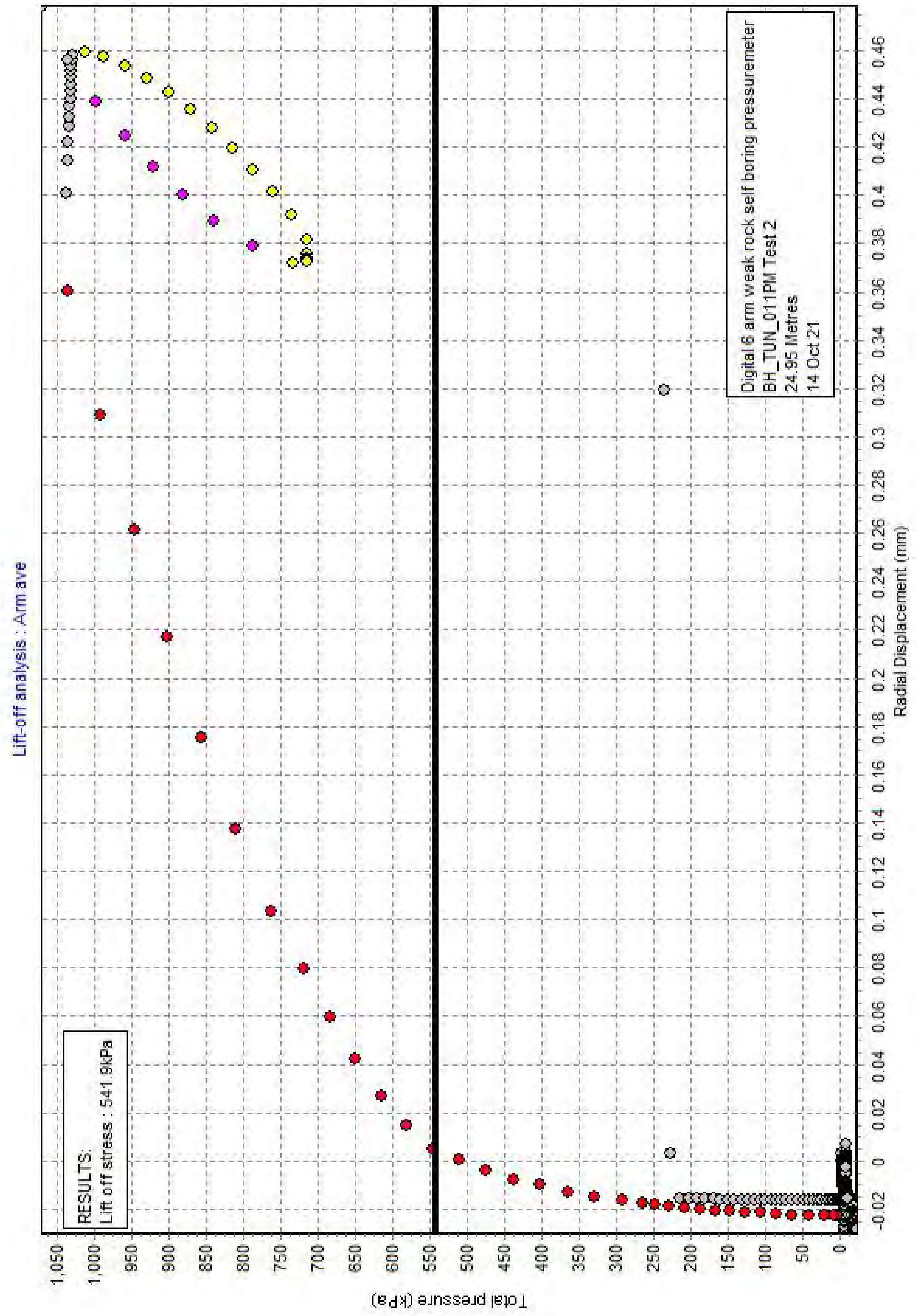

Arm Pairs vs Total Pressure
■ Arms 1+4
• Arms 2+5
△ Arms 3+6
B11PMT01
6.0 metres
13/10/21
Radial Displacement (mm)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Pressure (kPa)
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0

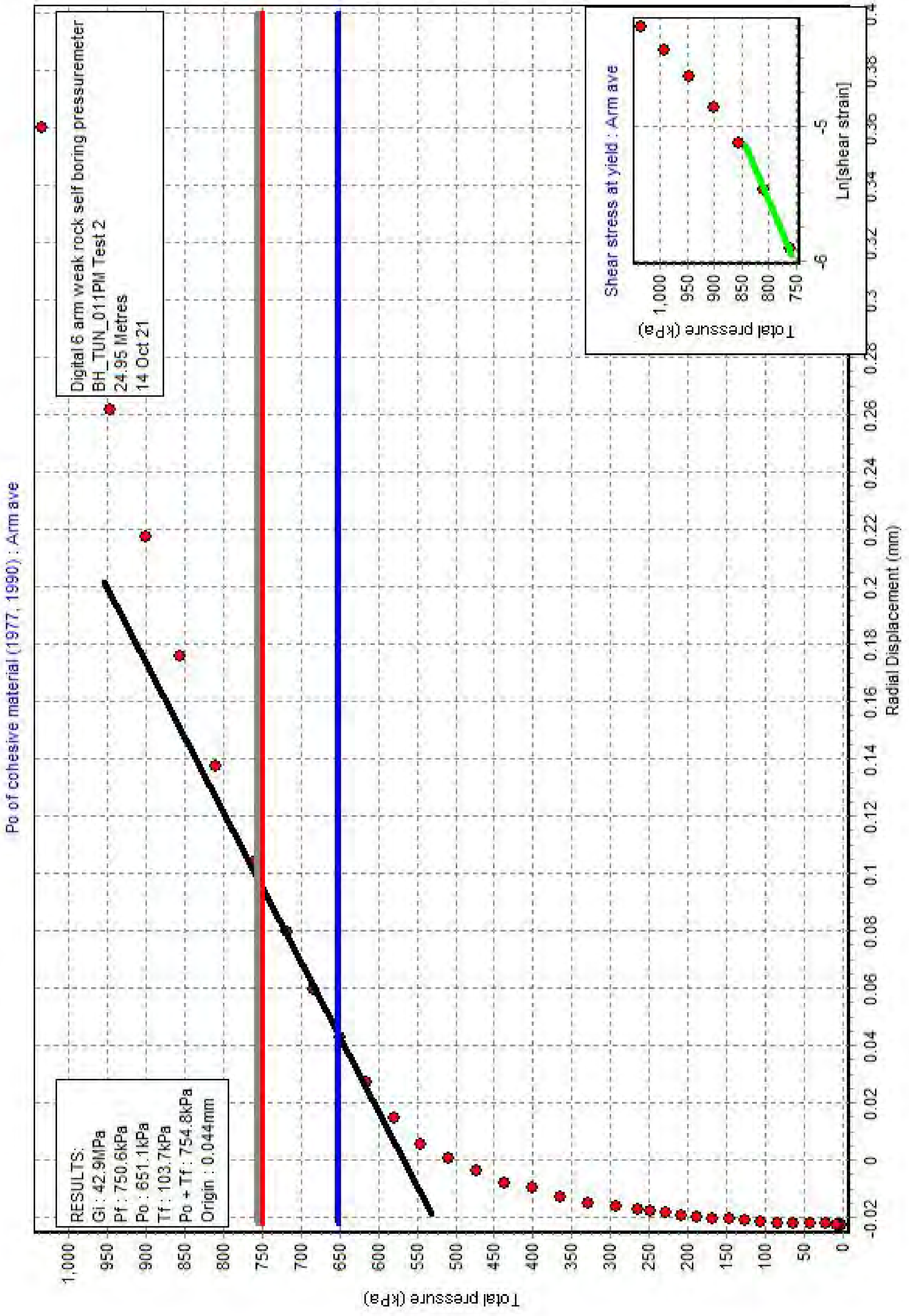

Odd and Even Arms vs Total Pressure
■ Even arms
• Odd arms
B11PMT01
6.0 metres
13/10/21
Pressure (kPa)
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Radial Displacement (mm)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5

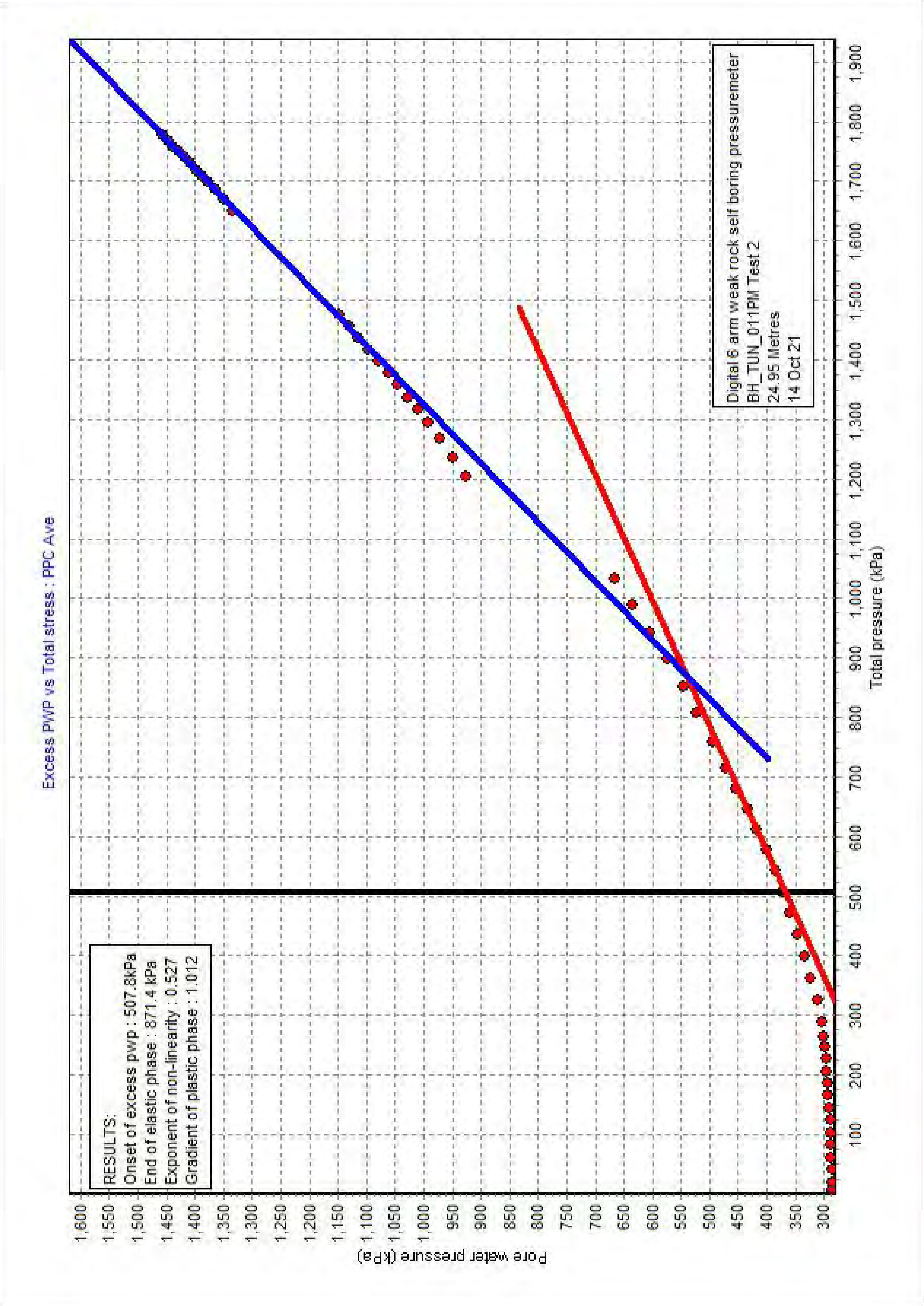

All Pressure Cells vs Time
■ TPC
● PPC A
▵ PPC B
B11PMT01
6.0 metres
13/10/21
Pressure (kPa)
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Elapsed Time (minutes)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70

```
BH_TUN_011PM Test 2 - SUMMARY OF RESULTS
[File made with WinSitu ]

[DETAILS OF TEST]
Project        :   TE8364
Site           :   ambridge Waste Water Treatment Plant Relocation Project
Borehole       :   BH_TUN_011PM
Test name      :   BH_TUN_011PM Test 2
Test date      :   14 Oct 21
Test depth     :   24.95 Metres
Water table    :   1.75 Metres
Ambient PWP    :   228.0 kPa
Material       :   Gault Clay
Probe          :   Digital 6 arm weak rock self boring pressuremeter
Diameter       :   88.1 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out
The file includes results from a curve fitting analysis

Analysed by YB / ES / RW on 15 Oct 21

Remarks:

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm)                   :   "Arm ave=0.52"
Po from Marsland & Randolph (kPa)    :   "Arm ave=651.1"
Po from Lift off (kPa)               :   "Arm ave=541.9"
PWP versus Total Stress (kPa)        :   "PPC Ave=507.8"
Best estimate of Po (kPa)            :   "Arm ave=629.0"

[UNDRAINED STRENGTH PARAMETERS]
Gibson & Anderson 1961 - Cu (kPa)    :   "Arm ave=267.2"
Limit pressure (kPa)                 :   "Arm ave=2395"
Jefferies 1988 - Cu (kPa)            :   "Arm ave=265.7"
Undrained yield stress (kPa)         :   "Arm ave=750.6"
PWP derived yield stress (kPa)       :   "PPC Ave=871.4"

[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=42.9"
Axis       Loop   Value    Mean Strain  Mean Pc  dE      dPc
           No     (MPa)    (%)          (kPa)    (%)     (kPa)
Arm ave    1      81.5     -0.240       861      0.358   292
Arm ave    2      62.6     2.021        1219     0.644   404
Arm ave    3      65.4     4.113        749      0.432   283

[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]
Axis       Loop   Intercept  Alpha      Gradient
           No     (MPa)      (MPa)
Arm ave    1      11.342     7.228      0.637
Arm ave    2      13.521     9.071      0.671
Arm ave    3      9.551      5.970      0.625

Non-linear exponent from PWP response :   "PPC Ave=0.527"

[PARAMETERS USED FOR UNDRAINED CURVE MODELLING]
{Axis is  Arm ave}
Strain Origin (mm)                   :   0.52
Po (kPa)                             :   629
Cu (kPa)                             :   267.2
Limit pressure (kPa)                 :   2395
Non-linear exponent                  :   0.625
Calculated alpha (MPa)               :   6.119
G at yield (MPa)                     :   40.0
```


Cavity strain vs Total Pressure : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 2
24.95 Metres
14 Oct 21
Total pressure (kPa)
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
1,300
1,400
1,500
1,600
1,700
Cavity strain (%)
-1
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6

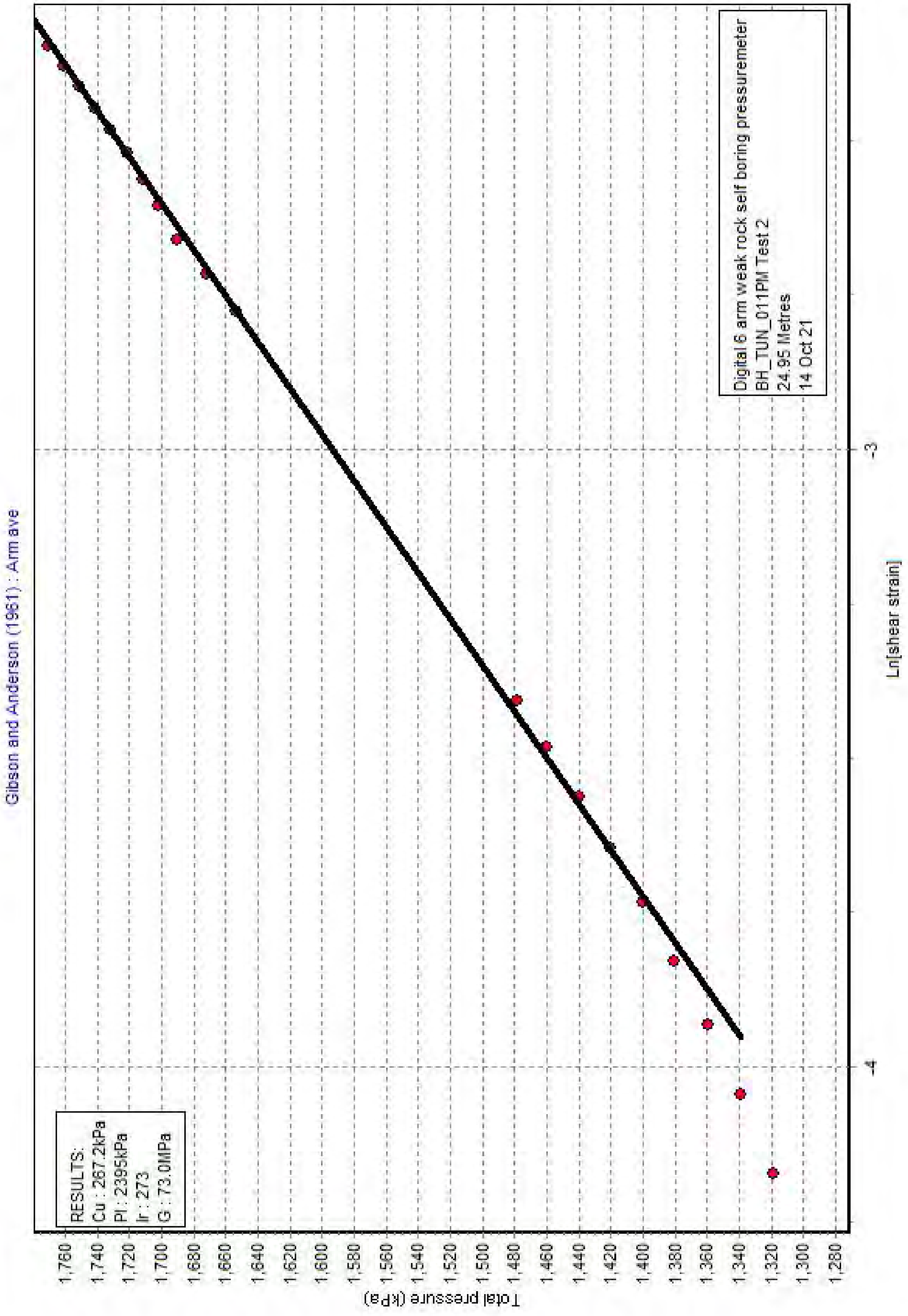

Lift-off analysis : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 2
24.95 Metres
14 Oct 21
RESULTS:
Lift off stress : 541.9kPa
Radial Displacement (mm)
-0.02
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
0.26
0.28
0.3
0.32
0.34
0.36
0.38
0.4
0.42
0.44
0.46
Total pressure (kPa)
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1,000
1,050

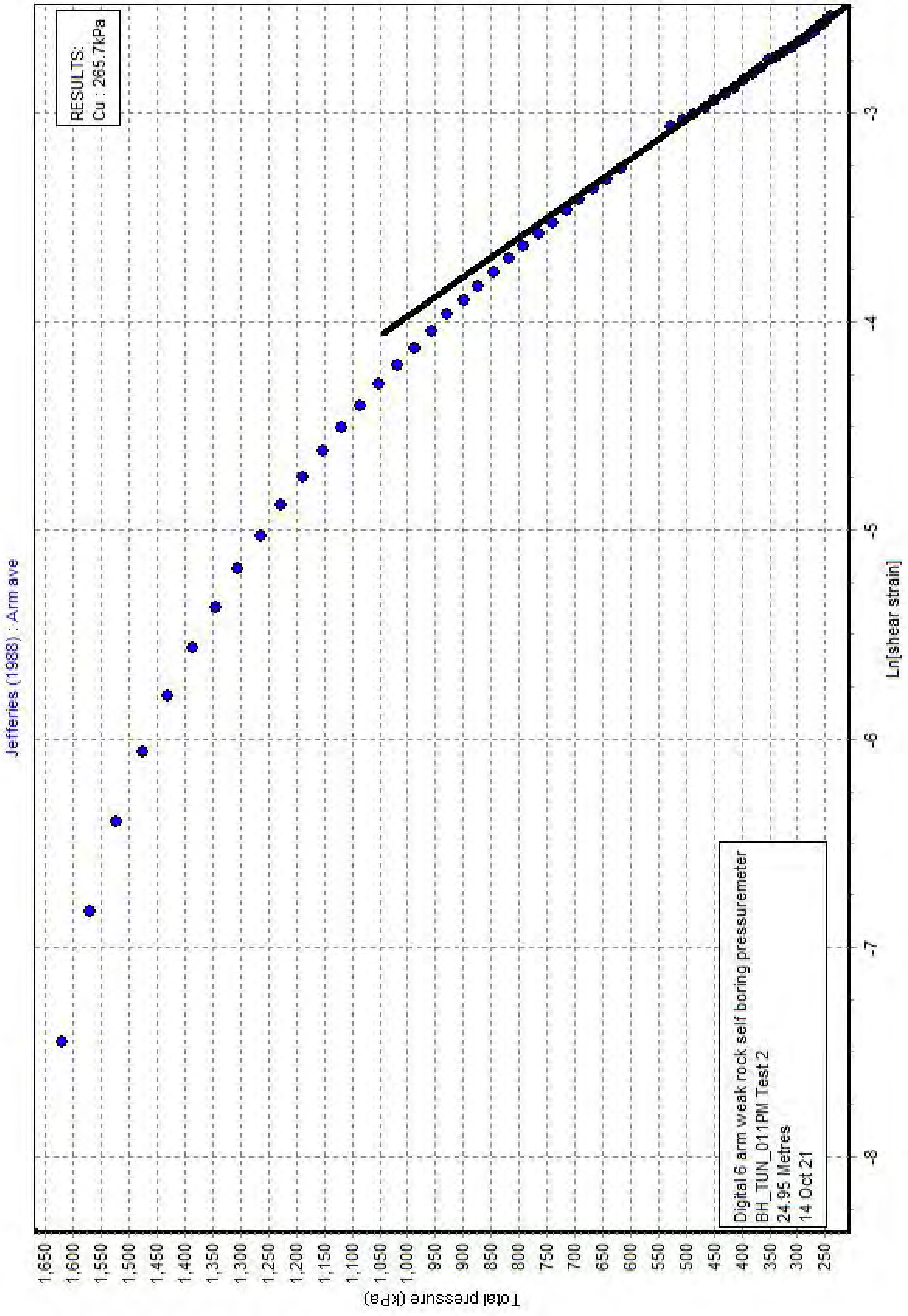

Po of cohesive material (1977, 1990) : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 2
24.95 Metres
14 Oct 21
RESULTS:
Gi : 42.9MPa
Pf : 750.6kPa
Po : 651.1kPa
Tf : 103.7kPa
Po + Tf : 754.8kPa
Origin : 0.044mm
Total pressure (kPa)
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
Radial Displacement (mm)
-0.02
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
0.26
0.28
0.3
0.32
0.34
0.36
0.38
0.4
Shear stress at yield : Arm ave
Total pressure (kPa)
1,000
950
900
850
800
750
Ln[shear strain]
-6
-5

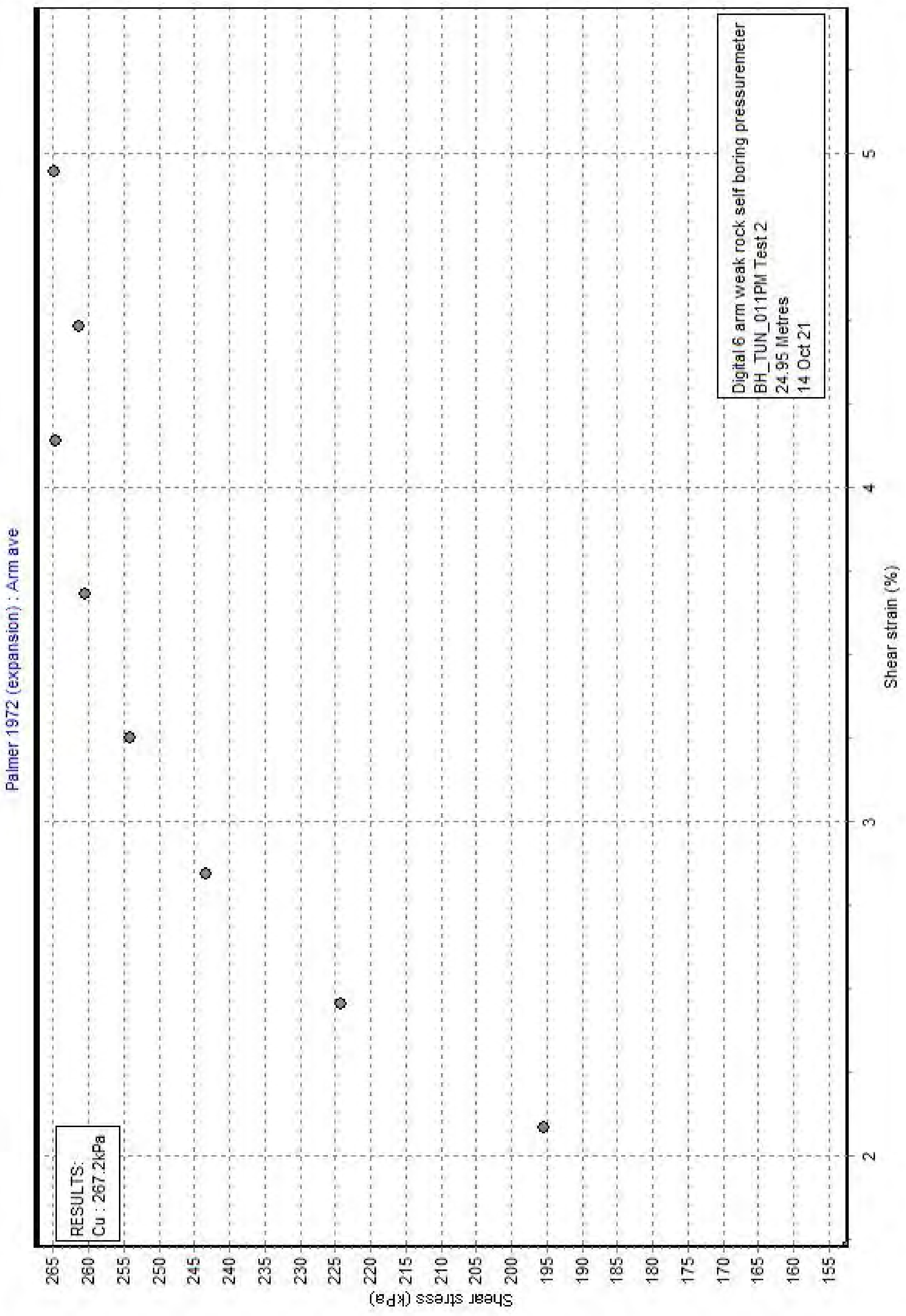


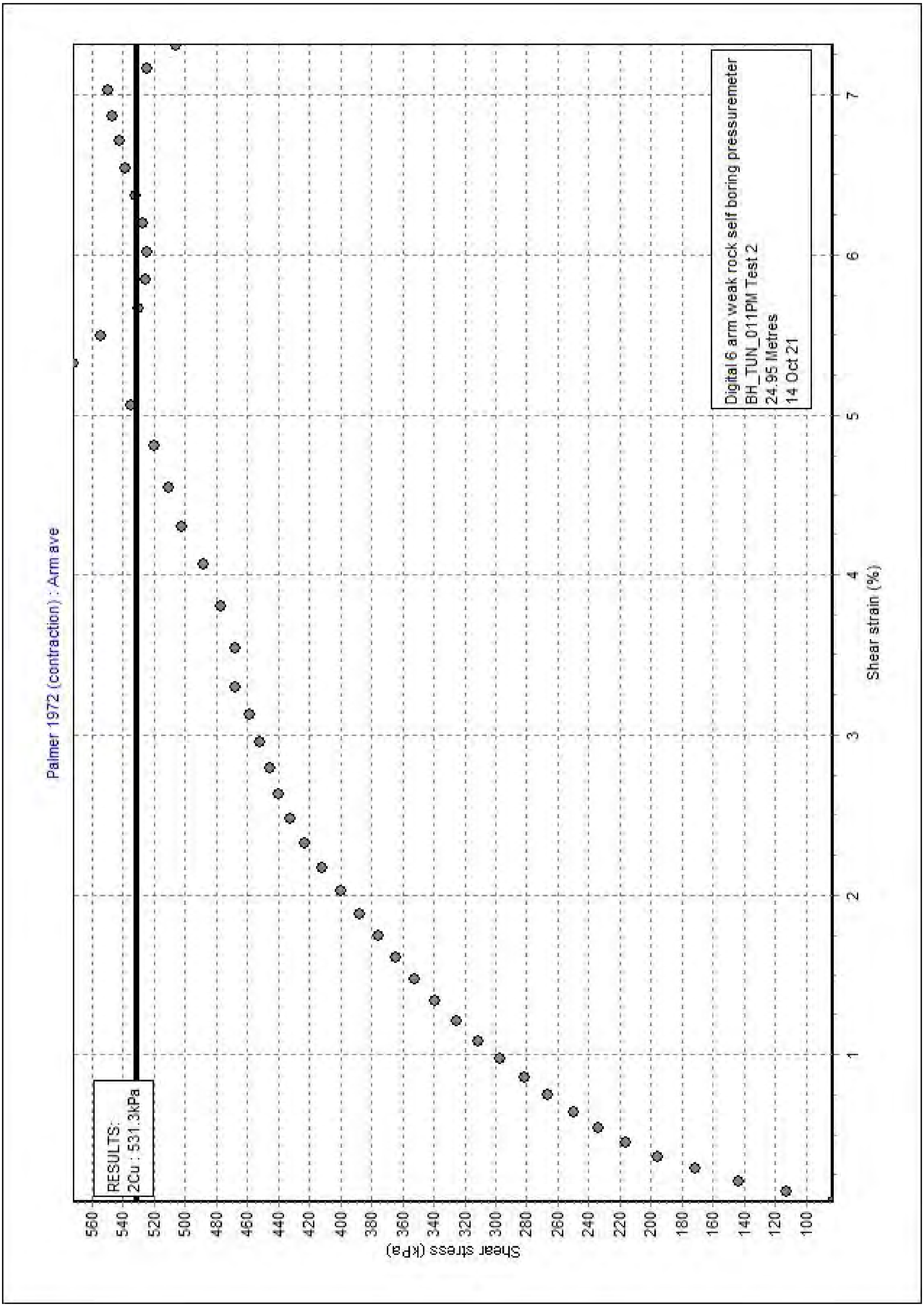
RESULTS:
Onset of excess pwp : 507.8kPa
End of elastic phase : 871.4 kPa
Exponent of non-linearity : 0.527
Gradient of plastic phase : 1.012

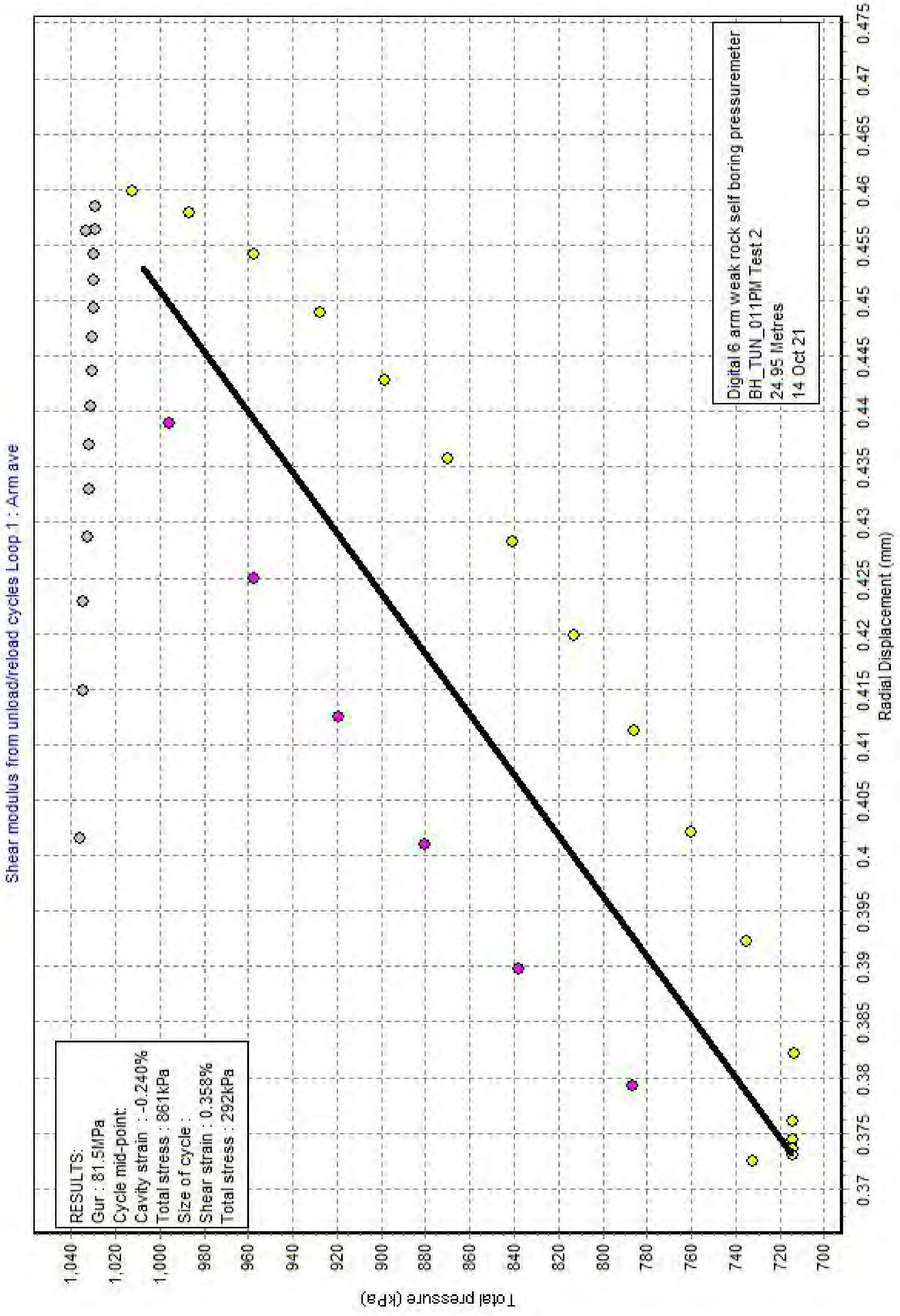
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 2
24.95 Metres
14 Oct 21

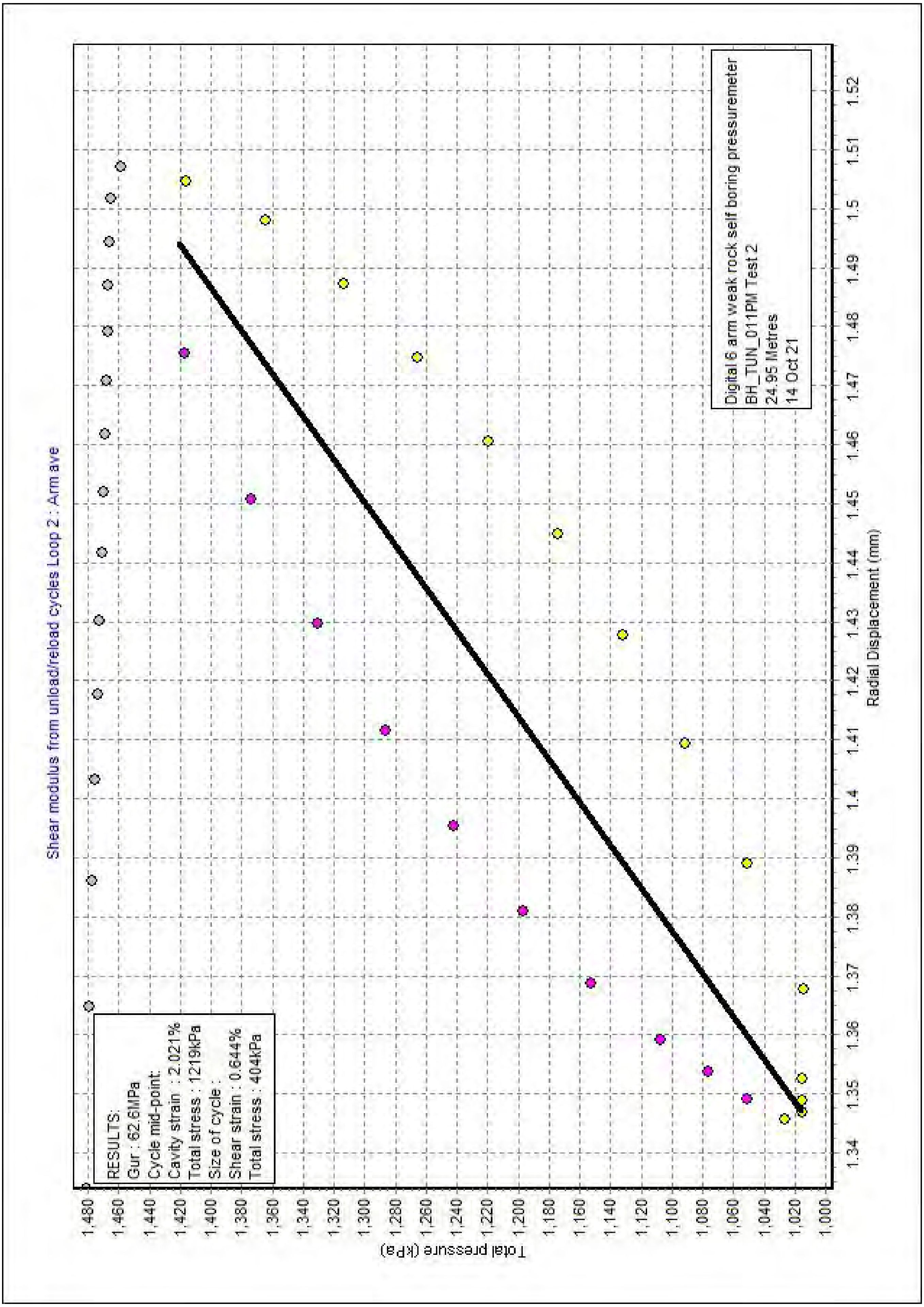

Gibson and Anderson (1961) : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 2
24.95 Metres
14 Oct 21
RESULTS:
Cu : 267.2kPa
Pl : 2395kPa
Ir : 273
G : 73.0MPa
Ln[shear strain]
-3
-4
Total pressure (kPa)
1,760
1,740
1,720
1,700
1,680
1,660
1,640
1,620
1,600
1,580
1,560
1,540
1,520
1,500
1,480
1,460
1,440
1,420
1,400
1,380
1,360
1,340
1,320
1,300
1,280

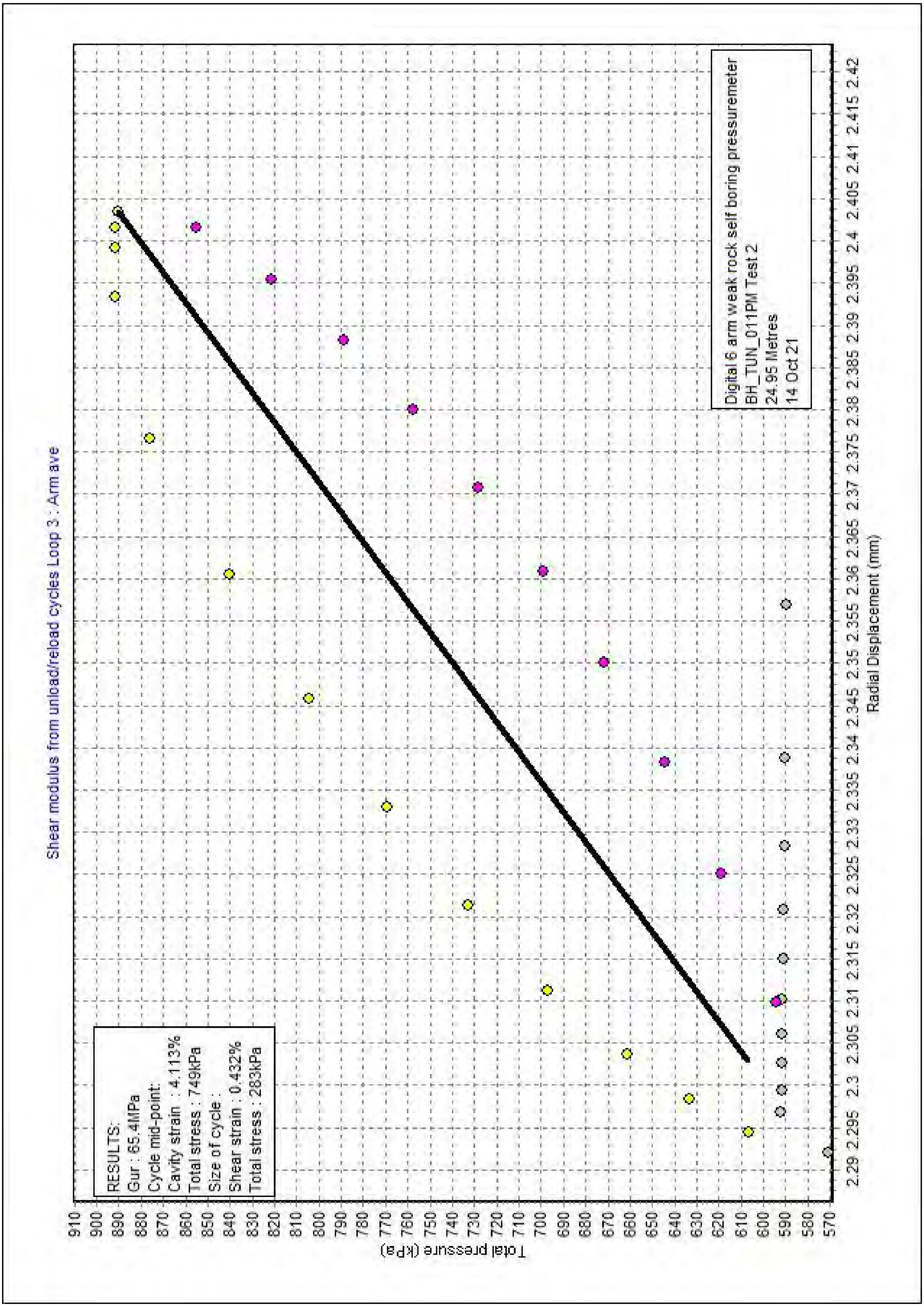

Jefferies (1988) : Arm ave
RESULTS:
Cu : 265.7kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 2
24.95 Metres
14 Oct 21
Total pressure (kPa)
1,650
1,600
1,550
1,500
1,450
1,400
1,350
1,300
1,250
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
Ln[shear strain]
-3
-4
-5
-6
-7
-8

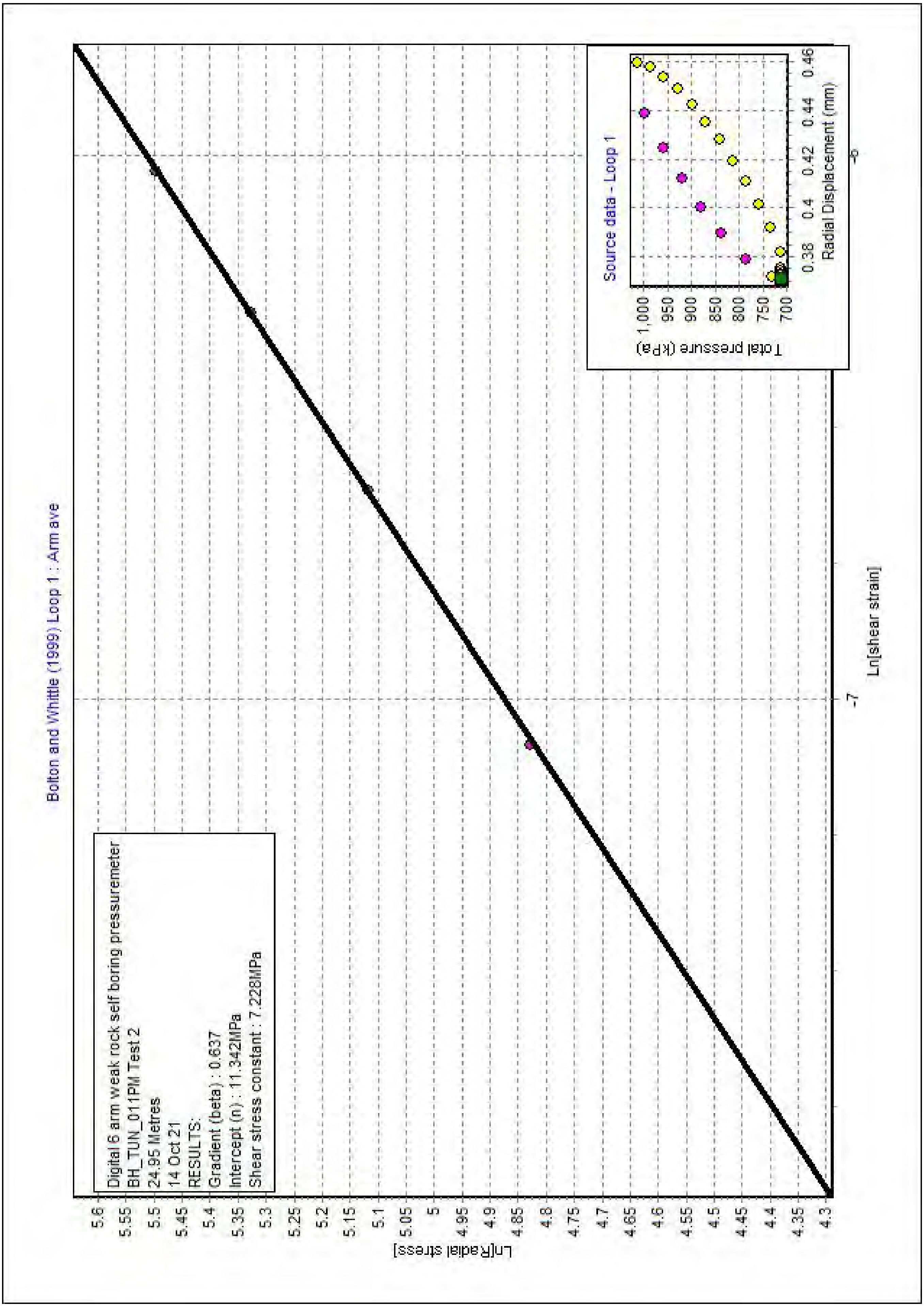

Palmer 1972 (expansion) : Arm ave
RESULTS:
Cu : 267.2kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 2
24.95 Metres
14 Oct 21
Shear stress (kPa)
265
260
255
250
245
240
235
230
225
220
215
210
205
200
195
190
185
180
175
170
165
160
155
Shear strain (%)
2
3
4
5


Palmer 1972 (contraction) : Arm ave
RESULTS:
2Cu : 531.3kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 2
24.95 Metres
14 Oct 21
Shear stress (kPa)
560
540
520
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
Shear strain (%)
1
2
3
4
5
6
7

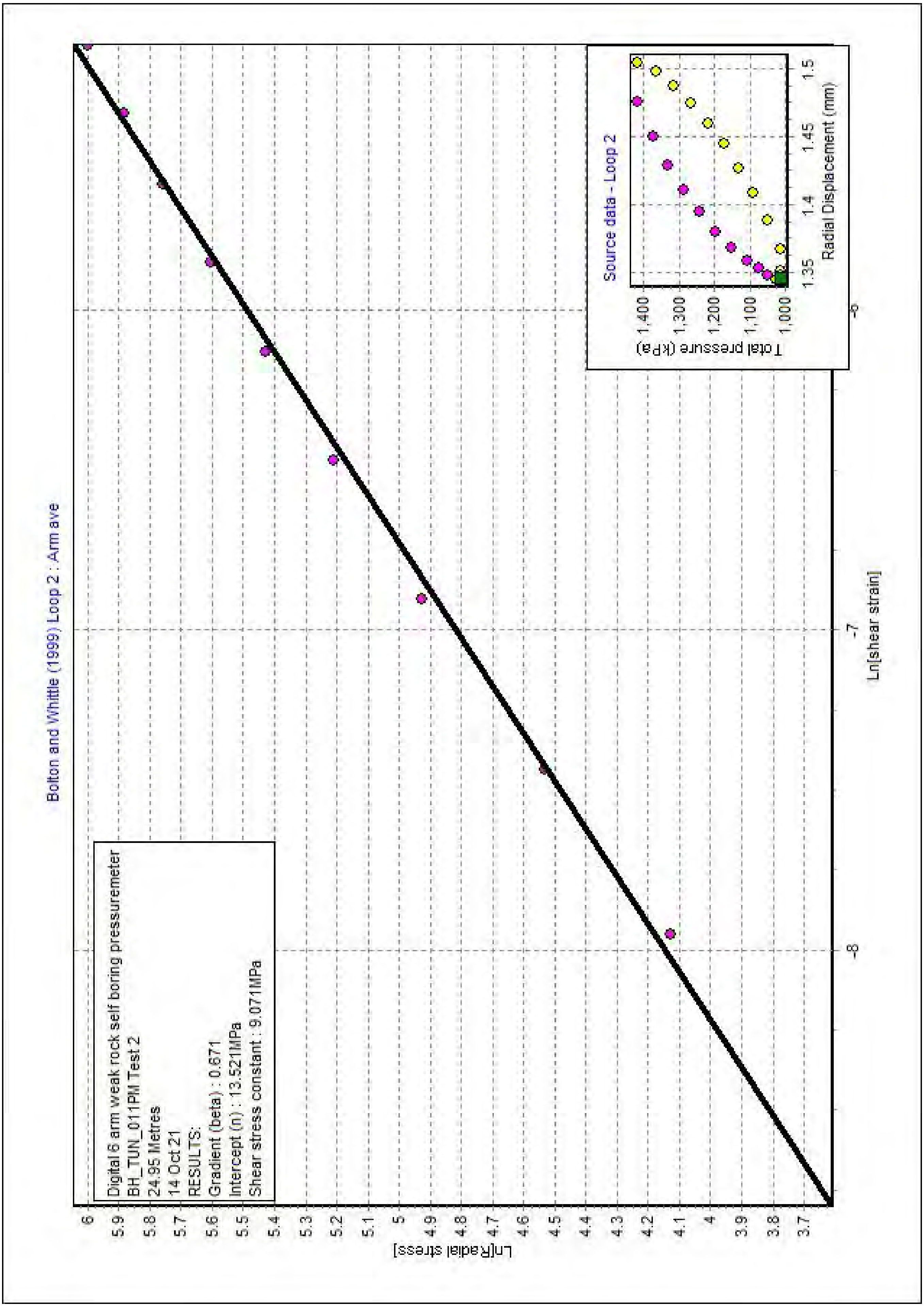

Shear modulus from unload/reload cycles Loop 1 : Arm ave
RESULTS:
Gur : 81.5MPa
Cycle mid-point:
Cavity strain : -0.240%
Total stress : 861kPa
Size of cycle :
Shear strain : 0.358%
Total stress : 292kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 2
24.95 Metres
14 Oct 21
Total pressure (kPa)
1,040
1,020
1,000
980
960
940
920
900
880
860
840
820
800
780
760
740
720
700
Radial Displacement (mm)
0.37
0.375
0.38
0.385
0.39
0.395
0.4
0.405
0.41
0.415
0.42
0.425
0.43
0.435
0.44
0.445
0.45
0.455
0.46
0.465
0.47
0.475


Shear modulus from unload/reload cycles Loop 2 : Arm ave
RESULTS:
Gur : 62.6MPa
Cycle mid-point:
Cavity strain : 2.021%
Total stress : 1219kPa
Size of cycle :
Shear strain : 0.644%
Total stress : 404kPa
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 2
24.95 Metres
14 Oct 21
Total pressure (kPa)
1,480
1,460
1,440
1,420
1,400
1,380
1,360
1,340
1,320
1,300
1,280
1,260
1,240
1,220
1,200
1,180
1,160
1,140
1,120
1,100
1,080
1,060
1,040
1,020
1,000
Radial Displacement (mm)
1.34
1.35
1.36
1.37
1.38
1.39
1.4
1.41
1.42
1.43
1.44
1.45
1.46
1.47
1.48
1.49
1.5
1.51
1.52

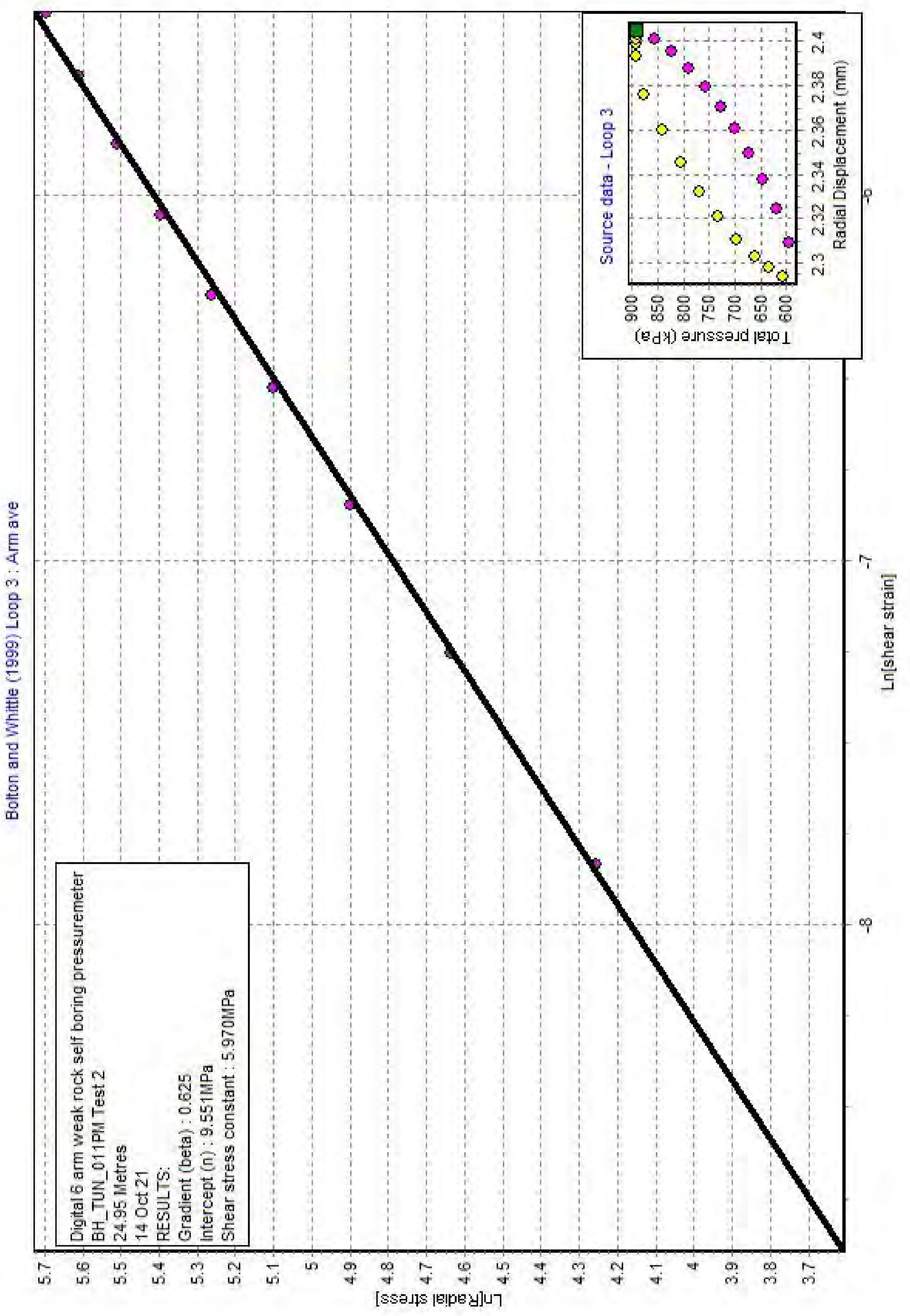

Shear modulus from unload/reload cycles Loop 3 : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 2
24.95 Metres
14 Oct 21
RESULTS:
Gur : 65.4MPa
Cycle mid-point:
Cavity strain : 4.113%
Total stress : 749kPa
Size of cycle :
Shear strain : 0.432%
Total stress : 283kPa
Total pressure (kPa)
910
900
890
880
870
860
850
840
830
820
810
800
790
780
770
760
750
740
730
720
710
700
690
680
670
660
650
640
630
620
610
600
590
580
570
Radial Displacement (mm)
2.29
2.295
2.3
2.305
2.31
2.315
2.32
2.325
2.33
2.335
2.34
2.345
2.35
2.355
2.36
2.365
2.37
2.375
2.38
2.385
2.39
2.395
2.4
2.405
2.41
2.415
2.42

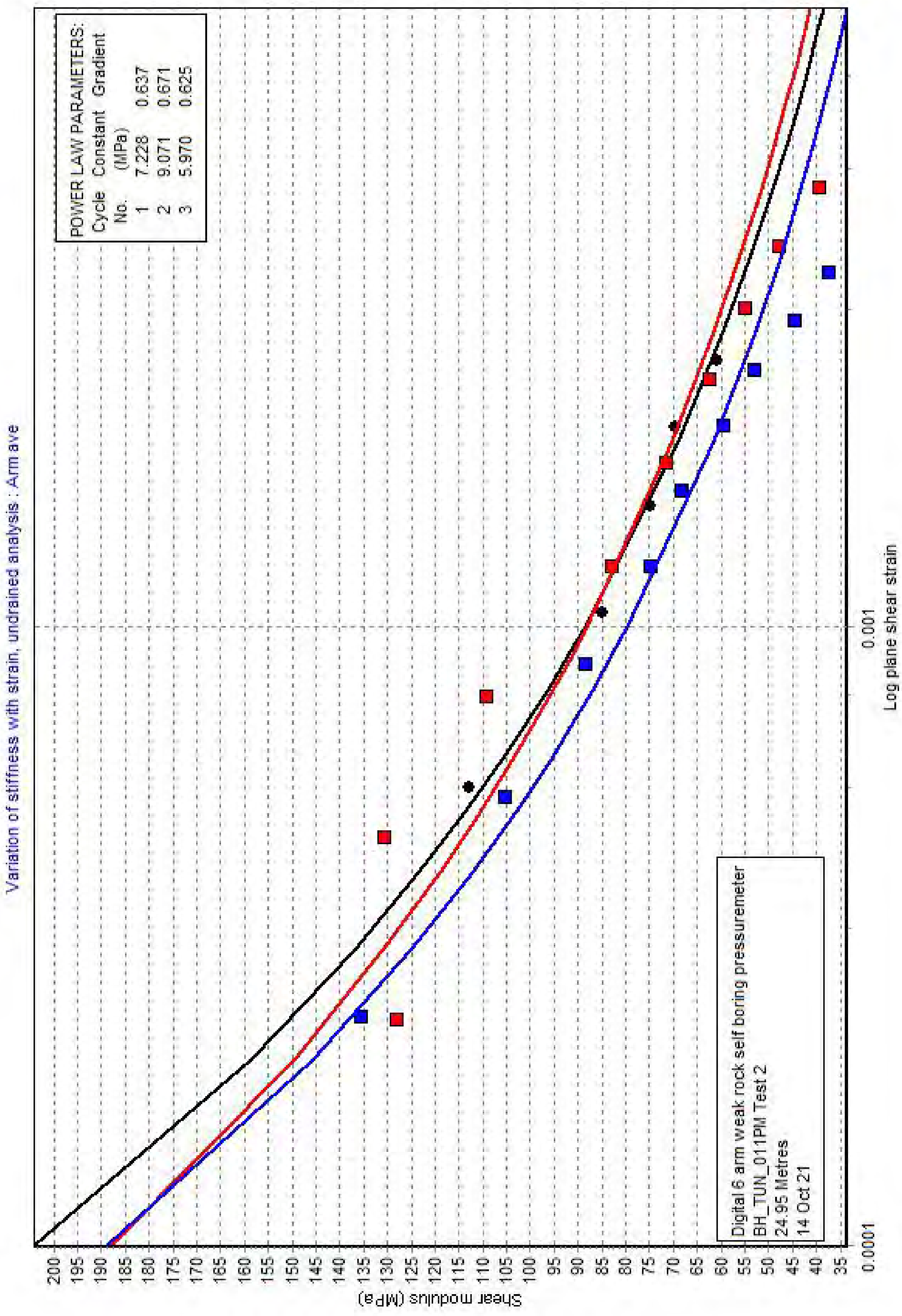


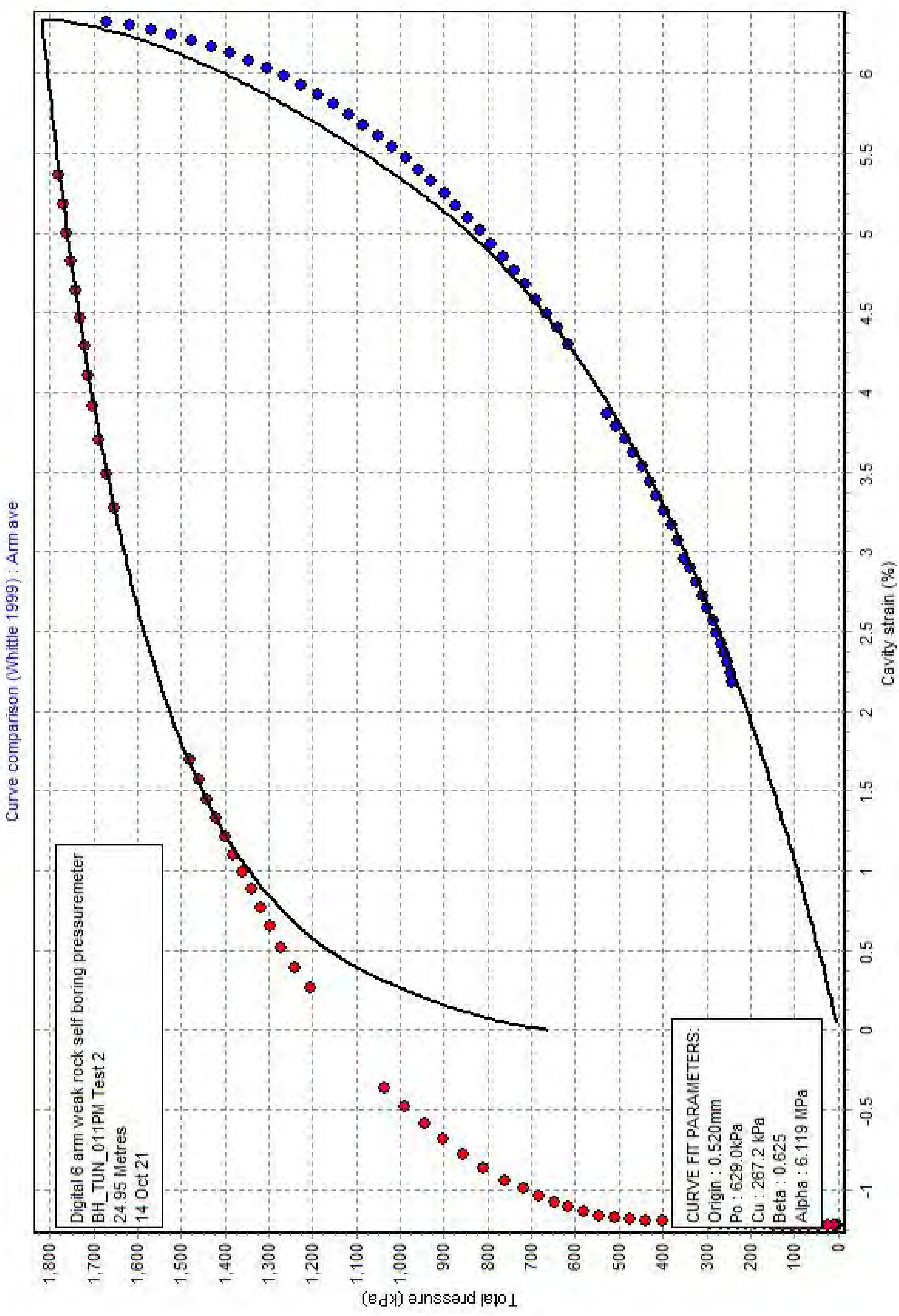
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 2
24.95 Metres
14 Oct 21
RESULTS:
Gradient (beta) : 0.637
Intercept (n) : 11.342MPa
Shear stress constant : 7.228MPa

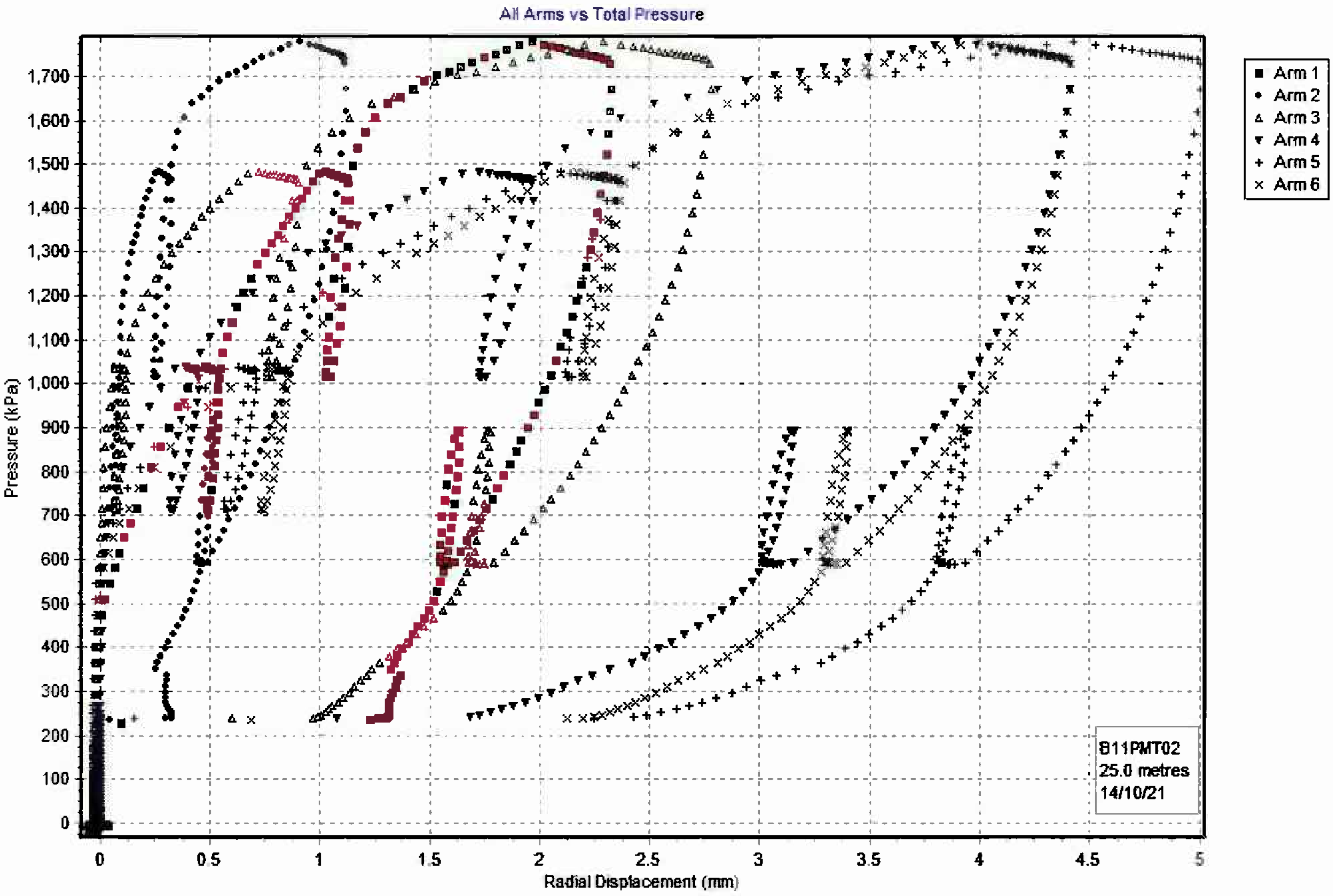


Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 2
24.95 Metres
14 Oct 21
RESULTS:
Gradient (beta) : 0.671
Intercept (n) : 13.521MPa
Shear stress constant : 9.071MPa


Bolton and Whittle (1999) Loop 3 : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 2
24.95 Metres
14 Oct 21
RESULTS:
Gradient (beta) : 0.625
Intercept (n) : 9.551MPa
Shear stress constant : 5.970MPa
Ln[Radial stress]
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
Ln[shear strain]
-8
-7
-6
Source data - Loop 3
Total pressure (kPa)
900
850
800
750
700
650
600
Radial Displacement (mm)
2.3
2.32
2.34
2.36
2.38
2.4


Variation of stiffness with strain, undrained analysis : Arm ave
POWER LAW PARAMETERS:
Cycle No. | Constant (MPa) | Gradient
1 | 7.228 | 0.637
2 | 9.071 | 0.671
3 | 5.970 | 0.625
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 2
24.95 Metres
14 Oct 21
Shear modulus (MPa)
200
195
190
185
180
175
170
165
160
155
150
145
140
135
130
125
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
Log plane shear strain
0.0001
0.001


Curve comparison (Whittle 1999) : Arm ave
Digital 6 arm weak rock self boring pressuremeter
BH_TUN_011PM Test 2
24.95 Metres
14 Oct 21
CURVE FIT PARAMETERS:
Origin : 0.520mm
Po : 629.0kPa
Cu : 267.2 kPa
Beta : 0.625
Alpha : 6.119 MPa
Total pressure (kPa)
1,800
1,700
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
0
Cavity strain (%)
-1
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6

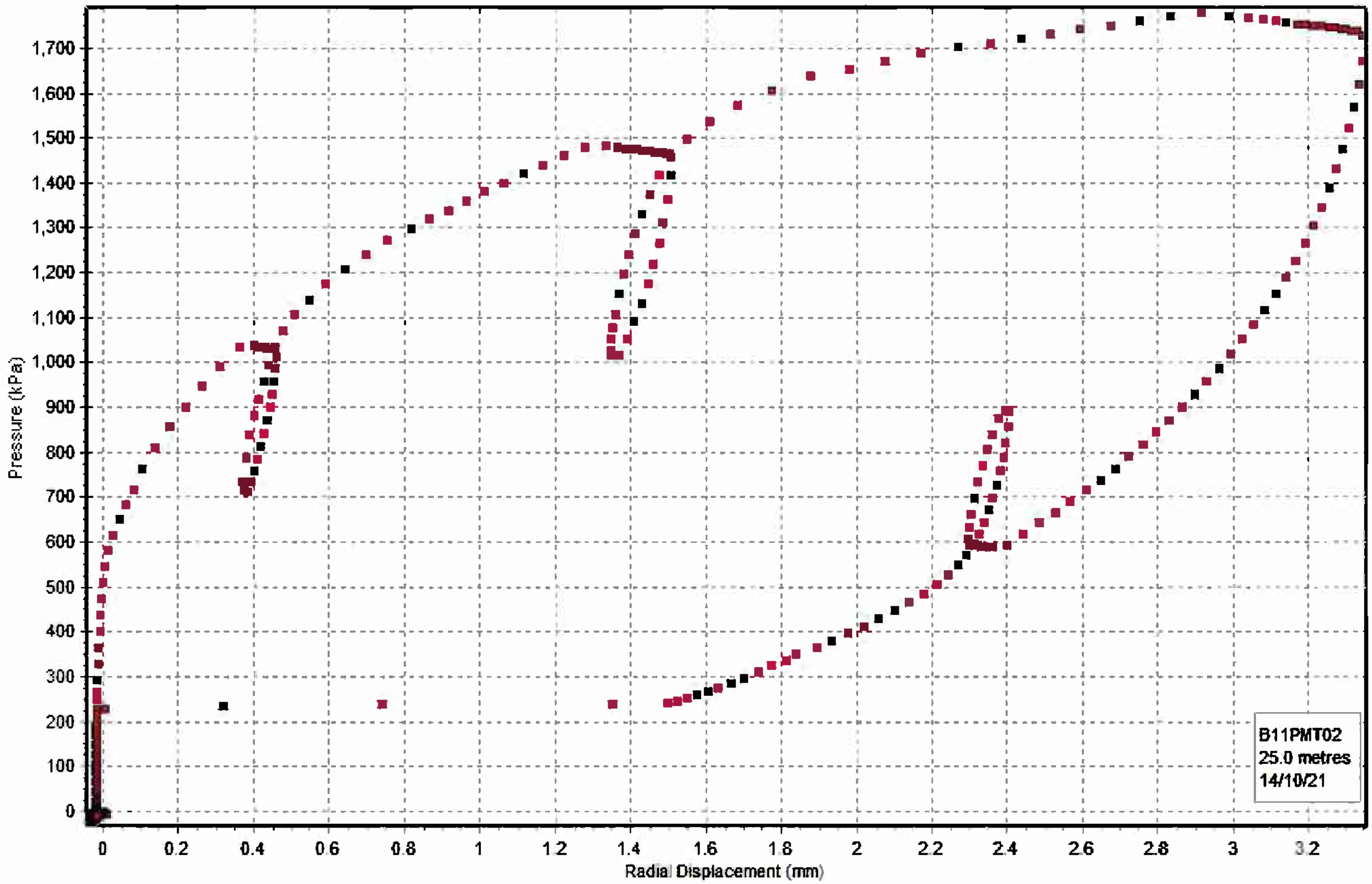

All Arms vs Total Pressure
Pressure (kPa)
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
1,300
1,400
1,500
1,600
1,700
Radial Displacement (mm)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
■ Arm 1
● Arm 2
△ Arm 3
▼ Arm 4
+ Arm 5
× Arm 6
B11PMT02
25.0 metres
14/10/21

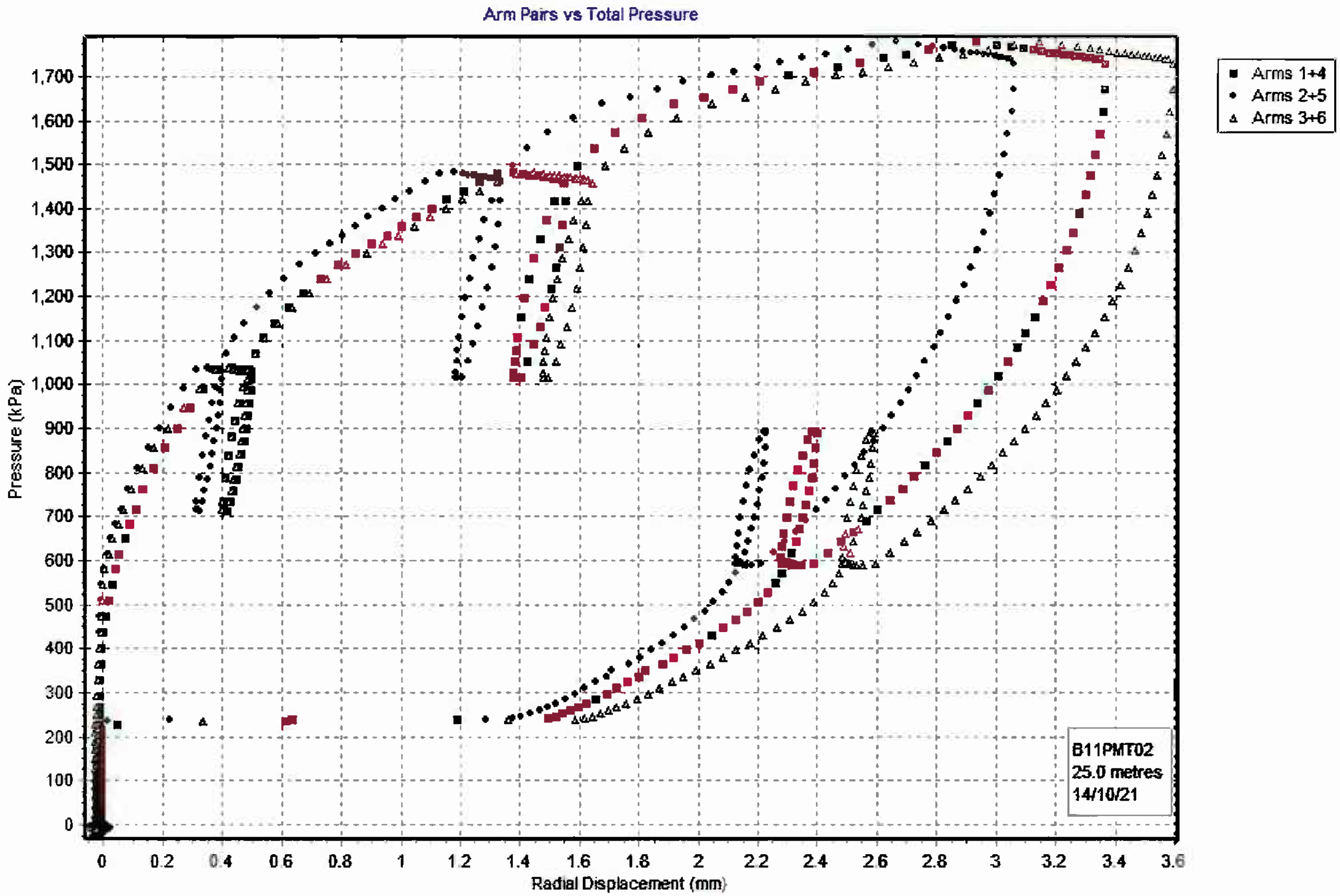
CIR1506/21

Cambridge WWTPR

Pressuremeter Testing

Arm Average vs Total Pressure

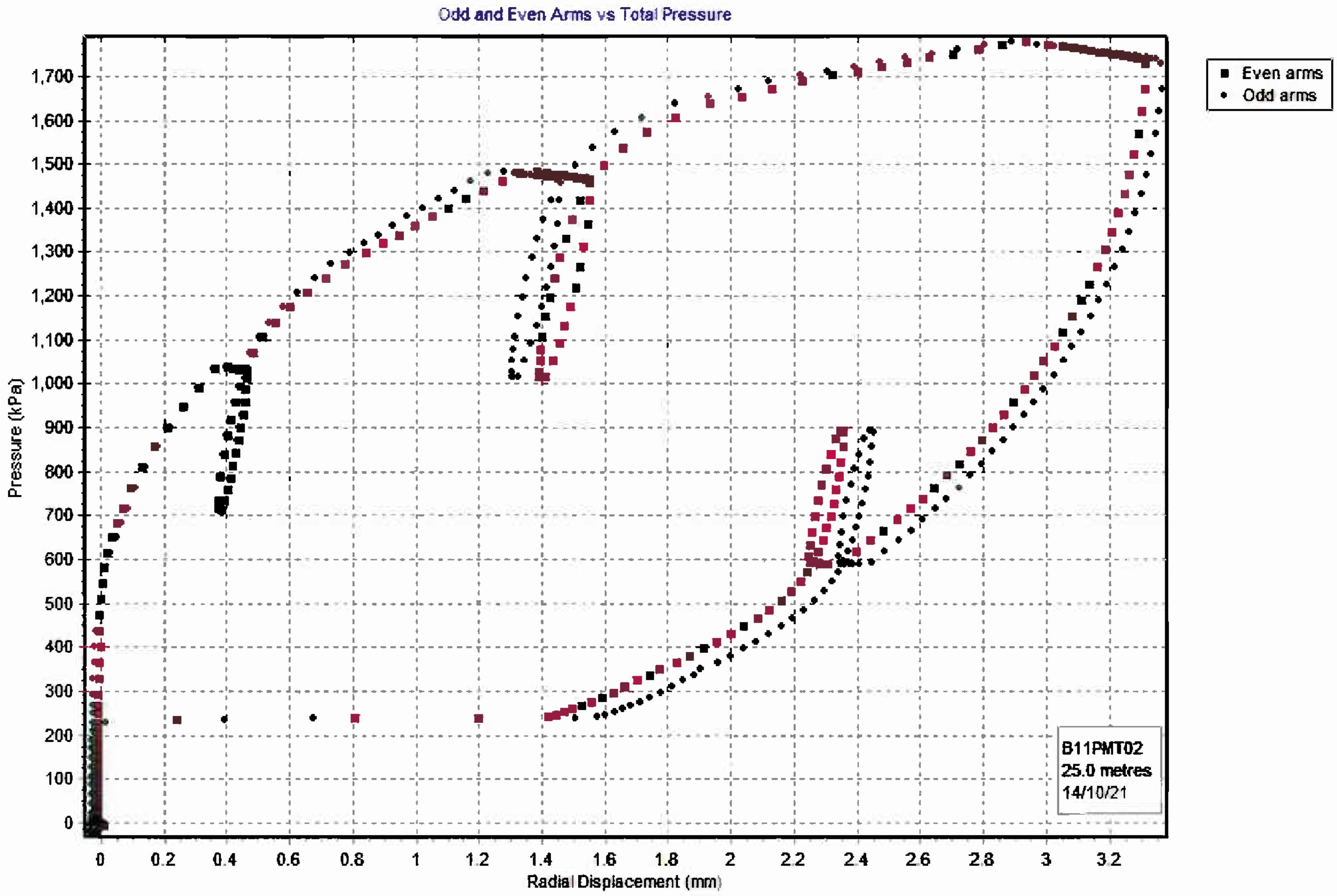


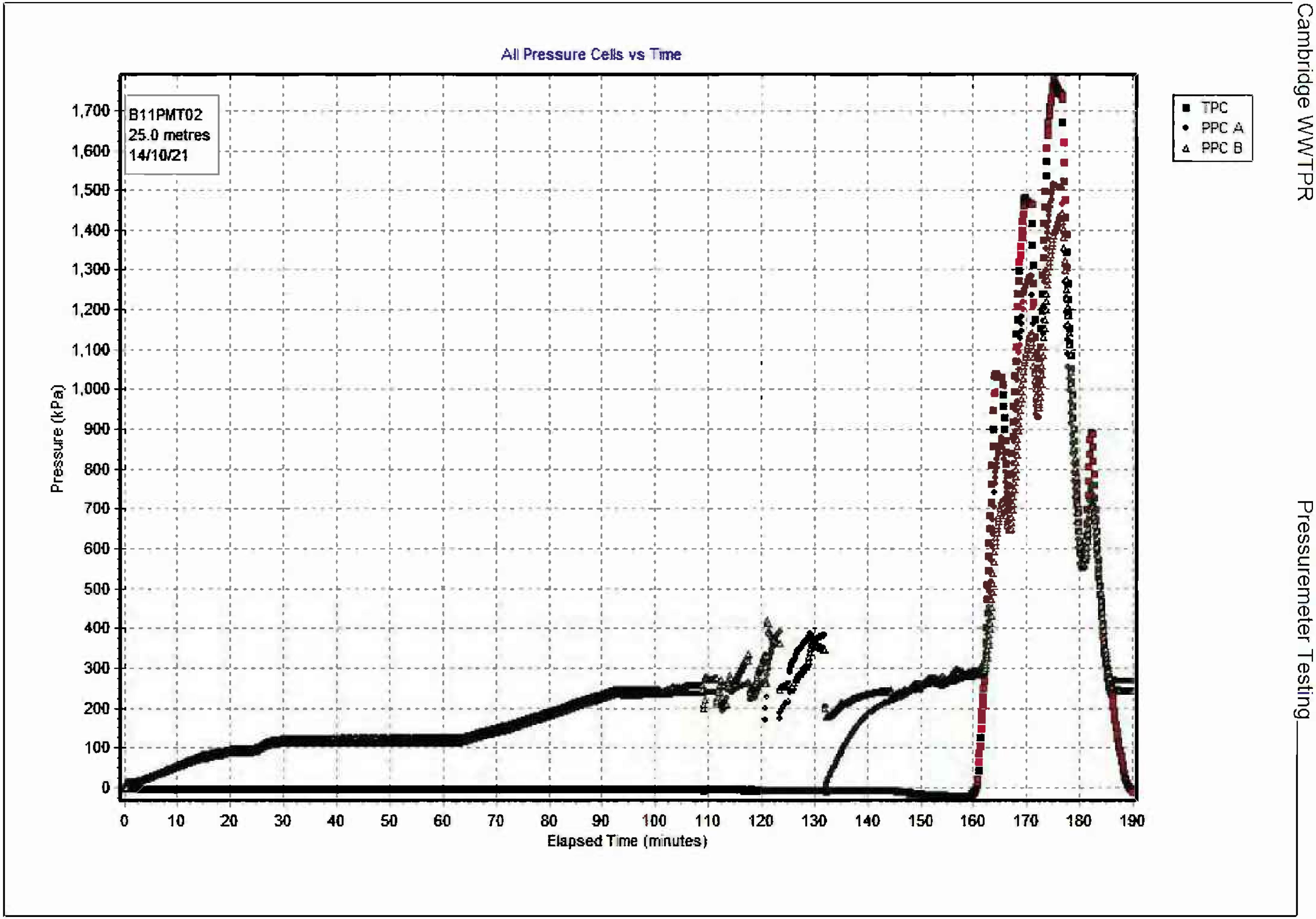

Arm Pairs vs Total Pressure
Pressure (kPa)
1,700
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
0
Radial Displacement (mm)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
3.6
■ Arms 1+4
• Arms 2+5
△ Arms 3+6
B11PMT02
25.0 metres
14/10/21

CIR1506/21

Cambridge WWTPR

Pressuremeter Testing




All Pressure Cells vs Time
B11PMT02
25.0 metres
14/10/21
■ TPC
• PPC A
▵ PPC B
Pressure (kPa)
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
1,300
1,400
1,500
1,600
1,700
Elapsed Time (minutes)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190

B018T01 - TEST & CALIBRATION DETAILS

[PROJECT DETAILS]

Contract name : CWW TPR

[BOREHOLE DETAILS]

Borehole : BH_TUN_006PM

[TEST DETAILS]

Test name : B018T01
Test date : 01/10/21
Depth (M) : 27.00
Material: : Gault Clay
Heading (deg) : n/a
Data Rate (secs) : 6
Start Line : 1
Stop Line : 630

[COMMENTS]

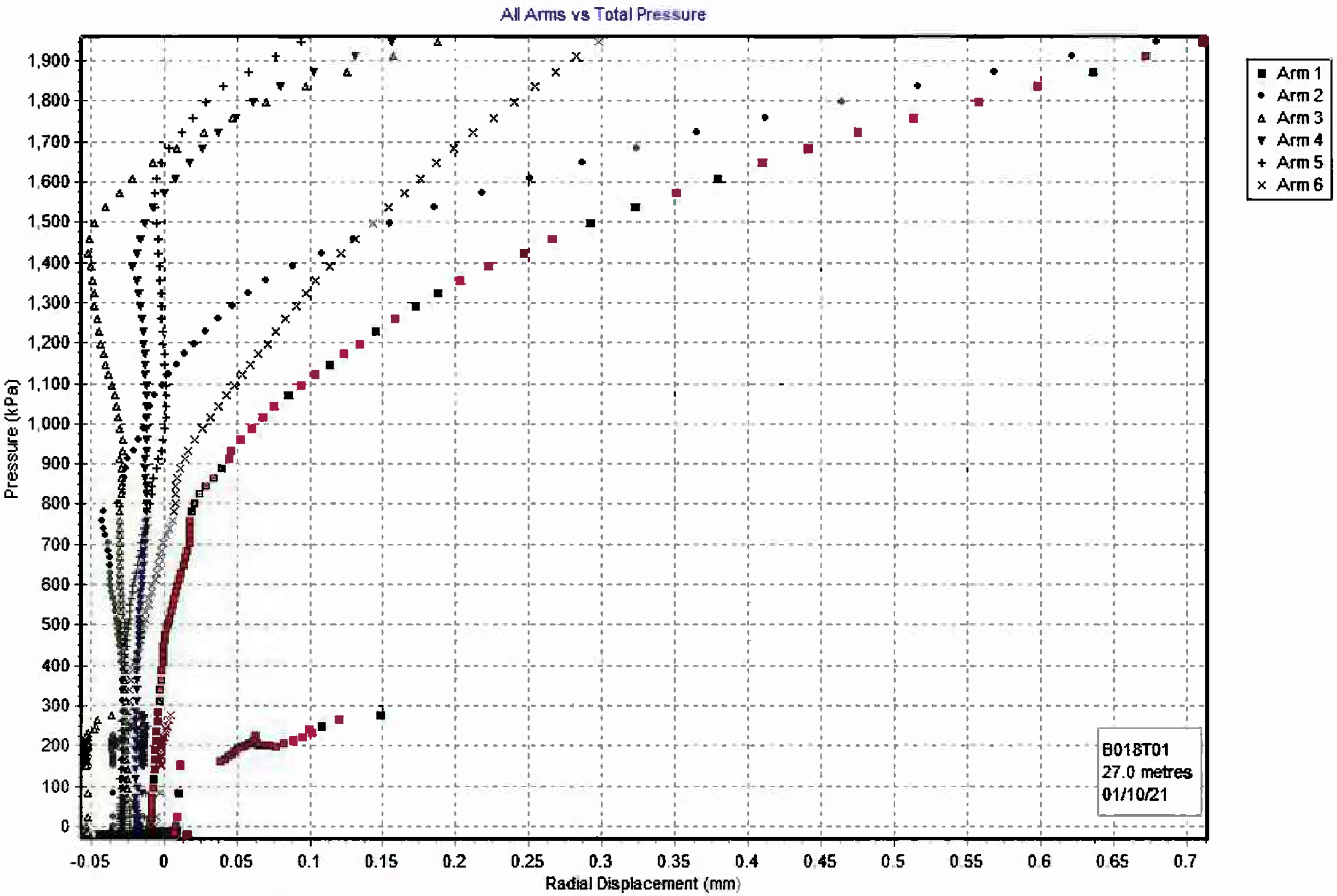
Challenging drilling. Likely washed out top of pocket resulting in burst.

[PROBE DETAILS]

Type : Digital 6 Arm Self Boring Pressuremeter
Diameter over probe : 88.10mm
Diameter under membrane : 79.15mm
CHL strip thickness : 0.5000mm

[CALIBRATION FACTORS]

	TRANSDUCERS	MEMBRANE	COMPLIANCE
ARM 1	-83.9 mV and 306.3 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
ARM 2	-930.9 mV and 326.5 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
ARM 3	-323.9 mV and 326.9 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
ARM 4	75.5 mV and 330.0 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
ARM 5	75.7 mV and 330.4 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
ARM 6	-137.3 mV and 329.0 mV/mm	17.3 kPa and 9.1 kPa/mm	3.4 mm/GPa
PPC A	-2572.5 mV and 402.4 mV/MPa		
PPC B	-2403.0 mV and 388.5 mV/MPa		
TPC	-2379.2 mV and 457.3 mV/MPa		

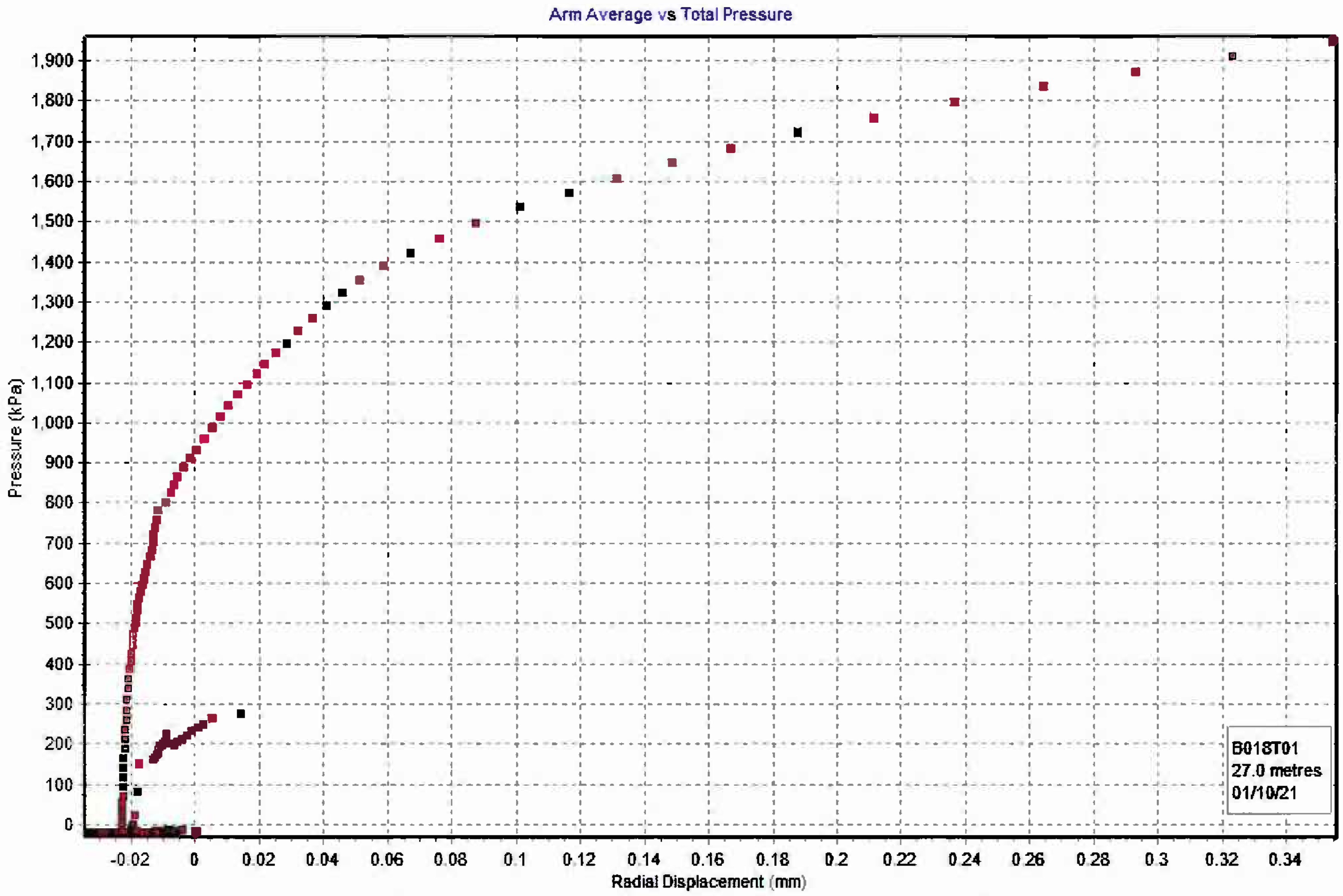


CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361

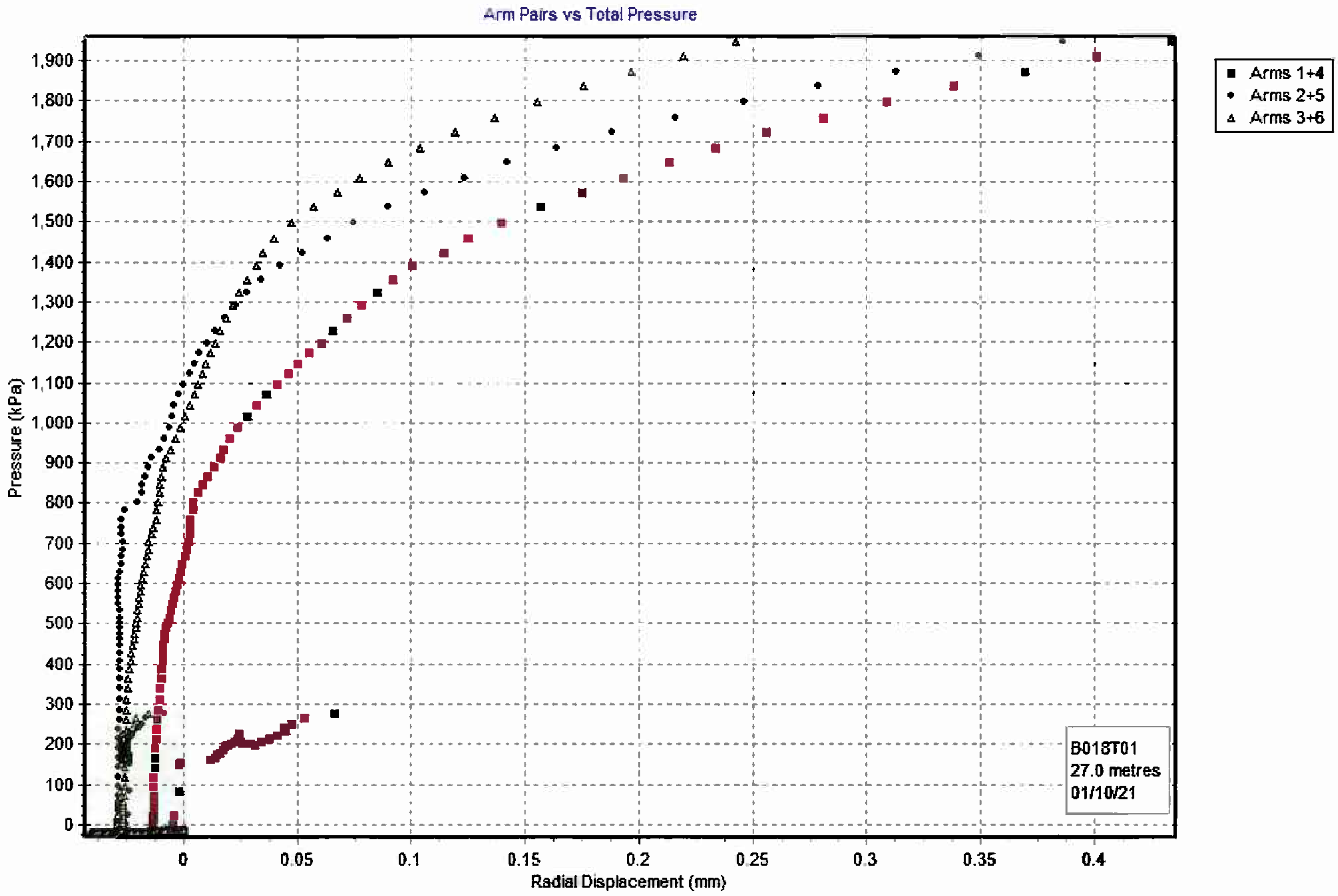
CIR1506/21

Cambridge WWTPR

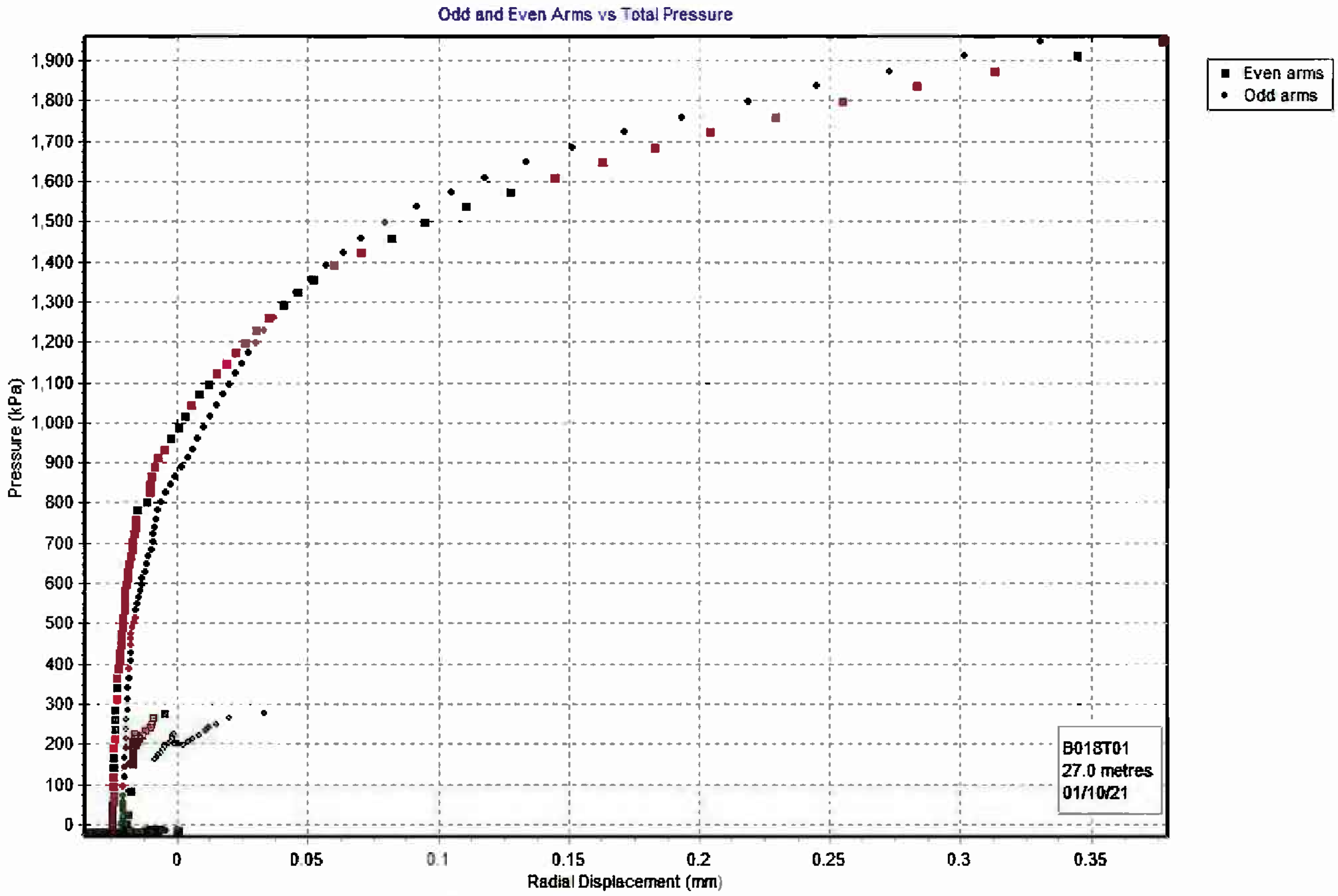
Pressuremeter Testing



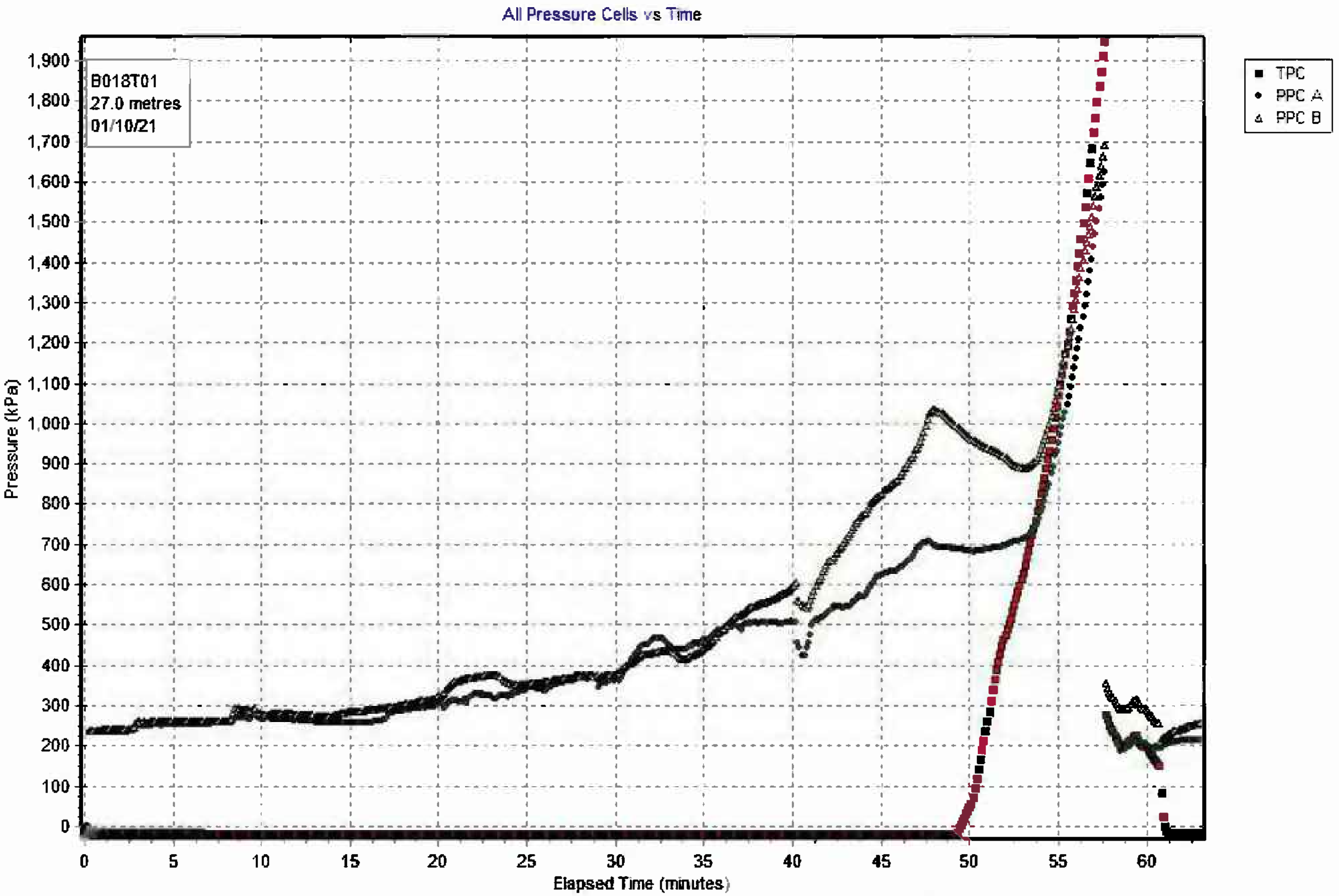
CAMBRIDGE INSITU, Little Eversden, Cambridge CB23 1HE Tel +44 (0)1223 262361



CAMBRIDGE INSITU, Little Eversden, Cambridge CB23 1HE Tel +44 (0)1223 262361



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361

B018T02 - TEST & CALIBRATION DETAILS

[PROJECT DETAILS]
Contract name : CWW TPR

[BOREHOLE DETAILS]
Borehole : BH_TUN_018PM

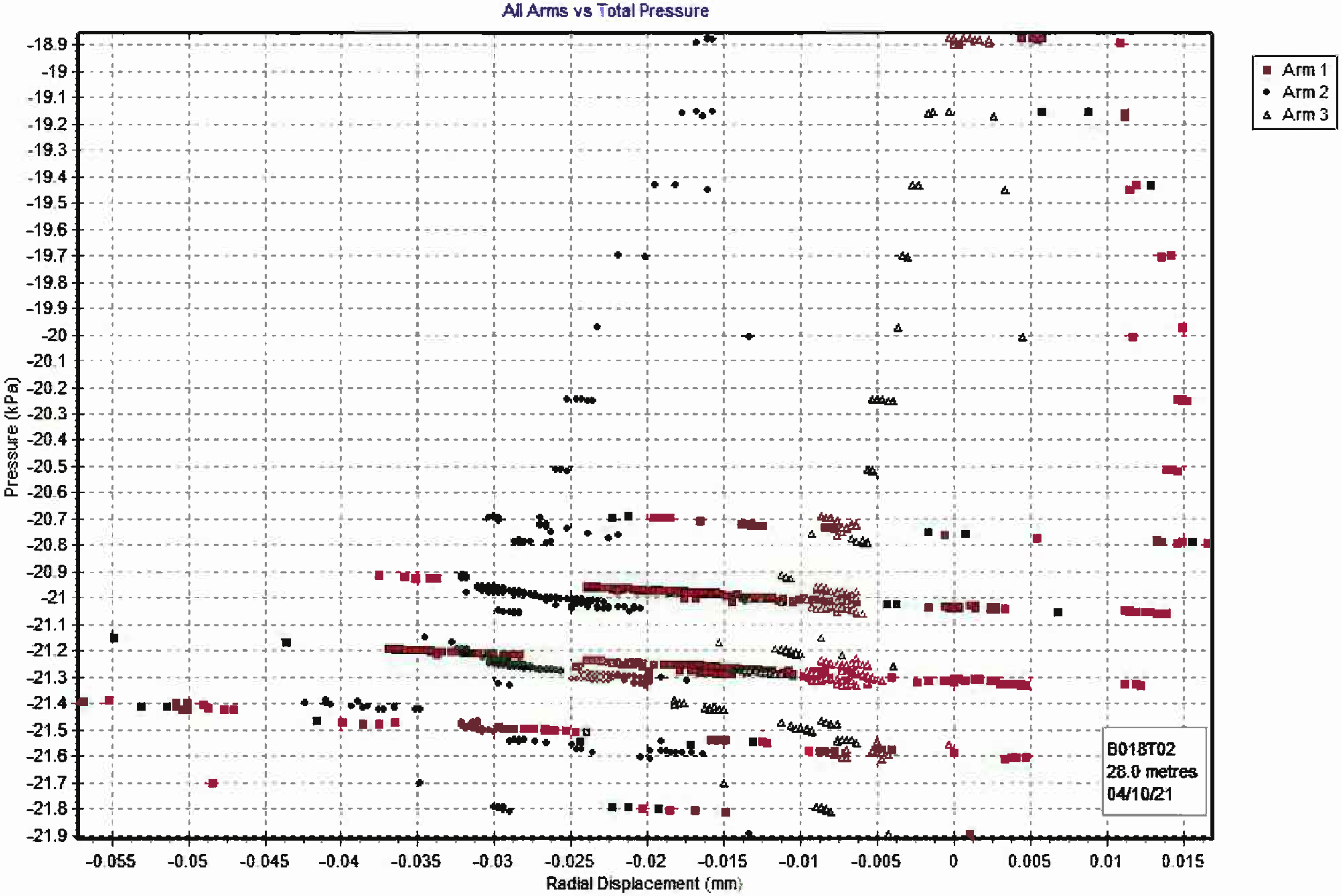
[TEST DETAILS]
Test name : B018T02
Test date : 04/10/21
Depth (M) : 28.00
Material: : Gault Clay
Heading (deg) : n/a
Data Rate (secs) : 5
Start Line : 1
Stop Line : 933

[COMMENTS]
SBP test terminated. Refusal at 0.5m.

[PROBE DETAILS]
Type : Digital 3 Arm Self Boring Pressuremeter
Diameter over probe : 88.10mm
Diameter under membrane : 79.15mm
CHL strip thickness : 0.5000mm

[CALIBRATION FACTORS]

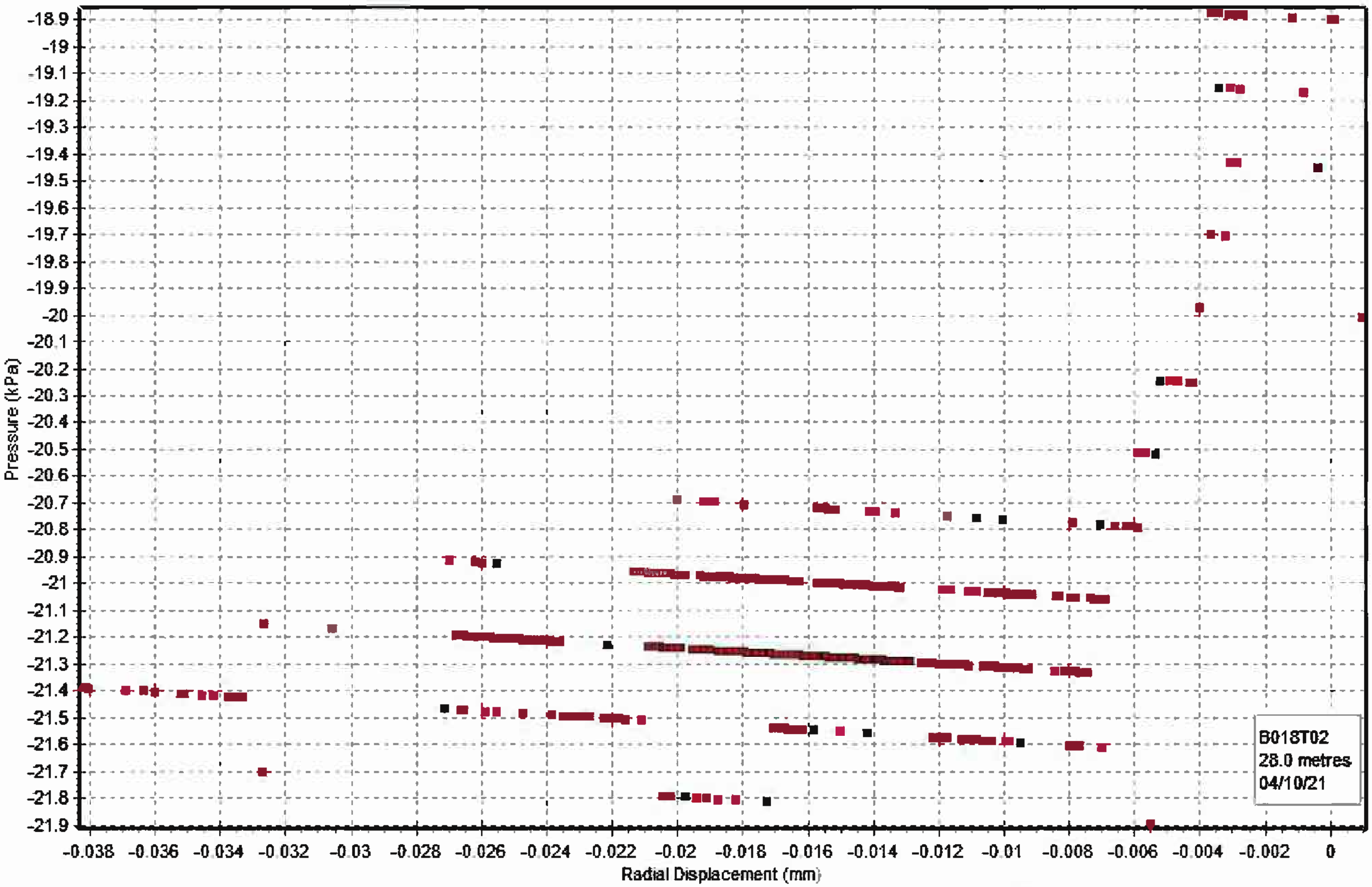
	TRANSDUCERS	MEMBRANE	COMPLIANCE
ARM 1	31.9 mV and 295.5 mV/mm	18.9 kPa and 7.1 kPa/mm	3.2 mm/GPa
ARM 2	71.3 mV and 292.7 mV/mm	18.9 kPa and 7.1 kPa/mm	3.2 mm/GPa
ARM 3	-25.6 mV and 300.5 mV/mm	18.9 kPa and 7.1 kPa/mm	3.2 mm/GPa
TPC	-2072.8 mV and 362.4 mV/MPa		
PPC A	-2133.9 mV and 430.6 mV/MPa		
PPC B	-1767.9 mV and 424.2 mV/MPa		



B018T02
28.0 metres
04/10/21

CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361

Arm Average vs Total Pressure

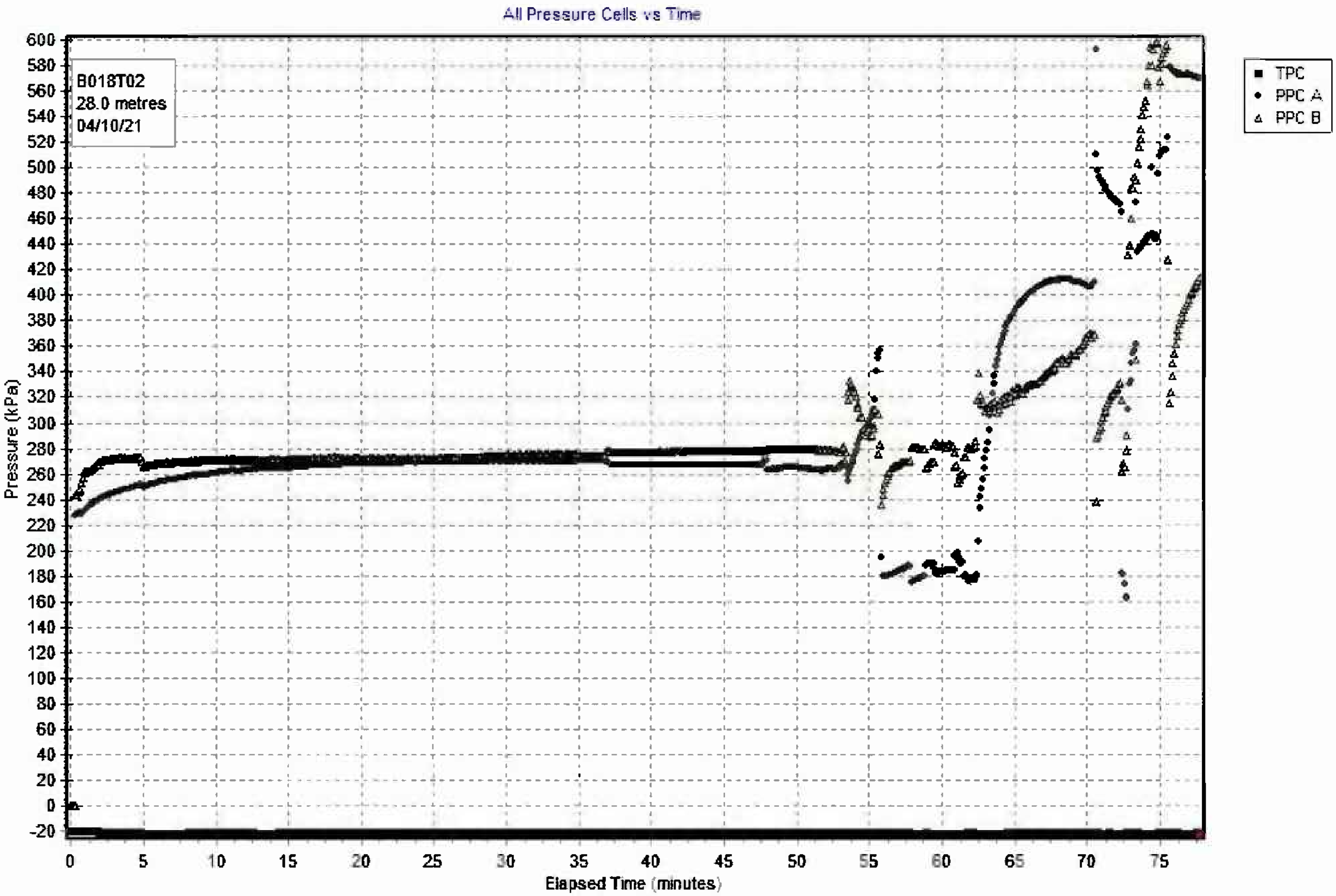


CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361

CIR1506/21

Cambridge WWTPR

Pressuremeter Testing



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361

B018T03 - TEST & CALIBRATION DETAILS

[PROJECT DETAILS]
Contract name : CWW TPR

[BOREHOLE DETAILS]
Borehole : BH_TUN_018PM

[TEST DETAILS]
Test name : B018T03
Test date : 04/10/21
Depth (M) : 28.70
Material: : Gault Clay
Heading (deg) : n/a
Data Rate (secs) : 10
Start Line : 1
Stop Line : 59

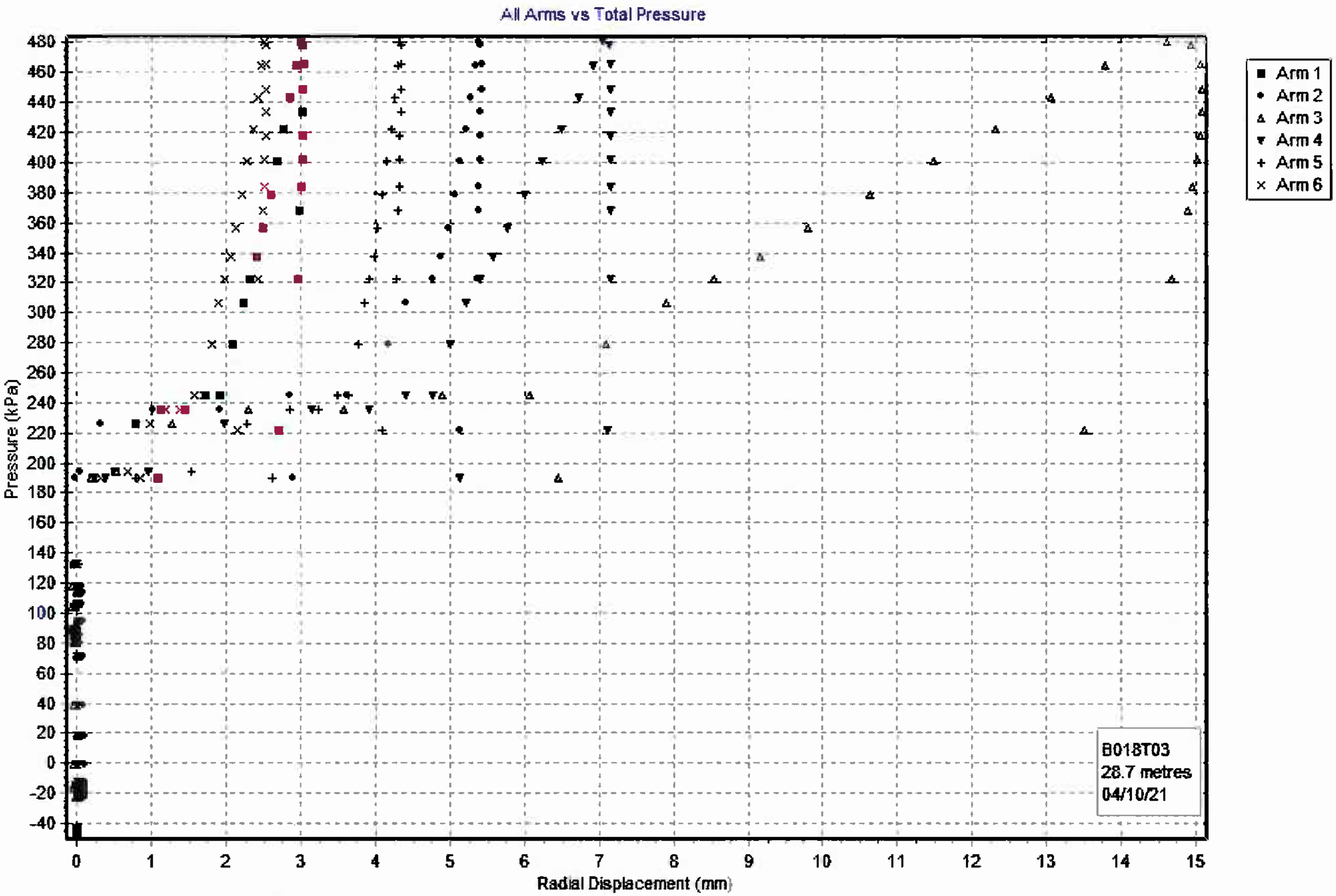
[COMMENTS]
Very stiff clay. Pocket likely had significant flush channel. No data obtained suitable for analysis

[PROBE DETAILS]
Type : Digital High Pressure Dilatometer
Diameter over probe : 97.00mm
Diameter under membrane : 81.00mm
CHL strip thickness : 1.0000mm

[CALIBRATION FACTORS]

	TRANSDUCERS	MEMBRANE	COMPLIANCE
ARM 1	-2027.6 mV and 146.0 mV/mm	43.3 kPa and 6.1 kPa/mm	3.1 mm/GPa
ARM 2	-2660.2 mV and 138.9 mV/mm	43.3 kPa and 6.1 kPa/mm	3.1 mm/GPa
ARM 3	-2305.5 mV and 146.2 mV/mm	43.3 kPa and 6.1 kPa/mm	3.1 mm/GPa
ARM 4	-2073.2 mV and 140.7 mV/mm	43.3 kPa and 6.1 kPa/mm	3.1 mm/GPa
ARM 5	-2326.9 mV and 139.3 mV/mm	43.3 kPa and 6.1 kPa/mm	3.1 mm/GPa
ARM 6	-2068.4 mV and 125.3 mV/mm	43.3 kPa and 6.1 kPa/mm	3.1 mm/GPa
TPC A	-1601.8 mV and 108.8 mV/MPa *		
TPC B	-2052.5 mV and 108.9 mV/MPa *		

[COMPASS FACTORS (units in millivolts)]
Sin Sensor : Min: -1000.0000 Max: 1000.0000
Cos Sensor : Min: -1000.0000 Max: 1000.0000

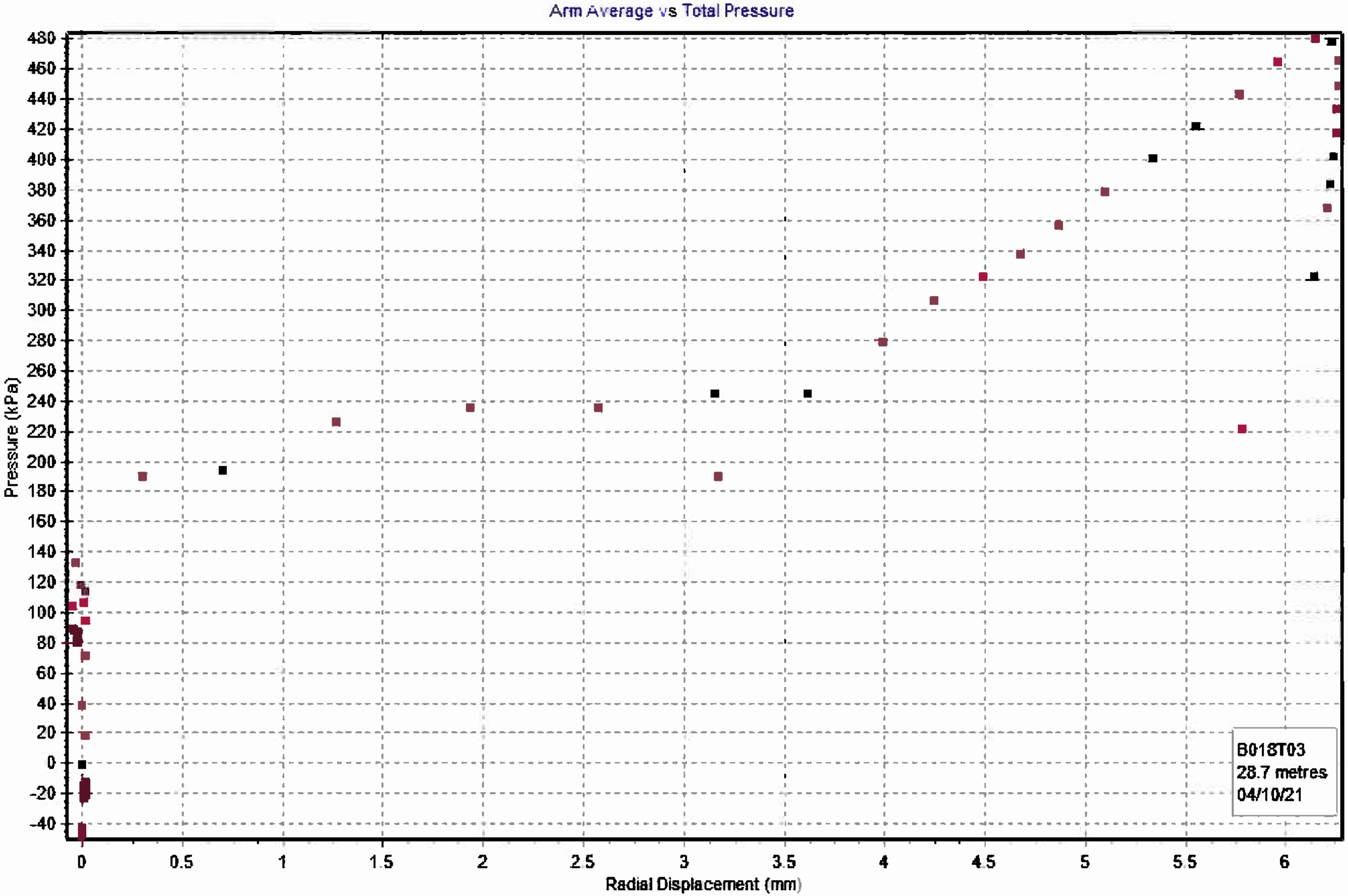


CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361

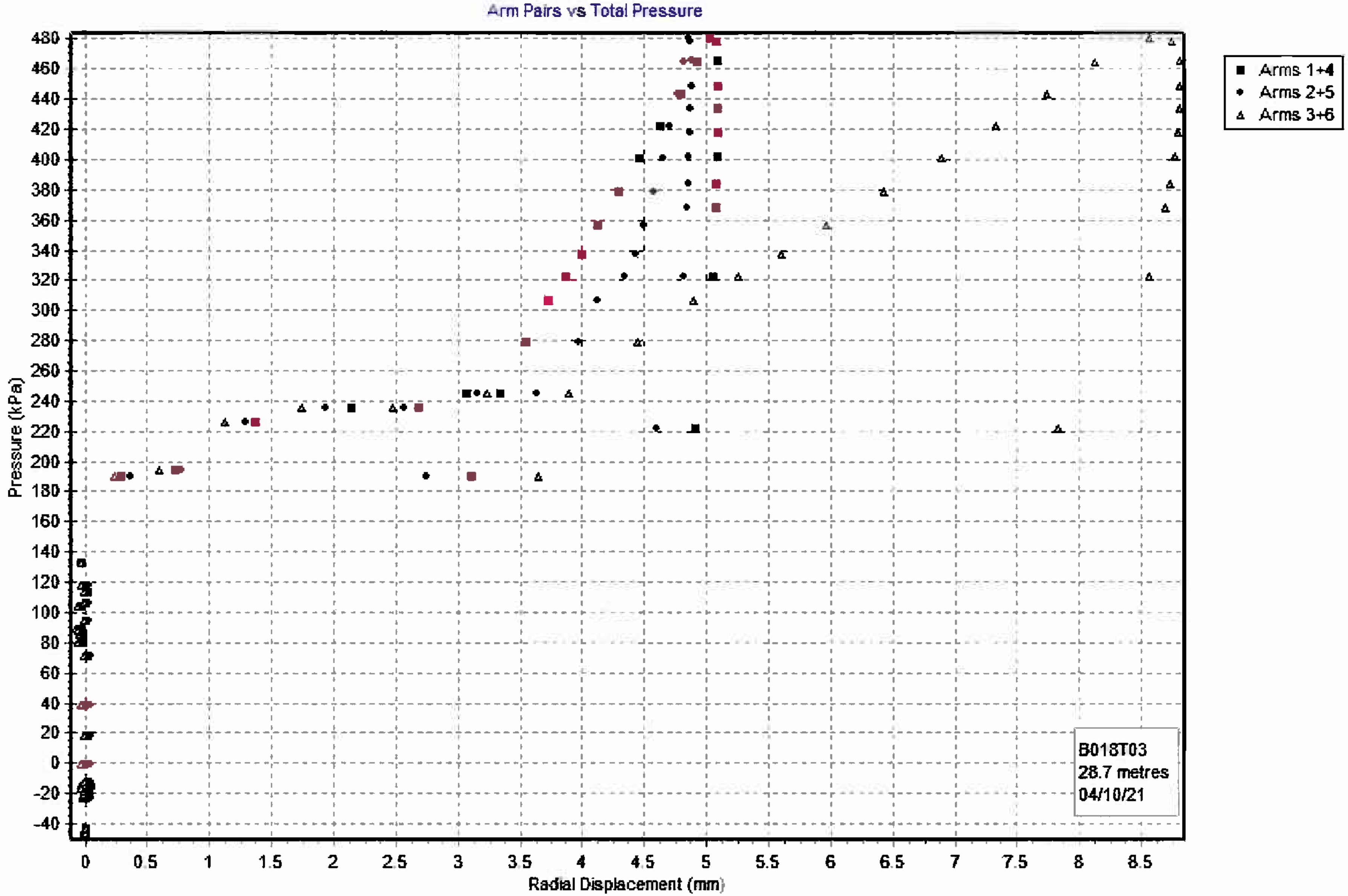
CIR1506/21

Cambridge WWTPR

Pressuremeter Testing



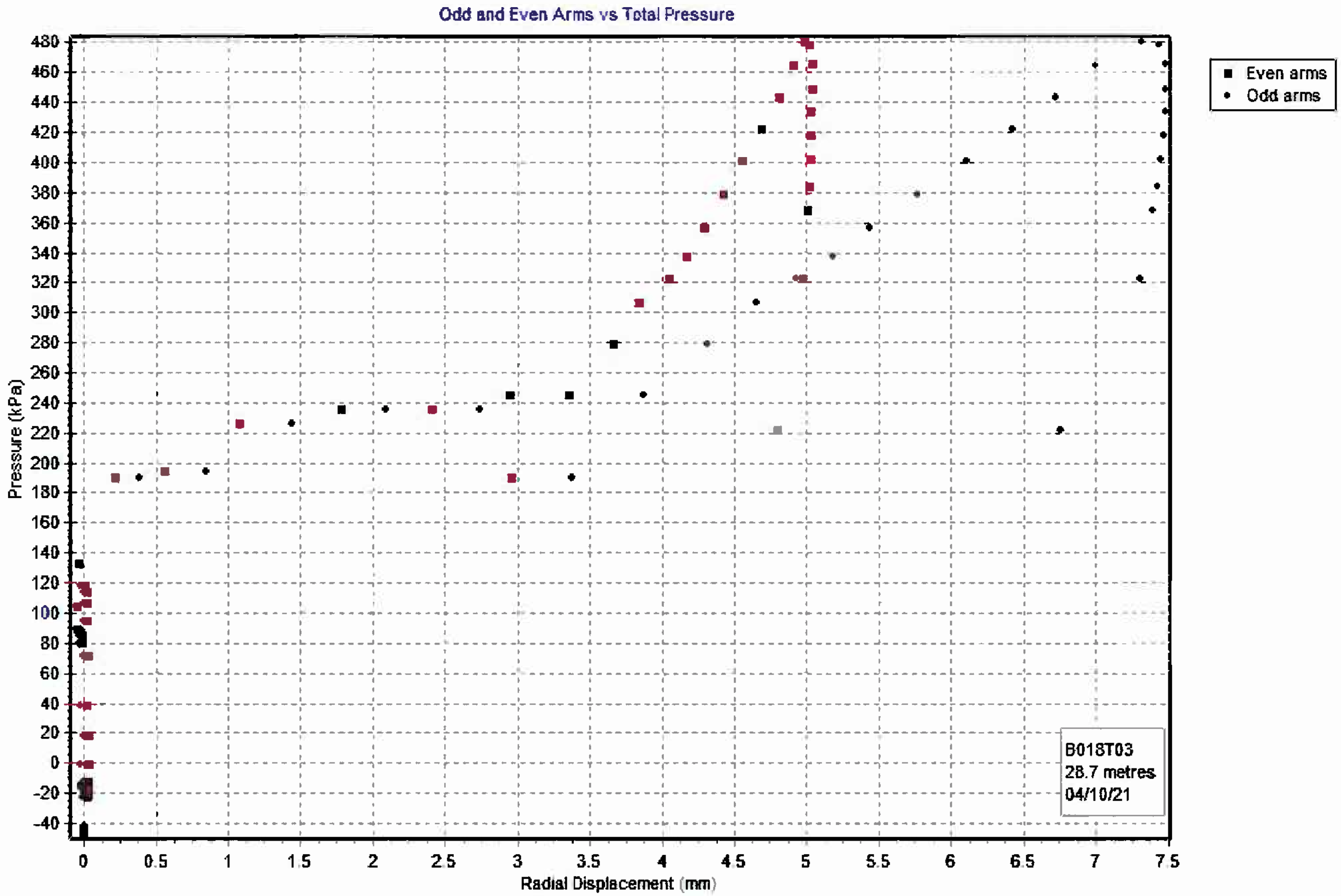
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361


Arm Pairs vs Total Pressure
Pressure (kPa)
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
-20
-40
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
Radial Displacement (mm)
■ Arms 1+4
● Arms 2+5
△ Arms 3+6
B018T03
28.7 metres
04/10/21

CIR1506/21

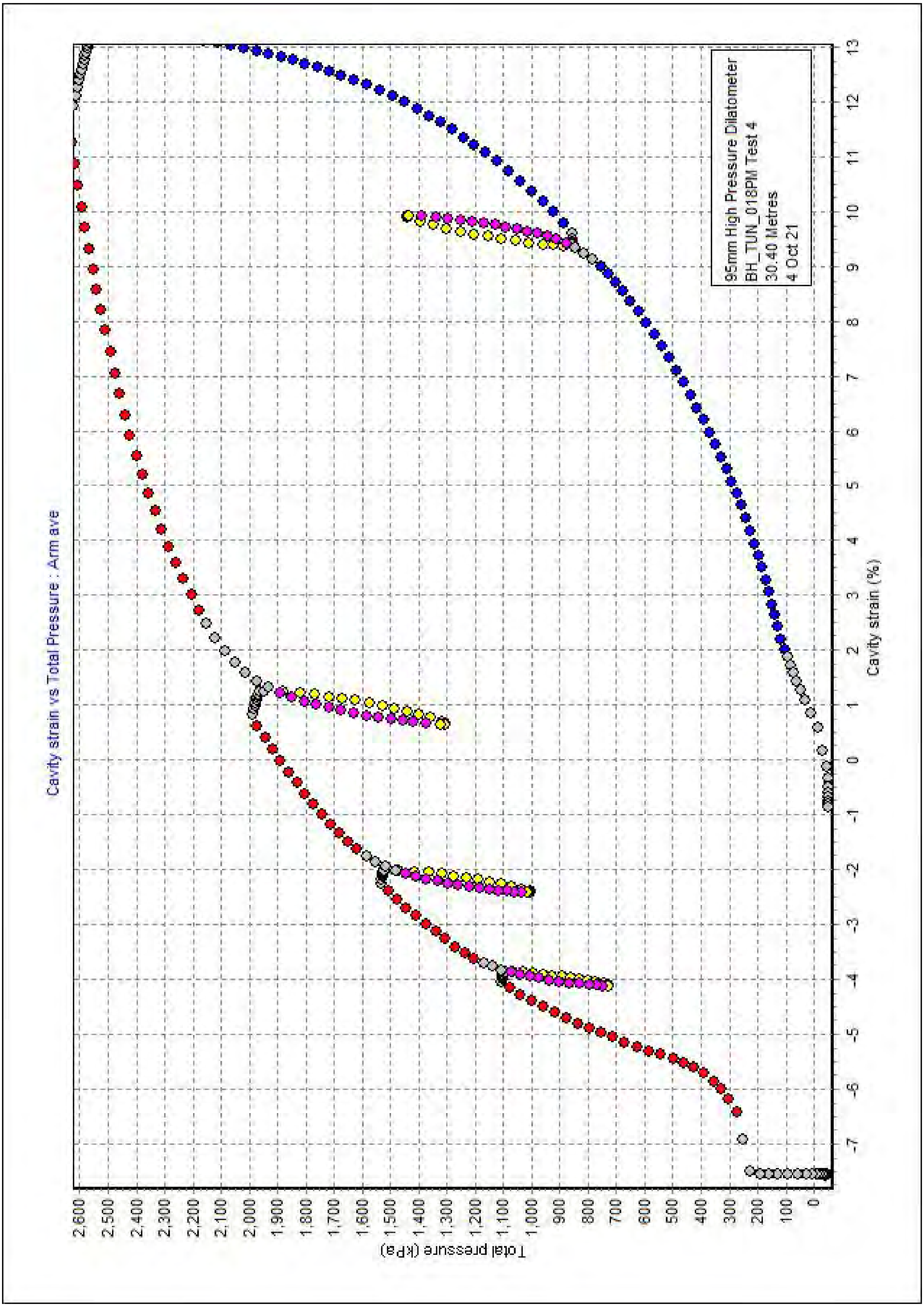
Cambridge WWTPR

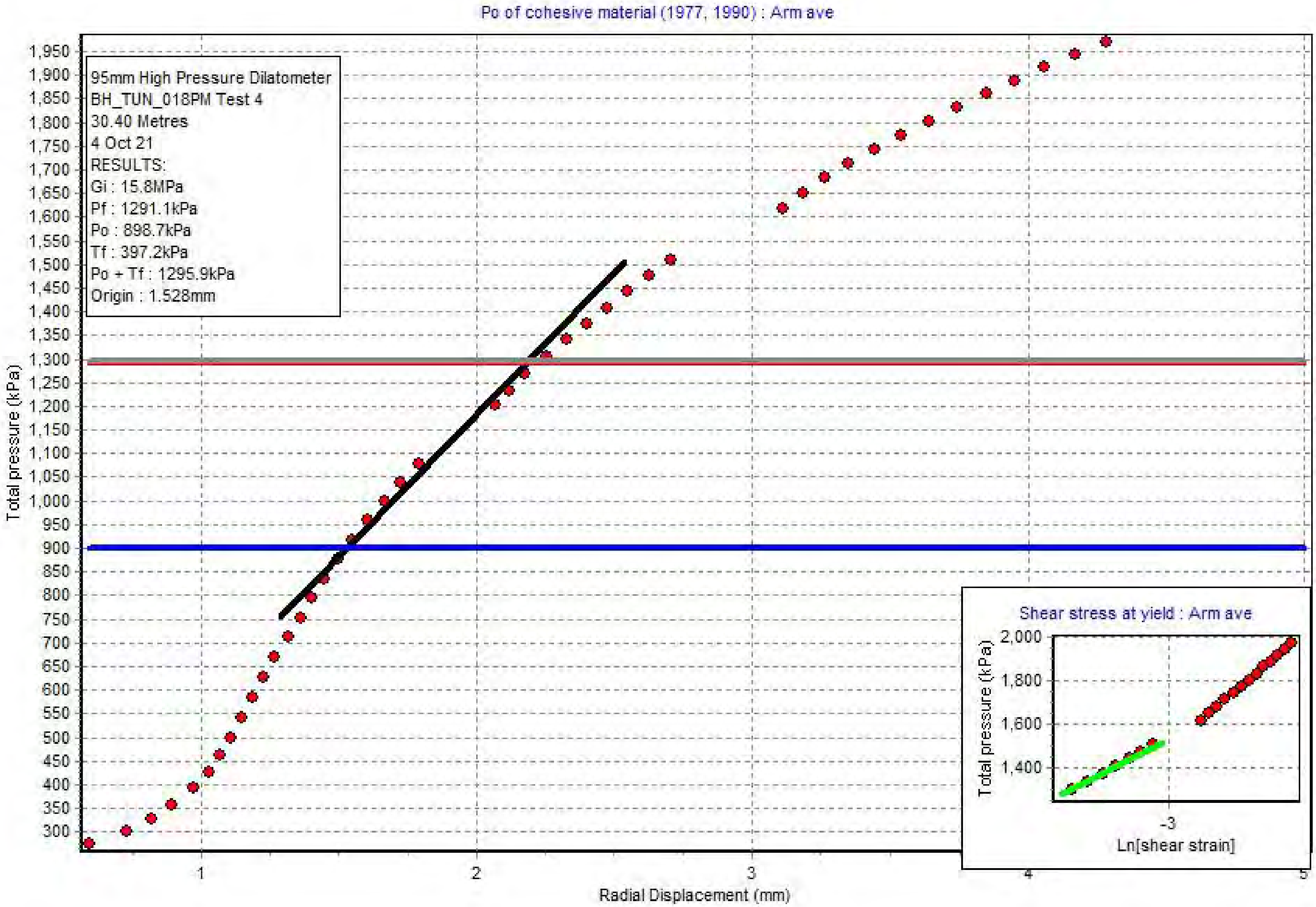
Pressuremeter Testing

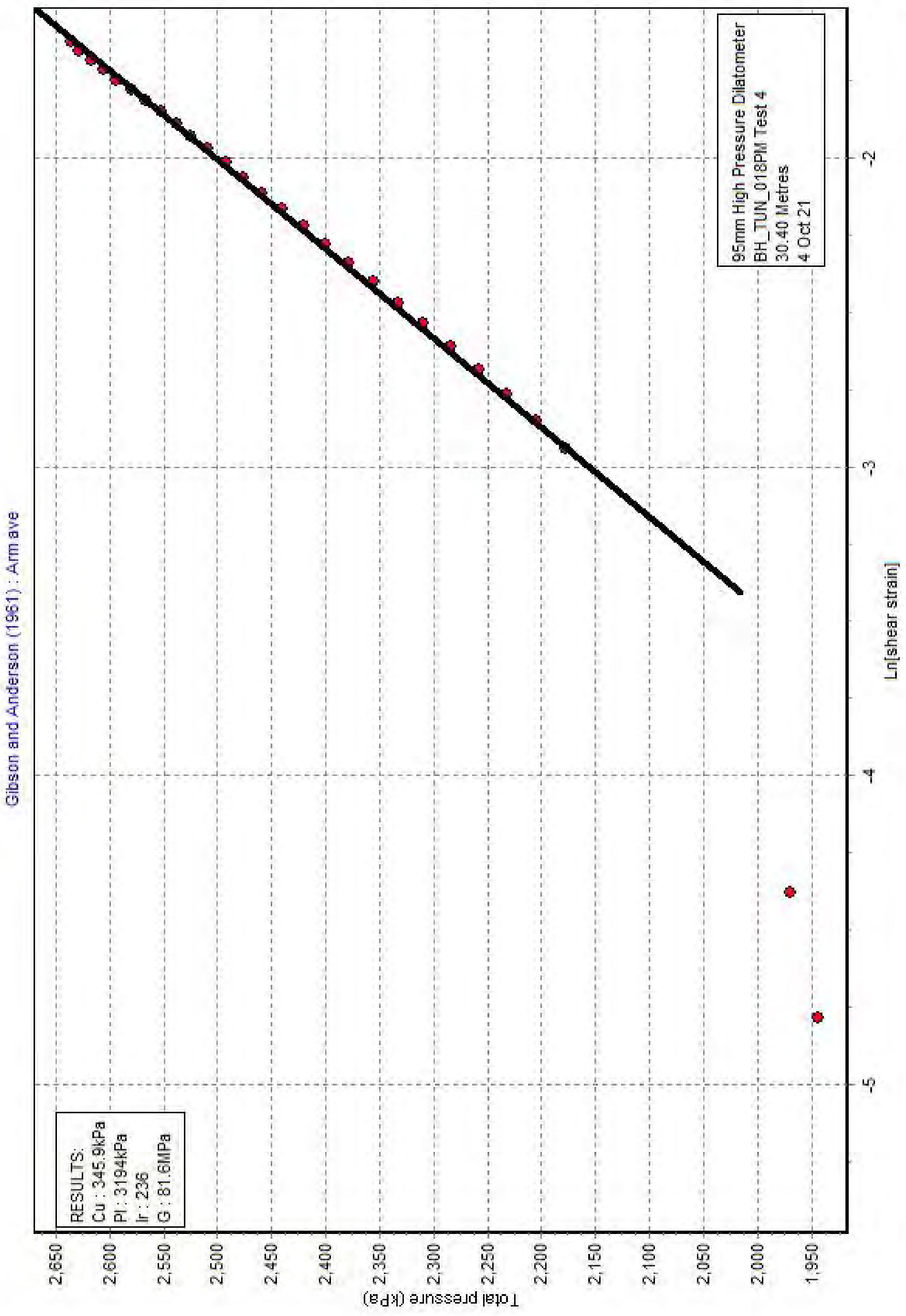


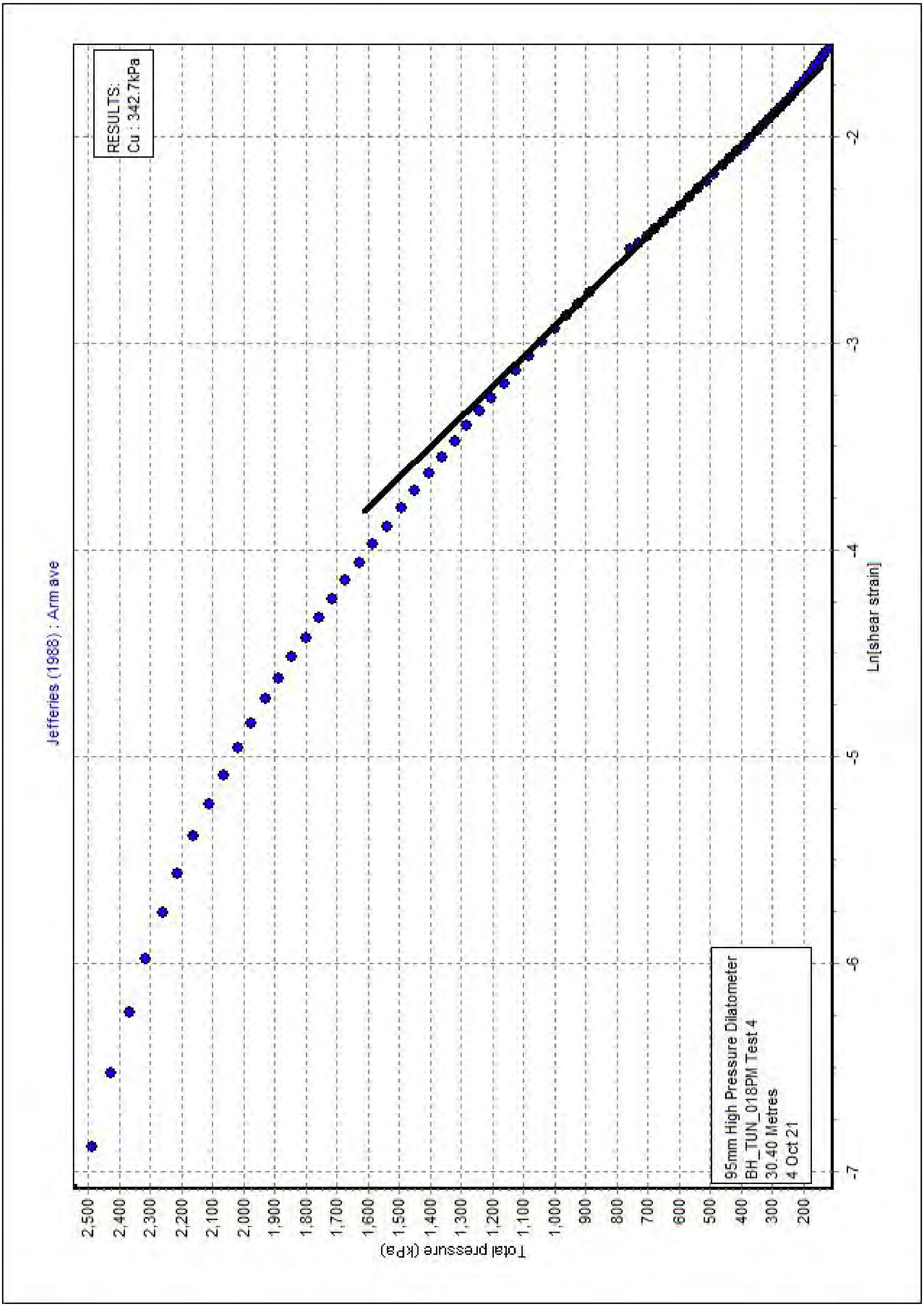
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361

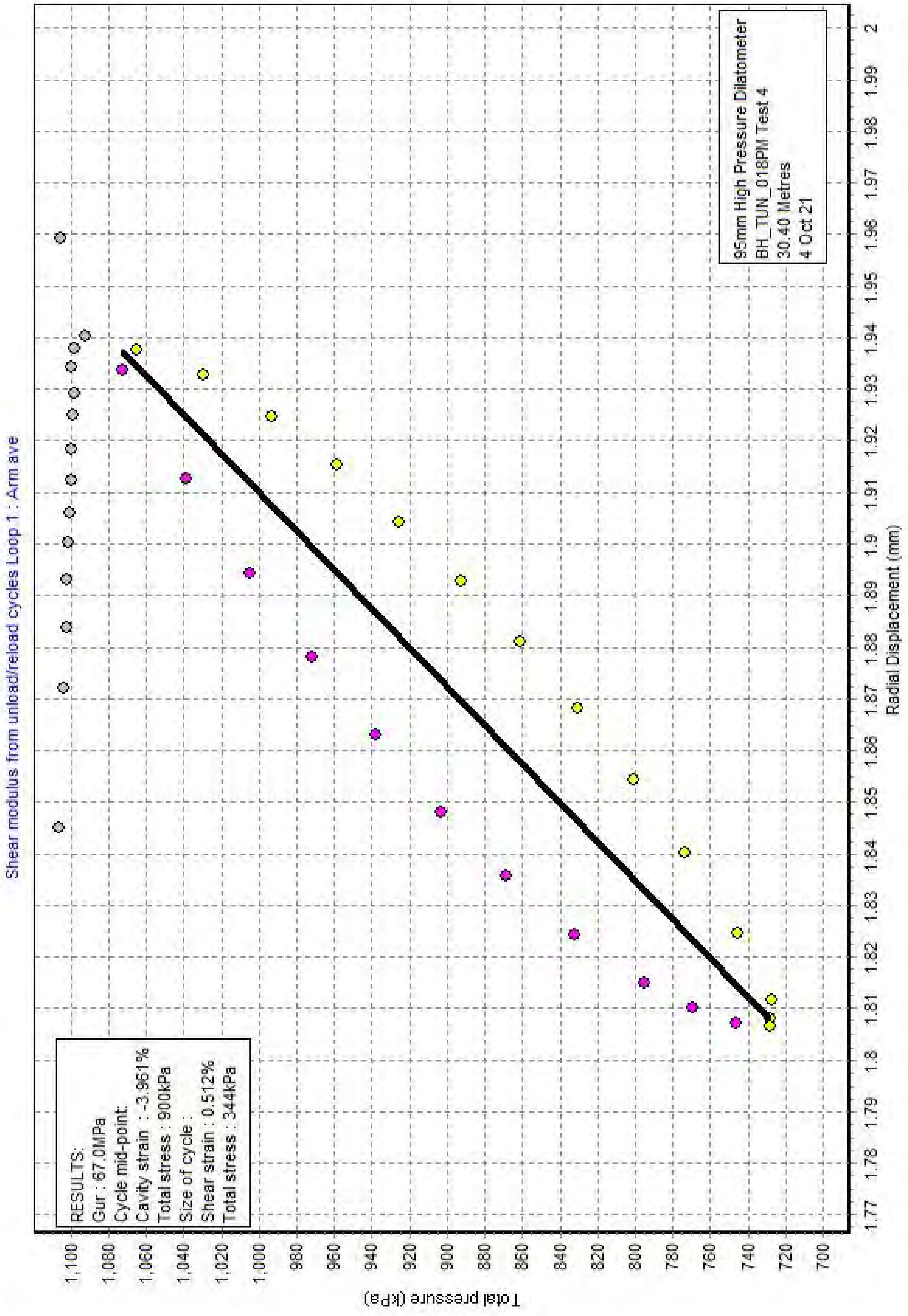
```
BH_TUN_018PM Test 4 - SUMMARY OF RESULTS
[File made with WinSitu ]

[DETAILS OF TEST]
Project        :   TE8364
Site           :   Cambridge Waste Water Treatment Plant Relocation Project
Borehole       :   BH_TUN_018PM
Test name      :   BH_TUN_018PM Test 4
Test date      :   4 Oct 21
Test depth     :   30.40 Metres
Water table    :   4 Metres
Ambient PWP    :   259.0 kPa
Material       :   Gault Clay
Probe          :   95mm High Pressure Dilatometer
Diameter       :   97.0 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out
The file includes results from a curve fitting analysis

Analysed by YB / ES / RW on 5 Oct 21

Remarks:

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm)                  :   "Arm ave=3.95"
Po from Marsland & Randolph (kPa)   :   "Arm ave=898.7"
Best estimate of Po (kPa)           :   "Arm ave=958.0"

[UNDRAINED STRENGTH PARAMETERS]
Gibson & Anderson 1961 - Cu (kPa)   :   "Arm ave=345.9"
Limit pressure (kPa)                :   "Arm ave=3194"
Jefferies 1988 - Cu (kPa)           :   "Arm ave=342.7"
Undrained yield stress (kPa)        :   "Arm ave=1291.1"

[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=15.8"
Axis       Loop   Value    Mean Strain  Mean Pc  dE      dPc
           No     (MPa)    (%)          (kPa)    (%)     (kPa)
Arm ave    1      67.0     -3.961       900      0.512   344
Arm ave    2      55.9     -2.201       1222     0.761   427
Arm ave    3      50.5     0.969        1596     1.140   579
Arm ave    4      57.0     9.675        1163     0.968   554

[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]
Axis       Loop   Intercept  Alpha      Gradient
           No     (MPa)      (MPa)
Arm ave    1      8.751      5.345      0.611
Arm ave    2      9.397      5.786      0.616
Arm ave    3      9.238      5.614      0.608
Arm ave    4      10.640     6.548      0.615


[PARAMETERS USED FOR UNDRAINED CURVE MODELLING]
{Axis is  Arm ave}
Strain Origin (mm)                  :   3.95
Po (kPa)                            :   958
Cu (kPa)                            :   345.9
Limit pressure (kPa)                :   3194
Non-linear exponent                 :   0.608
Calculated alpha (MPa)              :   6.476
G at yield (MPa)                    :   42.8
```

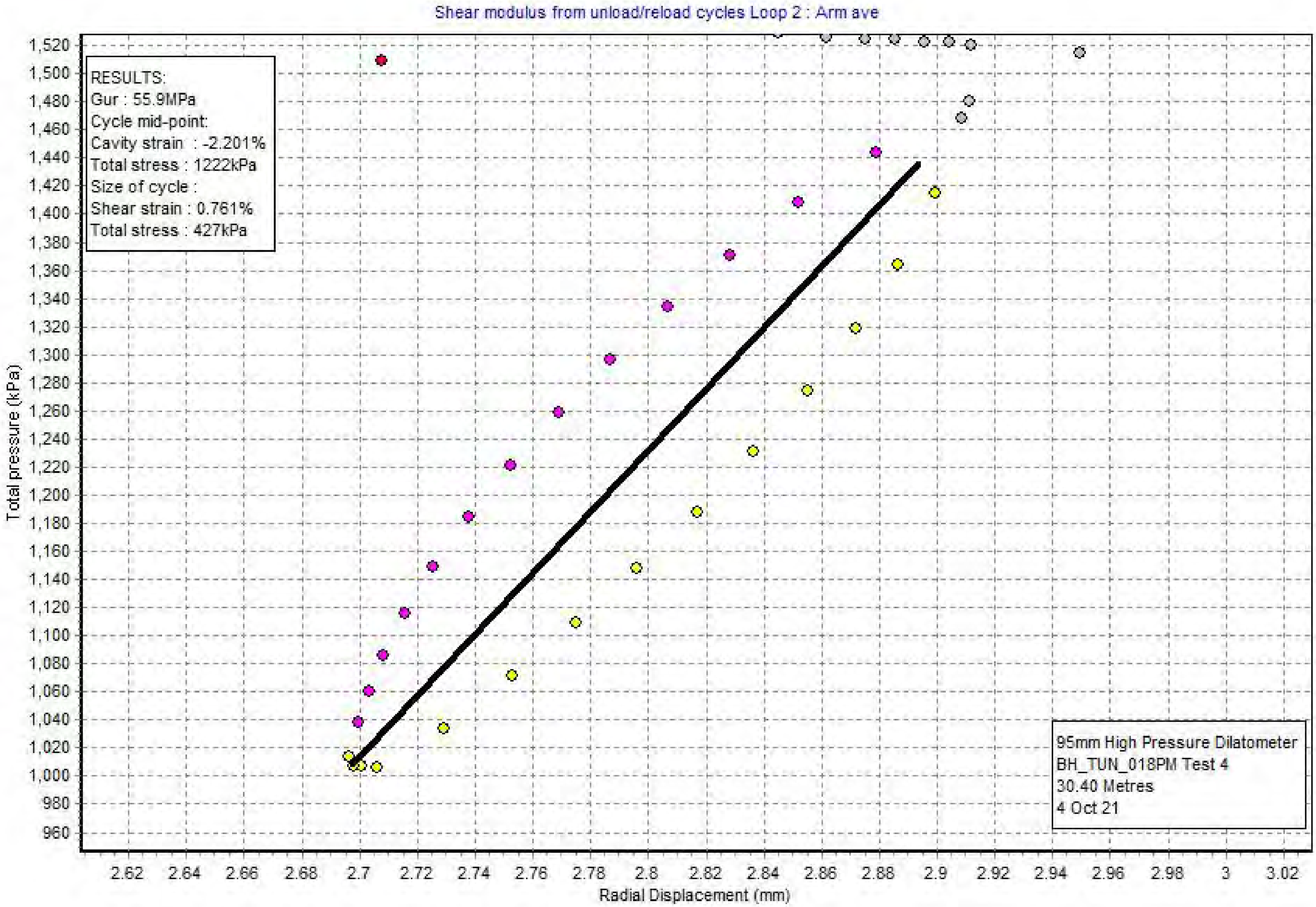

Cavity strain vs Total Pressure : Arm ave
95mm High Pressure Dilatometer
BH_TUN_018PM Test 4
30.40 Metres
4 Oct 21
Total pressure (kPa)
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
1,300
1,400
1,500
1,600
1,700
1,800
1,900
2,000
2,100
2,200
2,300
2,400
2,500
2,600
Cavity strain (%)
-7
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
13

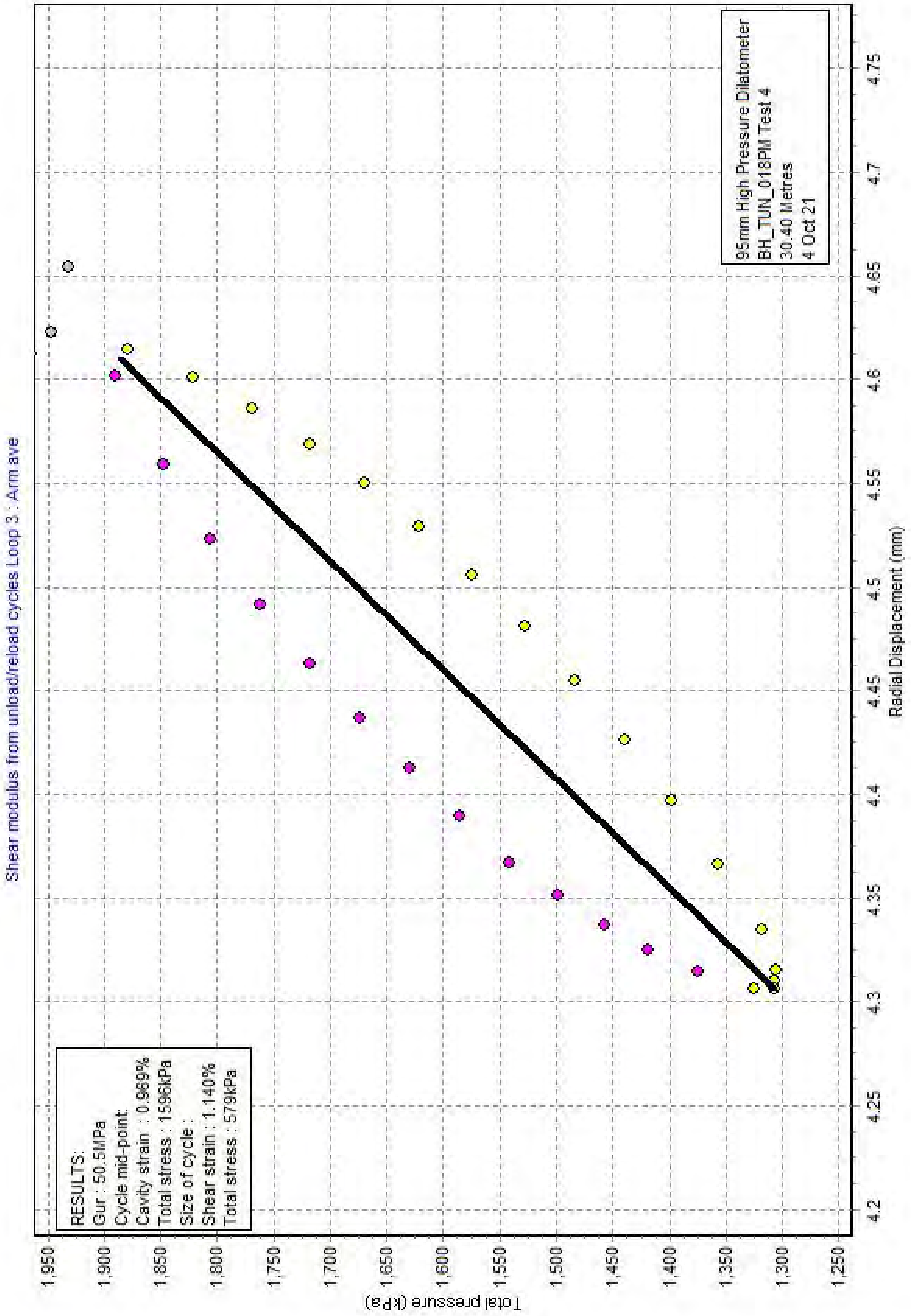

Po of cohesive material (1977, 1990) : Arm ave
95mm High Pressure Dilatometer
BH_TUN_018PM Test 4
30.40 Metres
4 Oct 21
RESULTS:
Gi : 15.8MPa
Pf : 1291.1kPa
Po : 898.7kPa
Tf : 397.2kPa
Po + Tf : 1295.9kPa
Origin : 1.528mm
Total pressure (kPa)
1,950
1,900
1,850
1,800
1,750
1,700
1,650
1,600
1,550
1,500
1,450
1,400
1,350
1,300
1,250
1,200
1,150
1,100
1,050
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
1
2
3
4
5
Radial Displacement (mm)
Shear stress at yield : Arm ave
Total pressure (kPa)
2,000
1,800
1,600
1,400
-3
Ln[shear strain]

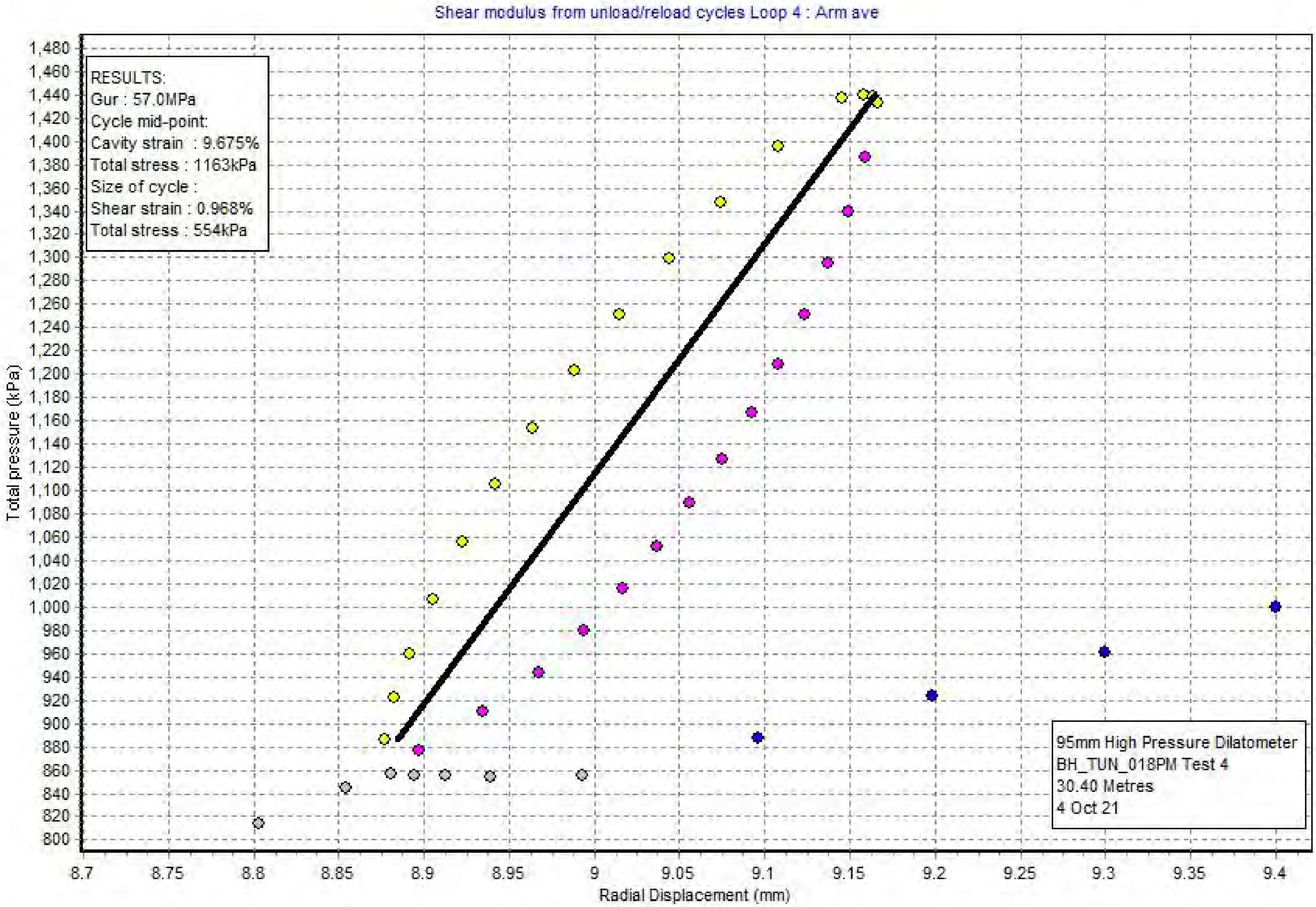

Gibson and Anderson (1961) : Arm ave
95mm High Pressure Dilatometer
BH_TUN_018PM Test 4
30.40 Metres
4 Oct 21
RESULTS:
Cu : 345.9kPa
Pl : 3194kPa
Ir : 236
G : 81.6MPa
Total pressure (kPa)
2,650
2,600
2,550
2,500
2,450
2,400
2,350
2,300
2,250
2,200
2,150
2,100
2,050
2,000
1,950
Ln[shear strain]
-5
-4
-3
-2

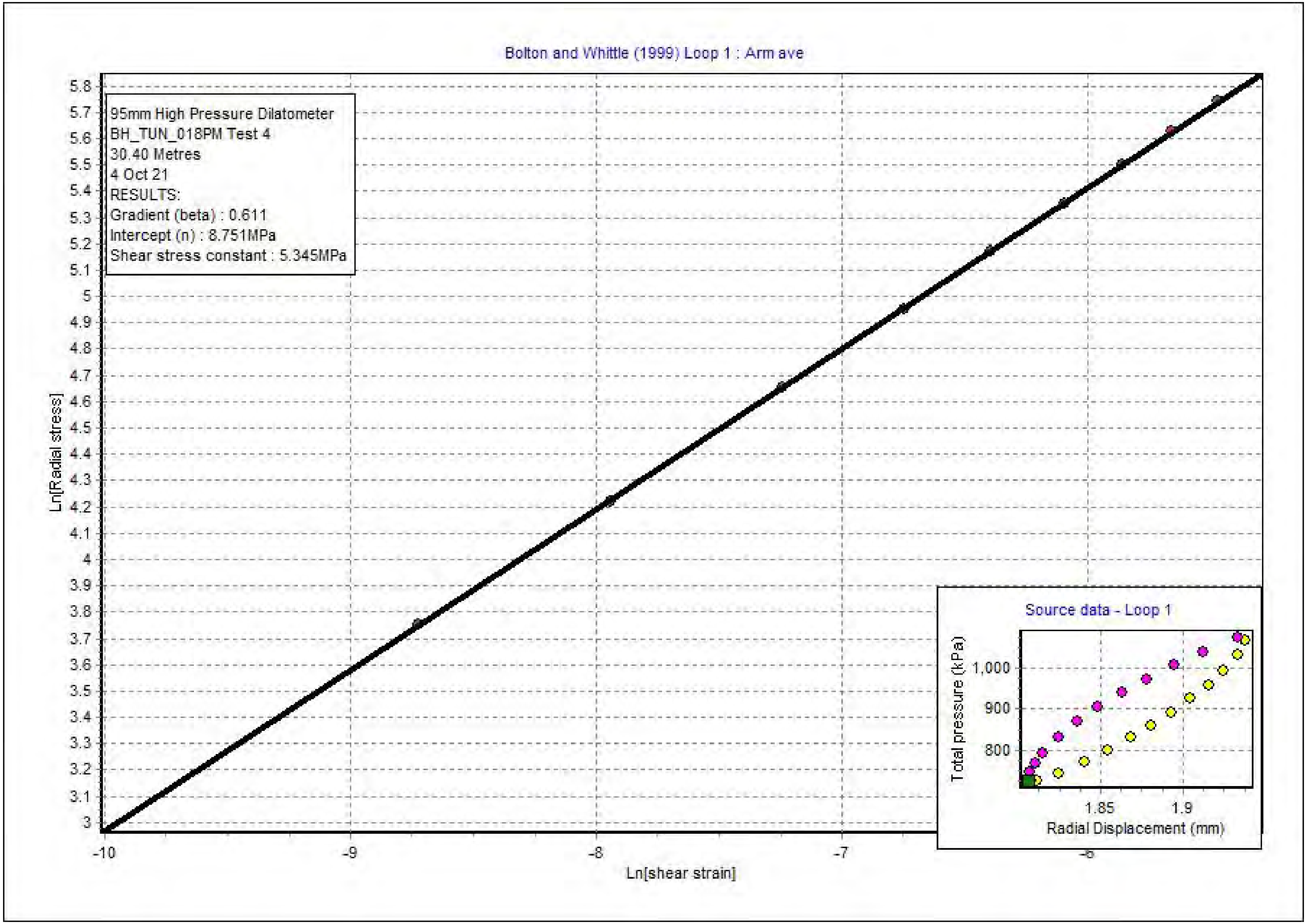

Jefferies (1988) : Arm ave
RESULTS:
Cu : 342.7kPa
95mm High Pressure Dilatometer
BH_TUN_018PM Test 4
30.40 Metres
4 Oct 21
Total pressure (kPa)
2,500
2,400
2,300
2,200
2,100
2,000
1,900
1,800
1,700
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
Ln[shear strain]
-7
-6
-5
-4
-3
-2


Shear modulus from unload/reload cycles Loop 1 : Arm ave
RESULTS:
Gur : 67.0MPa
Cycle mid-point:
Cavity strain : -3.961%
Total stress : 900kPa
Size of cycle :
Shear strain : 0.512%
Total stress : 344kPa
95mm High Pressure Dilatometer
BH_TUN_018PM Test 4
30.40 Metres
4 Oct 21
Total pressure (kPa)
1,100
1,080
1,060
1,040
1,020
1,000
980
960
940
920
900
880
860
840
820
800
780
760
740
720
700
Radial Displacement (mm)
1.77
1.78
1.79
1.8
1.81
1.82
1.83
1.84
1.85
1.86
1.87
1.88
1.89
1.9
1.91
1.92
1.93
1.94
1.95
1.96
1.97
1.98
1.99
2


Shear modulus from unload/reload cycles Loop 2 : Arm ave
RESULTS:
Gur : 55.9MPa
Cycle mid-point:
Cavity strain : -2.201%
Total stress : 1222kPa
Size of cycle :
Shear strain : 0.761%
Total stress : 427kPa
95mm High Pressure Dilatometer
BH_TUN_018PM Test 4
30.40 Metres
4 Oct 21
Total pressure (kPa)
1,520
1,500
1,480
1,460
1,440
1,420
1,400
1,380
1,360
1,340
1,320
1,300
1,280
1,260
1,240
1,220
1,200
1,180
1,160
1,140
1,120
1,100
1,080
1,060
1,040
1,020
1,000
980
960
Radial Displacement (mm)
2.62
2.64
2.66
2.68
2.7
2.72
2.74
2.76
2.78
2.8
2.82
2.84
2.86
2.88
2.9
2.92
2.94
2.96
2.98
3
3.02

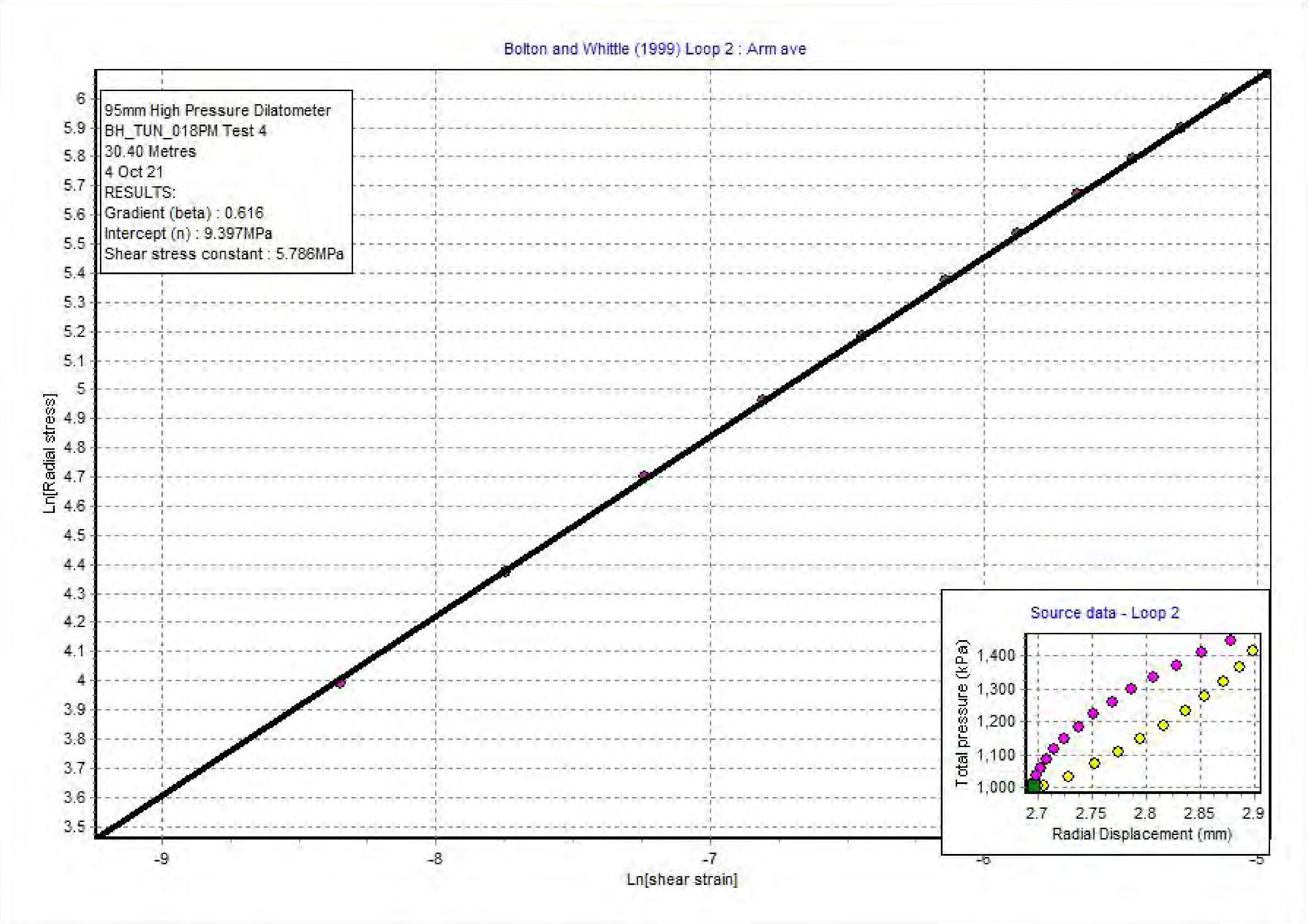

Shear modulus from unload/reload cycles Loop 3 : Arm ave
95mm High Pressure Dilatometer
BH_TUN_018PM Test 4
30.40 Metres
4 Oct 21
RESULTS:
Gur : 50.5MPa
Cycle mid-point:
Cavity strain : 0.969%
Total stress : 1596kPa
Size of cycle :
Shear strain : 1.140%
Total stress : 579kPa
Radial Displacement (mm)
4.2
4.25
4.3
4.35
4.4
4.45
4.5
4.55
4.6
4.65
4.7
4.75
Total pressure (kPa)
1,250
1,300
1,350
1,400
1,450
1,500
1,550
1,600
1,650
1,700
1,750
1,800
1,850
1,900
1,950

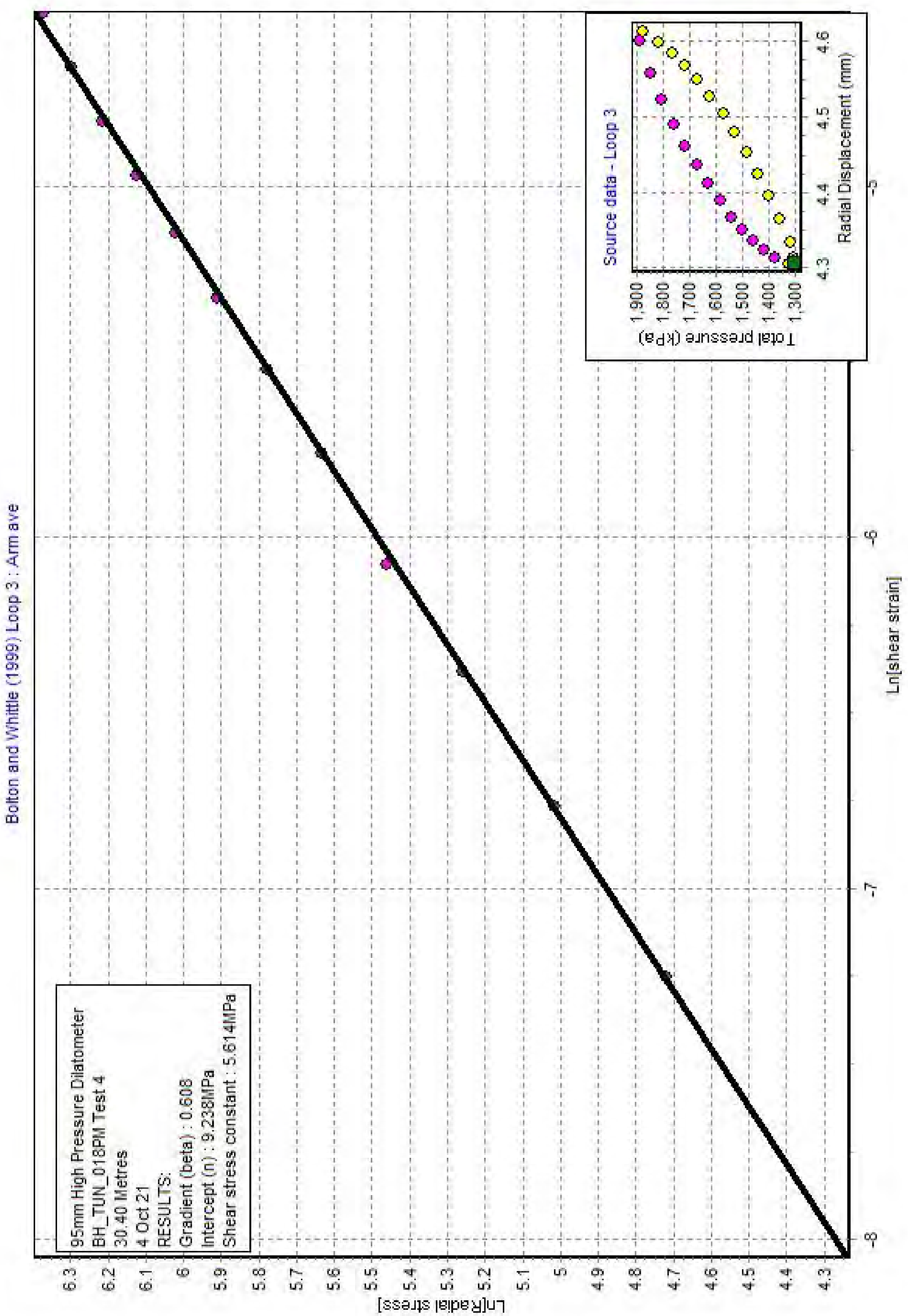

Shear modulus from unload/reload cycles Loop 4 : Arm ave
RESULTS:
Gur : 57.0MPa
Cycle mid-point:
Cavity strain : 9.675%
Total stress : 1163kPa
Size of cycle :
Shear strain : 0.968%
Total stress : 554kPa
95mm High Pressure Dilatometer
BH_TUN_018PM Test 4
30.40 Metres
4 Oct 21
Total pressure (kPa)
1,480
1,460
1,440
1,420
1,400
1,380
1,360
1,340
1,320
1,300
1,280
1,260
1,240
1,220
1,200
1,180
1,160
1,140
1,120
1,100
1,080
1,060
1,040
1,020
1,000
980
960
940
920
900
880
860
840
820
800
Radial Displacement (mm)
8.7
8.75
8.8
8.85
8.9
8.95
9
9.05
9.1
9.15
9.2
9.25
9.3
9.35
9.4



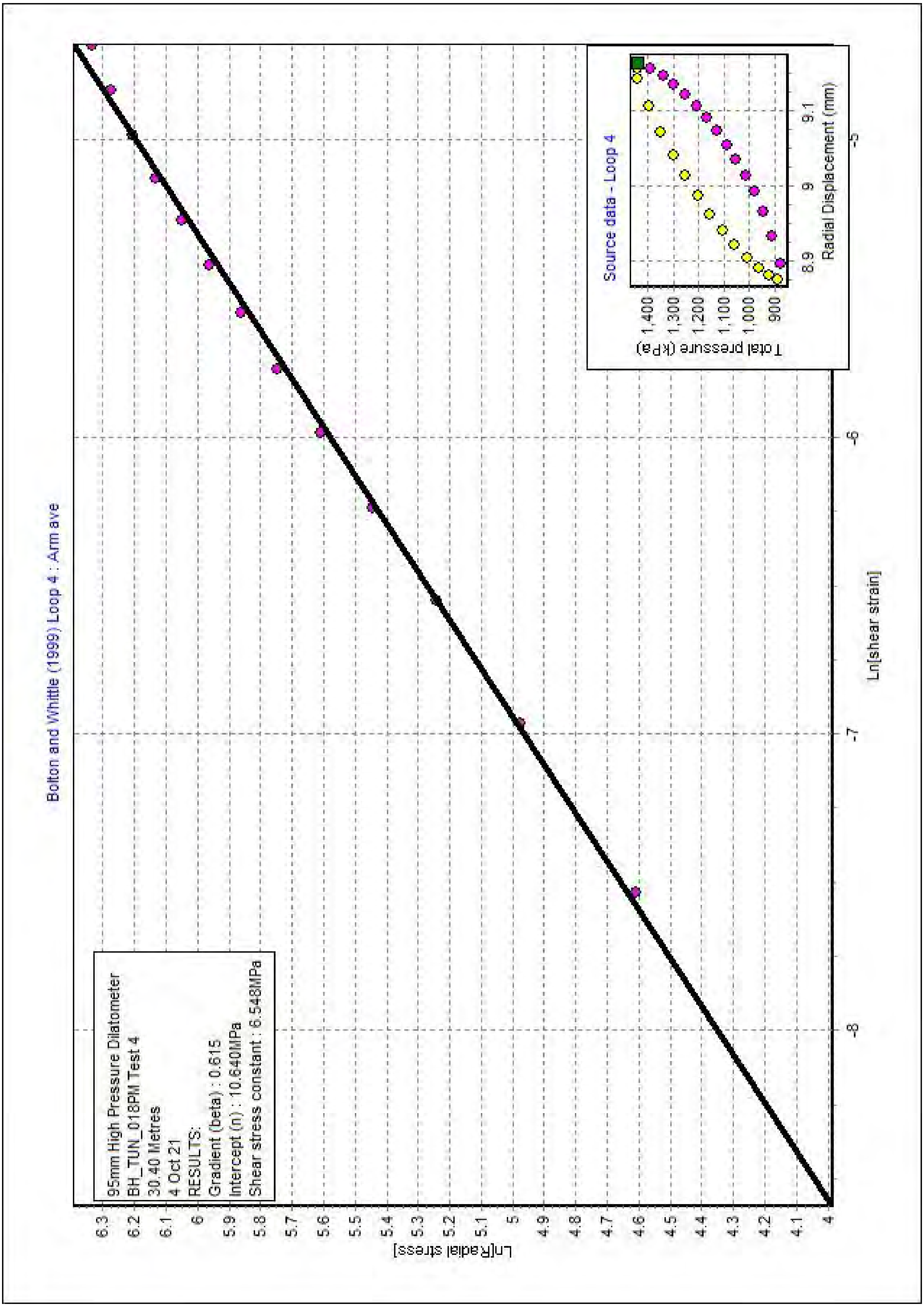
Bolton and Whittle (1999) Loop 1 : Arm ave

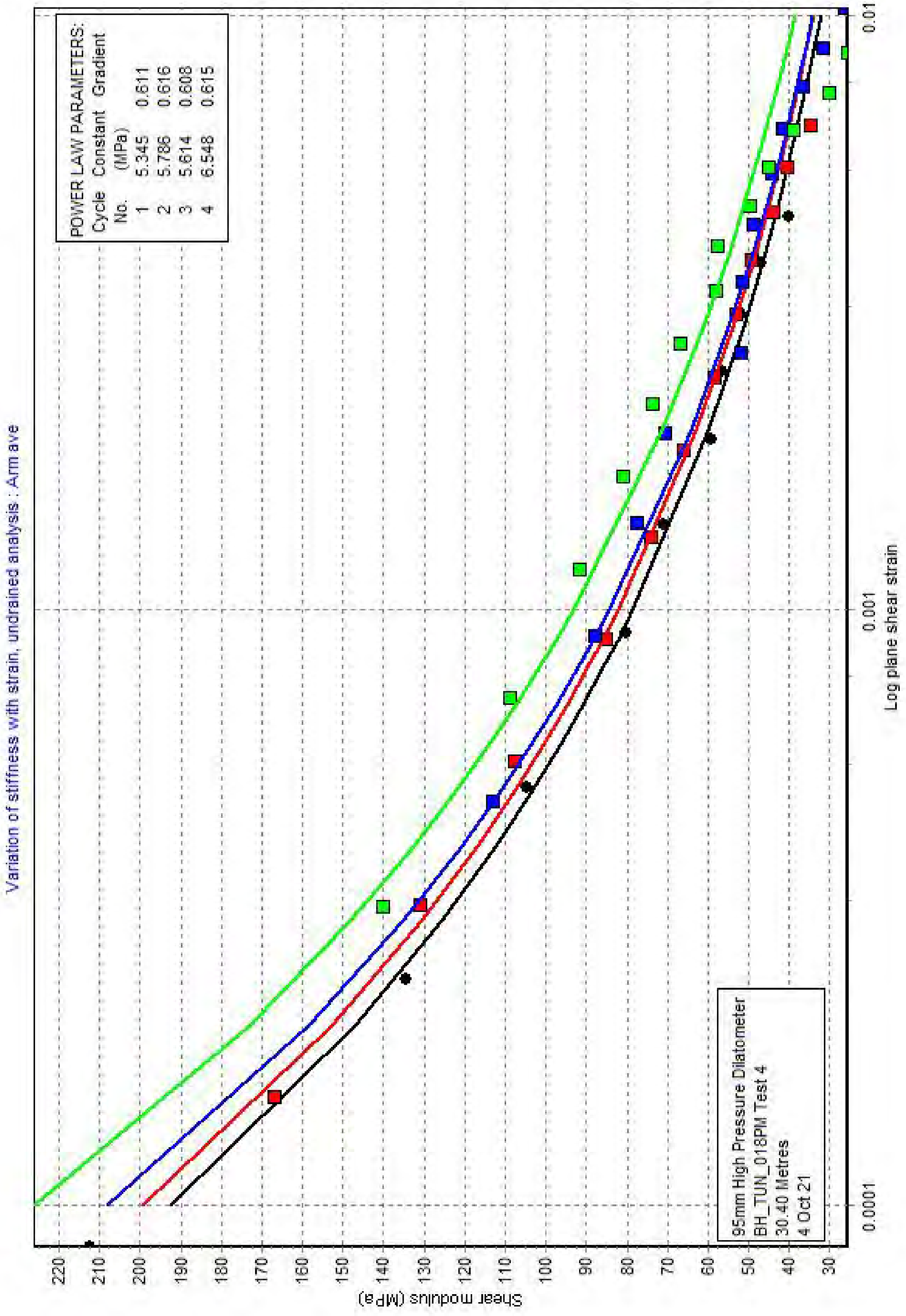
95mm High Pressure Dilatometer
BH_TUN_018PM Test 4
30.40 Metres
4 Oct 21
RESULTS:
Gradient (beta) : 0.611
Intercept (n) : 8.751MPa
Shear stress constant : 5.345MPa


Bolton and Whittle (1999) Loop 2 : Arm ave
95mm High Pressure Dilatometer
BH_TUN_018PM Test 4
30.40 Metres
4 Oct 21
RESULTS:
Gradient (beta) : 0.616
Intercept (n) : 9.397MPa
Shear stress constant : 5.786MPa
Ln[Radial stress]
6
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4
3.9
3.8
3.7
3.6
3.5
-9
-8
-7
-6
-5
Ln[shear strain]
Source data - Loop 2
Total pressure (kPa)
1,400
1,300
1,200
1,100
1,000
2.7
2.75
2.8
2.85
2.9
Radial Displacement (mm)

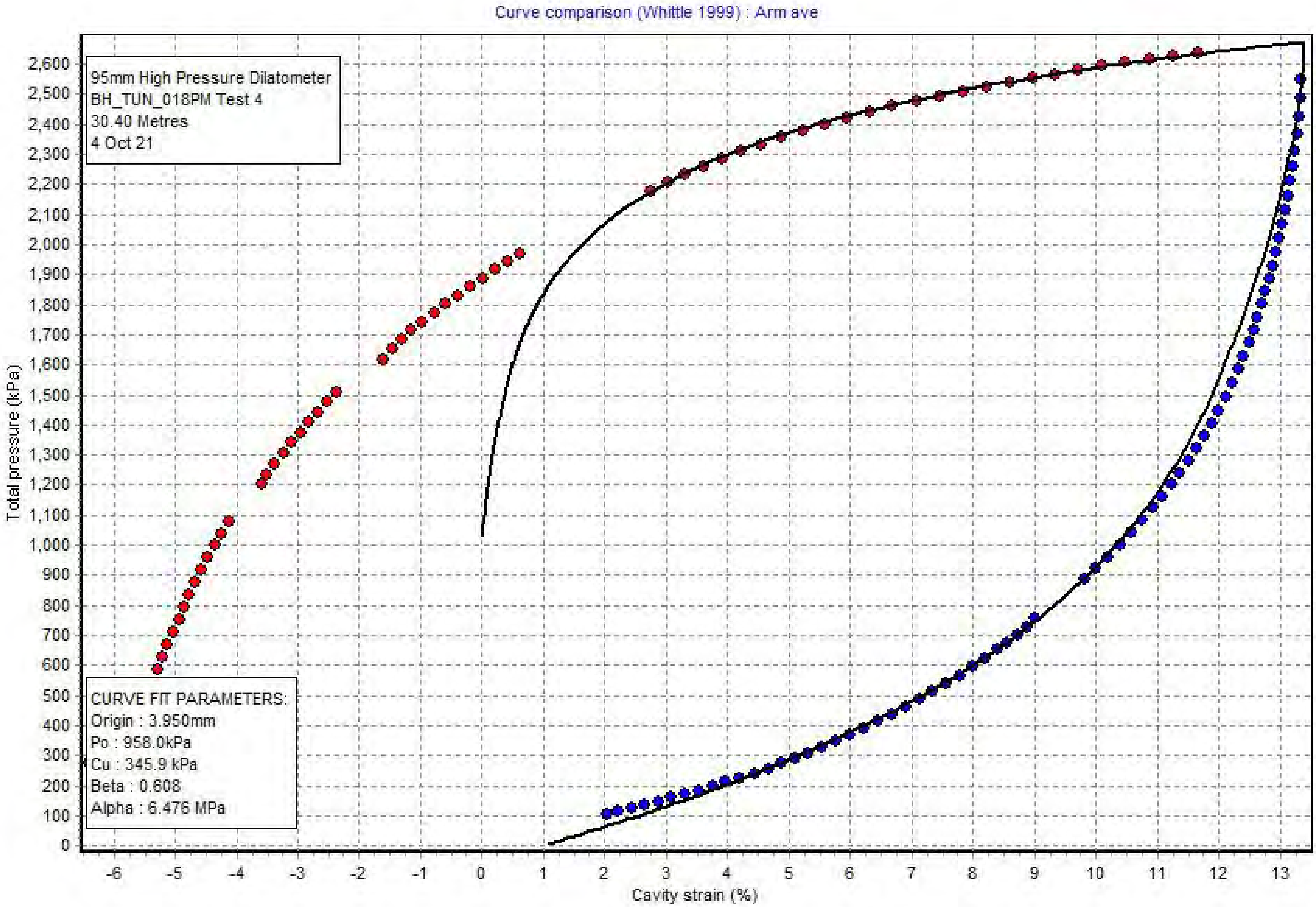


95mm High Pressure Dilatometer
BH_TUN_018PM Test 4
30.40 Metres
4 Oct 21
RESULTS:
Gradient (beta) : 0.608
Intercept (n) : 9.238MPa
Shear stress constant : 5.614MPa


Bolton and Whittle (1999) Loop 4 : Arm ave
95mm High Pressure Dilatometer
BH_TUN_018PM Test 4
30.40 Metres
4 Oct 21
RESULTS:
Gradient (beta) : 0.615
Intercept (n) : 10.640MPa
Shear stress constant : 6.548MPa
Ln[Radial stress]
4
4.1
4.2
4.3
4.4
4.5
4.6
4.7
4.8
4.9
5
5.1
5.2
5.3
5.4
5.5
5.6
5.7
5.8
5.9
6
6.1
6.2
6.3
Ln[shear strain]
-8
-7
-6
-5
Source data - Loop 4
Total pressure (kPa)
900
1,000
1,100
1,200
1,300
1,400
Radial Displacement (mm)
8.9
9
9.1

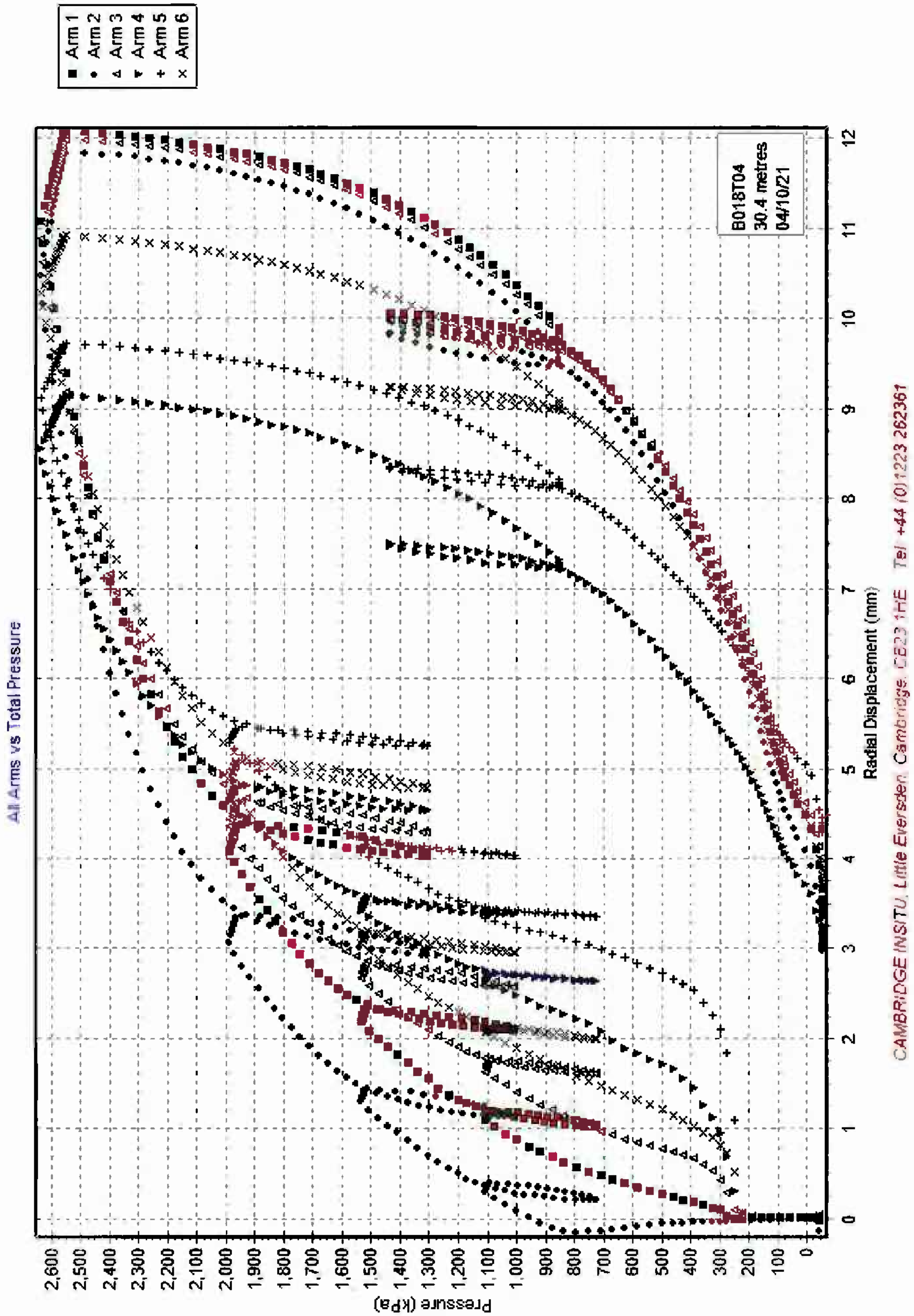

Variation of stiffness with strain, undrained analysis : Arm ave
POWER LAW PARAMETERS:
Cycle No. | Constant (MPa) | Gradient
1 5.345 0.611
2 5.786 0.616
3 5.614 0.608
4 6.548 0.615
95mm High Pressure Dilatometer
BH_TUN_018PM Test 4
30.40 Metres
4 Oct 21
Shear modulus (MPa)
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
Log plane shear strain
0.0001
0.001
0.01

Curve comparison (Whittle 1999) : Arm ave

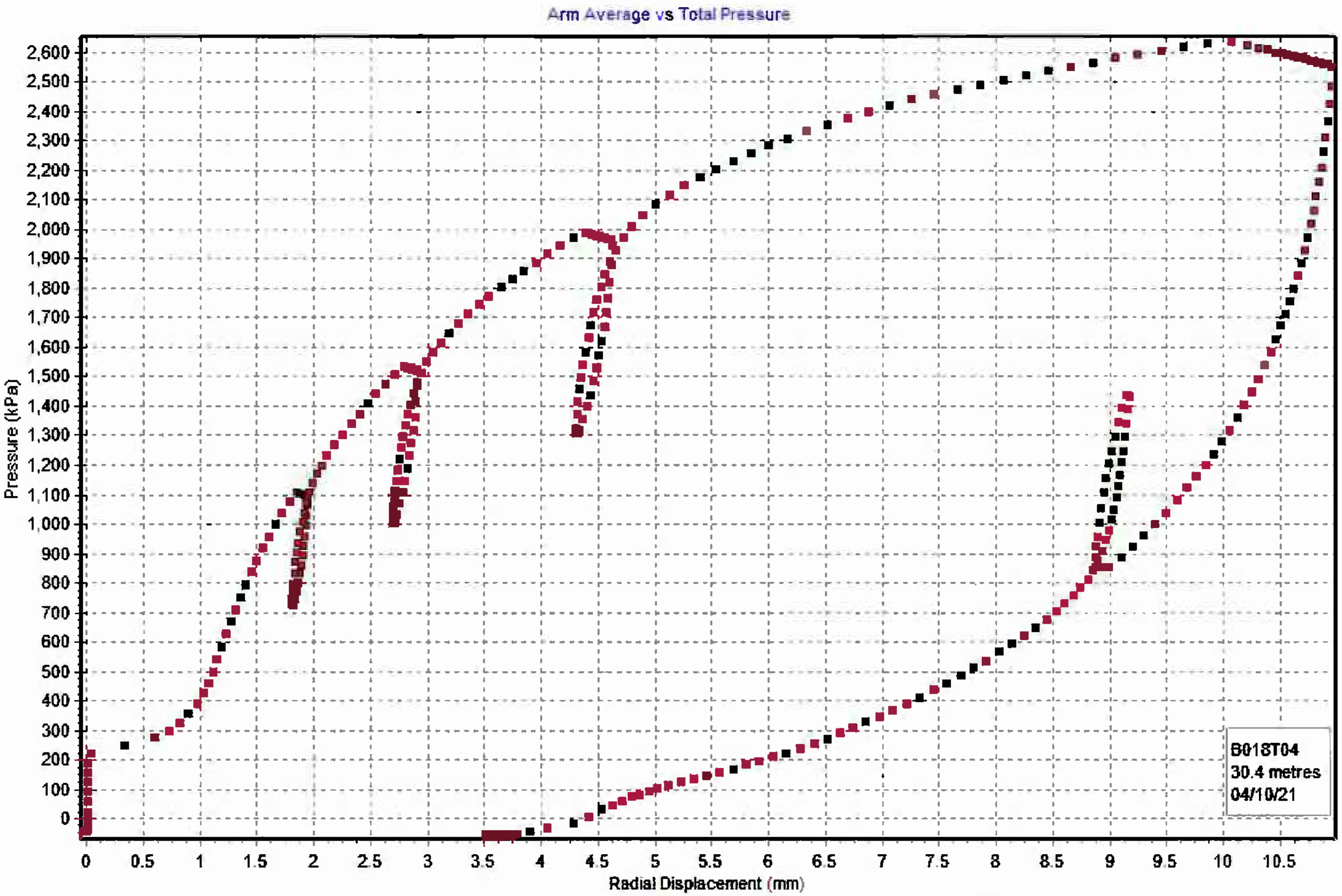


95mm High Pressure Dilatometer
BH_TUN_018PM Test 4
30.40 Metres
4 Oct 21

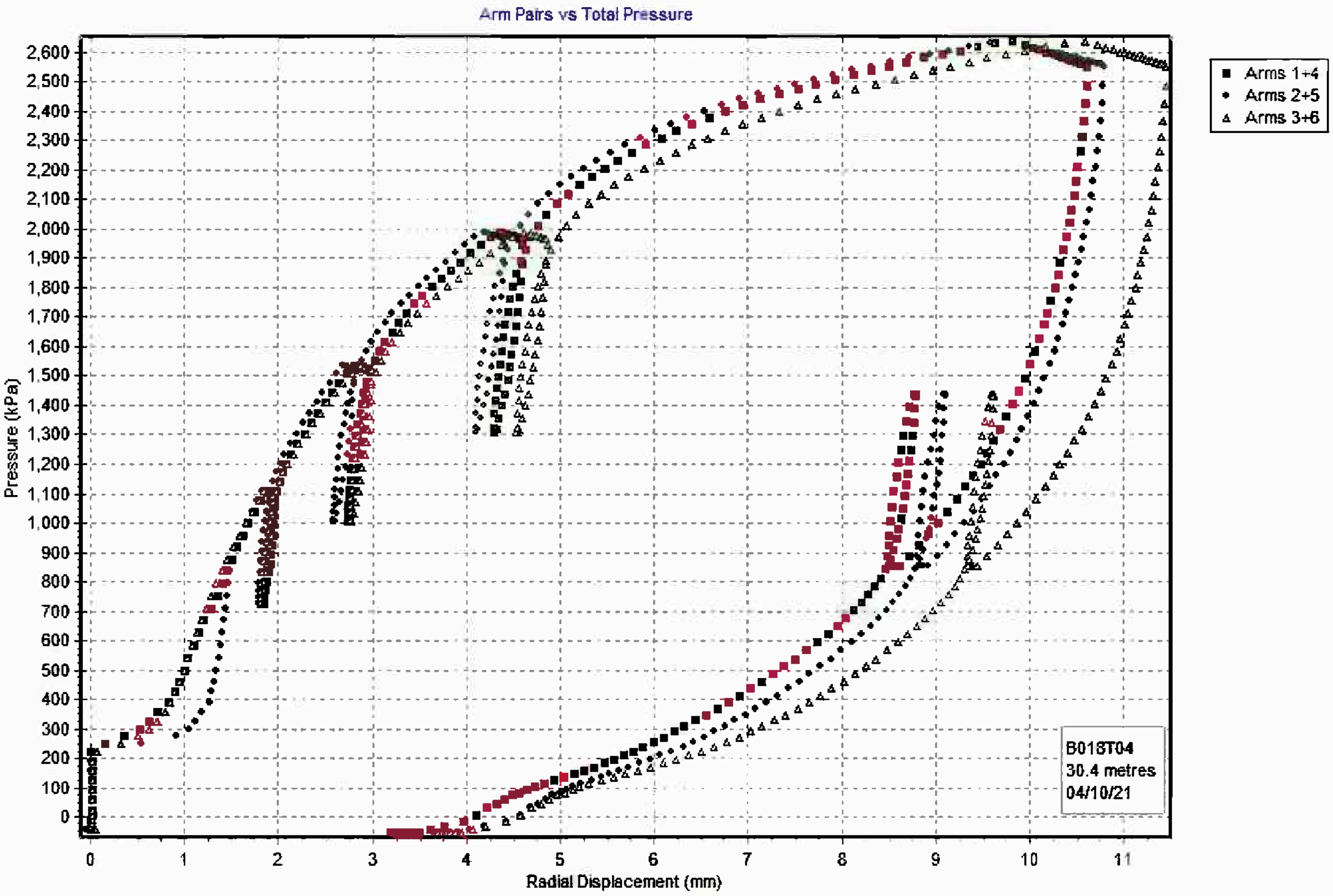
CURVE FIT PARAMETERS:
Origin : 3.950mm
Po : 958.0kPa
Cu : 345.9 kPa
Beta : 0.608
Alpha : 6.476 MPa


All Arms vs Total Pressure
Arm 1
Arm 2
Arm 3
Arm 4
Arm 5
Arm 6
B018T04
30.4 metres
04/10/21
Pressure (kPa)
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
1,300
1,400
1,500
1,600
1,700
1,800
1,900
2,000
2,100
2,200
2,300
2,400
2,500
2,600
Radial Displacement (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel +44 (0)1223 262361

Arm Average vs Total Pressure



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361

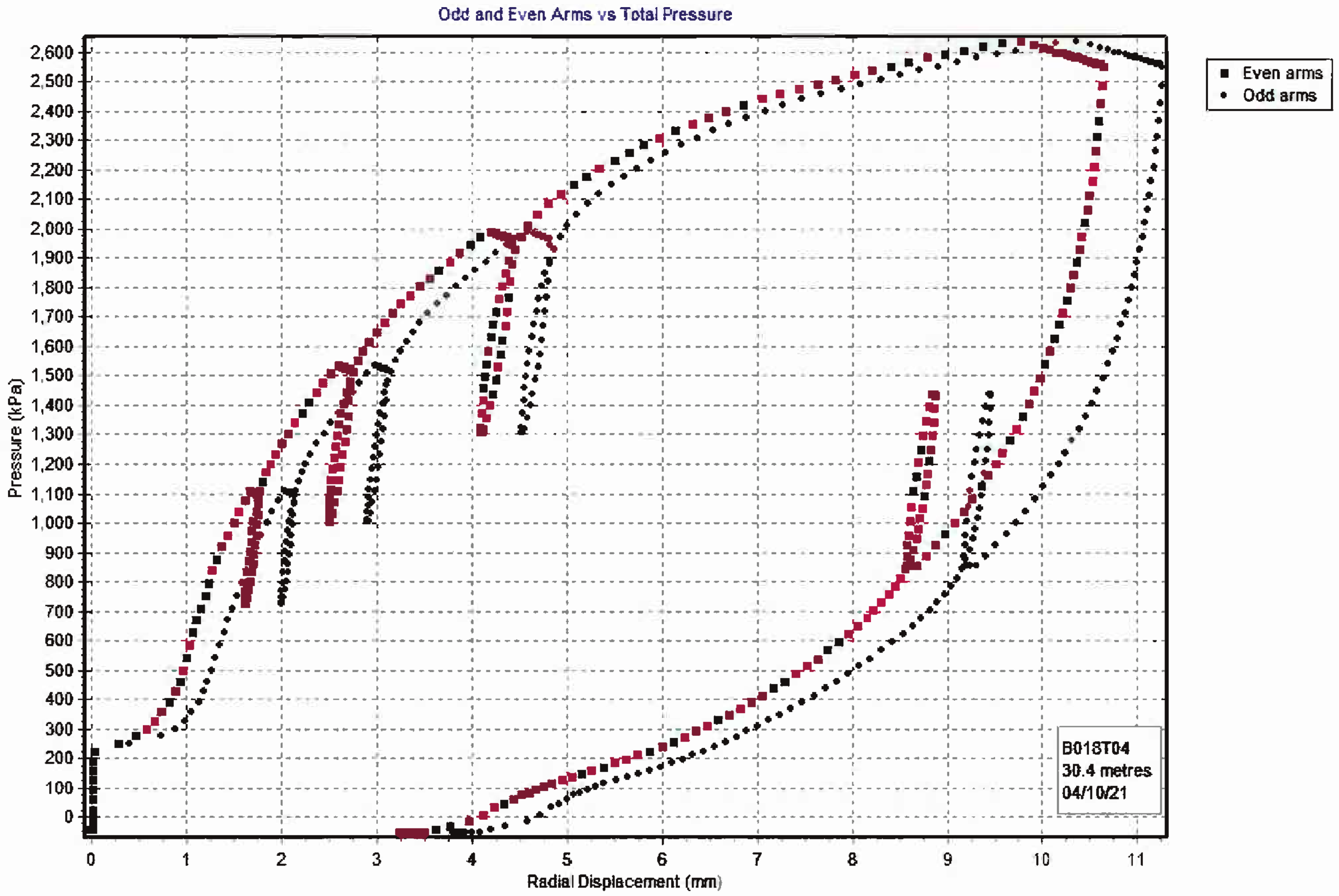


CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel +44 (0)1223 262361

CIR1506/21

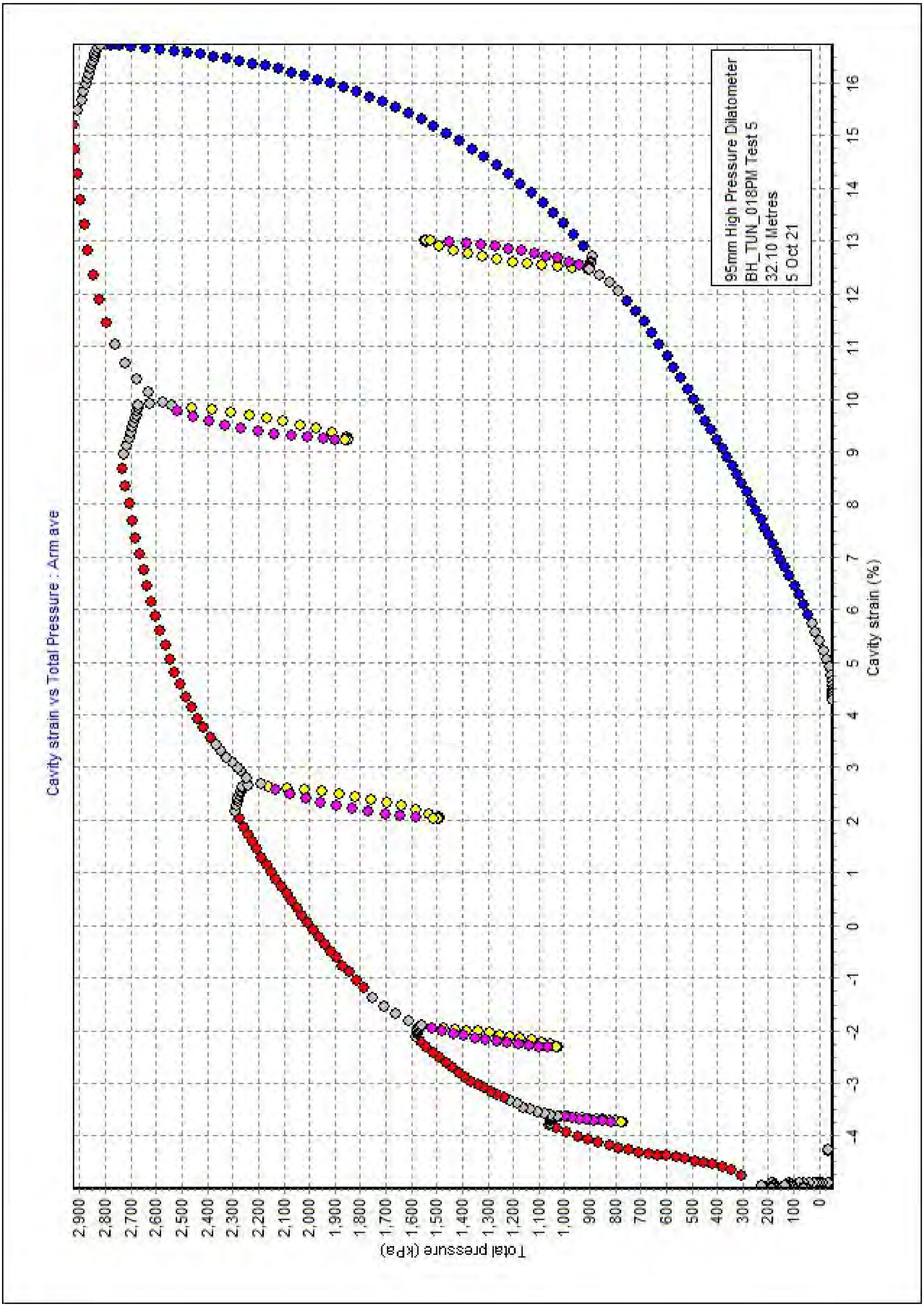
Cambridge WWTPR

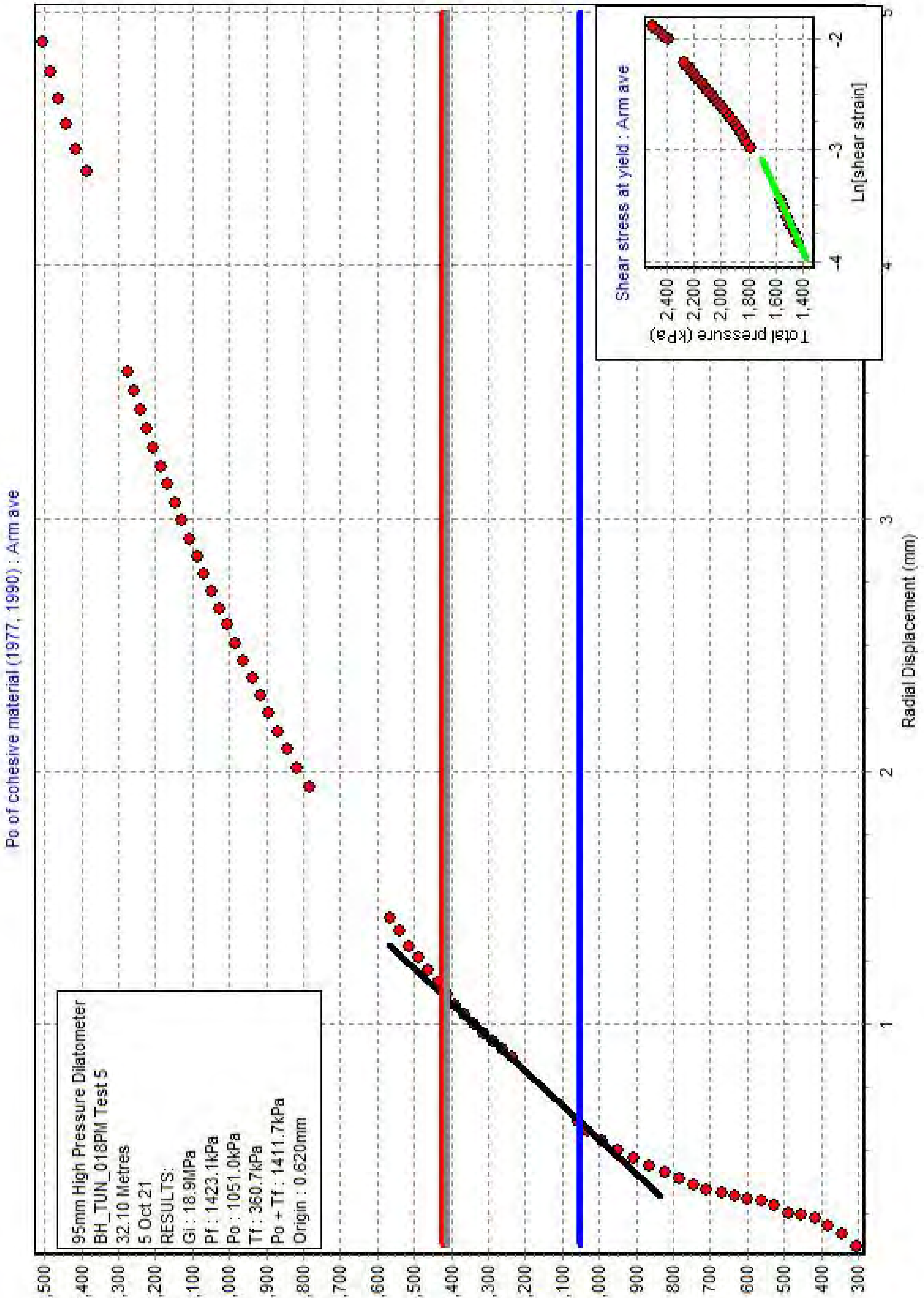
Pressuremeter Testing

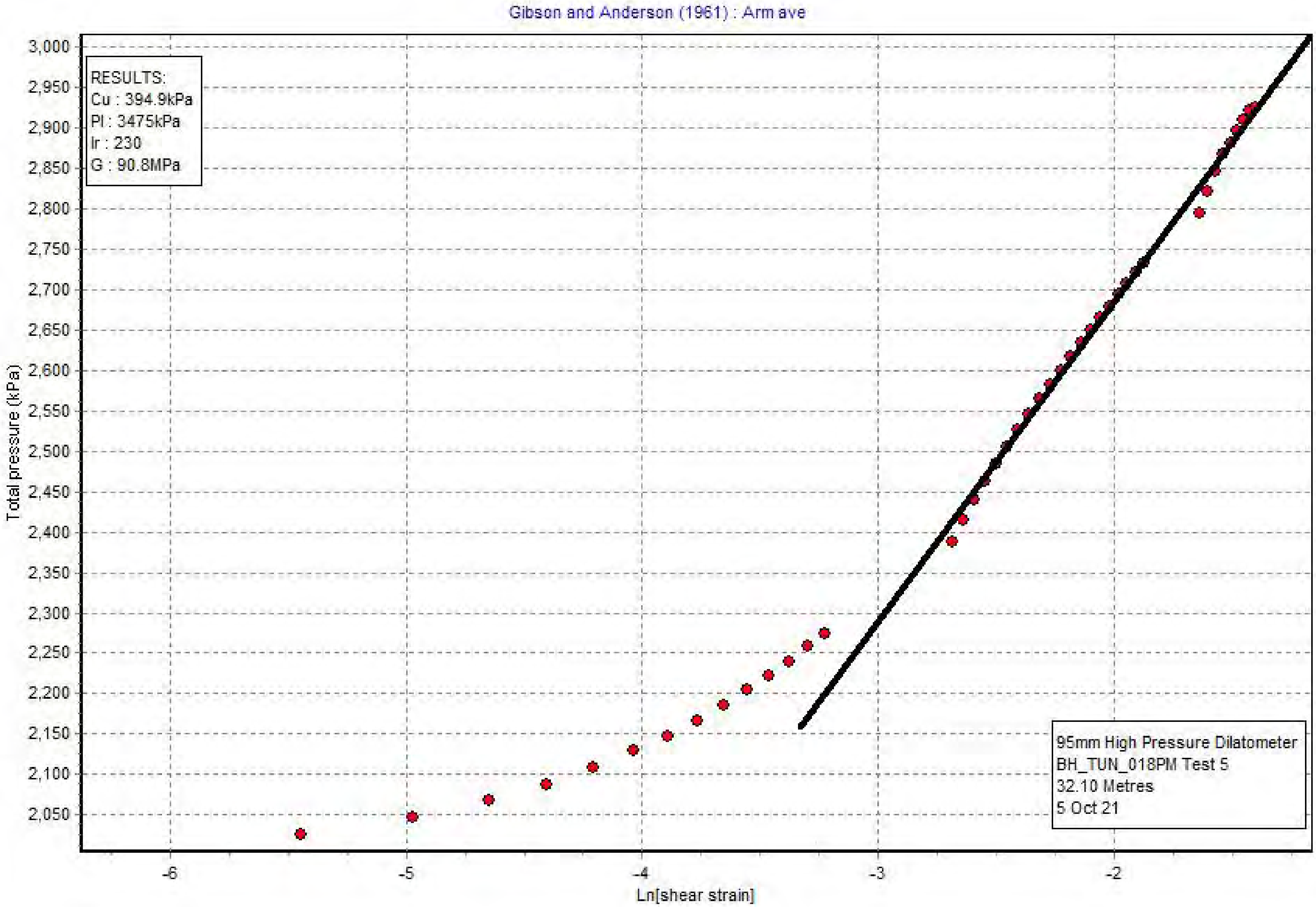


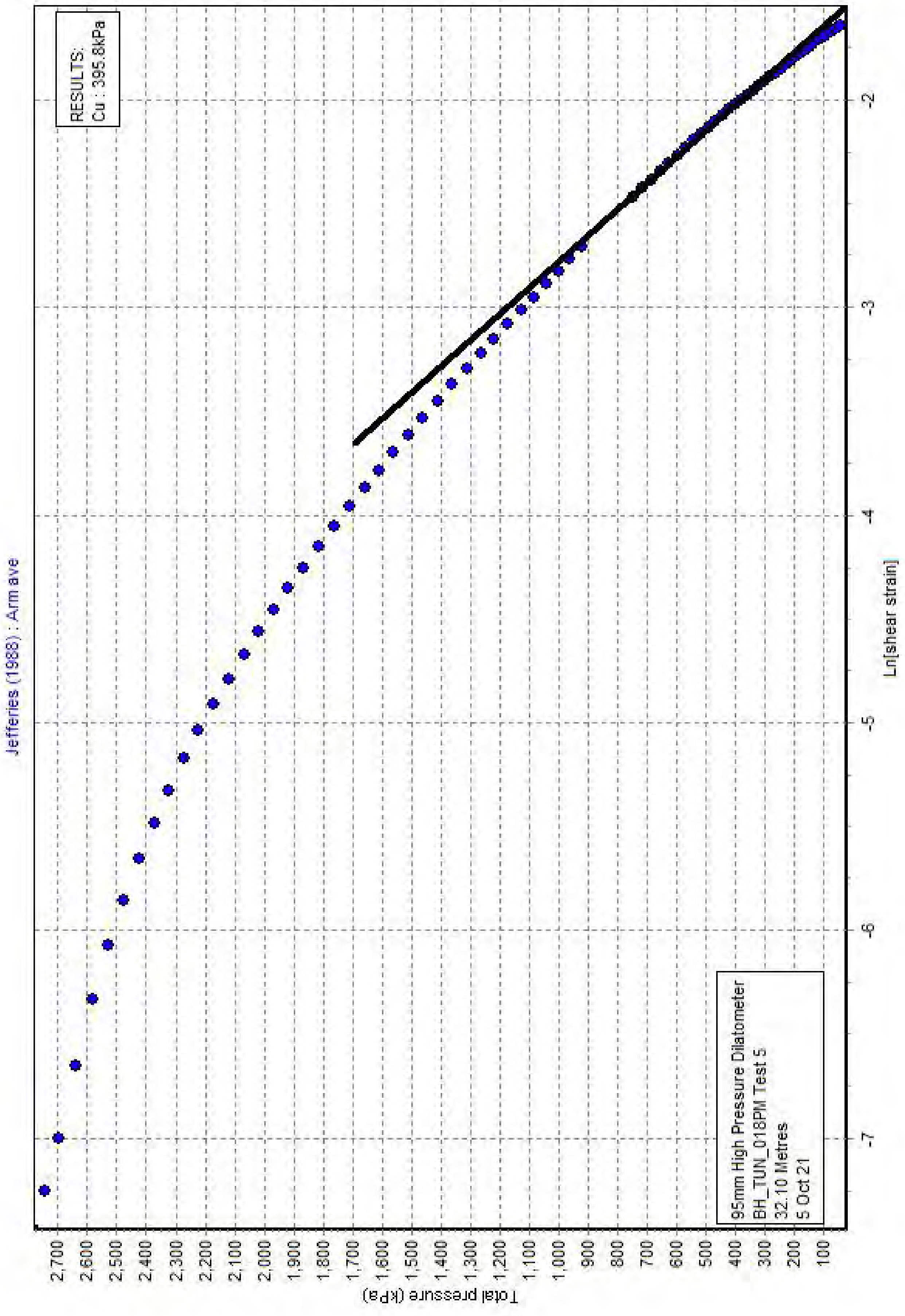
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361

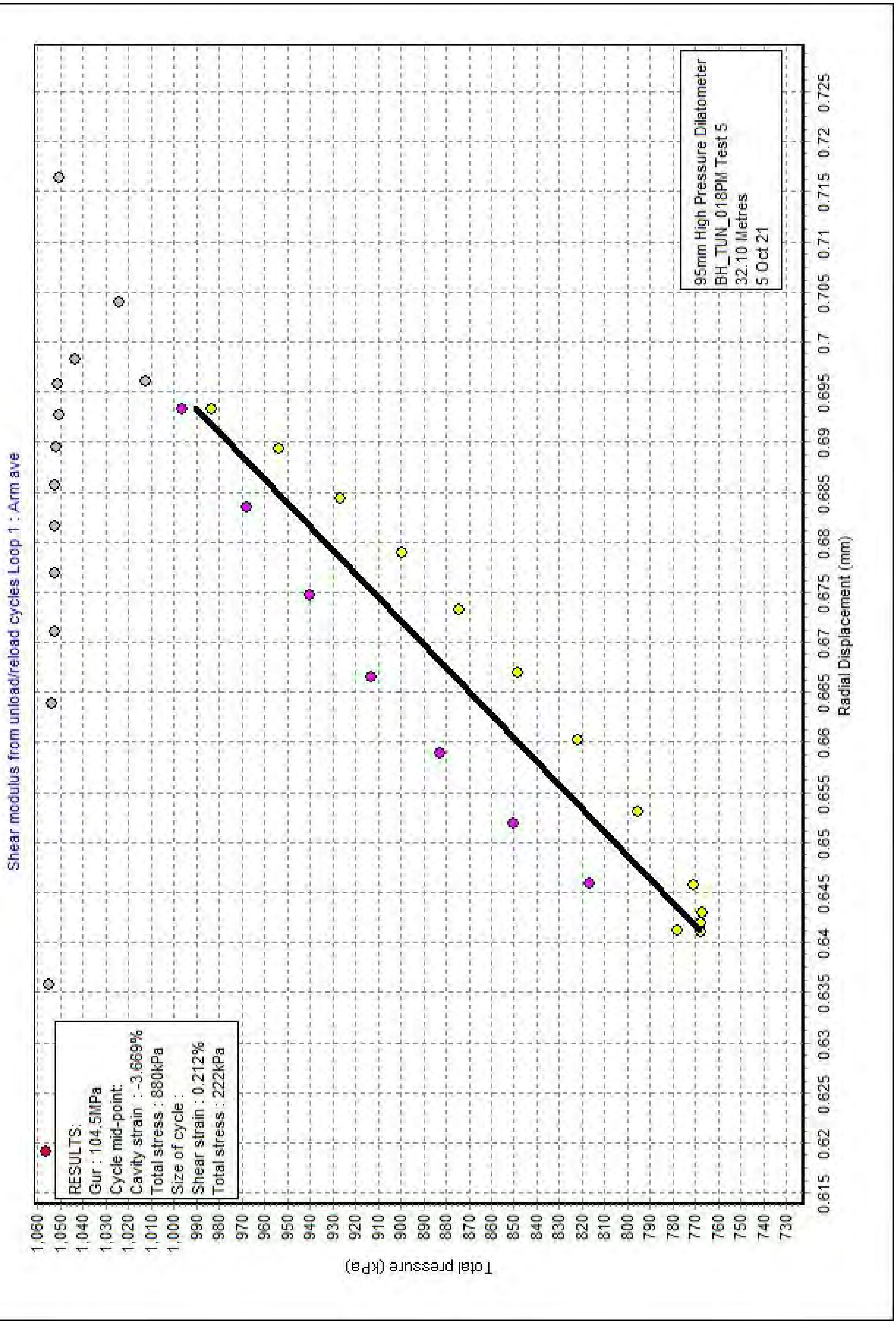
```
BH_TUN_018PM Test 5 - SUMMARY OF RESULTS
[File made with WinSitu ]

[DETAILS OF TEST]
Project        :   TE8364
Site           :   Cambridge Waste Water Treatment Plant Relocation Project
Borehole       :   BH_TUN_018PM
Test name      :   BH_TUN_018PM Test 5
Test date      :   5 Oct 21
Test depth     :   32.10 Metres
Water table    :   4 Metres
Ambient PWP    :   276.0 kPa
Material       :   Gault Clay
Probe          :   95mm High Pressure Dilatometer
Diameter       :   97.0 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out
The file includes results from a curve fitting analysis

Analysed by YB / ES /  RW on 6 Oct 21

Remarks:

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm)                   :   "Arm ave=2.54"
Po from Marsland & Randolph (kPa)    :   "Arm ave=1051.0"
Best estimate of Po (kPa)            :   "Arm ave=932.0"

[UNDRAINED STRENGTH PARAMETERS]
Gibson & Anderson 1961 - Cu (kPa)    :   "Arm ave=394.9"
Limit pressure (kPa)                 :   "Arm ave=3475"
Jefferies 1988 - Cu (kPa)            :   "Arm ave=395.8"
Undrained yield stress (kPa)         :   "Arm ave=1423.1"

[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=18.9"
Axis       Loop   Value    Mean Strain  Mean Pc  dE      dPc
           No     (MPa)    (%)          (kPa)    (%)     (kPa)
Arm ave    1      104.5    -3.669       880      0.212   222
Arm ave    2      65.8     -2.107       1272     0.749   495
Arm ave    3      57.0     2.354        1832     1.170   670
Arm ave    4      60.7     9.545        2181     1.075   656
Arm ave    5      65.5     12.788       1254     0.896   590

[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]
Axis       Loop   Intercept  Alpha      Gradient
           No     (MPa)      (MPa)
Arm ave    1      12.352     7.989      0.647
Arm ave    2      12.515     8.147      0.651
Arm ave    3      11.848     7.523      0.635
Arm ave    4      11.578     7.039      0.608
Arm ave    5      10.445     6.154      0.589


[PARAMETERS USED FOR UNDRAINED CURVE MODELLING]
{Axis is  Arm ave}
Strain Origin (mm)                   :   2.54
Po (kPa)                             :   932
Cu (kPa)                             :   394.9
Limit pressure (kPa)                 :   3475
Non-linear exponent                  :   0.589
Calculated alpha (MPa)               :   6.443
G at yield (MPa)                     :   45.2
```

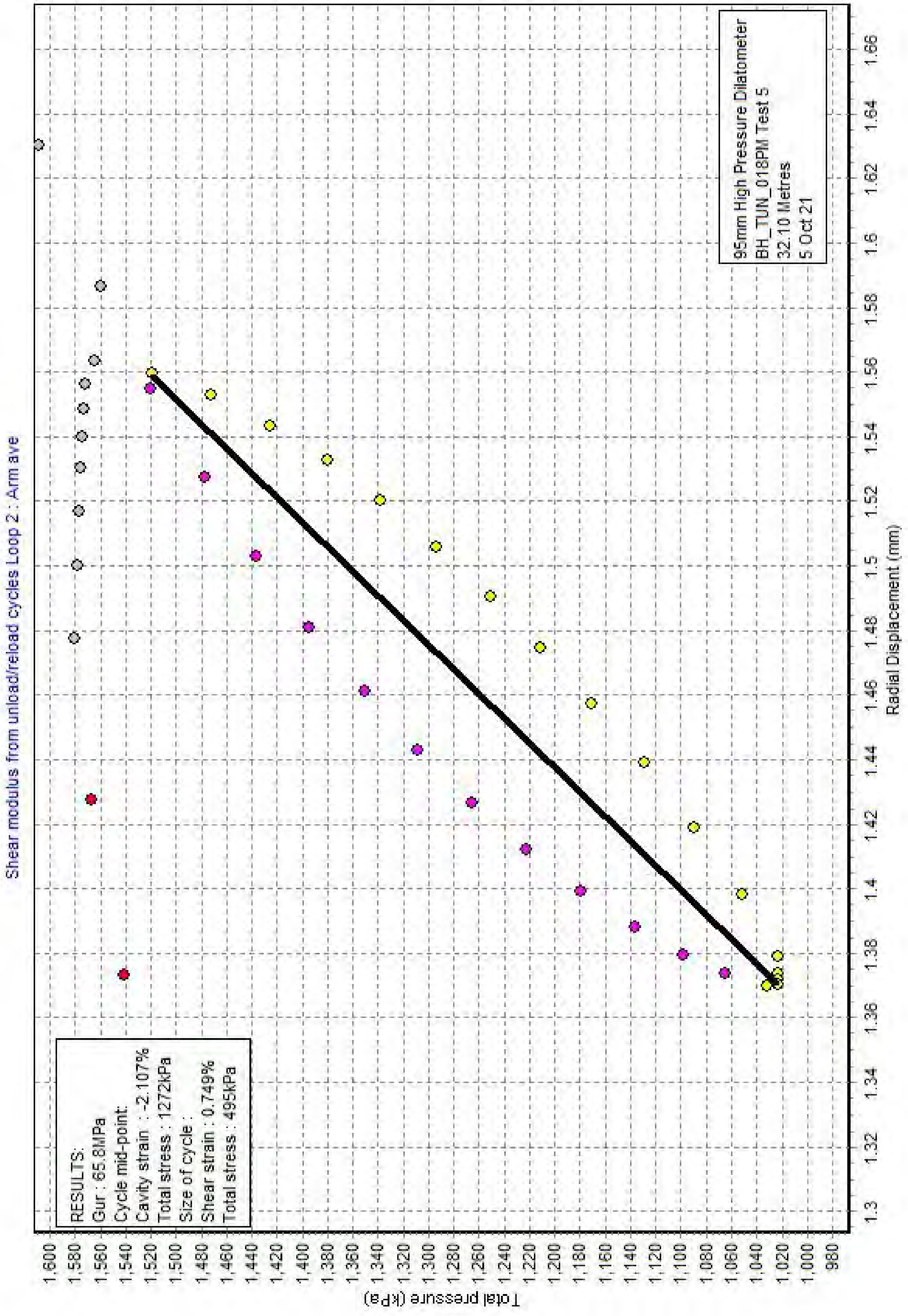

Cavity strain vs Total Pressure : Arm ave
95mm High Pressure Dilatometer
BH_TUN_018PM Test 5
32.10 Metres
5 Oct 21
Total pressure (kPa)
Cavity strain (%)
2,900
2,800
2,700
2,600
2,500
2,400
2,300
2,200
2,100
2,000
1,900
1,800
1,700
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
0
-4
-3
-2
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

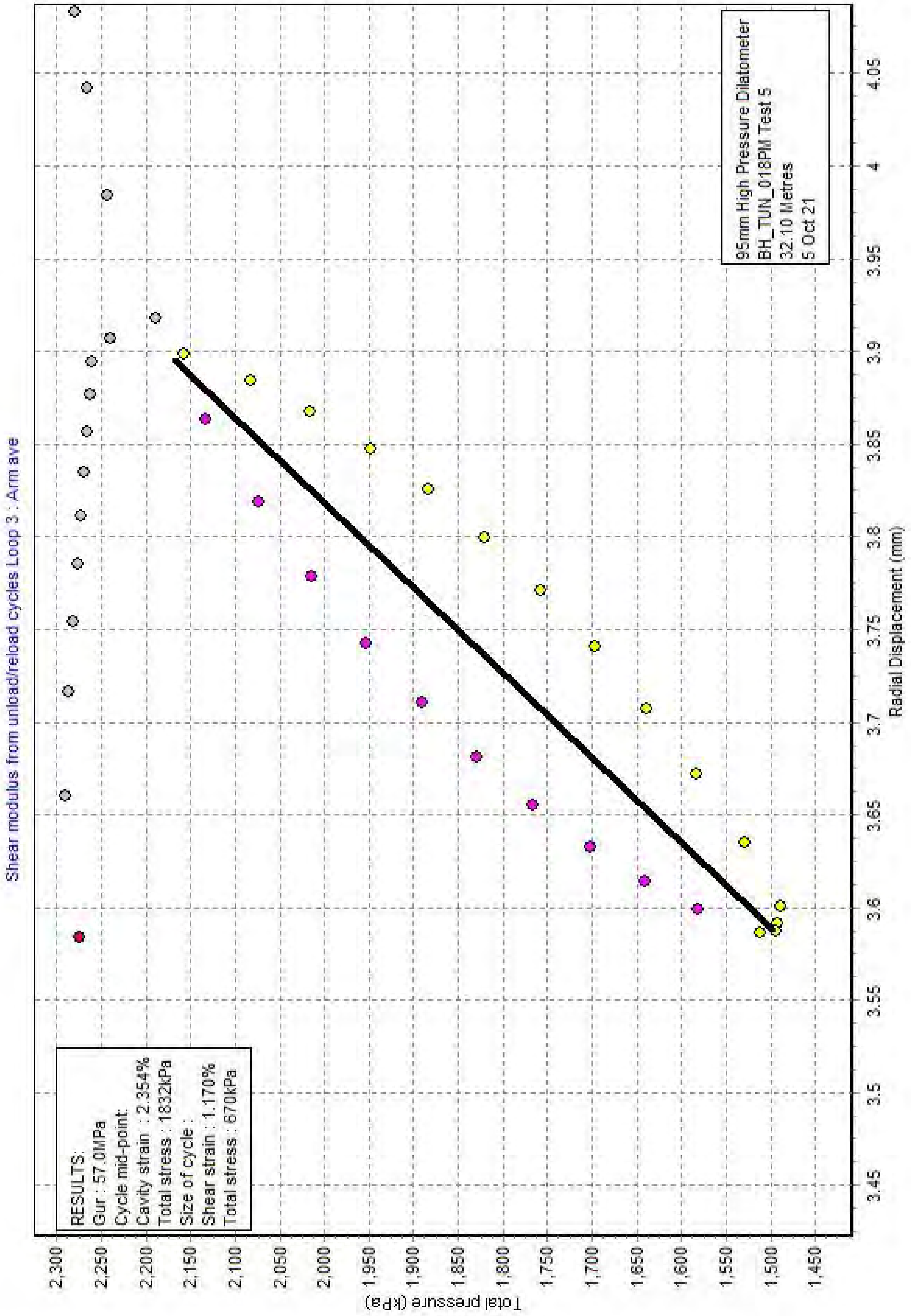

Po of cohesive material (1977, 1990) : Arm ave
95mm High Pressure Dilatometer
BH_TUN_018PM Test 5
32.10 Metres
5 Oct 21
RESULTS:
Gi : 18.9MPa
Pf : 1423.1kPa
Po : 1051.0kPa
Tf : 360.7kPa
Po + Tf : 1411.7kPa
Origin : 0.620mm
Total pressure (kPa)
2,500
2,400
2,300
2,200
2,100
2,000
1,900
1,800
1,700
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
Radial Displacement (mm)
1
2
3
4
5
Shear stress at yield : Arm ave
Total pressure (kPa)
2,400
2,200
2,000
1,800
1,600
1,400
Ln[shear strain]
-4
-3
-2

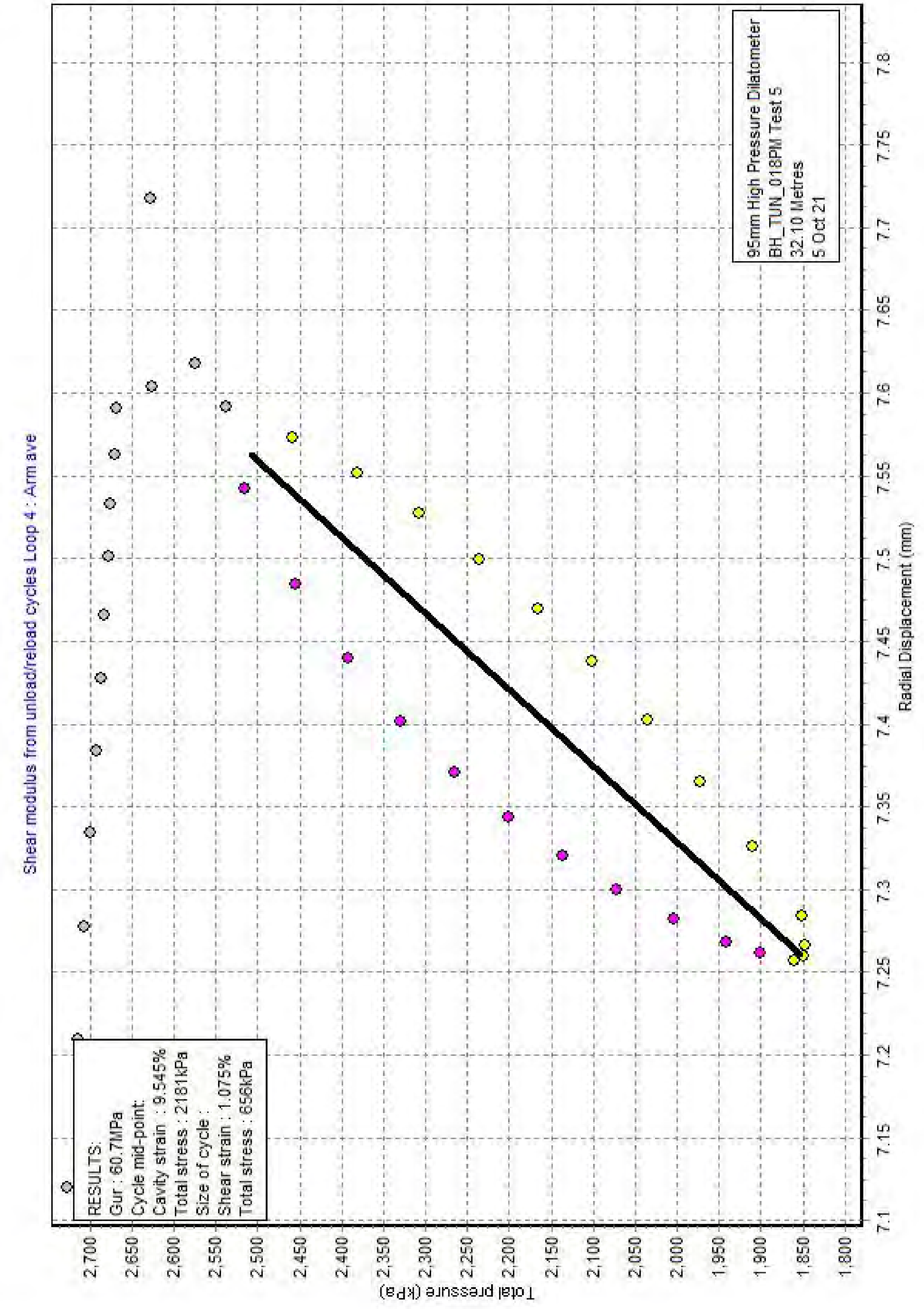

Gibson and Anderson (1961) : Arm ave
RESULTS:
Cu : 394.9kPa
Pl : 3475kPa
Ir : 230
G : 90.8MPa
95mm High Pressure Dilatometer
BH_TUN_018PM Test 5
32.10 Metres
5 Oct 21
Total pressure (kPa)
3,000
2,950
2,900
2,850
2,800
2,750
2,700
2,650
2,600
2,550
2,500
2,450
2,400
2,350
2,300
2,250
2,200
2,150
2,100
2,050
-6
-5
-4
-3
-2
Ln[shear strain]

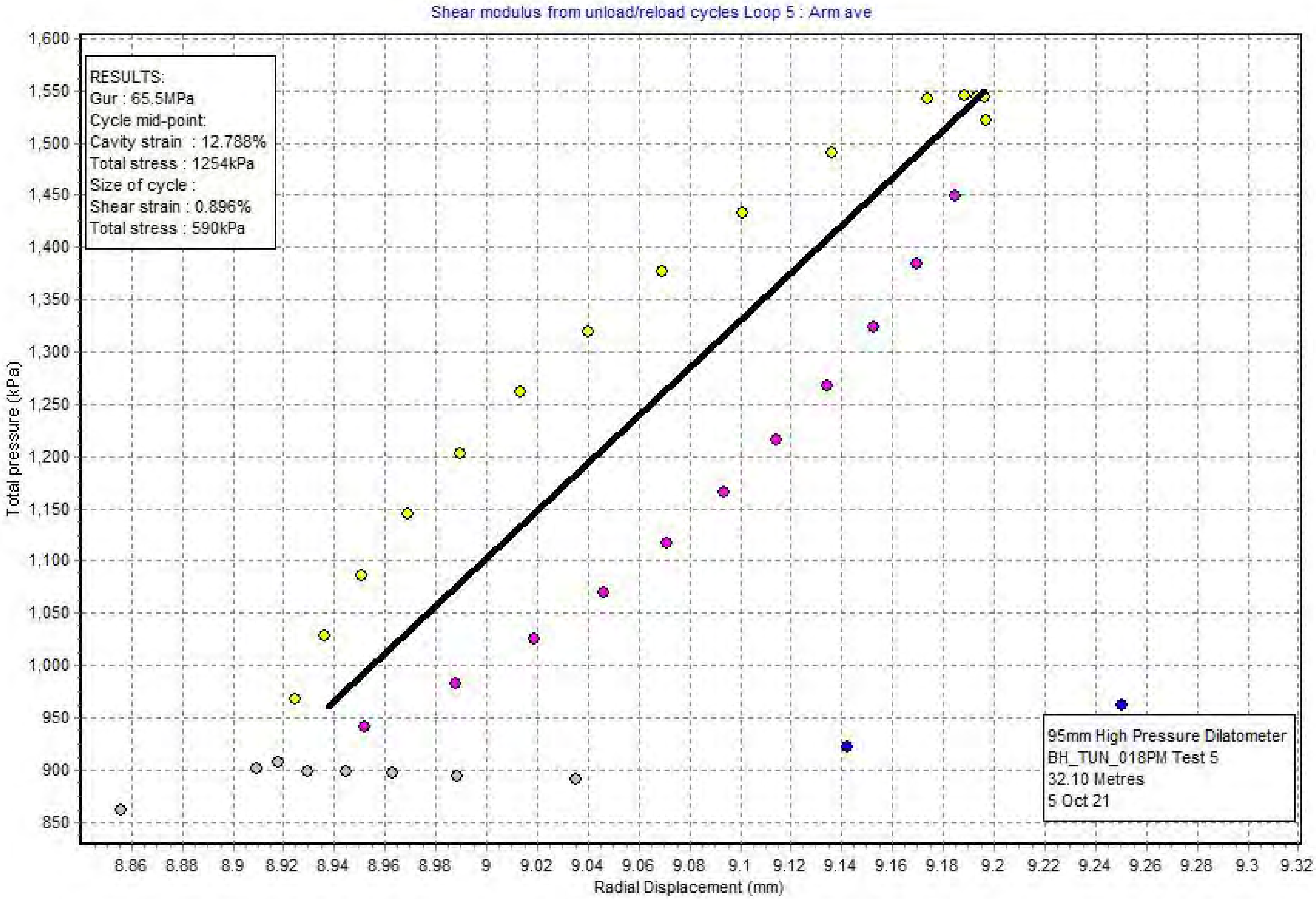

Jefferies (1988) : Arm ave
RESULTS:
Cu : 395.8kPa
95mm High Pressure Dilatometer
BH_TUN_018PM Test 5
32.10 Metres
5 Oct 21
Total pressure (kPa)
2,700
2,600
2,500
2,400
2,300
2,200
2,100
2,000
1,900
1,800
1,700
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
Ln[shear strain]
-7
-6
-5
-4
-3
-2

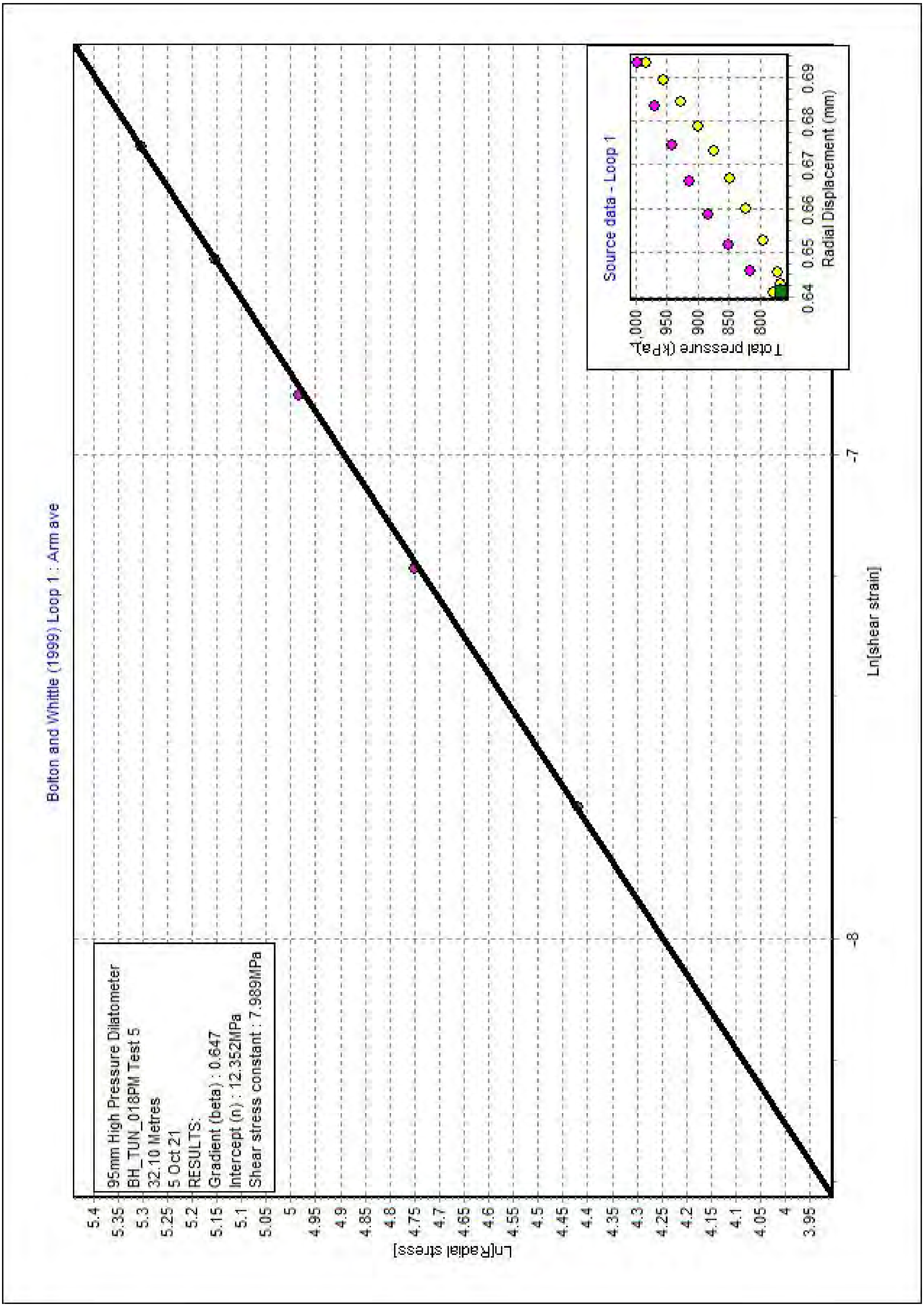

Shear modulus from unload/reload cycles Loop 1 : Arm ave
RESULTS:
Gur : 104.5MPa
Cycle mid-point:
Cavity strain : -3.669%
Total stress : 880kPa
Size of cycle :
Shear strain : 0.212%
Total stress : 222kPa
95mm High Pressure Dilatometer
BH_TUN_018PM Test 5
32.10 Metres
5 Oct 21
Total pressure (kPa)
1,060
1,050
1,040
1,030
1,020
1,010
1,000
990
980
970
960
950
940
930
920
910
900
890
880
870
860
850
840
830
820
810
800
790
780
770
760
750
740
730
Radial Displacement (mm)
0.615
0.62
0.625
0.63
0.635
0.64
0.645
0.65
0.655
0.66
0.665
0.67
0.675
0.68
0.685
0.69
0.695
0.7
0.705
0.71
0.715
0.72
0.725

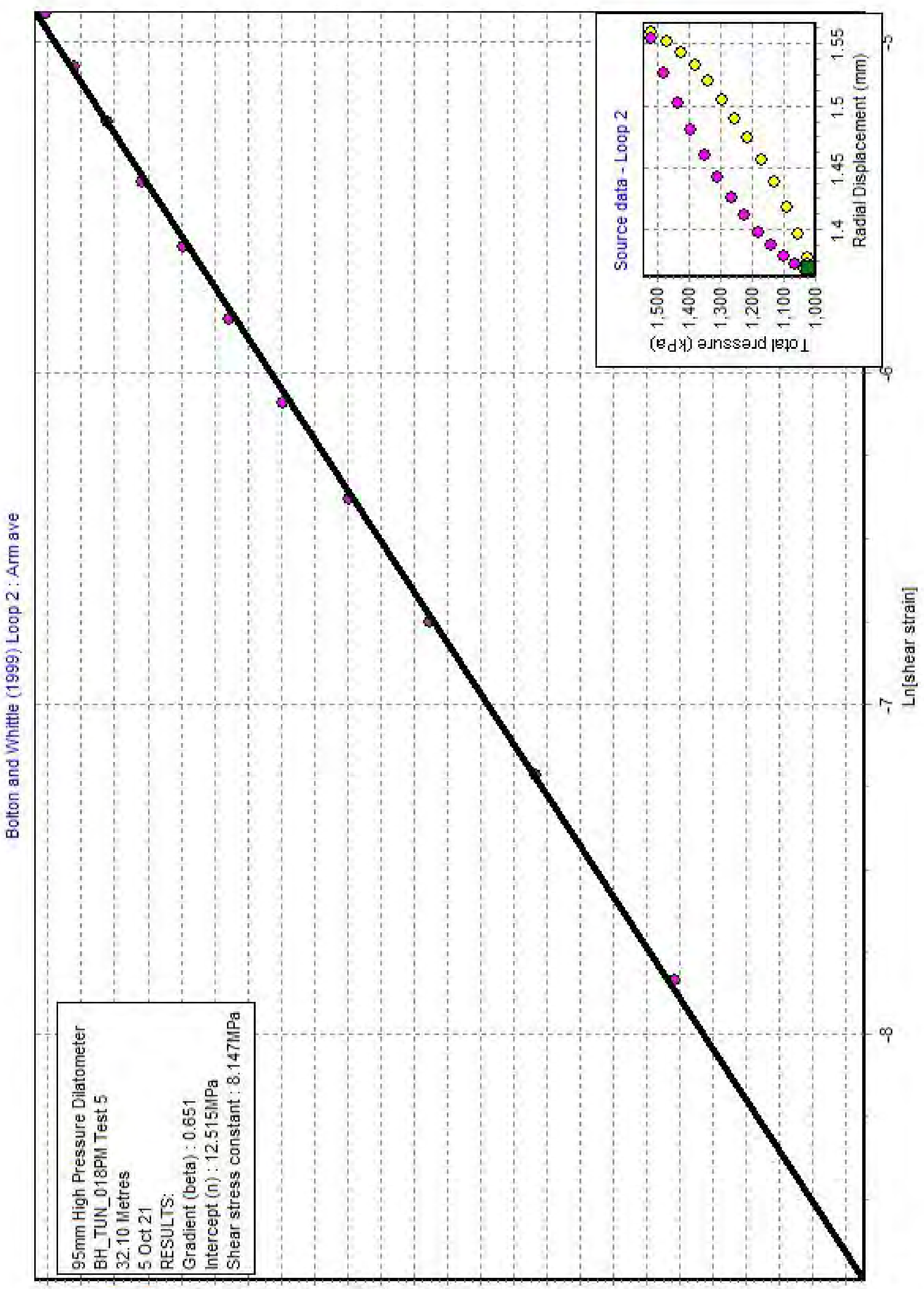

Shear modulus from unload/reload cycles Loop 2 : Arm ave
95mm High Pressure Dilatometer
BH_TUN_018PM Test 5
32.10 Metres
5 Oct 21
RESULTS:
Gur : 65.8MPa
Cycle mid-point:
Cavity strain : -2.107%
Total stress : 1272kPa
Size of cycle :
Shear strain : 0.749%
Total stress : 495kPa
Radial Displacement (mm)
1.3
1.32
1.34
1.36
1.38
1.4
1.42
1.44
1.46
1.48
1.5
1.52
1.54
1.56
1.58
1.6
1.62
1.64
1.66
Total pressure (kPa)
1,600
1,580
1,560
1,540
1,520
1,500
1,480
1,460
1,440
1,420
1,400
1,380
1,360
1,340
1,320
1,300
1,280
1,260
1,240
1,220
1,200
1,180
1,160
1,140
1,120
1,100
1,080
1,060
1,040
1,020
1,000
980


Shear modulus from unload/reload cycles Loop 3 : Arm ave
95mm High Pressure Dilatometer
BH_TUN_018PM Test 5
32.10 Metres
5 Oct 21
RESULTS:
Gur : 57.0MPa
Cycle mid-point:
Cavity strain : 2.354%
Total stress : 1832kPa
Size of cycle :
Shear strain : 1.170%
Total stress : 670kPa
Radial Displacement (mm)
3.45
3.5
3.55
3.6
3.65
3.7
3.75
3.8
3.85
3.9
3.95
4
4.05
Total pressure (kPa)
2,300
2,250
2,200
2,150
2,100
2,050
2,000
1,950
1,900
1,850
1,800
1,750
1,700
1,650
1,600
1,550
1,500
1,450


Shear modulus from unload/reload cycles Loop 4 : Arm ave
95mm High Pressure Dilatometer
BH_TUN_018PM Test 5
32.10 Metres
5 Oct 21
RESULTS:
Gur : 60.7MPa
Cycle mid-point:
Cavity strain : 9.545%
Total stress : 2181kPa
Size of cycle :
Shear strain : 1.075%
Total stress : 656kPa
Total pressure (kPa)
2,700
2,650
2,600
2,550
2,500
2,450
2,400
2,350
2,300
2,250
2,200
2,150
2,100
2,050
2,000
1,950
1,900
1,850
1,800
Radial Displacement (mm)
7.1
7.15
7.2
7.25
7.3
7.35
7.4
7.45
7.5
7.55
7.6
7.65
7.7
7.75
7.8

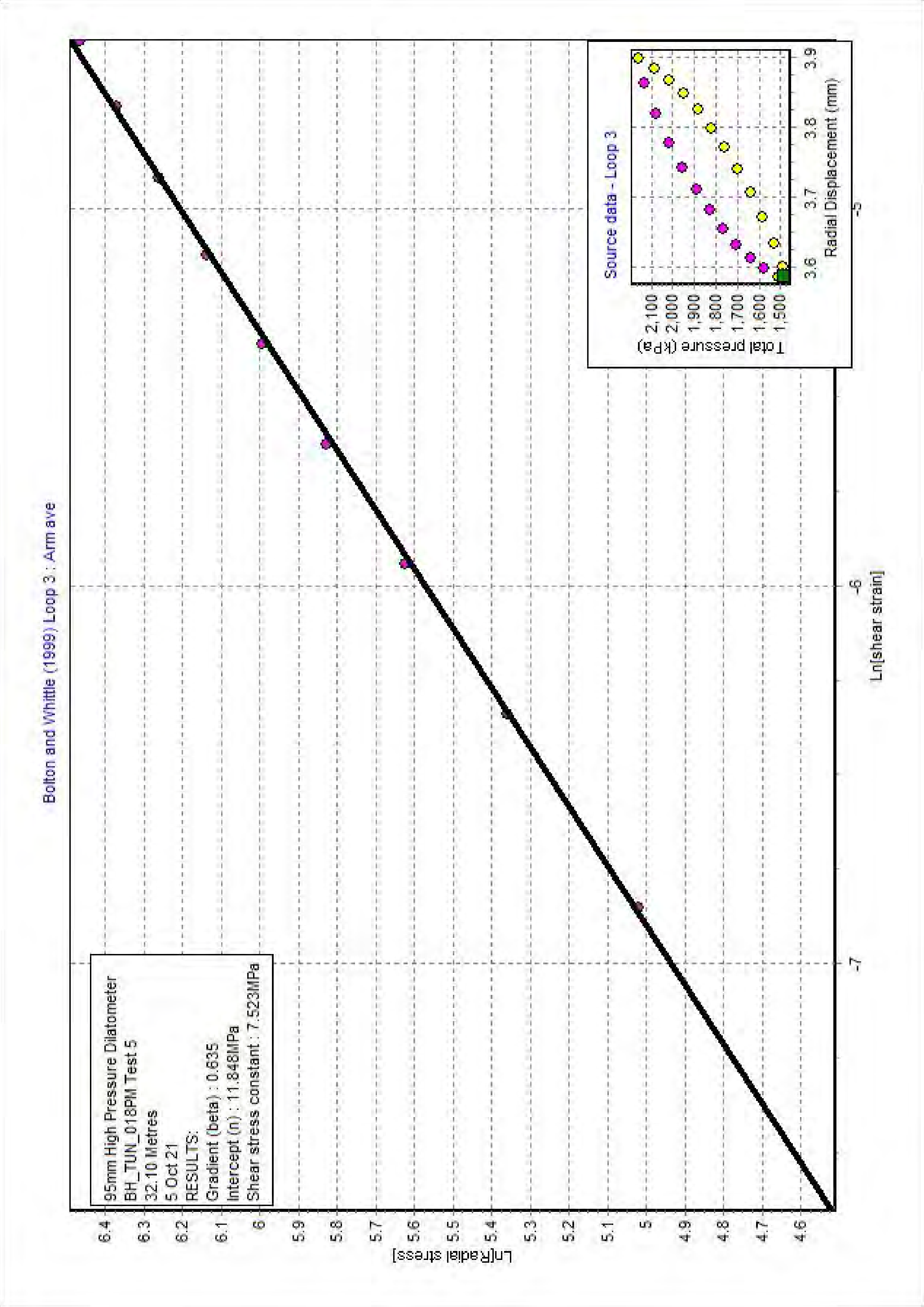

Shear modulus from unload/reload cycles Loop 5 : Arm ave
RESULTS:
Gur : 65.5MPa
Cycle mid-point:
Cavity strain : 12.788%
Total stress : 1254kPa
Size of cycle :
Shear strain : 0.896%
Total stress : 590kPa
95mm High Pressure Dilatometer
BH_TUN_018PM Test 5
32.10 Metres
5 Oct 21
Total pressure (kPa)
1,600
1,550
1,500
1,450
1,400
1,350
1,300
1,250
1,200
1,150
1,100
1,050
1,000
950
900
850
Radial Displacement (mm)
8.86
8.88
8.9
8.92
8.94
8.96
8.98
9
9.02
9.04
9.06
9.08
9.1
9.12
9.14
9.16
9.18
9.2
9.22
9.24
9.26
9.28
9.3
9.32

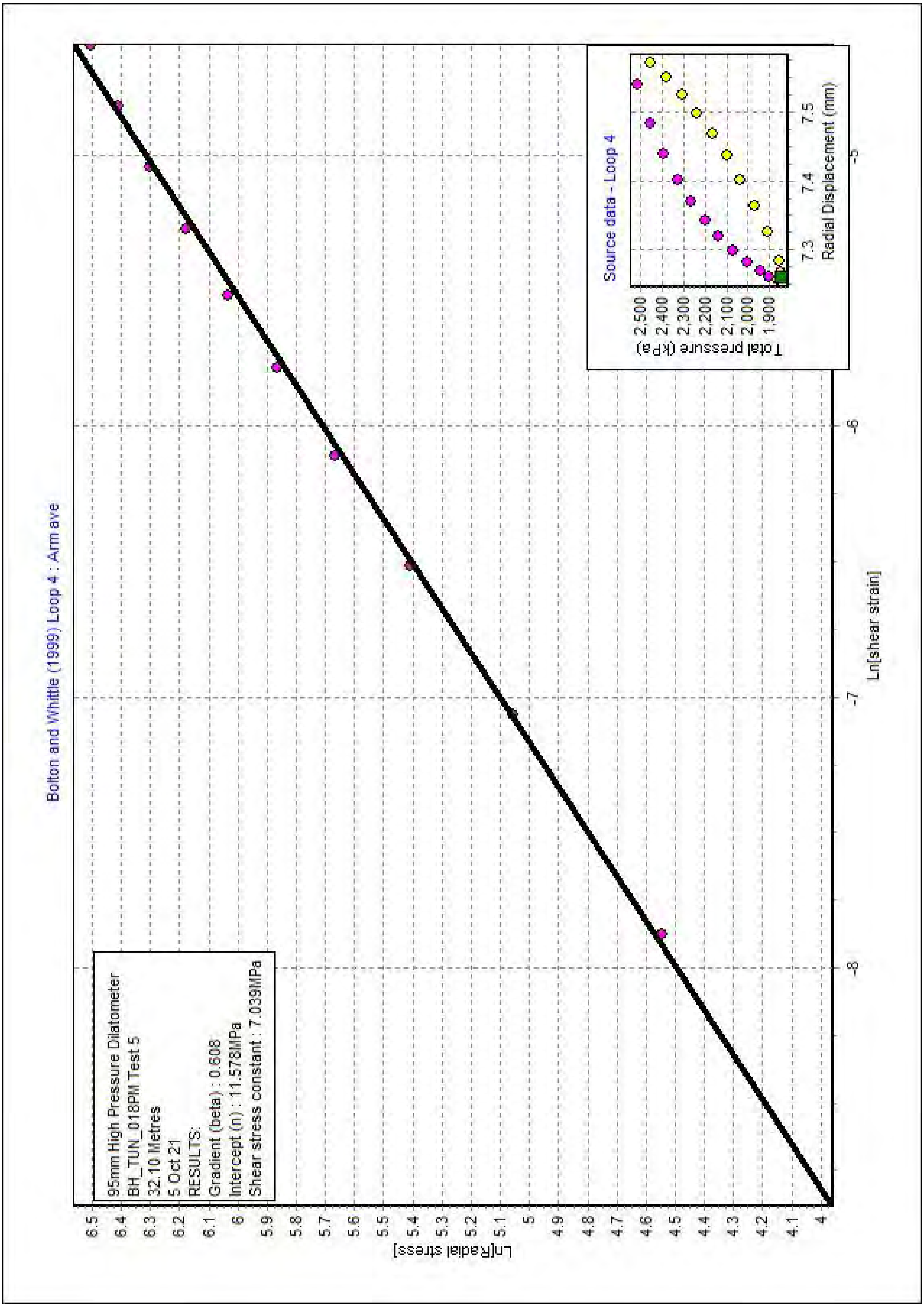

Bolton and Whittle (1999) Loop 1 : Arm ave
95mm High Pressure Dilatometer
BH_TUN_018PM Test 5
32.10 Metres
5 Oct 21
RESULTS:
Gradient (beta) : 0.647
Intercept (n) : 12.352MPa
Shear stress constant : 7.989MPa
Ln[Radial stress]
5.4
5.35
5.3
5.25
5.2
5.15
5.1
5.05
5
4.95
4.9
4.85
4.8
4.75
4.7
4.65
4.6
4.55
4.5
4.45
4.4
4.35
4.3
4.25
4.2
4.15
4.1
4.05
4
3.95
Ln[shear strain]
-8
-7
Source data - Loop 1
Total pressure (kPa)
000
950
900
850
800
Radial Displacement (mm)
0.64
0.65
0.66
0.67
0.68
0.69

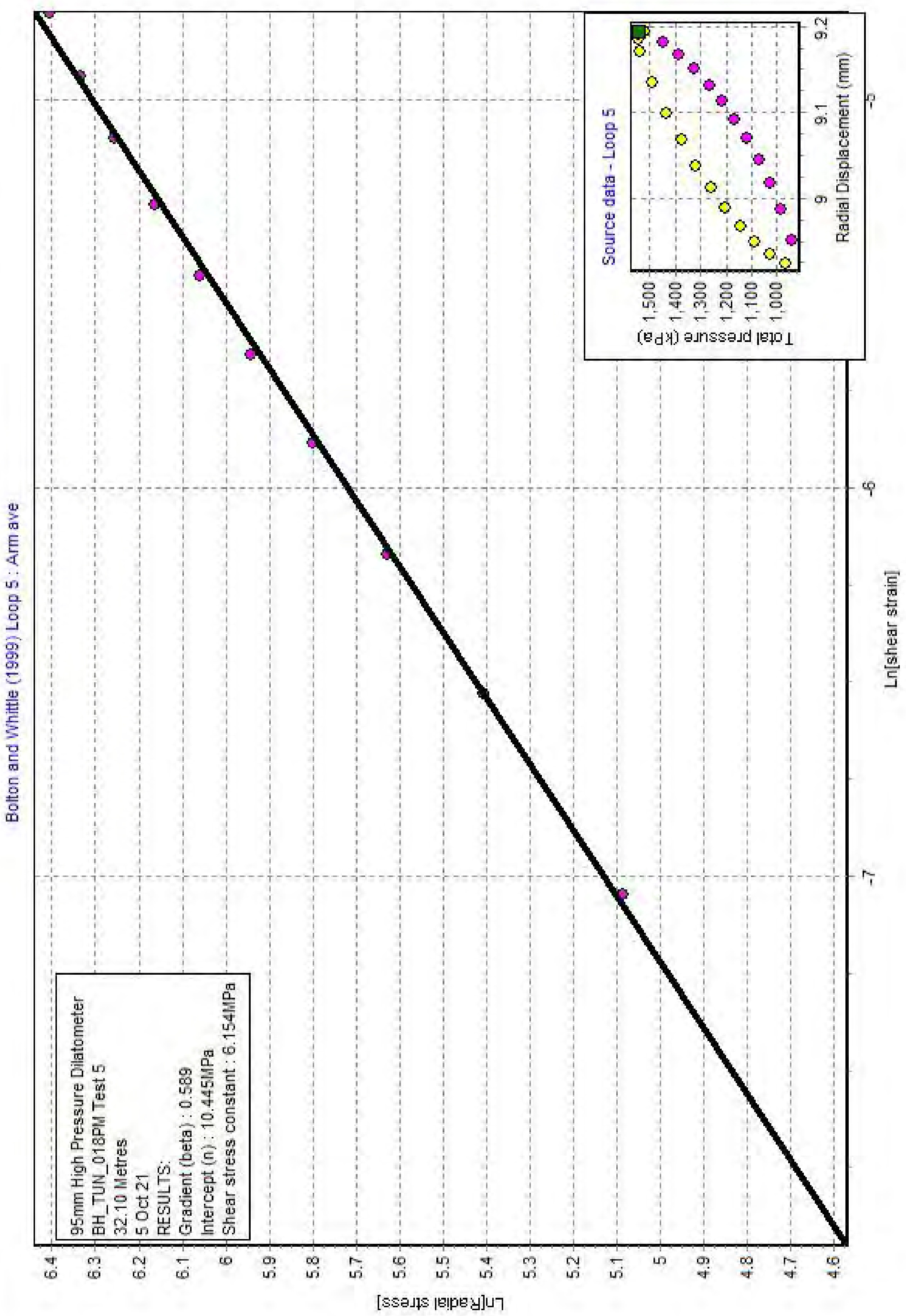


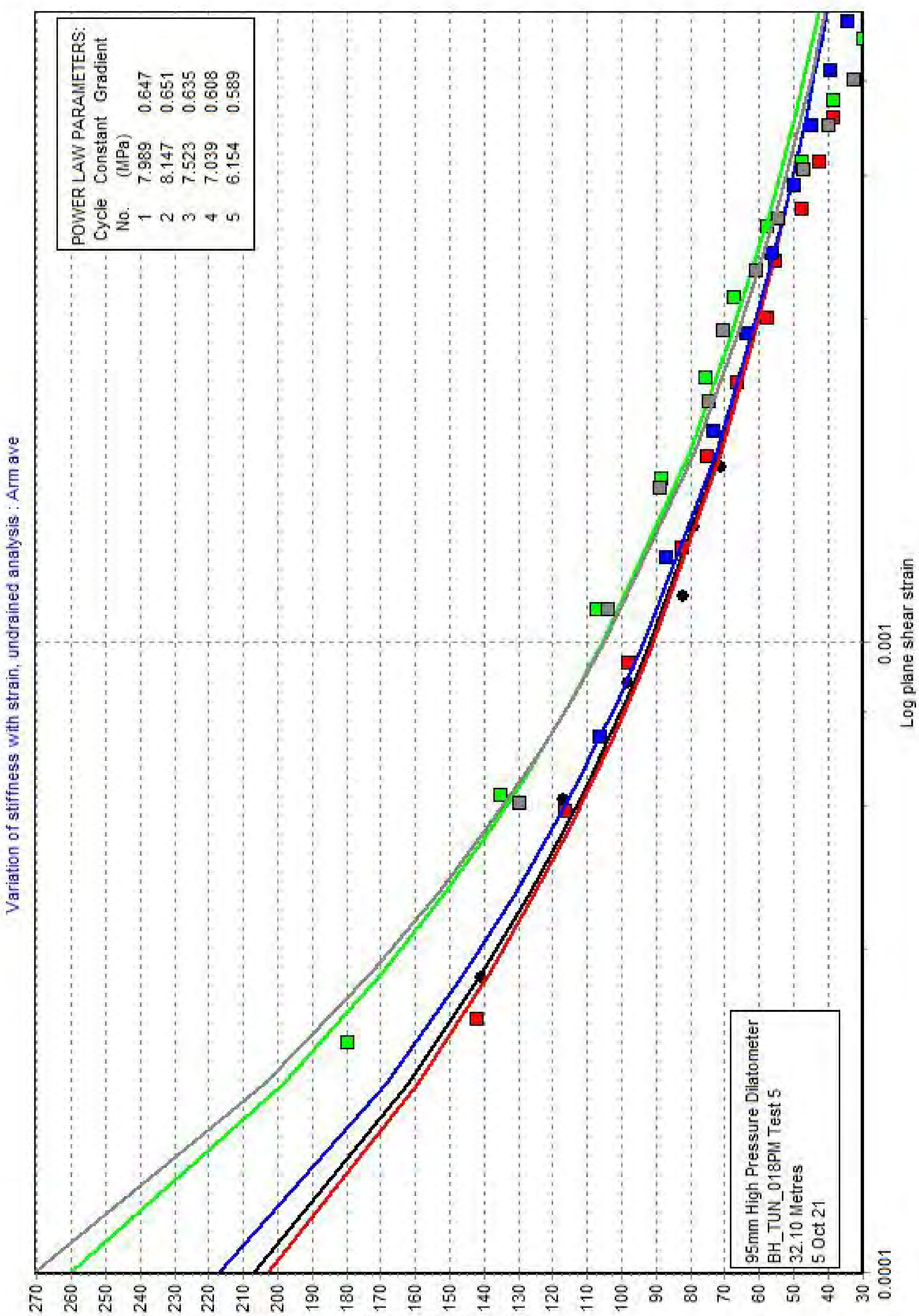
Bolton and Whittle (1999) Loop 2 : Arm ave

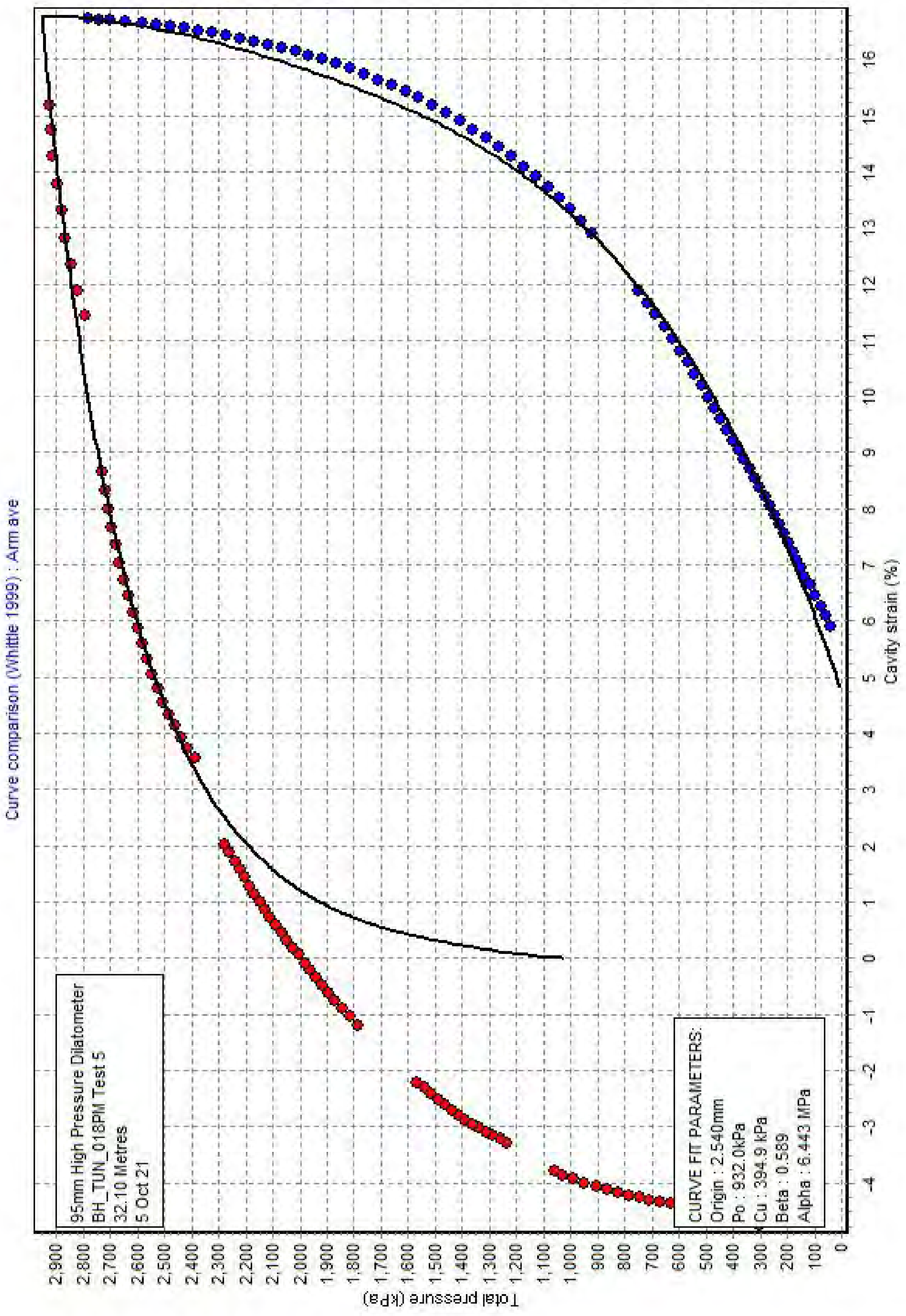
95mm High Pressure Dilatometer
BH_TUN_018PM Test 5
32.10 Metres
5 Oct 21
RESULTS:
Gradient (beta) : 0.651
Intercept (n) : 12.515MPa
Shear stress constant : 8.147MPa

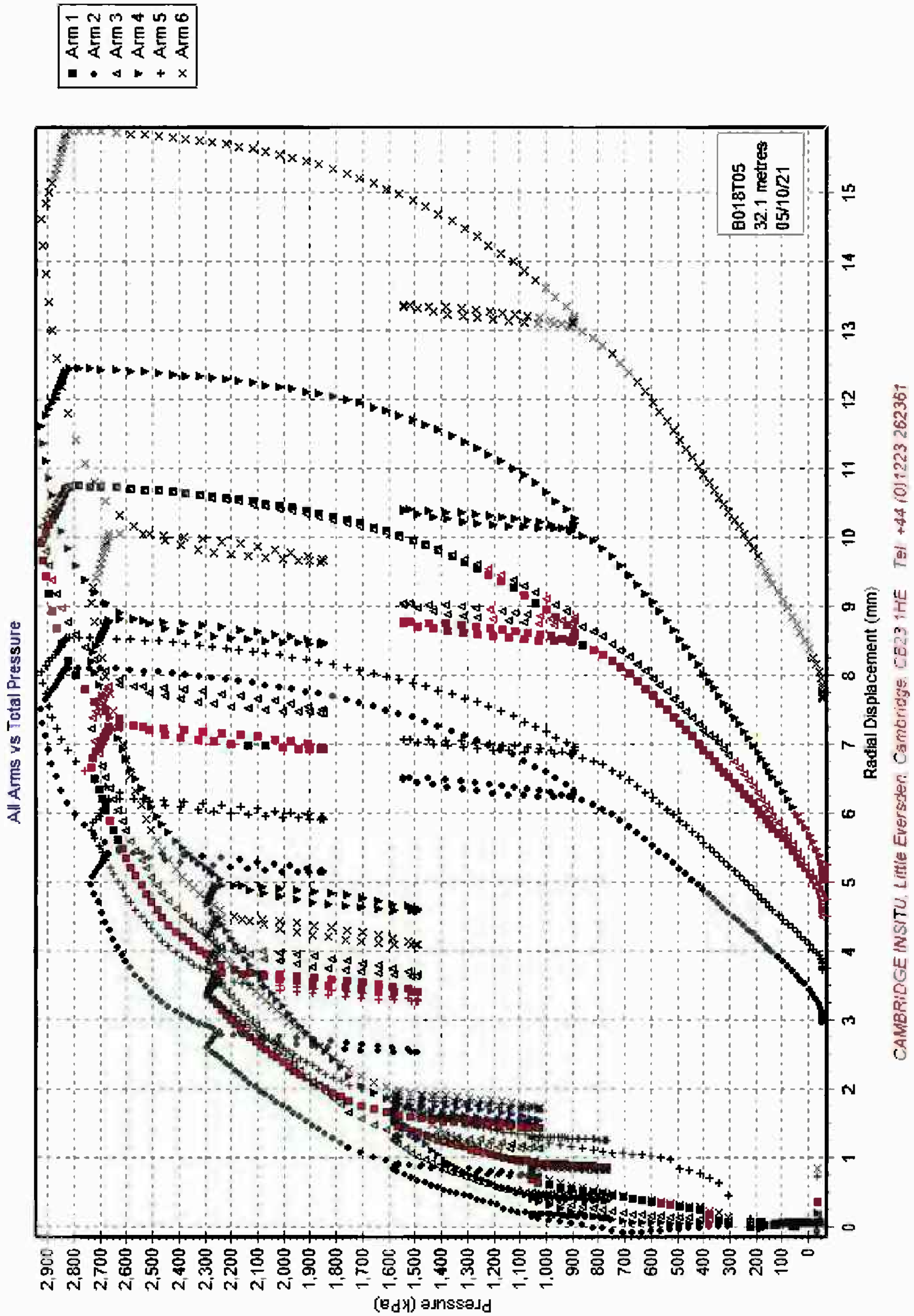

Bolton and Whittle (1999) Loop 3 : Arm ave
95mm High Pressure Dilatometer
BH_TUN_018PM Test 5
32.10 Metres
5 Oct 21
RESULTS:
Gradient (beta) : 0.635
Intercept (n) : 11.848MPa
Shear stress constant : 7.523MPa
Ln[Radial stress]
4.6
4.7
4.8
4.9
5
5.1
5.2
5.3
5.4
5.5
5.6
5.7
5.8
5.9
6
6.1
6.2
6.3
6.4
Ln[shear strain]
-7
-6
-5
Source data - Loop 3
Total pressure (kPa)
1,500
1,600
1,700
1,800
1,900
2,000
2,100
Radial Displacement (mm)
3.6
3.7
3.8
3.9

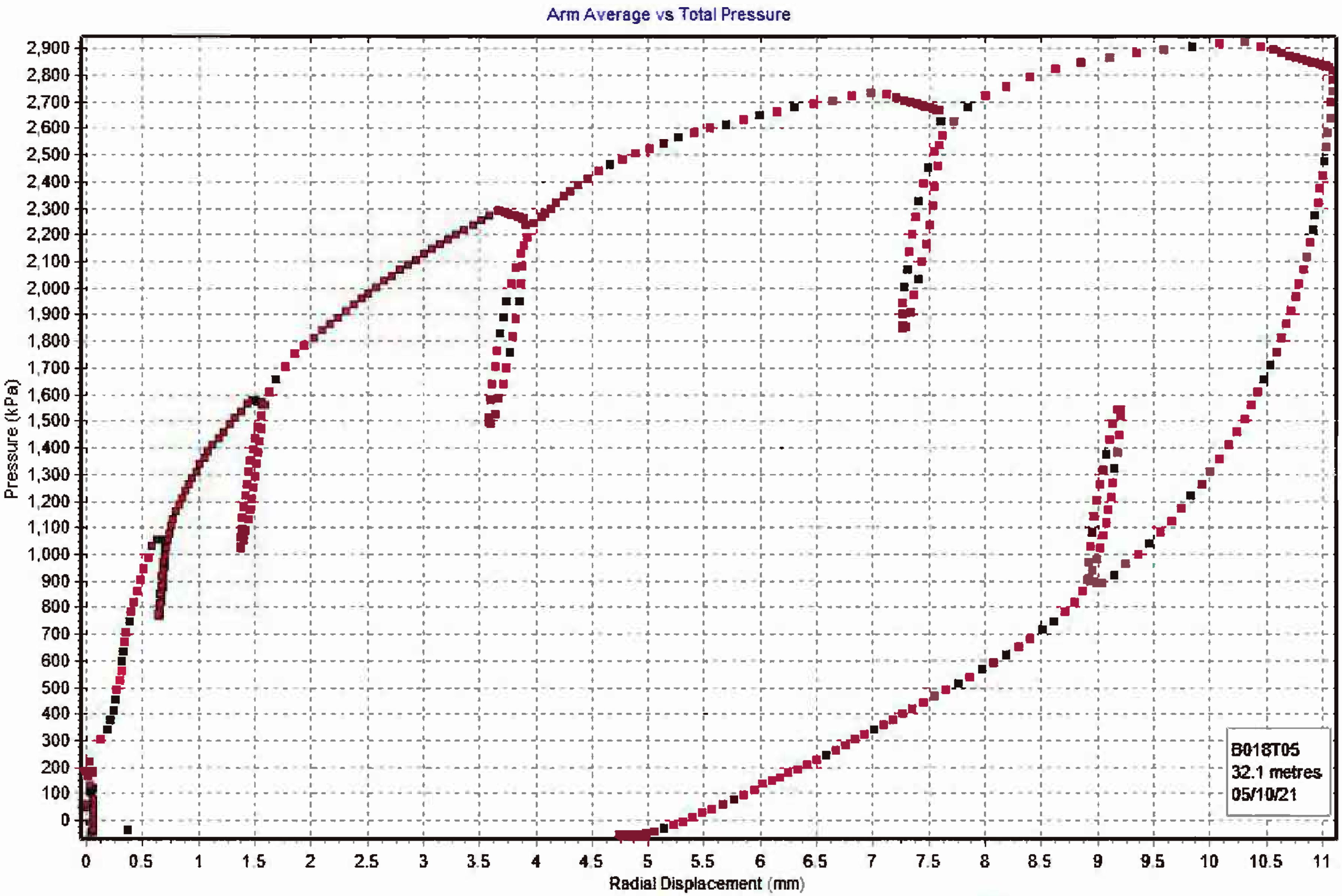

Bolton and Whittle (1999) Loop 4 : Arm ave
95mm High Pressure Dilatometer
BH_TUN_018PM Test 5
32.10 Metres
5 Oct 21
RESULTS:
Gradient (beta) : 0.608
Intercept (n) : 11.578MPa
Shear stress constant : 7.039MPa
Ln[Radial stress]
4
4.1
4.2
4.3
4.4
4.5
4.6
4.7
4.8
4.9
5
5.1
5.2
5.3
5.4
5.5
5.6
5.7
5.8
5.9
6
6.1
6.2
6.3
6.4
6.5
Ln[shear strain]
-8
-7
-6
-5
Source data - Loop 4
Total pressure (kPa)
1,900
2,000
2,100
2,200
2,300
2,400
2,500
Radial Displacement (mm)
7.3
7.4
7.5


Bolton and Whittle (1999) Loop 5 : Arm ave
95mm High Pressure Dilatometer
BH_TUN_018PM Test 5
32.10 Metres
5 Oct 21
RESULTS:
Gradient (beta) : 0.589
Intercept (n) : 10.445MPa
Shear stress constant : 6.154MPa
Ln[Radial stress]
6.4
6.3
6.2
6.1
6
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
Ln[shear strain]
-7
-6
-5
Source data - Loop 5
Total pressure (kPa)
1,500
1,400
1,300
1,200
1,100
1,000
Radial Displacement (mm)
9
9.1
9.2


Variation of stiffness with strain, undrained analysis : Arm ave
POWER LAW PARAMETERS:
Cycle No. | Constant (MPa) | Gradient
1 | 7.989 | 0.647
2 | 8.147 | 0.651
3 | 7.523 | 0.635
4 | 7.039 | 0.608
5 | 6.154 | 0.589
95mm High Pressure Dilatometer
BH_TUN_018PM Test 5
32.10 Metres
5 Oct 21
Shear modulus (MPa)
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
0.0001
0.001
Log plane shear strain


Curve comparison (Whittle 1999) : Arm ave
95mm High Pressure Dilatometer
BH_TUN_018PM Test 5
32.10 Metres
5 Oct 21
CURVE FIT PARAMETERS:
Origin : 2.540mm
Po : 932.0kPa
Cu : 394.9 kPa
Beta : 0.589
Alpha : 6.443 MPa
Total pressure (kPa)
2,900
2,800
2,700
2,600
2,500
2,400
2,300
2,200
2,100
2,000
1,900
1,800
1,700
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
0
Cavity strain (%)
-4
-3
-2
-1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16


All Arms vs Total Pressure
■ Arm 1
● Arm 2
▵ Arm 3
▾ Arm 4
+ Arm 5
× Arm 6
B018T05
32.1 metres
05/10/21
Radial Displacement (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Pressure (kPa)
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
1,300
1,400
1,500
1,600
1,700
1,800
1,900
2,000
2,100
2,200
2,300
2,400
2,500
2,600
2,700
2,800
2,900
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel +44 (0)1223 262361

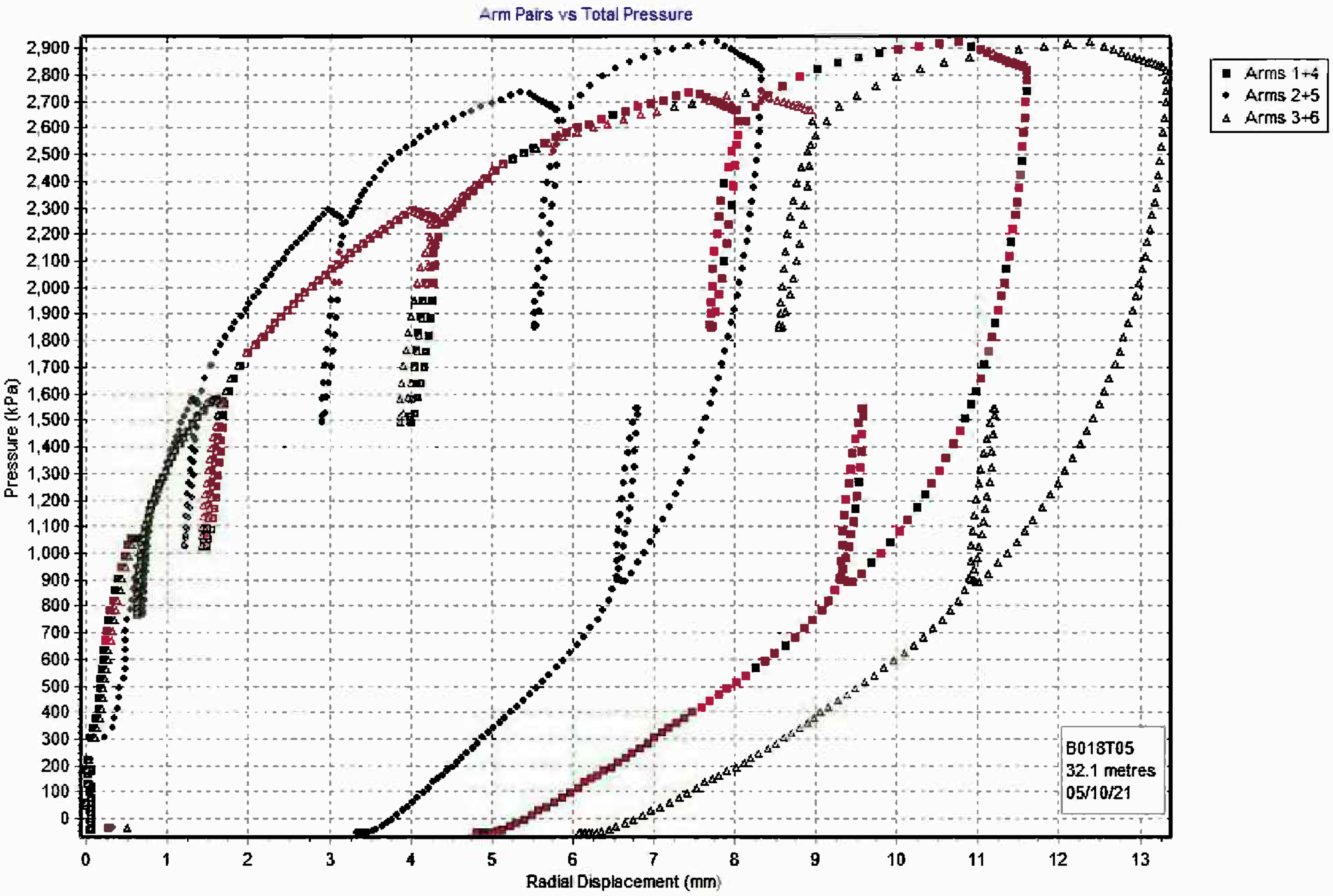


CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel. +44 (0)1223 262361

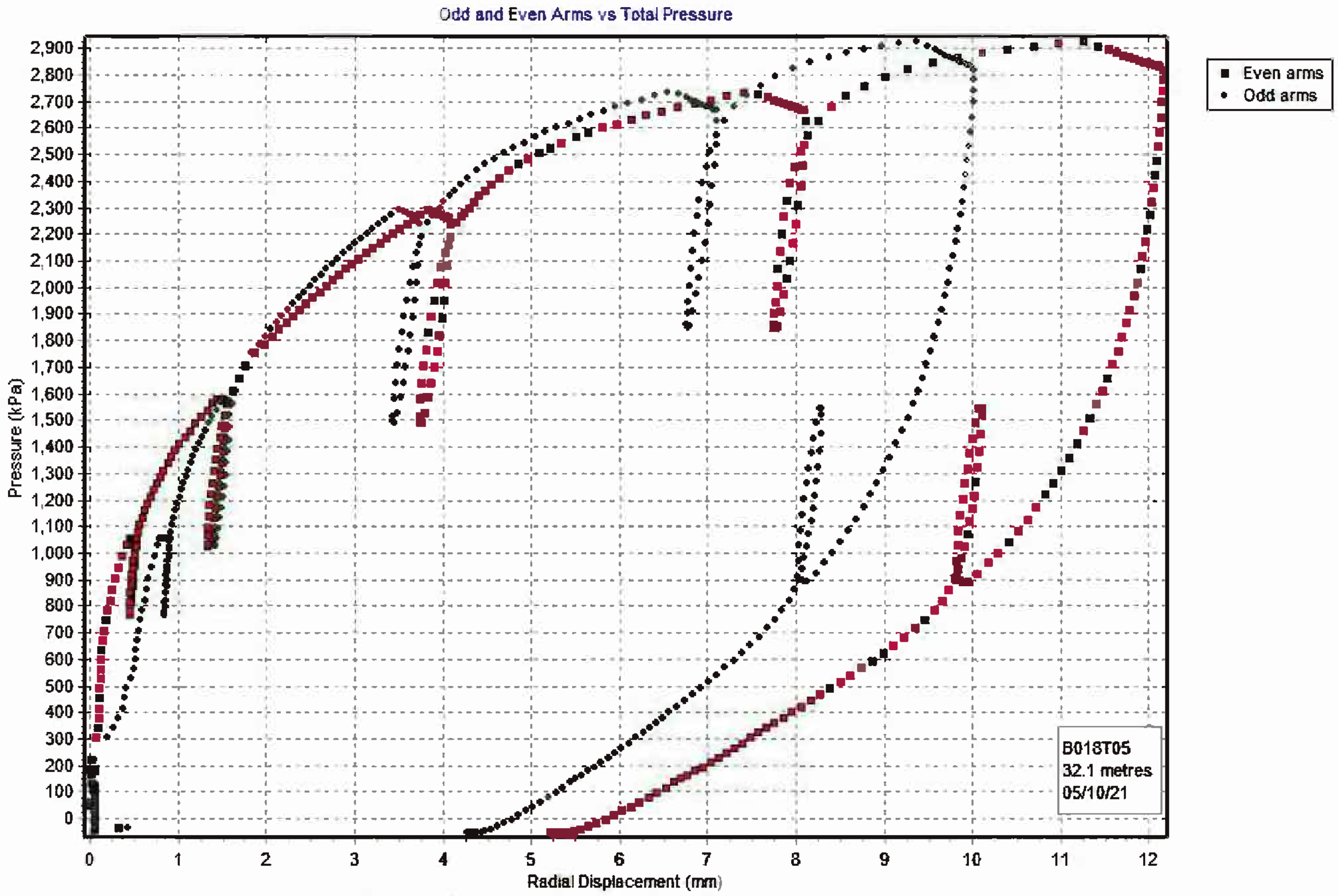
CIR1506/21

Cambridge WWTPR

Pressuremeter Testing



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel: +44 (0)1223 262361



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel: +44 (0)1223 262361

CALIBRATION DATA

DESCRIPTION	DATE	PROBE	NOTES
Transducers	19/07/2021	Shula SBP	Full calibration of all sensors
E1907T21	19/07/2021	Shula SBP	System compliance
E1907T22	19/07/2021	Shula SBP	Membrane stiffness
E0610T21	06/10/2021	Shula SBP	System compliance
E0610T22	06/10/2021	Shula SBP	Membrane stiffness
Straightness	14/10/2020	Shula SBP	Straightness check
Transducers	13/07/2021	Wally HPD	Full calibration of all sensors
E0907T21	09/07/2021	Wally HPD	System compliance
E0907T21	09/07/2021	Wally HPD	Membrane stiffness
Transducers	13/07/2021	Dougal SBP	Full calibration of all sensors
E0309T21	03/09/2021	Dougal SBP	System compliance
E0309T22	03/09/2021	Dougal SBP	Membrane stiffness
Straightness	14/10/2020	Dougal SBP	Straightness check

Calibration Date	Operator	Instrument Type	Serial Number	Instrument Name
19/07/2021	EJS	SBP	170530	Shula

Notes: Faulty PPC B replaced

Pressure cells

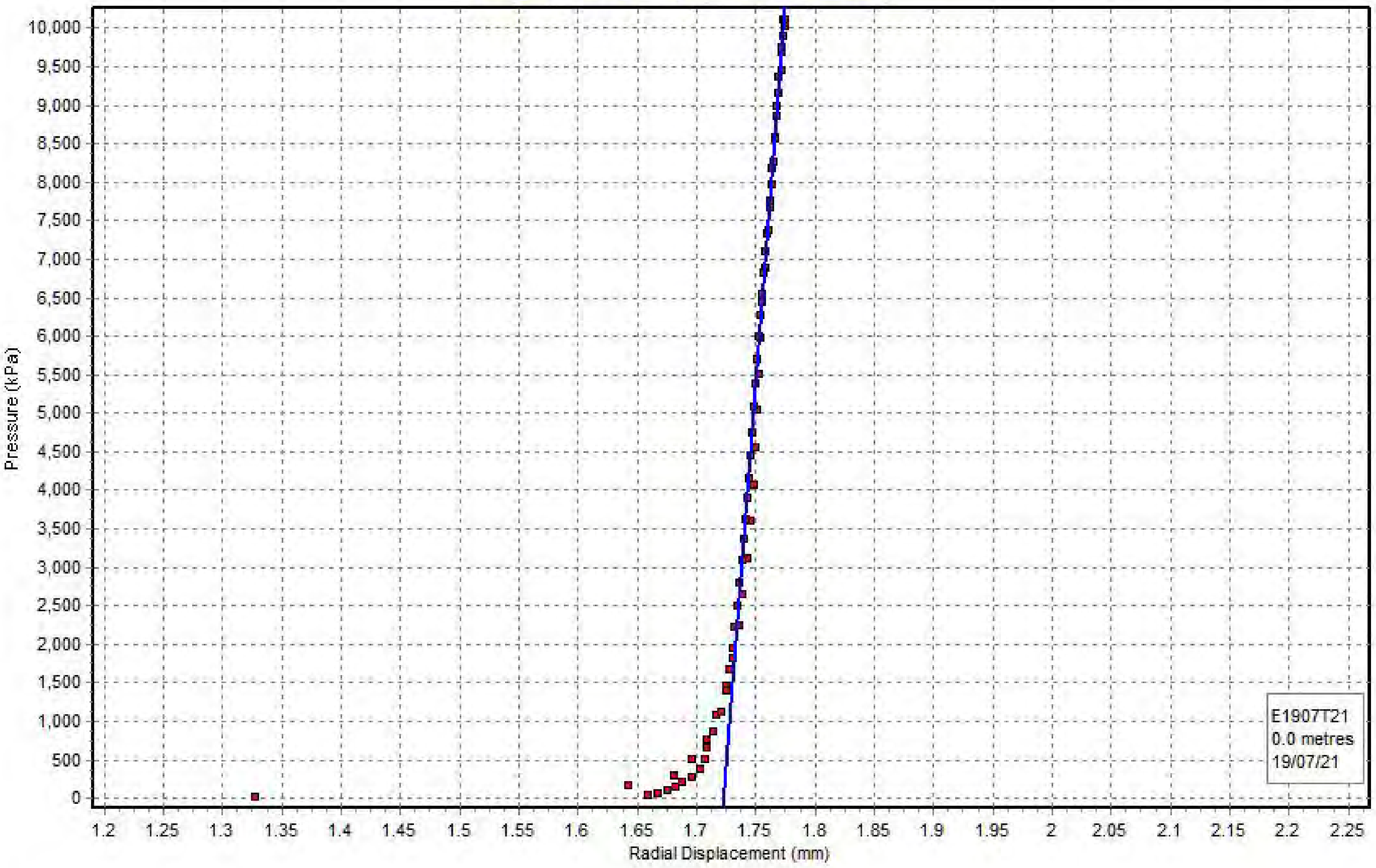
Test Gauge:

Gauge Zero Offset (Bar) 0.0

Mpa	TPC (mV)	Linearity (%)	Hysteresis (%)	PPC A (mV)	Linearity (%)	Hysteresis (%)	PPC B (mV)	Linearity (%)	Hysteresis (%)
0.00	-2381.8	98.6	0.01	-2562.4	100.6	-0.01	-2294.1	100 9	-0.11
1.00	-1930.8	98.9	-0.06	-2157.5	99.4	-0.09	-1902.1	100.1	-0.17
2.00	-1478.4	99.0	-0.05	-1757.4	99.2	-0.13	-1513.1	99.8	-0.17
3.00	-1025.6	98.7	-0.14	-1358.4	106.7	-0.25	-1125.4	98.8	-0.30
4.00	-574.1	100.4	-0.18	-929.2	92.3	0.49	-741.4	101 0	-0.39
5.00	-114.9	100.6	-0.16	-557.9	100.4	-0.29	-349.0	100.6	-0.33
6.00	345.0	101.2	-0.14	-153.8	100.9	-0.26	41.7	100.6	-0.31
7.00	808.0	100.1	-0.08	252.3	100.1	-0.18	432.7	99.1	-0.25
8.00	1265.7	100.9	-0.13	655.1	100.7	-0.19	817.7	99.7	0.38
9.00	1727.3	101.8	-0.07	1060.5	101.2	-0.10	1205.2	100.6	-0.24
10.00	2192.9	-101.1		1467.9	-100.2		1595.9	-98.2	
9.00	1730.5	-100.4		1064.5	-99.8		1214.4	-105.9	
8.00	1271.6	-100.6		662.8	-100.2		803.0	-92.8	
7.00	811.5	-100.6		259.7	-100.2		442.6	-100.1	
6.00	351.6	-100.4		-143.4	-100.1		53.7	-100.3	
5.00	-107.4	-100.2		-546.3	-100.0		-336.1	-100.5	
4.00	-565.7	-99.2		-948.8	-99.3		-726.4	-99.7	
3.00	-1019.3	-99.9		-1348.4	-100.3		-1113.6	-101.1	
2.00	-1476.0	-98.9		-1752.2	-99.8		-1506.3	-100.2	
1.00	-1928.2	-99.3		-2153.9	-101.4		-1895.6	-101.5	
0.00	-2382.4			-2562.0			-2289.8		
Zero	-2390.9 mV			-2559.5 mV			-2287.4 mV		
Slope	457.3 mV/MPa			402.4 mV/MPa			388.5 mV/MPa		

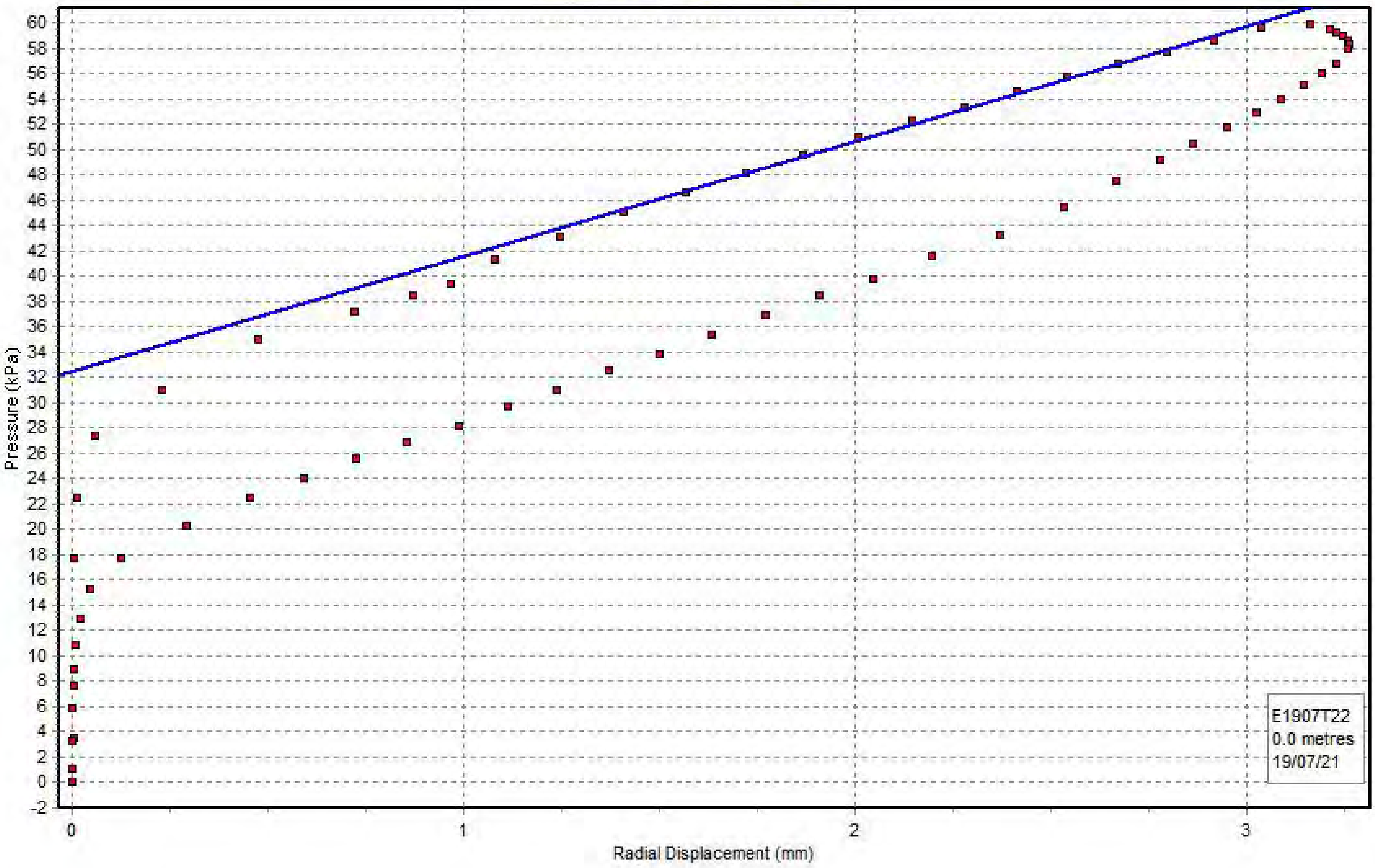
Arm Springs

mm	Arm 1 (mV)	Linearity (%)	Hysteresis (%)	Arm 2 (mV)	Linearity (%)	Hysteresis (%)	Arm 3 (mV)	Linearity (%)	Hysteresis (%)	Arm 4 (mV)	Linearity (%)	Hysteresis (%)	Arm 5 (mV)	Linearity (%)	Hysteresis (%)	Arm 6 (mV)	Linearity (%)	Hysteresis (%)
0	9.3	100.6	0.04	-811.2	101.0	0.01	-250.6	100 8	0.00	160.9	100.7	0.01	159.6	102.0	0.03	-56.0	101.4	-0.01
1	317.5	100.6	0.11	-481.3	100.6	0.19	79.0	100 8	0.24	493.3	100.6	0.17	496.6	100.4	0.26	277.6	100.4	0.12
2	625.6	99.9	0.21	-152.9	100.0	0.24	408.4	100 0	0.35	825.2	100.0	0.24	828.3	100.0	0.30	608.0	99.9	0.14
3	931.5	99.6	0.17	173.5	99.5	0.21	735.3	100 2	0.35	1155.2	99.6	0.24	1158.7	99.4	0.30	936.6	99.5	0.16
4	1236.5	99.6	0.14	498.5	100.0	0.12	1062.7	99.2	0.31	1483.9	99.9	0.20	1487.2	99.3	0.25	1264.0	99.6	0.13
5	1541.6	99.8	0.08	824.9	97.7	0.07	1387.0	97.7	0.09	1813.5	98.8	0.12	1815.4	98.9	0.18	1591.6	99.6	0.09
6	1847.3	-100.3		1144.0	-98.1		1706.4	-98.3		2139.5	-99.5		2142.1	-100.0		1919.4	-100.2	
5	1540.1	-99.9		823.6	-100.3		1385.2	-100.5		1811.1	-100.4		1811.8	-99.7		1589.8	-99.8	
4	1234.0	-99.8		496.1	-100.1		1056.6	-100.4		1479.9	-99.9		1482.3	-99.7		1261.4	-99.7	
3	928.3	-100.1		169.3	-100.1		728.4	-100.0		1150.4	-100.0		1152.8	-100.0		933.5	-99.8	
2	621.7	-100.0		-157.6	-100.3		401.6	-100.1		820.4	-100.1		822.4	-100.2		605.3	-100.3	
1	315.5	-100.2		-485.1	-99.9		74.4	-99.4		490.0	-99.8		491.4	-100.6		275.3	-100.6	
0	8.6			-811.3			-250.6			160.8			159.0			-55.8		
Zero	10.1 mV			-809.4 mV			-249.5 mV			161.9 mV			162.5 mV			-53.4 mV		
Slope	306.3 mV/mm			326.5 mV/mm			326.9 mV/mm			330.0 mV/mm			330.4 mV/mm			329.0 mV/mm		

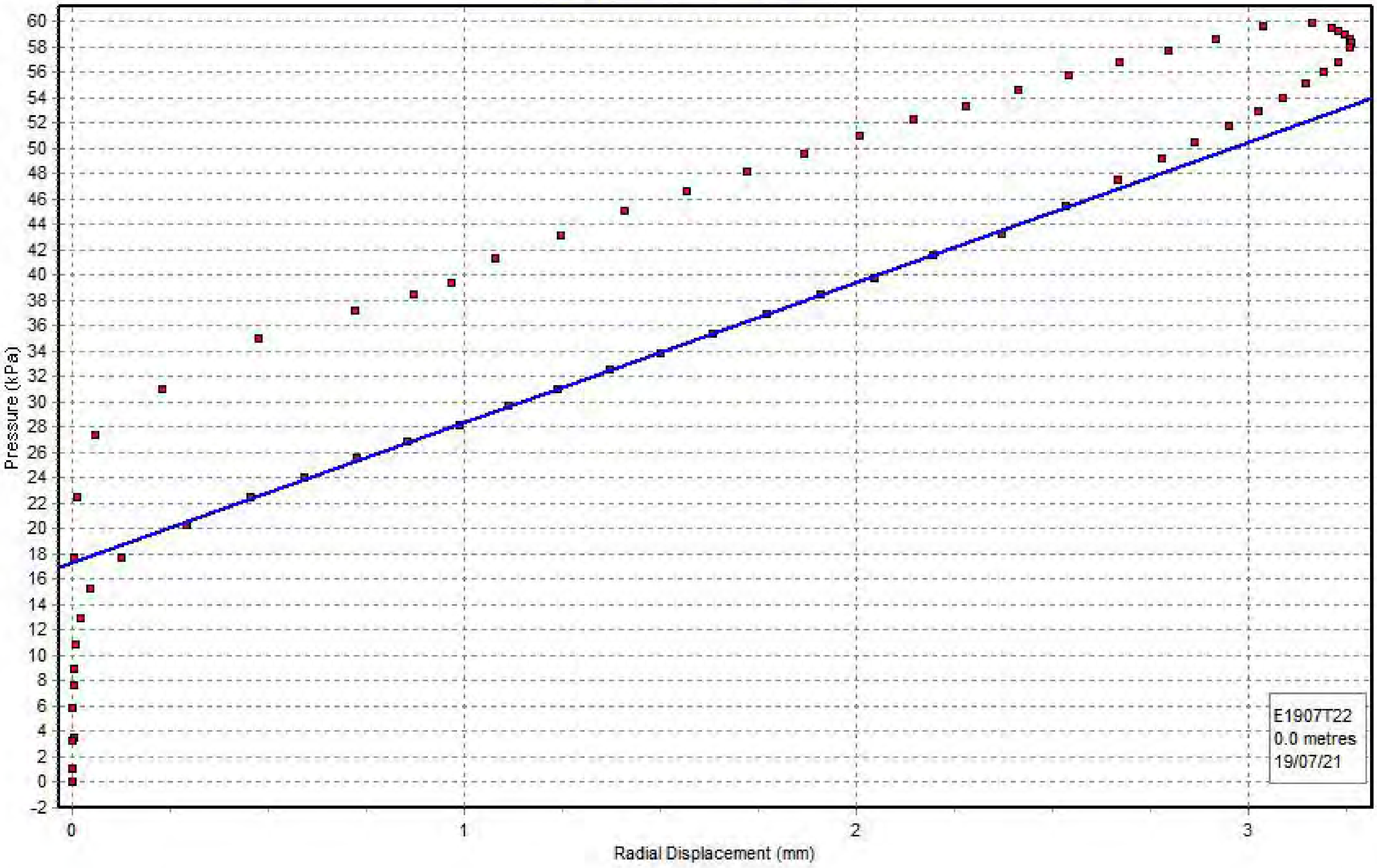


Arm Average vs Total Pressure - CALIBRATION FOR SYSTEM STIFFNESS
SLOPE: 3.4 mm/GPa   (Cylinder slope = 1.6 mm/GPa)

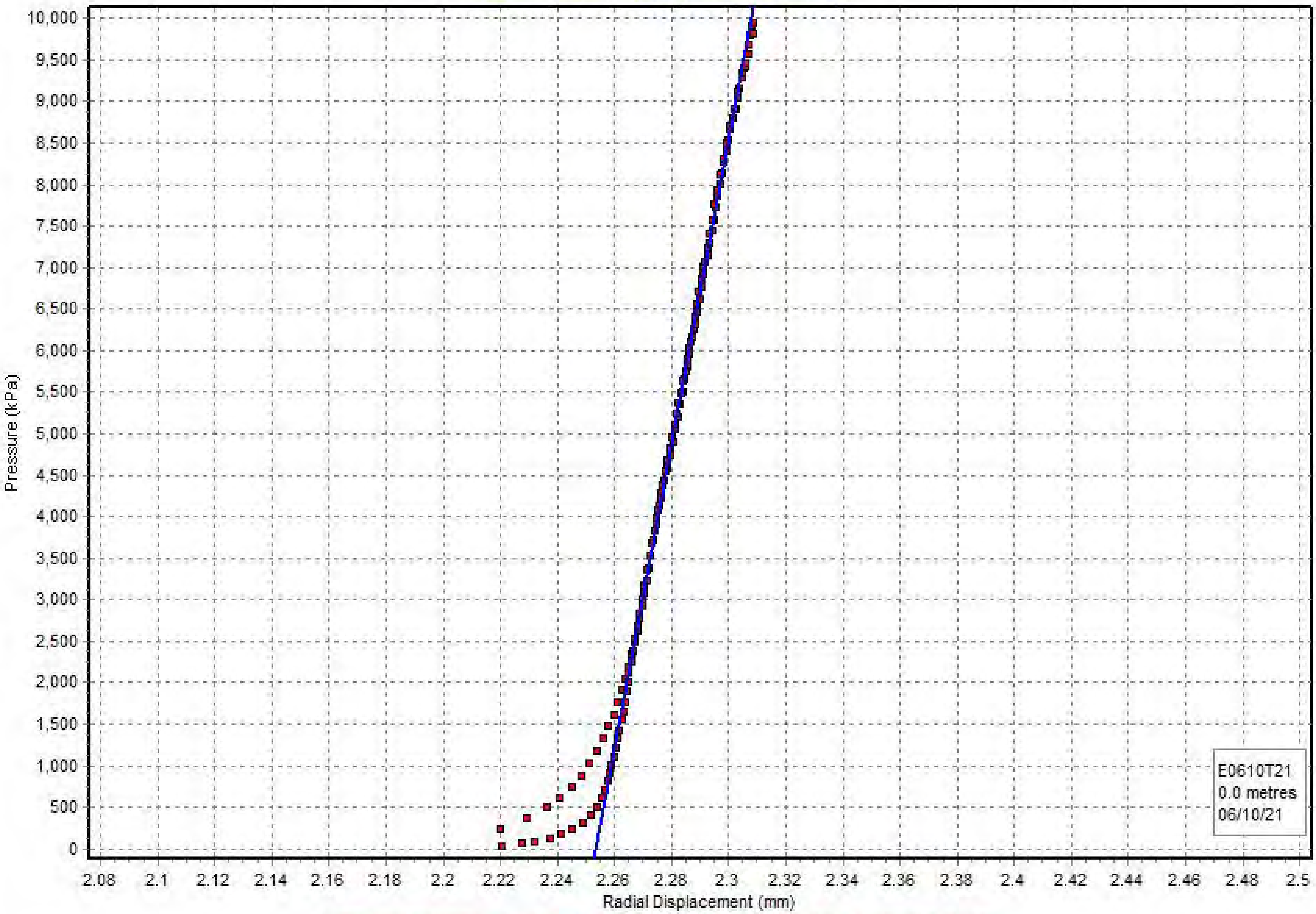
Arm Average vs Total Pressure - CALIBRATION FOR MEMBRANE STIFFNESS
ZERO: 32.5 kPa   SLOPE: 9.1 kPa/mm



Arm Average vs Total Pressure - CALIBRATION FOR MEMBRANE STIFFNESS
ZERO: 17.3 kPa SLOPE: 11.0 kPa/mm

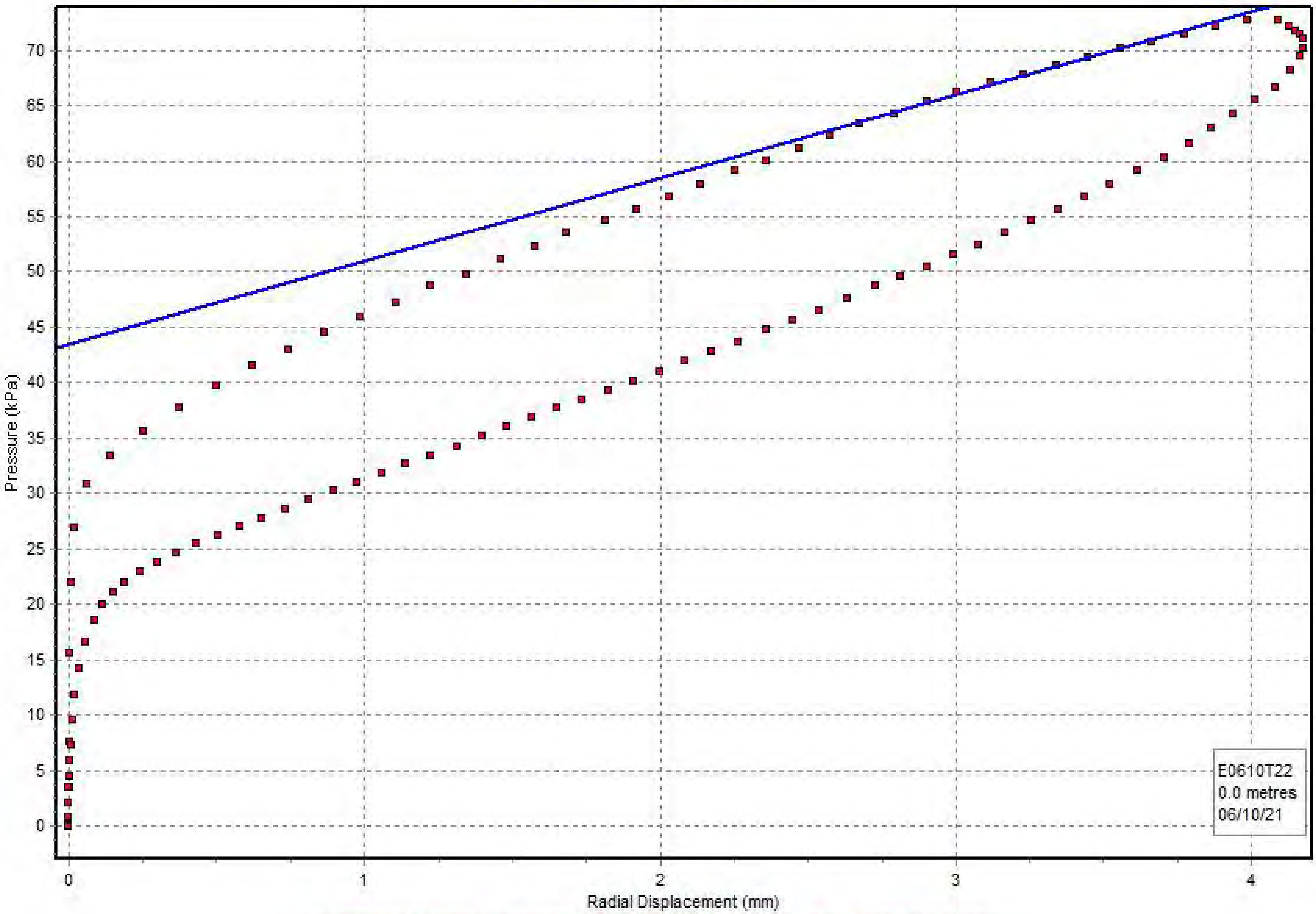


Arm Average vs Total Pressure - CALIBRATION FOR SYSTEM STIFFNESS
SLOPE: 3.3 mm/GPa (Cylinder slope = 2.2 mm/GPa)



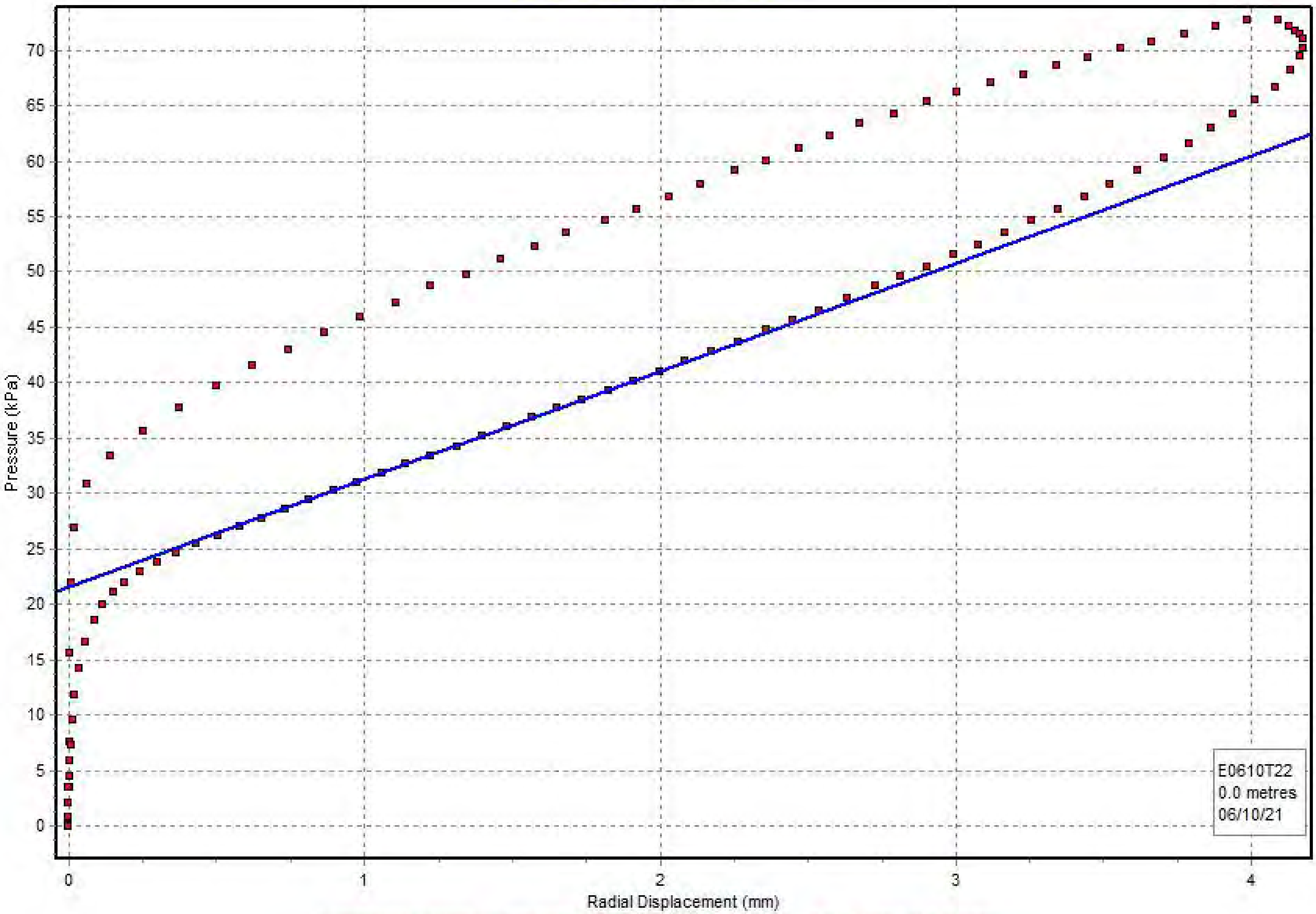
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel: +44 (0)1223 262361

Arm Average vs Total Pressure - CALIBRATION FOR MEMBRANE STIFFNESS
ZERO: 43.4 kPa SLOPE: 7.5 kPa/mm



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel: +44 (0)1223 262361

Arm Average vs Total Pressure - CALIBRATION FOR MEMBRANE STIFFNESS
ZERO: 21.5 kPa SLOPE: 9.7 kPa/mm



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel: +44 (0)1223 262361

Self Boring Pressuremeter straightness calibration sheet

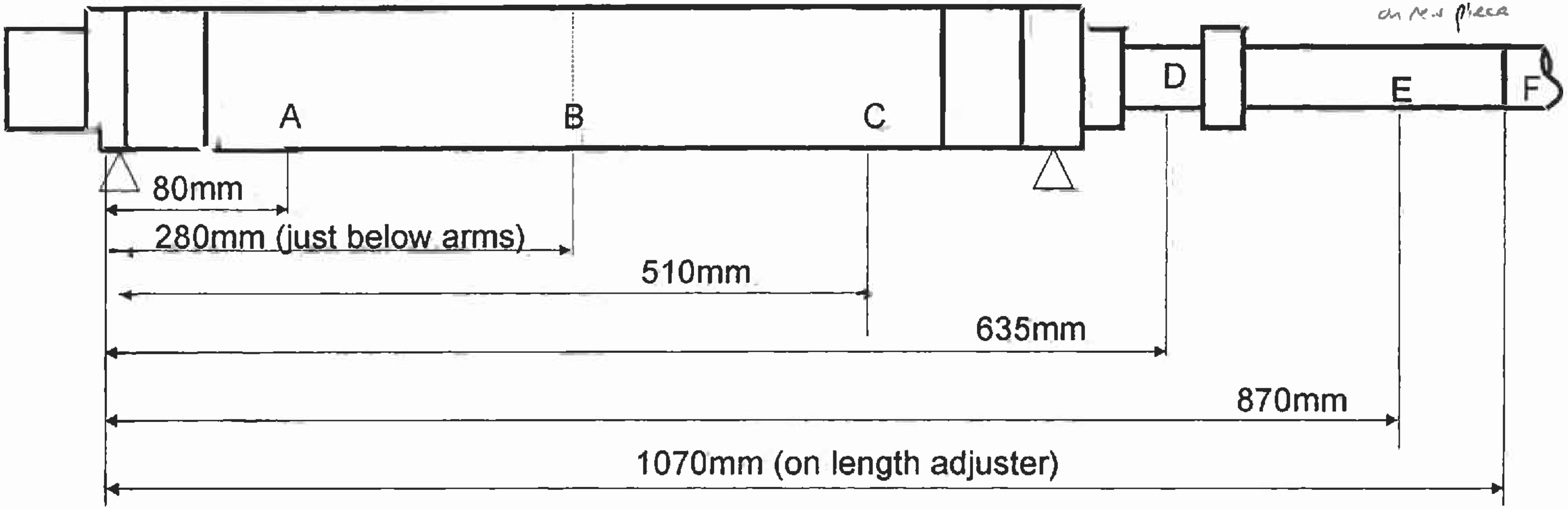
on new piece
0.66mm

Total Runout at -	A: 0.25	B: N/A	C: 0.1mm	D: 0.2mm	E: 0.36mm	F: 0.57mm
After Straightening -	A: 0.25	B: N/A	C: 0 1mm	D: 0.2mm	E: 0.19mm	F: 0.15mm

on clamp ring

on clamp ring

0.3mm
on new piece



Date of check
14/10/20

Serial Number

Instrument Name
SHULA

Operator Signature
[redacted]

Initials
SPB

Comments
Quick check after new tube end fitted. Membrane was on probe (ready to use), so could not check [illegible]

CAMBRIDGE INSITU LTD
LITTLE EVERSDEN
CAMBRIDGE
CB23 1HE

T: +44 1223 262962
E: cam@cambridge-insitu.com
W: www.cambridge-insitu.com

Drawn By JJB	Date 20140303	Scale NTS
Description Checking Straightness of Self Boring Pressuremeter		
Item Number		Iss
File Location \\camb-sbs2011\Public\Working Instructions\Calibration Sheets\20140303 SBP Straightness Calibration Sheet Rev1.odg		

Calibration Date	Operator	Instrument Type	Serial Number	Instrument Name
13-Jul-21	B/KGCS/EJS (pressure	HPD	160208	Wally

Notes: Arms calibrated 06/05/21; Arms 4 and 6 redone 13/05/21 KC; Pressure Cells 13/7/21

Arm Springs

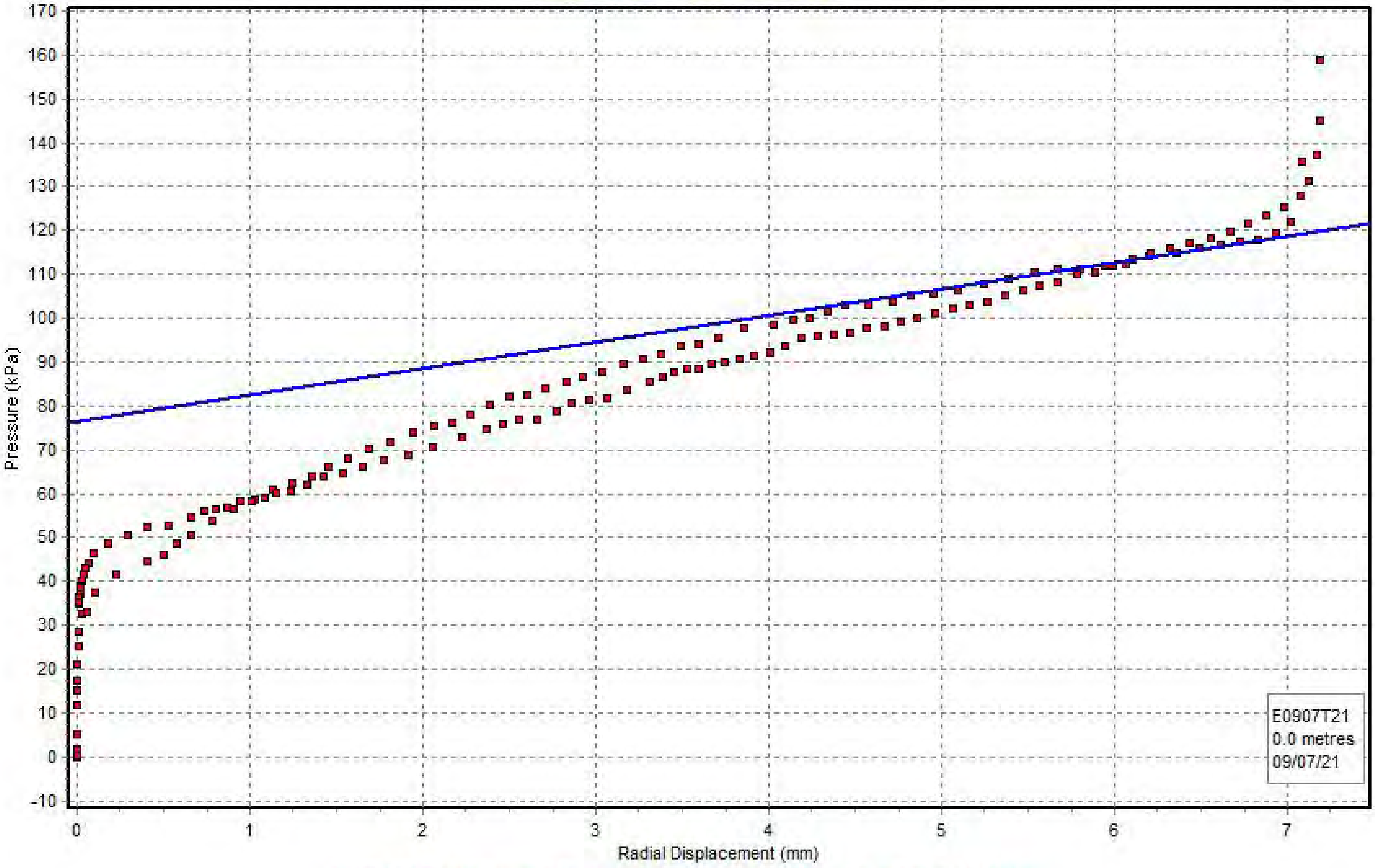
mm	Arm 1	Linearity	Hysteresis	Arm 2	Linearity	Hysteresis	Arm 3	Linearity	Hysteresis	Arm 4	Linearity	Hysteresis	Arm 5	Linearity	Hysteresis	Arm 6	Linearity	Hysteresis
	(mV)	(%)	(%)	(mV)	(%)	(%)	(mV)	(%)	(%)	(mV)	(%)	(%)	(mV)	(%)	(%)	(mV)	(%)	(%)
0	-2006.0	103.3	0.05	-2624.1	103.3	0.04	-2252.7	102.3	0.05	-2062.5	98.1	0.00	-2278.1	102.5	0.02	-2041.8	109.2	0.08
2	-1704.4	102.2	0.11	-2337.0	102.0	0.03	-1953.7	101.7	0.07	-1786.5	102.6	-0.07	-1992.4	101.8	-0.03	-1768.1	103.1	0.03
4	-1406.1	101.6	0.14	-2053.6	101.3	-0.03	-1656.2	101.7	0.10	-1497.8	101.9	-0.05	-1708.8	101.2	-0.05	-1509.6	101.8	0.16
6	-1109.4	100.5	0.16	-1772.2	100.5	-0.09	-1358.7	101.4	0.12	-1211.2	100.9	-0.01	-1426.7	100.6	-0.06	-1254.5	100.5	0.07
8	-815.9	100.0	0.16	-1493.0	99.5	-0.12	-1062.2	99.9	0.16	-927.3	100.5	-0.01	-1146.4	100.2	-0.06	-1002.5	99.2	0.00
10	-523.9	99.7	0.18	-1216.7	99.5	-0.15	-770.0	99.2	0.19	-644.6	99.8	0.03	-867.2	99.5	-0.05	-753.9	98.7	-0.06
12	-232.9	98.7	0.20	-940.4	98.6	-0.15	-479.9	98.7	0.16	-363.7	98.9	0.03	-590.0	98.4	-0.06	-506.6	97.9	-0.09
14	55.2	98.1	0.17	-666.4	98.8	-0.16	-191.4	98.3	0.12	-85.3	98.1	0.04	-315.9	98.8	-0.07	-261.1	97.3	-0.12
16	341.6	98.4	0.15	-392.0	98.0	-0.12	96.1	98.2	0.10	190.8	98.1	-0.06	-40.7	98.7	-0.04	-17.3	97.7	-0.10
18	628.9	97.6	0.13	-119.7	98.9	-0.07	383.1	97.5	0.06	466.9	98.9	0.00	234.4	98.7	-0.02	227.6	96.7	0.00
20	913.9	-98.9		155.1	-98.2		668.3	-98.1		745.1	-98.9		509.4	-98.5		469.9	-96.7	
18	625.1	-98.6		-117.7	-97.6		381.4	-98.5		466.9	-97.5		235.0	-98.5		227.6	-96.8	
16	337.2	-98.3		-388.8	-98.3		93.3	-98.5		192.6	-99.2		-39.5	-98.5		-14.9	-97.0	
14	50.2	-98.9		-662.0	-98.7		-194.8	-99.1		-86.5	-98.8		-313.9	-98.5		-258.1	-98.3	
12	-238.6	-99.6		-936.2	-99.5		-484.5	-99.5		-364.5	-99.9		-588.3	-99.6		-504.4	-98.9	
10	-529.3	-99.8		-1212.6	-99.7		-775.5	-99.7		-645.5	-100.0		-865.8	-100.1		-752.4	-99.8	
8	-820.6	-100.5		-1489.6	-100.8		-1067.0	-101.0		-927.0	-100.9		-1144.8	-100.5		-1002.6	-101.2	
6	-1114.2	-101.4		-1769.6	-102.0		-1362.3	-101.5		-1211.0	-101.4		-1424.9	-101.4		-1256.3	-102.7	
4	-1410.3	-101.8		-2052.9	-102.6		-1659.1	-101.4		-1496.4	-102.4		-1707.5	-102.0		-1513.6	-101.9	
2	-1707.5	-102.7		-2337.9	-103.4		-1955.6	-102.1		-1784.4	-98.8		-1991.7	-103.0		-1768.9	-109.7	
0	-2007.5			-2625.1			-2254.1			-2062.4			-2278.7			-2043.8		
Intercept	-1994.0	mV		-2611.1	mV		-2242.6	mV		-2058.7	mV		-2267.1	mV		-2017.6	mV	
Slope	146.0	mV/mm		138.9	mV/mm		146.2	mV/mm		140.7	mV/mm		139.3	mV/mm		125.3	mV/mm	
lax Output		mV			mV			mV			mV			mV			mV	
lin Output		mV			mV			mV			mV			mV			mV	
lax Range		mm			mm			mm			mm			mm			mm	

Pressure Cells

Gauge Zero Offset 0.0

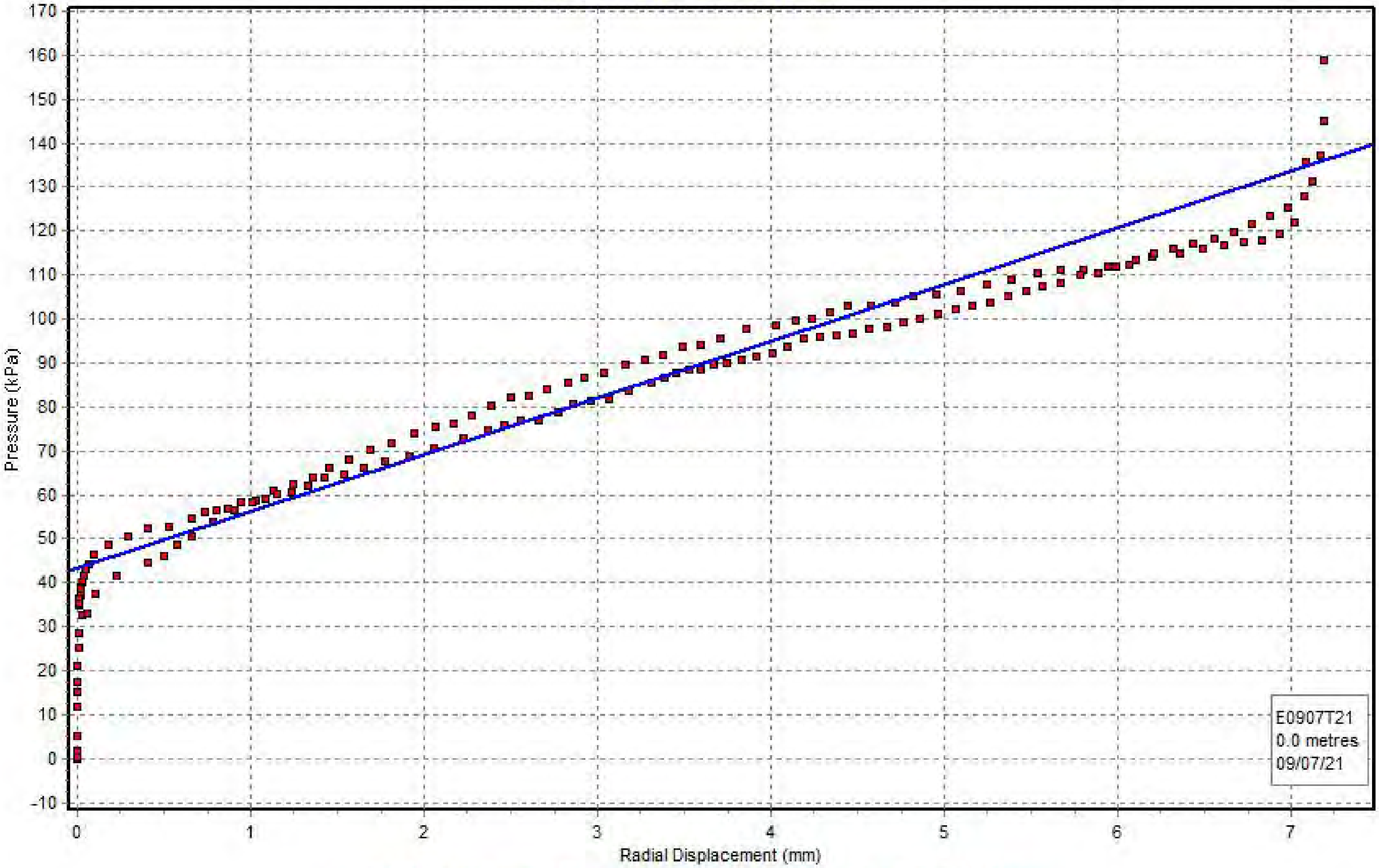
Bars	TPC A	Linearity	Hysteresis	TPC B	Linearity	Hysteresis
	(mV)	(%)	(%)	(mV)	(%)	(%)
0.0	-1595.0	100.4	-0.13	-2045.7	100.1	-0.10
20.0	-1376.5	99.7	-0.24	-1827.7	99.4	-0.21
40.0	-1159.5	99.7	-0.19	-1611.2	100.2	-0.22
60.0	-942.6	100.1	-0.19	-1393.0	99.8	-0.18
80.0	-724.8	100.2	-0.19	-1175.6	100.3	-0.22
100.0	-506.7	99.7	-0.19	-957.0	99.7	-0.21
120.0	-289.7	100.2	-0.21	-739.7	100.5	-0.20
140.0	-71.7	100.4	-0.19	-520.8	100.0	-0.16
160.0	146.8	100.6	-0.13	-303.0	100.4	-0.13
180.0	365.8	99.9	-0.06	-84.2	100.4	-0.06
200.0	583.3	99.3		134.5	99.7	
180.0	367.2	100.0		-82.8	99.8	
160.0	149.6	99.8		-300.2	99.7	
140.0	-67.6	99.9		-517.4	100.1	
120.0	-285.1	99.9		-735.4	99.7	
100.0	-502.6	100.2		-952.5	100.2	
80.0	-720.7	100.1		-1170.8	100.2	
60.0	-938.5	99.7		-1389.0	99.7	
40.0	-1155.4	99.2		-1606.3	99.6	
20.0	-1371.3	101.5		-1823.2	101.2	
0.0	-1592.1			-2043.6		
Intercept	-1592.9	mV		-2044.3	mV	
Slope	10.882	mV/Bars		10.893	mV/Bars	
Slope	108.8	mV/MPa		108.9	mV/MPa	

Arm Average vs Total Pressure - CALIBRATION FOR MEMBRANE STIFFNESS
ZERO: 76.4 kPa SLOPE: 6.1 kPa/mm



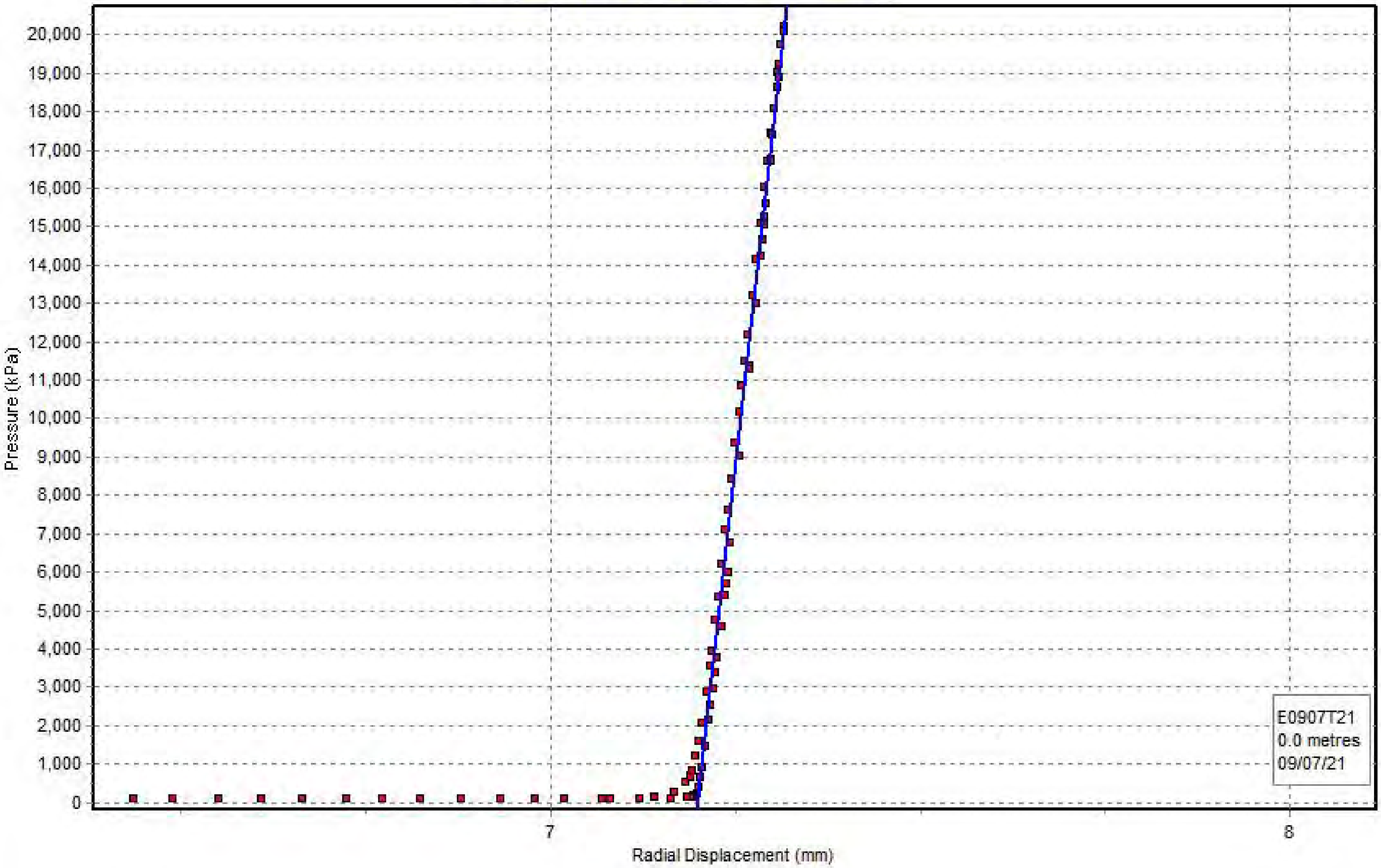
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel: +44 (0)1223 262361

Arm Average vs Total Pressure - CALIBRATION FOR MEMBRANE STIFFNESS
ZERO: 43.3 kPa SLOPE: 12.9 kPa/mm



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel: +44 (0)1223 262361

Arm Average vs Total Pressure - CALIBRATION FOR SYSTEM STIFFNESS
SLOPE: 3.1 mm/GPa (Cylinder slope = 2.7 mm/GPa)



Current Calibrations

Calibration Date	Operator	Instrument Type	Serial Number	Instrument Name
13/07/2021	ES	SBP	920123	Dougal

Notes:

Pressure cells

Test Gauge:

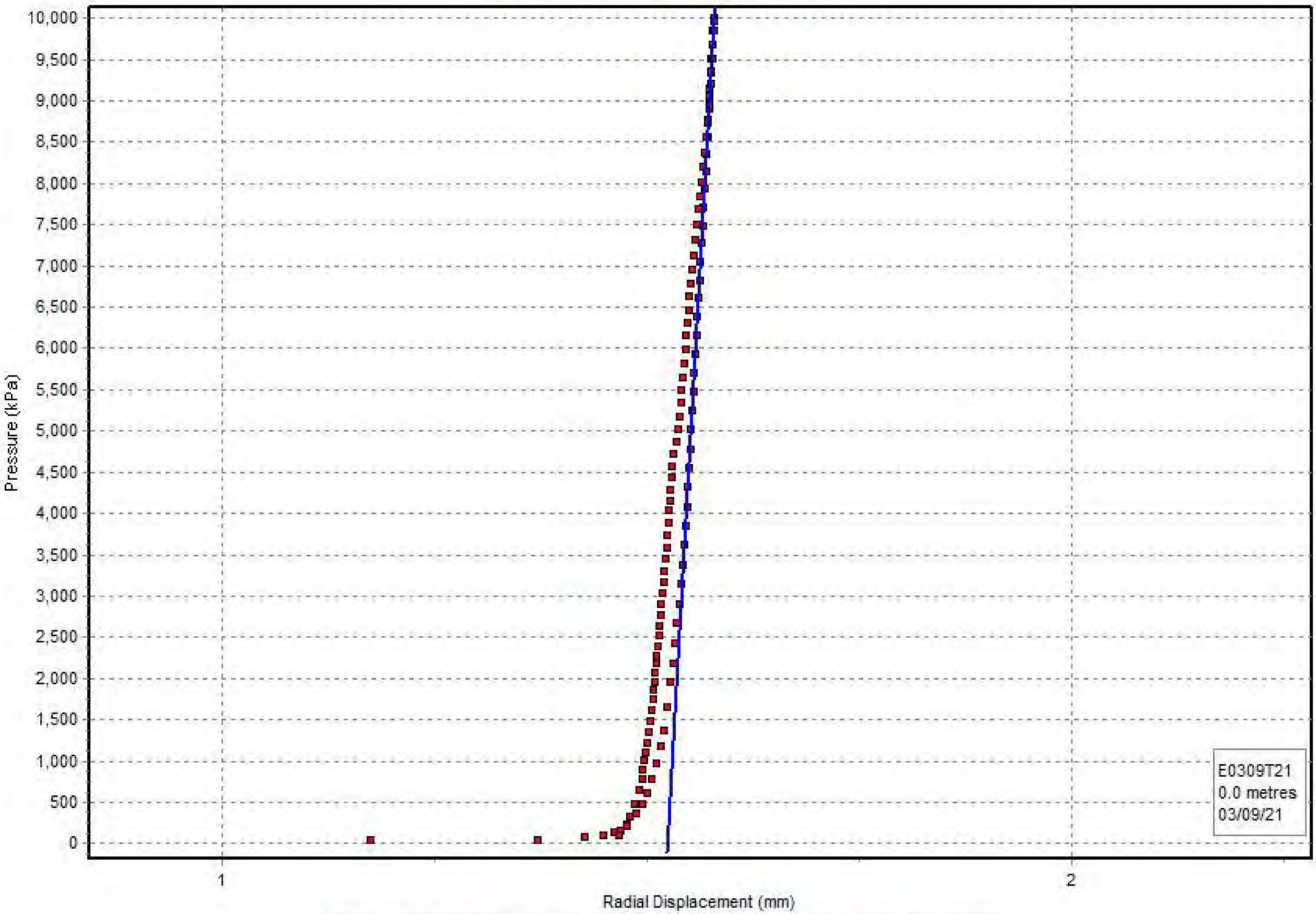
Gauge Zero Offset (Bar): 0.0

Mpa	TPC	Linearity	Hysteresis	PPC A	Linearity	Hysteresis	PPC B	Linearity	Hysteresis
	(mV)	(%)	(%)	(mV)	(%)	(%)	(mV)	(%)	(%)
0.00	-2074.3	99.4	0.01	-2136.0	100.1	-0.05	-1813.0	99.8	0.0
1.00	-1714.2	99.1	-0.08	-1705.1	100.1	-0.15	-1389.9	99.6	-0.0
2.00	-1355.0	98.9	-0.10	-1274.2	99.5	-0.14	-967.4	99.2	-0.0
3.00	-996.4	99.4	-0.16	-845.9	99.6	-0.17	-546.8	99.5	-0.14
4.00	-636.0	100.0	-0.17	-416.9	100.0	-0.18	-124.6	100.0	-0.1
5.00	-273.7	100.7	-0.16	13.8	100.4	-0.17	299.6	100.3	-0.1
6.00	91.3	100.2	-0.12	445.9	100.1	-0.13	725.0	100.4	-0.14
7.00	454.4	100.8	-0.13	876.9	100.4	-0.14	1150.7	100.5	-0.14
8.00	819.8	100.9	-0.08	1309.0	100.2	-0.12	1577.1	100.4	-0.1
9.00	1185.6	101.3	-0.06	1740.3	100.4	-0.06	2003.0	100.8	-0.07
10.00	1552.8	-100.7		2172.8	-99.8		2430.6	-100.1	
9.00	1187.7	-100.7		1743.1	-99.6		2006.0	-99.9	
8.00	822.8	-100.3		1314.3	-100.2		1582.2	-100.3	
7.00	459.2	-100.3		883.0	-100.2		1156.6	-100.4	
6.00	95.6	-100.3		451.7	-100.0		730.8	-100.1	
5.00	-267.8	-99.9		21.2	-99.9		306.2	-100.0	
4.00	-629.8	-99.6		-409.1	-99.7		-117.8	-99.7	
3.00	-990.6	-99.5		-838.4	-99.8		-540.7	-99.7	
2.00	-1351.3	-99.4		-1268.0	-100.0		-963.4	-99.7	
1.00	-1711.4	-100.2		-1698.6	-101.1		-1386.4	-100.5	
0.00	-2074.6			-2133.9			-1812.8		
Zero	**-2078.5 mV**			**-2134.0 mV**			**-1814.8 mV**		
Slope	**362.4 mV/MPa**			**430.6 mV/MPa**			**424.2 mV/MPa**		

Arm Springs

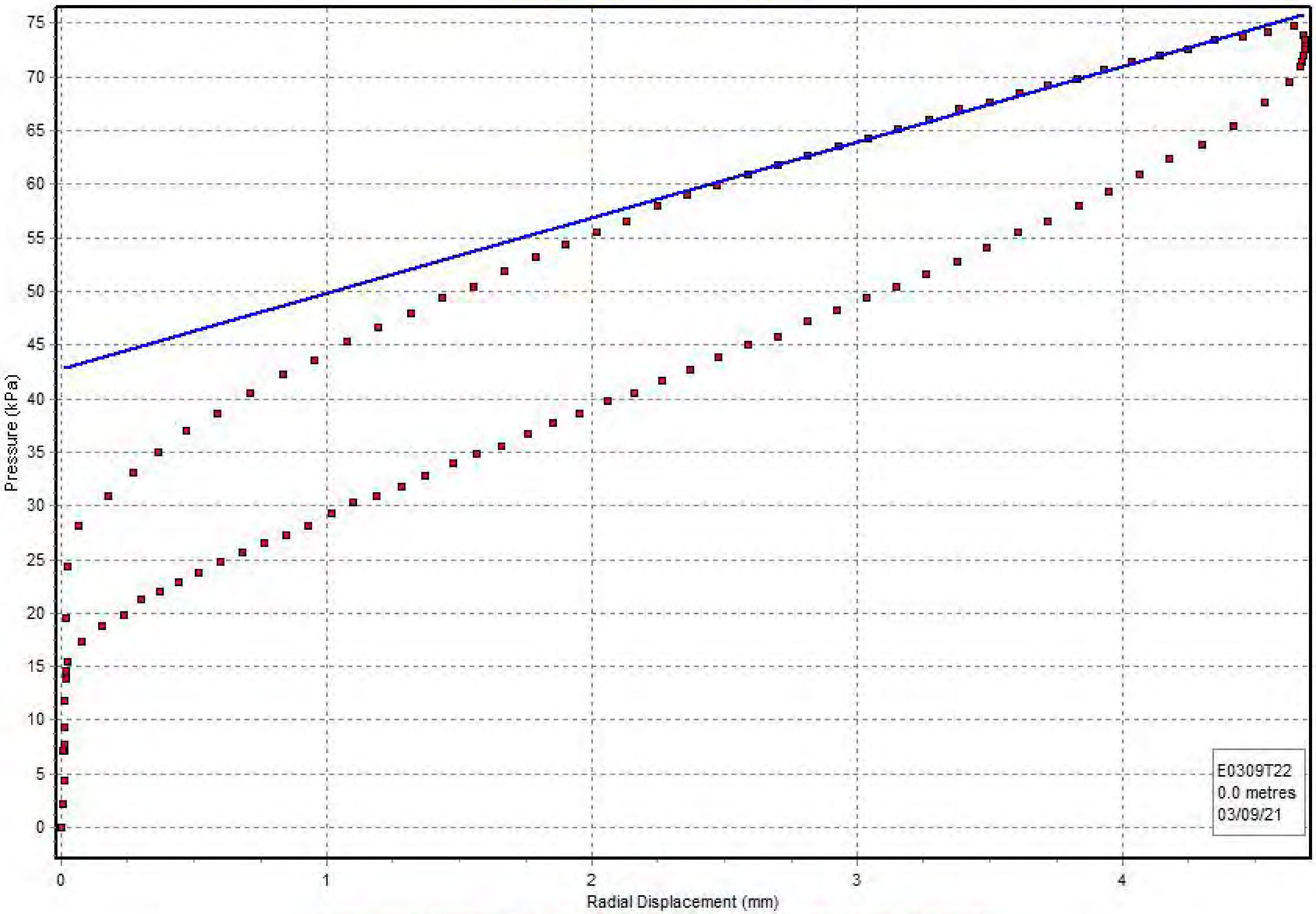
mm	Arm 1	Linearity	Hysteresis	Arm 2	Linearity	Hysteresis	Arm 3	Linearity	Hysteresis
	(mV)	(%)	(%)	(mV)	(%)	(%)	(mV)	(%)	(%)
0	103.2	101.8	0.00	192.3	101.7	-0.01	57.3	102.5	0.00
1	404.0	100.9	0.25	490.1	100.6	0.16	365.4	101.7	0.23
2	702.0	100.1	0.36	784.5	100.1	0.23	671.0	101.2	0.31
3	997.8	99.7	0.36	1077.4	99.8	0.22	975.1	100.7	0.35
4	1292.3	98.5	0.27	1369.4	99.4	0.17	1277.7	98.3	0.29
5	1583.3	98.2	0.01	1660.2	97.3	0.03	1573.1	88.0	-0.14
6	1873.4	-98.2		1945.0	-97.5		1837.7	-87.2	
5	1583.2	-100.1		1659.6	-100.2		1575.6	-100.8	
4	1287.5	-100.2		1366.4	-100.1		1272.6	-101.1	
3	991.5	-100.1		1073.5	-100.1		968.8	-100.9	
2	695.6	-100.2		780.5	-100.2		665.5	-101.2	
1	399.6	-100.3		487.3	-100.7		361.3	-101.1	
0	103.2			192.5			57.3		
Zero	**106.2 mV**			**195.5 mV**			**64.5 mV**		
Slope	**295.5** mV/mm			**292.7** mV/mm			**300.5** mV/mm		

Arm Average vs Total Pressure - CALIBRATION FOR SYSTEM STIFFNESS
SLOPE: 3.2 mm/GPa (Cylinder slope = 2.3 mm/GPa)



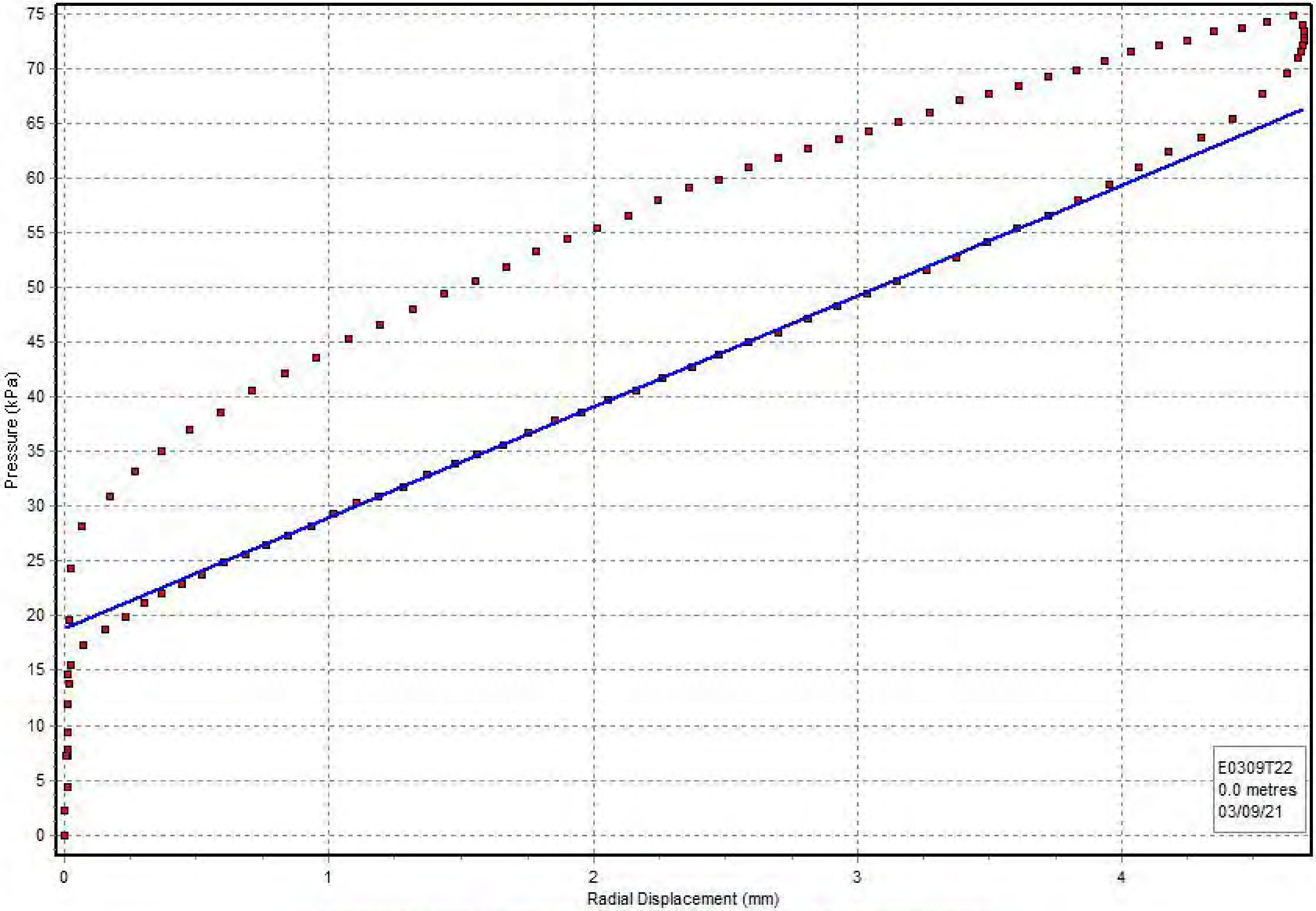
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel: +44 (0)1223 262361

Arm Average vs Total Pressure - CALIBRATION FOR MEMBRANE STIFFNESS
ZERO: 42.8 kPa   SLOPE: 7.1 kPa/mm



CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE   Tel: +44 (0)1223 262361

Arm Average vs Total Pressure - CALIBRATION FOR MEMBRANE STIFFNESS
ZERO: 18.9 kPa SLOPE: 10.1 kPa/mm



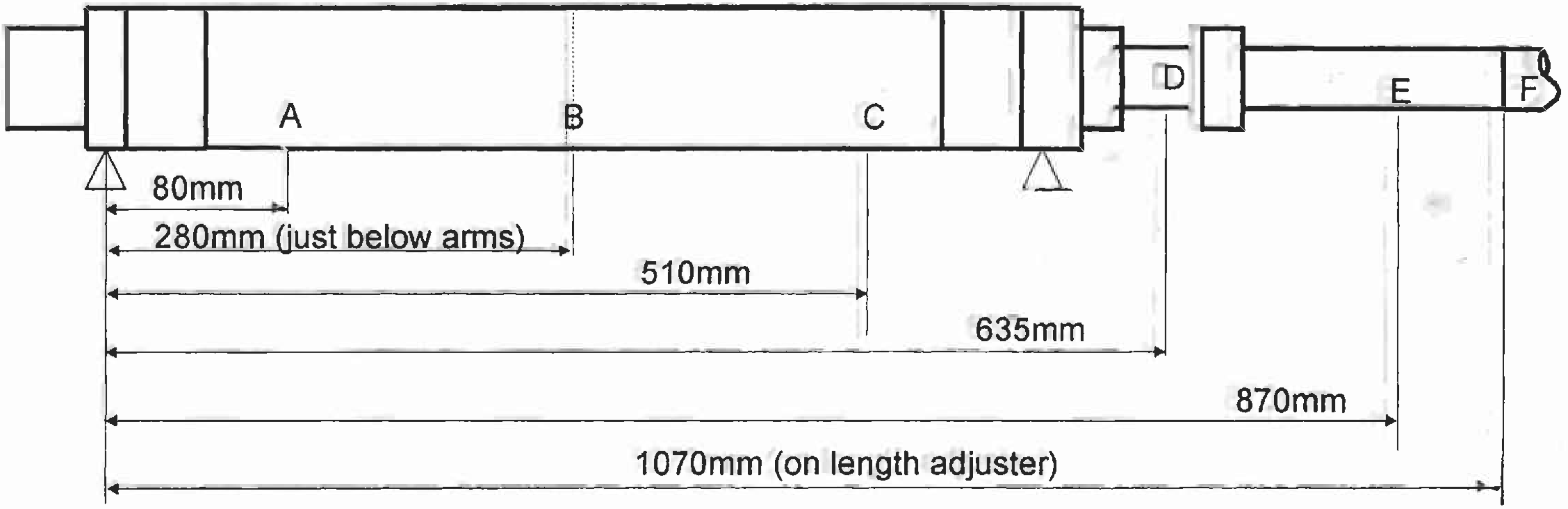
CAMBRIDGE INSITU, Little Eversden, Cambridge, CB23 1HE Tel: +44 (0)1223 262361

Self Boring Pressuremeter straightness calibration sheet

160
+66
200

Total Runout at - A: ~~17~~ 0.17mm B: ~~16~~ 0.16mm C: ~~8~~ 0.08mm D: ~~52~~ 0.52mm E: 2.03mm F: ~~[illegible]~~ 0.6mm

After Straightening - A: 0.1 B: 0.05 C: 0.08mm D: 0.4mm E: 1.7mm F: 0.2mm



↑ adjusted position on tube

Date of check 14/10/20	**Serial Number**	**Instrument Name** DOUGAL
Operator Signature ES / SDB		[redacted]
Comments Tube deformed at point E?		

Cambridge insitu Ltd

CAMBRIDGE INSITU LTD
LITTLE EVERSDEN
CAMBRIDGE
CB23 1HE

T: +44 1223 262962
E: cam@cambridge-insitu.com
W: www.cambridge-insitu.com

Drawn By JJB	**Date** 20140303	**Scale** NTS
Description Checking Straightness of Self Boring Pressuremeter		
Item Number		**Iss**
File Location \camb-sbs2011\Public\Working Instructions\Calibration Sheets\20140303 SBP Straightness Calibration Sheet Rev1.odg		

Project Name	Cambridge Waste Water Treatment Plant Relocation	Vane and Penetrometer Results for Excavations	Hole ID TP_FE_001
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Depth m	Test no.	Peak Vane kPa	Residual Vane kPa	Penetrometer kPa	Date	Remarks
0.00	1	58	30		20/09/2021	
0.00	2	65	40		20/09/2021	
0.00	3	62	35		20/09/2021	
0.50	1	62	40		20/09/2021	
0.50	2	50	30		20/09/2021	
0.50	3	69	40		20/09/2021	
1.00	1	61	38		20/09/2021	
1.00	2	59	36		20/09/2021	
1.00	3	62	38		20/09/2021	

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Vane and Penetrometer Results for Excavations**	Hole ID TP_FE_002
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Depth m	Test no.	Peak Vane kPa	Residual Vane kPa	Penetrometer kPa	Date	Remarks
0.00	1	62	25		21/09/2021	
0.00	2	54	15		21/09/2021	
0.00	3	45	10		21/09/2021	
0.50	1	78	30		21/09/2021	
0.50	2	60	20		21/09/2021	
0.50	3	68	22		21/09/2021	
1.00	1				21/09/2021	Material not suitable for Hand Vane Test

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Vane and Penetrometer Results for Excavations**	Hole ID TP_FE_003
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Depth m	Test no.	Peak Vane kPa	Residual Vane kPa	Penetrometer kPa	Date	Remarks
0.50	1	94	50		24/08/2021	
0.50	2	58	16		24/08/2021	
0.50	3	128	98		24/08/2021	
1.00	1				24/08/2021	Material not suitable for Hand Vane Test

Project Name	Cambridge Waste Water Treatment Plant Relocation	Hole ID	TP_FE_004
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Vane and Penetrometer Results for Excavations

Depth m	Test no.	Peak Vane kPa	Residual Vane kPa	Penetrometer kPa	Date	Remarks
0.50	1	90	43		25/08/2021	
0.50	2	72	34		25/08/2021	
0.50	3	110	38		25/08/2021	
1.00	1	84	65		25/08/2021	
1.00	2	90	35		25/08/2021	
1.00	3	85	35		25/08/2021	

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Vane and Penetrometer Results for Excavations**	Hole ID TP_FE_005
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Depth m	Test no.	Peak Vane kPa	Residual Vane kPa	Penetrometer kPa	Date	Remarks
0.50	1	55	10		26/08/2021	
0.50	2	95	40		26/08/2021	
0.50	3	57	20		26/08/2021	
1.00	1				26/08/2021	Material too stiff for Hand Vane Test

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Vane and Penetrometer Results for Excavations**	Hole ID TP_FE_006
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Depth m	Test no.	Peak Vane kPa	Residual Vane kPa	Penetrometer kPa	Date	Remarks
0.50	1	68	30		26/08/2021	
0.50	2	62	33		26/08/2021	
0.50	3	67	15		26/08/2021	
1.00	1				26/08/2021	Material too stiff for Hand Vane Test

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Vane and Penetrometer Results for Excavations**	Hole ID TP_STW_003
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Depth m	Test no.	Peak Vane kPa	Residual Vane kPa	Penetrometer kPa	Date	Remarks
0.00	1	60	10		02/09/2021	
0.00	2	30	5		02/09/2021	
0.00	3	35	6		02/09/2021	
0.50	1	45	5		02/09/2021	
0.50	2	57	10		02/09/2021	
0.50	3	60	10		02/09/2021	
1.00	1				02/09/2021	Material too stiff for Hand Vane Test

Project Name	Cambridge Waste Water Treatment Plant Relocation		Hole ID
Project No.	TE8364		TP_STW_004
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Vane and Penetrometer Results for Excavations

Depth m	Test no.	Peak Vane kPa	Residual Vane kPa	Penetrometer kPa	Date	Remarks
0.00	1	58	14		27/08/2021	
0.00	2	95	22		27/08/2021	
0.00	3	125	48		27/08/2021	
0.50	1	115	25		27/08/2021	
0.50	2	85	5		27/08/2021	
0.50	3	135	20		27/08/2021	
1.00	1				27/08/2021	Material too stiff for Hand Vane Test

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Vane and Penetrometer Results for Excavations**	Hole ID TP_STW_005
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Depth m	Test no.	Peak Vane kPa	Residual Vane kPa	Penetrometer kPa	Date	Remarks
0.00	1	25	15		03/09/2021	
0.00	2	42	10		03/09/2021	
0.00	3	35	18		03/09/2021	
0.50	1					Material not suitable for Hand Vane Test
1.00	1					Material too stiff for Hand Vane Test

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Vane and Penetrometer Results for Excavations**	Hole ID TP_STW_006
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Depth m	Test no.	Peak Vane kPa	Residual Vane kPa	Penetrometer kPa	Date	Remarks
0.00	1	-	-		31/08/2021	Test failed: Too friable
0.00	2	-	-		31/08/2021	Test failed: Too friable
0.00	3				31/08/2021	Test failed: Too friable
0.50	1	82	40		31/08/2021	
0.50	2	80			31/08/2021	Residual test failed
0.50	3	80	15		31/08/2021	
1.00	1	115	40		31/08/2021	
1.00	2	105	38		31/08/2021	
1.00	3	75	20		31/08/2021	

SOIL ENGINEERING

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Vane and Penetrometer Results for Excavations**	Hole ID TP_STW_007
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Depth m	Test no.	Peak Vane kPa	Residual Vane kPa	Penetrometer kPa	Date	Remarks
0.00	1	-	-		31/08/2021	Material not suitable for Hand Vane Test
0.50	1	95	5		31/08/2021	
0.50	2	80	10		31/08/2021	
0.50	3	55	5		31/08/2021	
1.00	1				31/08/2021	Material not suitable for Hand Vane Test

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation
Project No.	TE8364
Engineer	Mott MacDonald Bentley
Employer	Barhale Limited

Vane and Penetrometer Results for Excavations

Hole ID

TP_STW_010

Depth m	Test no.	Peak Vane kPa	Residual Vane kPa	Penetrometer kPa	Date	Remarks
0.00	1	-	-		01/09/2021	Material not suitable for Hand Vane Test
0.50	1	125	20		01/09/2021	
0.50	2	70	10		01/09/2021	
0.50	3	70	5		01/09/2021	
1.00	1				01/09/2021	Material not suitable for Hand Vane Test

Form No. SE-IST-F-017 IssueNo.RevisionNo 1.04 Issue Date 08/11/2012

SOIL ENGINEERING

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation
Project No.	TE8364
Engineer	Mott MacDonald Bentley
Employer	Barhale Limited

Vane and Penetrometer Results for Excavations

Hole ID

TP_STW_011

Depth m	Test no.	Peak Vane kPa	Residual Vane kPa	Penetrometer kPa	Date	Remarks
0.00	1	90	48		21/09/2021	
0.00	2	45	10		21/09/2021	
0.00	3	40	5		21/09/2021	
0.50	1				21/09/2021	Material not suitable for Hand Vane Test
1.00	1				21/09/2021	Material too Stiff for Hand Vane Test

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Vane and Penetrometer Results for Excavations**	Hole ID TP_STW_012
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Depth m	Test no.	Peak Vane kPa	Residual Vane kPa	Penetrometer kPa	Date	Remarks
0.00	1	40	20		03/09/2021	
0.00	2	40	10		03/09/2021	
0.00	3	50	12		03/09/2021	
0.50	1	125	15		03/09/2021	
0.50	2	120	10		03/09/2021	
0.50	3	115	15		03/09/2021	
1.00	1					Material too stiff for Hand Vane Test

Project Name	Cambridge Waste Water Treatment Plant Relocation		Hole ID
Project No.	TE8364		TP_STW_013
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Vane and Penetrometer Results for Excavations

Depth m	Test no.	Peak Vane kPa	Residual Vane kPa	Penetrometer kPa	Date	Remarks
0.00	1	90	-		06/09/2021	Residual Test not undertaken
0.00	2	85	-		06/09/2021	Residual Test not undertaken
0.00	3	88	-		06/09/2021	Residual Test not undertaken
0.50	1	55	-		06/09/2021	Residual Test not undertaken
0.50	2	53	-		06/09/2021	Residual Test not undertaken
0.50	3	60	-		06/09/2021	Residual Test not undertaken
1.00	1	90	-		06/09/2021	Residual Test not undertaken
1.00	2	95	-		06/09/2021	Residual Test not undertaken
1.00	3	89			06/09/2021	Residual Test not undertaken

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Vane and Penetrometer Results for Excavations**	Hole ID TP_STW_014
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Depth m	Test no.	Peak Vane kPa	Residual Vane kPa	Penetrometer kPa	Date	Remarks
0.00	1	15	5		03/09/2021	
0.00	2	20	7		03/09/2021	
0.00	3	15	10		03/09/2021	
0.50	1	65	25		03/09/2021	
0.50	2	60	20		03/09/2021	
0.50	3	72	18		03/09/2021	
1.00	1				03/09/2021	Material too stiff for Hand Vane Test

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation		Hole ID
Project No.	TE8364		TP_STW_015
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Vane and Penetrometer Results for Excavations

Depth m	Test no.	Peak Vane kPa	Residual Vane kPa	Penetrometer kPa	Date	Remarks
0.00	1	48	19		07/09/2021	
0.00	2	40			07/09/2021	
0.00	3	74	28		07/09/2021	
0.50	1	105	25		07/09/2021	
0.50	2	55	25		07/09/2021	
0.50	3	58	9		07/09/2021	
1.00	1				07/09/2021	Material too stiff for Hand Vane Test

Project Name	Cambridge Waste Water Treatment Plant Relocation		Hole ID
Project No.	TE8364		TP_STW_016
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Vane and Penetrometer Results for Excavations

Depth m	Test no.	Peak Vane kPa	Residual Vane kPa	Penetrometer kPa	Date	Remarks
0.00	1	50	10		08/09/2021	
0.00	2	60	12		08/09/2021	
0.00	3	42	5		08/09/2021	
0.50	1	60			08/09/2021	
0.50	2	84	20		08/09/2021	
0.50	3	55	10		08/09/2021	
1.00	1				08/09/2021	Material not suitable for Hand Vane Test

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Vane and Penetrometer Results for Excavations**	Hole ID TP_STW_017
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Depth m	Test no.	Peak Vane kPa	Residual Vane kPa	Penetrometer kPa	Date	Remarks
0.00	1	45	5		10/09/2021	
0.00	2	37	10		10/09/2021	
0.00	3	64	15		10/09/2021	
0.50	1	75	30		10/09/2021	
0.50	2	80	10		10/09/2021	
0.50	3	60	5		10/09/2021	
1.00	1				10/09/2021	Material too stiff for Hand Vane Test

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Vane and Penetrometer Results for Excavations**	Hole ID TP_STW_018
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Depth m	Test no.	Peak Vane kPa	Residual Vane kPa	Penetrometer kPa	Date	Remarks
0.00	1	30	5		09/09/2021	
0.00	2	46	10		09/09/2021	
0.00	3	35	10		09/09/2021	
0.50	1	68	10		09/09/2021	
0.50	2	84	20		09/09/2021	
0.50	3	92	25		09/09/2021	
1.00	1				09/09/2021	Material too stiff for Hand Vane Test

Project Name	Cambridge Waste Water Treatment Plant Relocation		
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Vane and Penetrometer Results for Excavations

Hole ID

TP_STW_019

Depth m	Test no.	Peak Vane kPa	Residual Vane kPa	Penetrometer kPa	Date	Remarks
0.00	1	50	5		10/09/2021	
0.00	2	48	10		10/09/2021	
0.00	3	64	12		10/09/2021	
0.50	1	84	20		10/09/2021	
0.50	2	60	10		10/09/2021	
0.50	3	90	25		10/09/2021	
1.00	1				10/09/2021	Material not suitable for Hand Vane Test

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Vane and Penetrometer Results for Excavations**	Hole ID TP_STW_020
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Depth m	Test no.	Peak Vane kPa	Residual Vane kPa	Penetrometer kPa	Date	Remarks
0.00	1	68	10		13/09/2021	
0.00	2	54	5		13/09/2021	
0.00	3	48	10		13/09/2021	
0.50	1	72	20		13/09/2021	
0.50	2	65	15		13/09/2021	
0.50	3	70	20		13/09/2021	
1.00	1				13/09/2021	Material not suitable for Hand Vane Test

Project Name	Cambridge Waste Water Treatment Plant Relocation
Project No.	TE8364
Engineer	Mott MacDonald Bentley
Employer	Barhale Limited

Vane and Penetrometer Results for Excavations

Hole ID

TP_STW_021

Depth m	Test no.	Peak Vane kPa	Residual Vane kPa	Penetrometer kPa	Date	Remarks
0.00	1	45	10		13/09/2021	
0.00	2	50	5		13/09/2021	
0.00	3	60	10		13/09/2021	
0.50	1	75	15		13/09/2021	
0.50	2	68	10		13/09/2021	
0.50	3	60	5		13/09/2021	
1.00	1				13/09/2021	Material too Stiff for Hand Vane Test

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Vane and Penetrometer Results for Excavations**	Hole ID TP_STW_022
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Depth m	Test no.	Peak Vane kPa	Residual Vane kPa	Penetrometer kPa	Date	Remarks
0.00	1	35	10		14/09/2021	
0.00	2	40	5		14/09/2021	
0.00	3	28	3		14/09/2021	
0.50	1	85	15		14/09/2021	
0.50	2	90	10		14/09/2021	
0.50	3	70	20		14/09/2021	
1.00	1				14/09/2021	Material too stiff for Hand Vane Test

Project Name	Cambridge Waste Water Treatment Plant Relocation	# Vane and Penetrometer Results for Excavations	Hole ID TP_STW_031
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Depth m	Test no.	Peak Vane kPa	Residual Vane kPa	Penetrometer kPa	Date	Remarks
0.00	1	35	15		03/09/2021	
0.00	2	40	10		03/09/2021	
0.00	3	25	5		03/09/2021	
0.50	1	85	30		03/09/2021	
0.50	2	75	15		03/09/2021	
0.50	3	90	20		03/09/2021	
1.00	1				03/09/2021	Material too stiff for Hand Vane Test

Project Name	Cambridge Waste Water Treatment Plant Relocation		Hole ID
Project No.	TE8364		TP_STW_032
Engineer	Mott MacDonald Bentley		
Employer	Barhale Limited		

Vane and Penetrometer Results for Excavations

Depth m	Test no.	Peak Vane kPa	Residual Vane kPa	Penetrometer kPa	Date	Remarks
0.00	1	28	12		13/09/2021	
0.00	2	35	12		13/09/2021	
0.00	3	52	22		13/09/2021	
0.50	1					Material too stiff for Hand Vane Test
1.00	1					Material too stiff for Hand Vane Test

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Soakaway Test Results**	**Hole ID**
Project No.	TE8364		TP_FE_001
Engineer	Mott MacDonald Bentley		**Table No.**
Employer	Barhale Limited		**1**

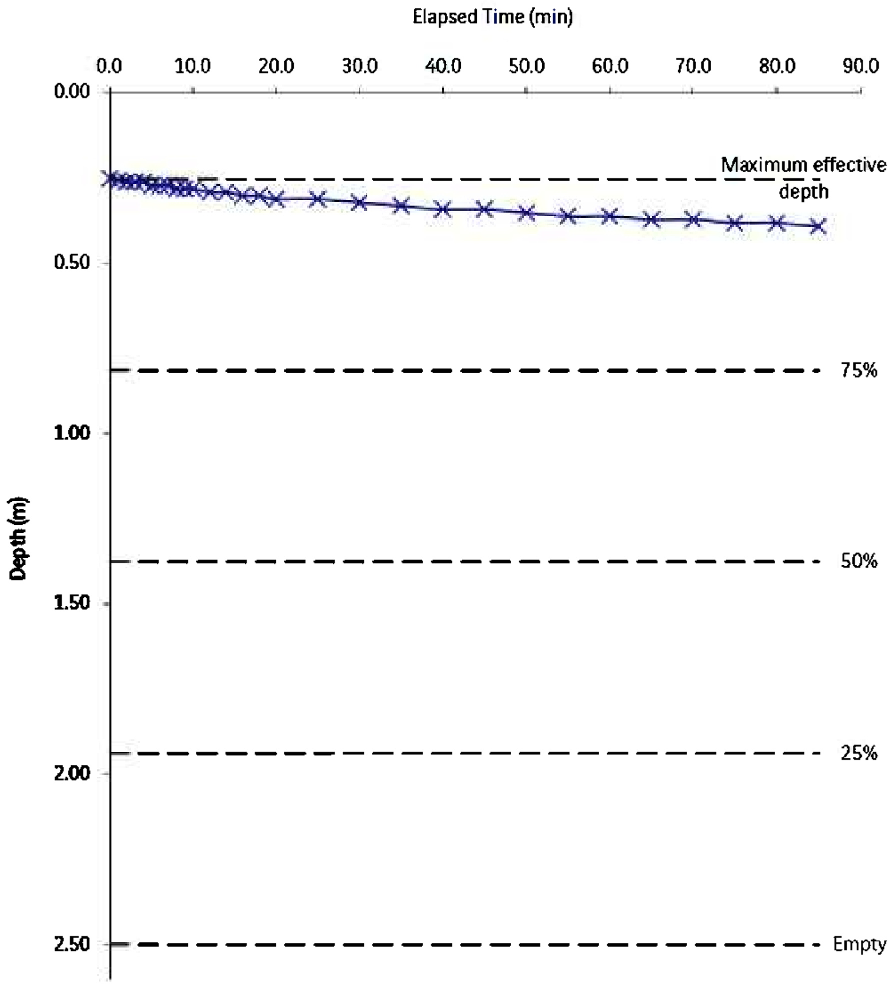
Pit Dimensions	**Length**	**m**	**1.70**	**Width**	**m**	**0.60**	**Depth at start**	**m**	**2.50**
Details of construction	**JCB 3CX Machine Excavated**						**Depth at end**	**m**	**1.7**
Invert of discharge drain / maximum effective depth					**m**	**0.25**	**Test no.**		**1**

Description 1.20m to 2.20m: Firm light grey sandy slightly gravelly CLAY. 2.20m to 2.40m: Light brown slightly sandy angular to subrounded fine to coarse GRAVEL. 2.40m to 2.50m: Firm dark grey sandy slightly gravelly CLAY.

Environment **Field**

Remarks Start Time: 15:07 Finish Time: 16:32. Test terminated at end of working day.

Elapsed Time mins	Water Depth m
0.0	**0.25**
1.0	**0.26**
2.0	**0.26**
3.0	**0.26**
4.0	**0.26**
5.0	**0.27**
6.0	**0.27**
7.0	**0.27**
8.0	**0.28**
9.0	**0.28**
10.0	**0.28**
12.0	**0.29**
14.0	**0.29**
16.0	**0.30**
18.0	**0.30**
20.0	**0.31**
25.0	**0.31**
30.0	**0.32**
35.0	**0.33**
40.0	**0.34**
45.0	**0.34**
50.0	**0.35**
55.0	**0.36**
60.0	**0.36**
65.0	**0.37**
70.0	**0.37**
75.0	**0.38**
80.0	**0.38**
85.0	**0.39**



Volume outflow between 75% and 25% effective depth		m^3	
Mean surface area through which outflow occurs		m^2	
Time for outflow between 75% and 25% effective depth		mins	
Soil infiltration rate	*f*	m/s	Not determined

Recorded By:	Alfred Lee	Checked By:	david.howard	Approved By:		SOIL ENGINEERING
Date:	06/09/2021	Date:	17/09/2021	Date:		
Form No.	SE-PGR-F-014	IssueNo.RevisionNo	2.05	Issue Date	23/03/2015	Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Soakaway Test Results**	**Hole ID** TP_FE_002
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		**Table No.** 1
Employer	Barhale Limited		

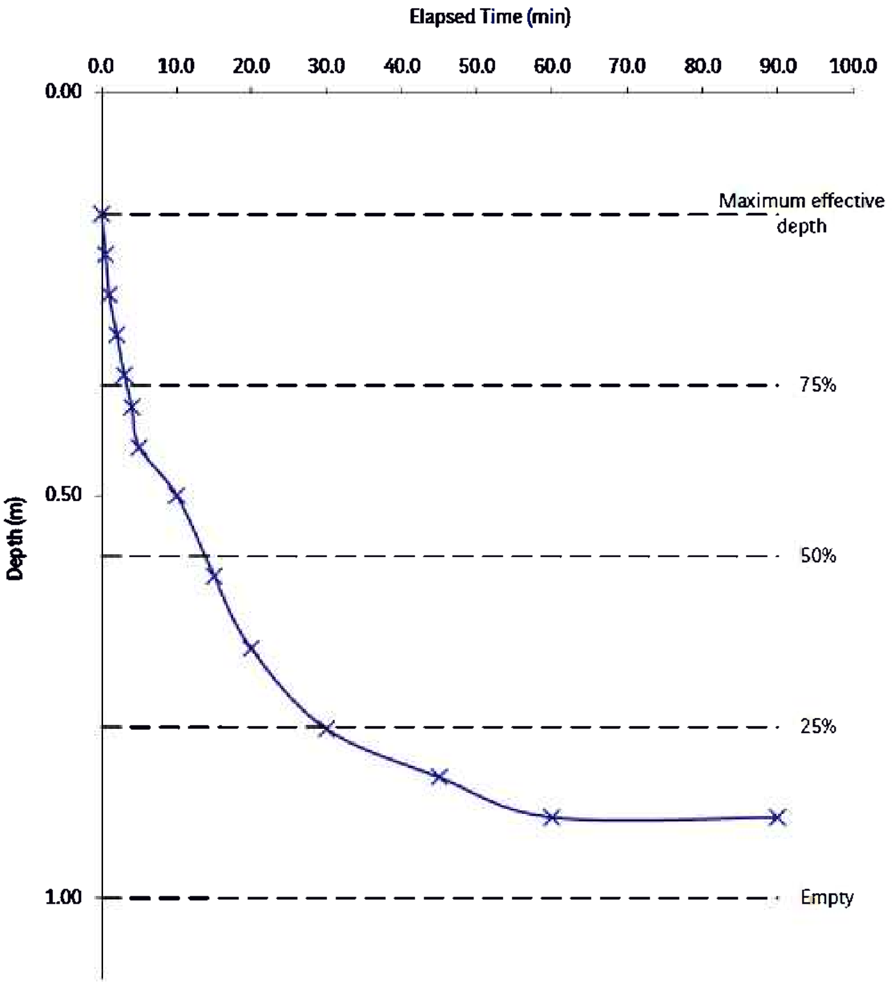
Pit Dimensions	**Length**	**m**	**1.80**	**Width**	**m**	**0.60**	**Depth at start**	**m**	**1.00**
Details of construction	**JCB 3CX Machine Excavated**						**Depth at end**	**m**	**1**
Invert of discharge drain / maximum effective depth					**m**	**0.15**	**Test no.**		**1**

Description 0.00 - 0.30m: CLAY. 0.30 - 0.70m: Gravelly CLAY. 0.70 - 1.00m: Sandy gravelly CLAY. 1.00 - 2.00m: Brown SAND and GRAVEL.

Environment **Field near to watercourse**

Remarks Start Time: 11:25 Finish Time: 11:55.

Elapsed Time mins	Water Depth m
0.0	**0.15**
0.5	**0.20**
1.0	**0.25**
2.0	**0.30**
3.0	**0.35**
4.0	**0.39**
5.0	**0.44**
10.0	**0.50**
15.0	**0.60**
20.0	**0.69**
30.0	**0.79**
45.0	**0.85**
60.0	**0.90**
90.0	**0.90**



Volume outflow between 75% and 25% effective depth	m^3	0.459
Mean surface area through which outflow occurs	m^2	3.12
Time for outflow between 75% and 25% effective depth	mins	26.00
Soil infiltration rate *f*	m/s	9.4E-05

Recorded By:	**Adam Meacher**	**Checked By:**	**david.howard**	**Approved By:**		SOIL ENGINEERING
Date:	**21/09/2021**	**Date:**	**11/10/2021**	**Date:**		
Form No.	SE-PGR-F-014	IssueNo.RevisionNo	2.05	Issue Date	23/03/2015	Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Soakaway Test Results**	**Hole ID** TP_FE_002
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		**Table No.** 1
Employer	Barhale Limited		

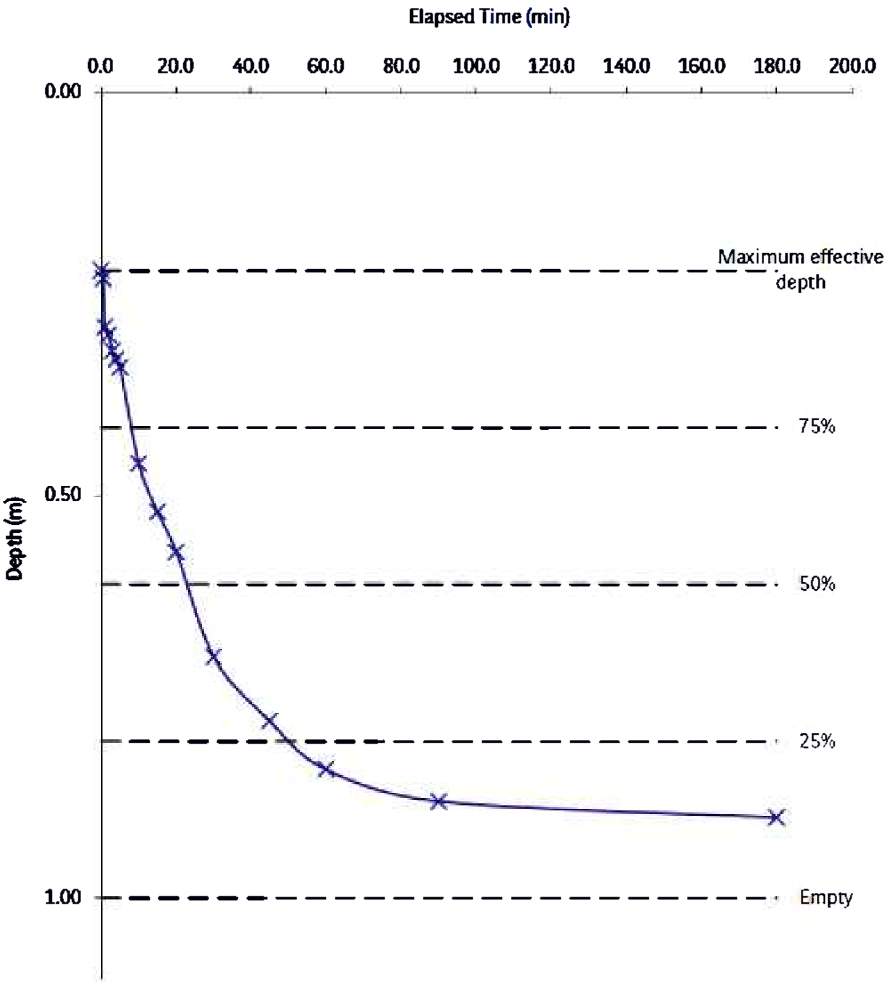
Pit Dimensions	**Length**	**m**	**1.80**	**Width**	**m**	**0.60**	**Depth at start**	**m**	**1.00**
Details of construction	**JCB 3CX Machine Excavated**						**Depth at end**	**m**	**1**
Invert of discharge drain / maximum effective depth					**m**	**0.22**	**Test no.**		**2**

Description 0.00 - 0.30m: CLAY. 0.30 - 0.70m: Gravelly CLAY. 0.70 - 1.00m: Sandy gravelly CLAY. 1.00 - 2.00m: Brown SAND and GRAVEL

Environment **Field near to watercourse**

Remarks Start Time: 13:02 Finish Time: 15:02

Elapsed Time mins	Water Depth m
0.0	0.22
0.5	0.23
1.0	0.29
2.0	0.30
3.0	0.32
4.0	0.33
5.0	0.34
10.0	0.46
15.0	0.52
20.0	0.57
30.0	0.70
45.0	0.78
60.0	0.84
90.0	0.88
180.0	0.90



Volume outflow between 75% and 25% effective depth	m^3	0.421
Mean surface area through which outflow occurs	m^2	2.952
Time for outflow between 75% and 25% effective depth	mins	43.00
Soil infiltration rate *f*	m/s	5.5E-05

Recorded By:	**Adam Meacher**	**Checked By:**	**david.howard**	**Approved By:**	
Date:	**21/09/2021**	**Date:**	**11/10/2021**	**Date:**	
Form No.	SE-PGR-F-014	IssueNo.RevisionNo	2.05	Issue Date	23/03/2015

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Soakaway Test Results**	Hole ID TP_STW_003
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		**Table No.** **1**
Employer	Barhale Limited		

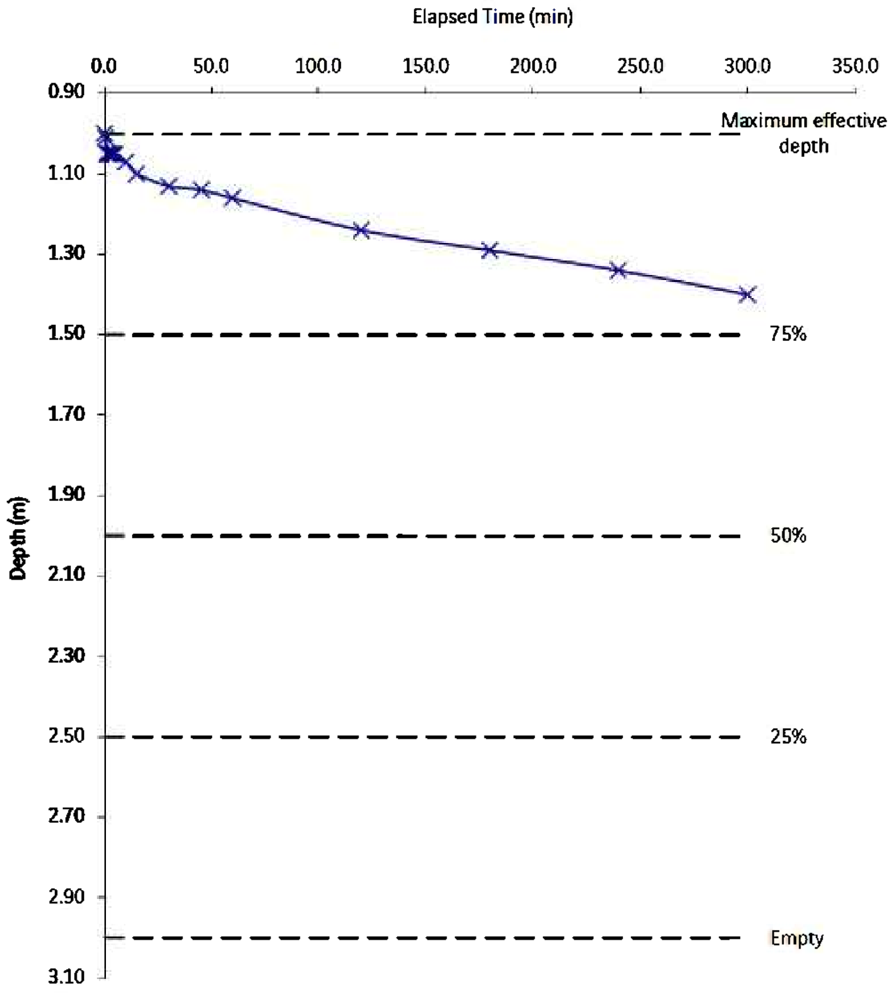
Pit Dimensions	**Length**	**m**	**2.50**	**Width**	**m**	**0.30**	**Depth at start**	**m**	**3.00**
Details of construction	**JCB 3CX Machine Excavated**						**Depth at end**	**m**	**3**
Invert of discharge drain / maximum effective depth					**m**	**1.00**	**Test no.**		**1**

Description Structureless CHALK composed of calcareous CLAY from 0.50m to 3.00m

Environment **Field**

Remarks Start Time: 11:18 Finish Time: 16:18. Test terminated at end of working day, 75% not achieved. Pit unsafe to be left overnight as not gravel filled.

Elapsed Time mins	Water Depth m
0.0	**1.00**
0.5	**1.01**
1.0	**1.05**
2.0	**1.05**
3.0	**1.05**
4.0	**1.05**
5.0	**1.05**
10.0	**1.07**
15.0	**1.10**
30.0	**1.13**
45.0	**1.14**
60.0	**1.16**
120.0	**1.24**
180.0	**1.29**
240.0	**1.34**
300.0	**1.40**



Volume outflow between 75% and 25% effective depth		m^3	
Mean surface area through which outflow occurs		m^2	
Time for outflow between 75% and 25% effective depth		mins	
Soil infiltration rate	*f*	m/s	Not determined

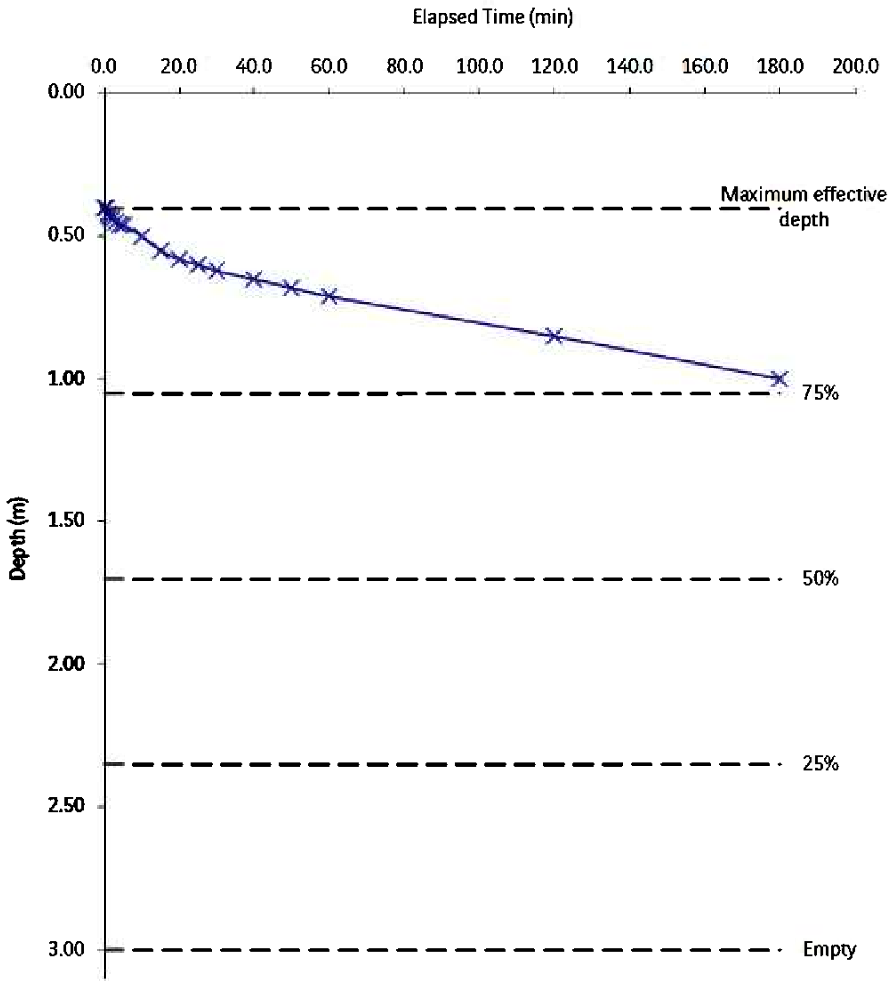
Recorded By:	**Adam Meacher**	**Checked By:**	**david.howard**	**Approved By:**	
Date:	**03/09/2021**	**Date:**	**17/09/2021**	**Date:**	
Form No.	SE-PGR-F-014	IssueNo.RevisionNo	2.05	Issue Date	23/03/2015

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Soakaway Test Results**	Hole ID TP_STW_013
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		**Table No.** **1**
Employer	Barhale Limited		

Pit Dimensions	**Length**	**m**	**2.50**	**Width**	**m**	**0.30**	**Depth at start**	**m**	**3.00**
Details of construction	**JCB 3CX Machine Excavated**						**Depth at end**	**m**	**3**
Invert of discharge drain / maximum effective depth					**m**	**0.40**	**Test no.**		**1**
Description	Structureless CHALK composed of calcareous CLAY from 0.40m to 3.00m								
Environment	**Field**								
Remarks	Start Time: 13:10 Finish Time: 16:10. Test terminated at end of working day, 75% not achieved. Pit unsafe to be left overnight as not gravel filled.								

Elapsed Time mins	Water Depth m
0.0	0.40
0.5	0.40
1.0	0.42
1.5	0.43
2.0	0.44
3.0	0.45
4.0	0.46
5.0	0.46
10.0	0.50
15.0	0.55
20.0	0.58
25.0	0.60
30.0	0.62
40.0	0.65
50.0	0.68
60.0	0.71
120.0	0.85
180.0	1.00



Volume outflow between 75% and 25% effective depth	m^3	
Mean surface area through which outflow occurs	m^2	
Time for outflow between 75% and 25% effective depth	mins	
Soil infiltration rate *f*	m/s	Not determined

Recorded By:	Alfred Lee	Checked By:	david.howard	Approved By:	
Date:	06/09/2021	Date:	17/09/2021	Date:	
Form No.	SE-PGR-F-014	IssueNo.RevisionNo	2.05	Issue Date	23/03/2015

soil engineering
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Soakaway Test Results**	Hole ID TP_STW_016
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		**Table No.** **1**
Employer	Barhale Limited		

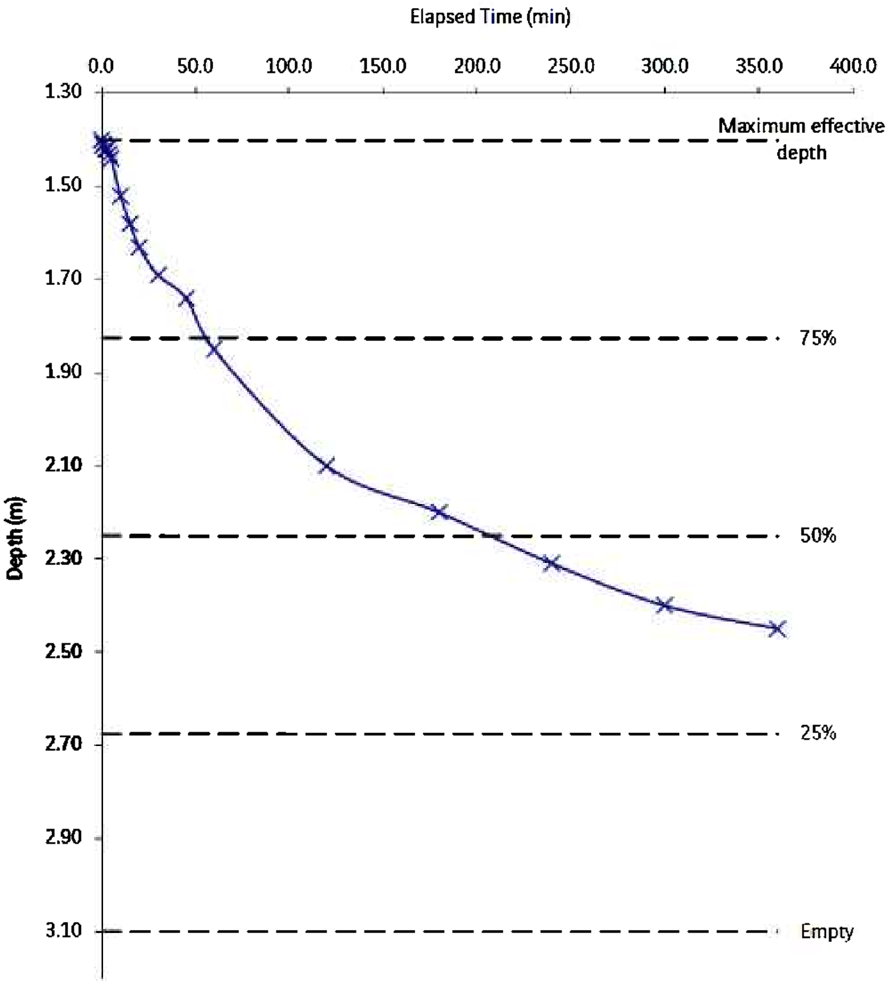
Pit Dimensions	**Length**	**m**	**2.50**	**Width**	**m**	**0.30**	**Depth at start**	**m**	**3.10**
Details of construction	**JCB 3CX Machine Excavated**						**Depth at end**	**m**	**3.1**
Invert of discharge drain / maximum effective depth					**m**	**1.40**	**Test no.**		**1**

Description Structureless CHALK composed of calcareous CLAY from 1.40m to 3.10m.

Environment **Field**

Remarks Start Time: 10:46 ; Finish Time: 16:46. Test terminated at end of working day, 25% not achieved. Pit unsafe to be left overnight as not gravel filled.

Elapsed Time mins	Water Depth m
0.0	**1.40**
0.5	**1.41**
1.0	**1.41**
2.0	**1.42**
3.0	**1.42**
4.0	**1.43**
5.0	**1.44**
10.0	**1.52**
15.0	**1.58**
20.0	**1.63**
30.0	**1.69**
45.0	**1.74**
60.0	**1.85**
120.0	**2.10**
180.0	**2.20**
240.0	**2.31**
300.0	**2.40**
360.0	**2.45**



Volume outflow between 75% and 25% effective depth		m^3	
Mean surface area through which outflow occurs		m^2	
Time for outflow between 75% and 25% effective depth		mins	
Soil infiltration rate	*f*	m/s	Not determined

Recorded By:	Adam Meacher	Checked By:	david.howard	Approved By:	
Date:	08/09/2021	Date:	17/09/2021	Date:	

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Soakaway Test Results**	**Hole ID** **TP_STW_018**
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		**Table No.** **1**
Employer	Barhale Limited		

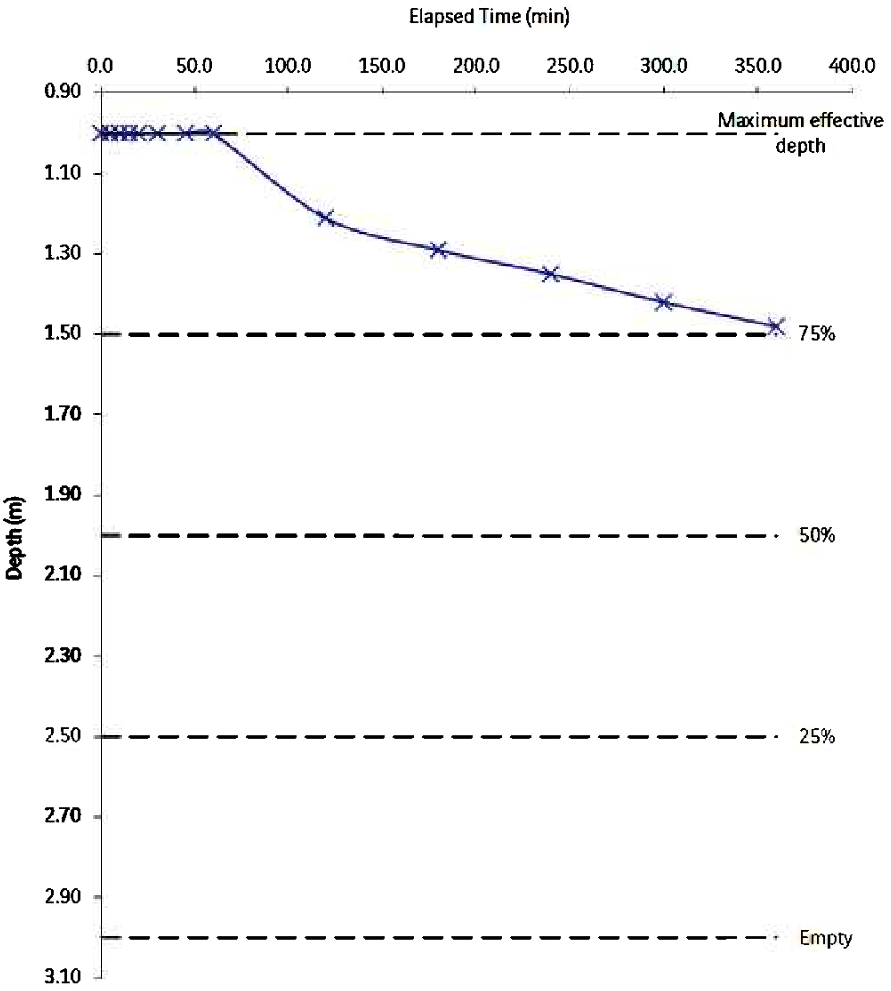
Pit Dimensions	**Length**	**m**	**2.50**	**Width**	**m**	**0.30**	**Depth at start**	**m**	**3.00**
Details of construction	**JCB 3CX Machine Excavated**						**Depth at end**	**m**	**3**
Invert of discharge drain / maximum effective depth					**m**	**1.00**	**Test no.**		**1**

Description Structureless CHALK composed of calcareous CLAY from 0.90m to 3.00m. Sand lense in sidewall of pit from 2.00m to 2.50m.

Environment **Field**

Remarks Start Time: 10:58 Finish Time: 16:58. Test terminated at end of working day, 75% not achieved. Pit unsafe to be left overnight as not gravel filled.

Elapsed Time mins	Water Depth m
0.0	**1.00**
5.0	**1.00**
10.0	**1.00**
15.0	**1.00**
20.0	**1.00**
30.0	**1.00**
45.0	**1.00**
60.0	**1.00**
120.0	**1.21**
180.0	**1.29**
240.0	**1.35**
300.0	**1.42**
360.0	**1.48**



Volume outflow between 75% and 25% effective depth		m^3	
Mean surface area through which outflow occurs		m^2	
Time for outflow between 75% and 25% effective depth		mins	
Soil infiltration rate	*f*	m/s	Not determined

Recorded By:	**Adam Meacher**	Checked By:	**david.howard**	Approved By:		SOIL ENGINEERING
Date:	09/09/2021	Date:	17/09/2021	Date:		
Form No.	SE-PGR-F-014	IssueNo.RevisionNo	2.05	Issue Date	23/03/2015	Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Soakaway Test Results**	**Hole ID** **TP_STW_022**
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		**Table No.** **1**
Employer	Barhale Limited		

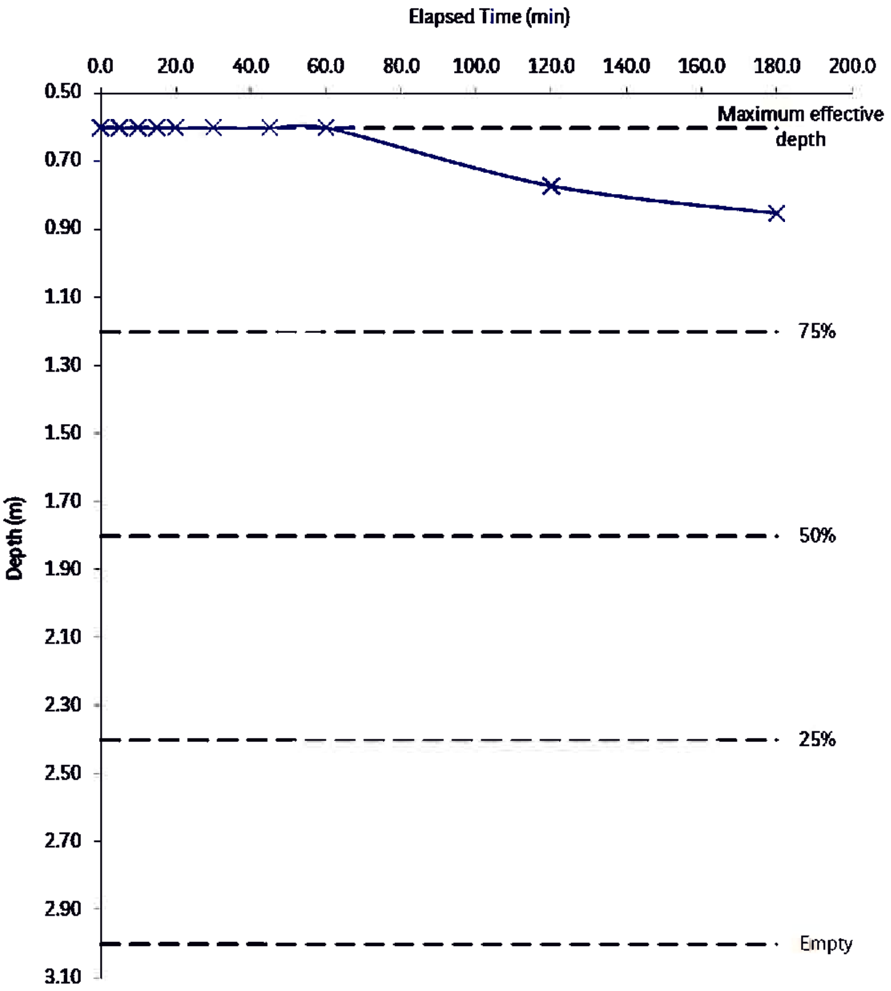
Pit Dimensions	**Length**	**m**	**2.50**	**Width**	**m**	**0.30**	**Depth at start**	**m**	**3.00**
Details of construction	**JCB 3CX Machine Excavated**						**Depth at end**	**m**	**3**
Invert of discharge drain / maximum effective depth					**m**	**0.60**	**Test no.**		**1**

Description Structureless CHALK composed of calcareous CLAY from 0.60m to 3.00m

Environment Field

Remarks Start Time: 11:10 Finish Time: 14:10. Test terminated due to adverse weather conditions

Elapsed Time mins	Water Depth m
0.0	0.60
5.0	0.60
10.0	0.60
15.0	0.60
20.0	0.60
30.0	0.60
45.0	0.60
60.0	0.60
120.0	0.77
180.0	0.85



Volume outflow between 75% and 25% effective depth	m^3	
Mean surface area through which outflow occurs	m^2	
Time for outflow between 75% and 25% effective depth	mins	
Soil infiltration rate *f*	m/s	Not determined

Recorded By:	**Adam Meacher**	**Checked By:**	**david.howard**	**Approved By:**		SOIL ENGINEERING
Date:	**14/09/2021**	**Date:**	**17/09/2021**	**Date:**		
Form No.	SE-PGR-F-014	IssueNo.RevisionNo	2.05	Issue Date	23/03/2015	Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Soakaway Test Results**	Hole ID TP_STW_031
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		**Table No.** 1
Employer	Barhale Limited		

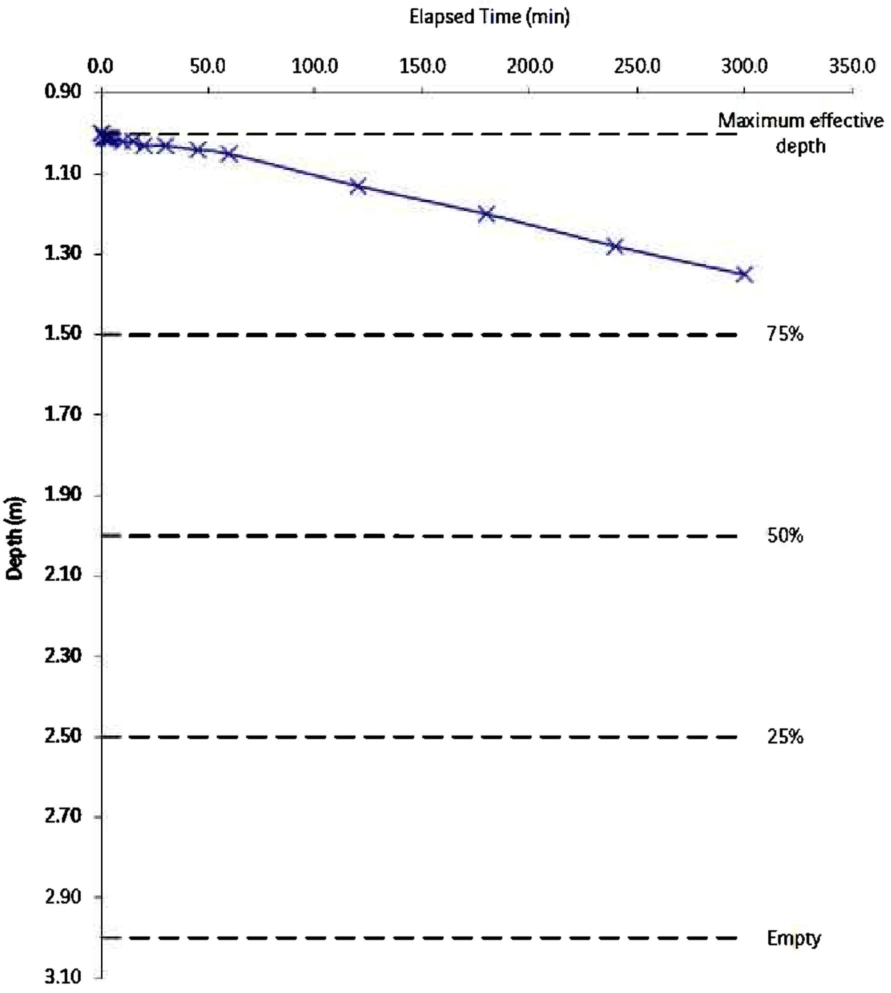
Pit Dimensions	Length	m	2.50	**Width**	m	0.30	**Depth at start**	m	3.00
Details of construction	**JCB 3CX Machine Excavated**						**Depth at end**	m	3
Invert of discharge drain / maximum effective depth					m	1.00	**Test no.**		1

Description Structureless CHALK composed of calcareous CLAY from 0.50m to 2.50m and Extremely weak to very weak medium density CHALK (probable CIRIA Grade B3/4)

Environment Field

Remarks Start Time: 11:19 Finish Time: 16:19. Test terminated at end of working day, 75% not achieved. Pit unsafe to be left overnight as not gravel filled.

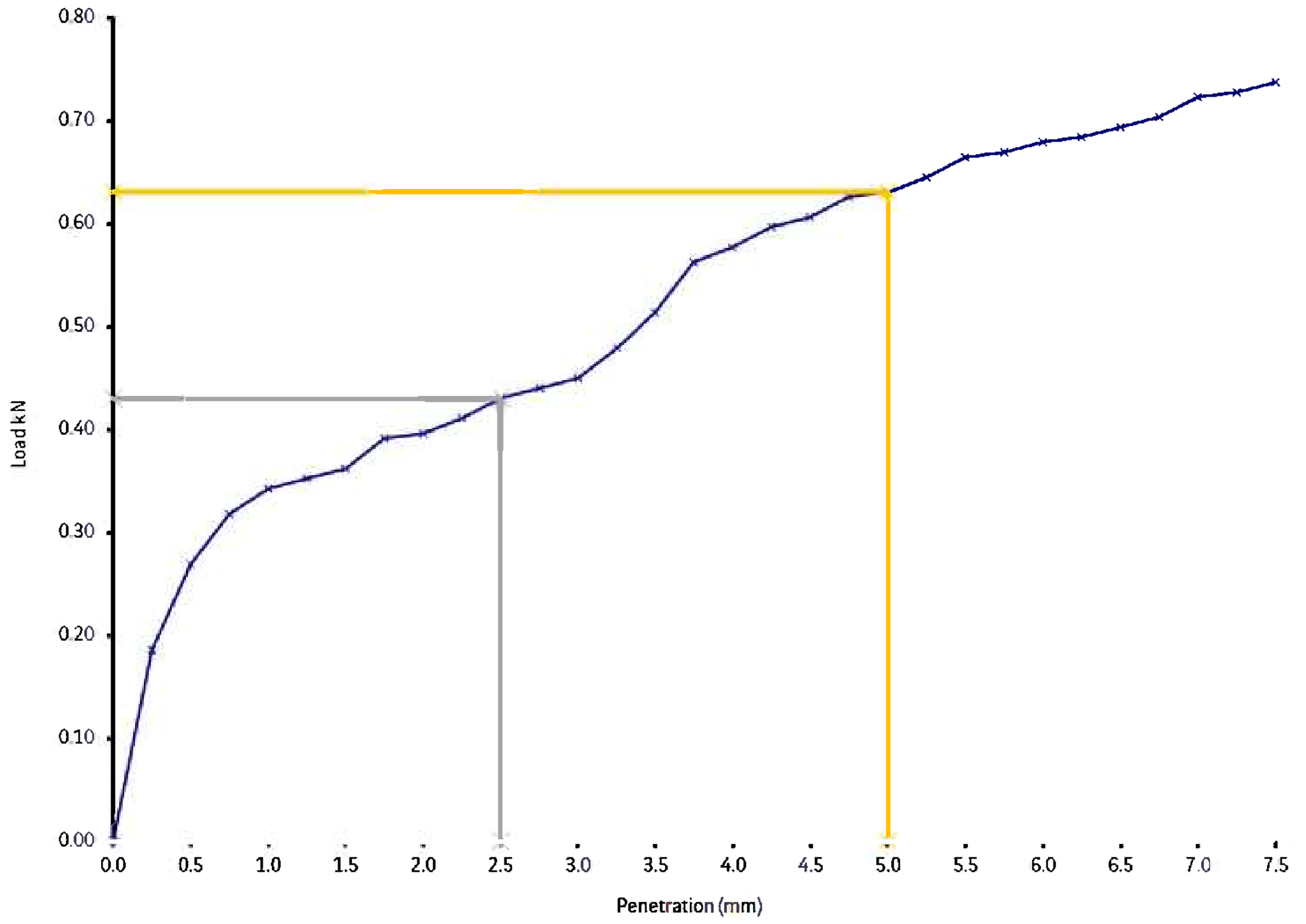
Elapsed Time mins	Water Depth m
0.0	1.00
0.5	1.00
1.0	1.01
2.0	1.01
3.0	1.01
4.0	1.01
5.0	1.01
10.0	1.02
15.0	1.02
20.0	1.03
30.0	1.03
45.0	1.04
60.0	1.05
120.0	1.13
180.0	1.20
240.0	1.28
300.0	1.35



Volume outflow between 75% and 25% effective depth	m^3	
Mean surface area through which outflow occurs	m^2	
Time for outflow between 75% and 25% effective depth	mins	
Soil infiltration rate *f*	m/s	Not determined

Recorded By:	Adam Meacher	Checked By:	david.howard	Approved By:	
Date:	15/09/2021	Date:	17/09/2021	Date:	
Form No. SE-PGR-F-014		IssueNo.RevisionNo 2.05		Issue Date 23/03/2015	SOIL ENGINEERING Part of the Bachy Soletanche Group

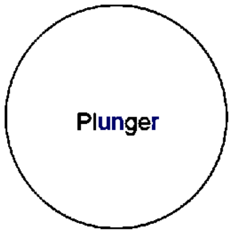
Project Name	Cambridge Waste Water Treatment Plant Relocation	**In Situ California Bearing Ratio Test**	Hole ID TP_FE_001
Project No.	TE8364		Test Depth 0.50m
Engineer	Mott MacDonald Bentley		Test Number 1
Employer	Barhale Limited	BS1377: Part 9: 1990: 4.3	Test Date 20/09/2021
Description	Brown CLAY.		



CBR values %

Penetration	CBR	Accepted CBR
2.50 mm	3.3	3.3
5.00 mm	3.2	
Curve correction	No	

Natural moisture content	71	%
Seating load	1	N
Surcharge	10.5	kPa
Kentledge used		

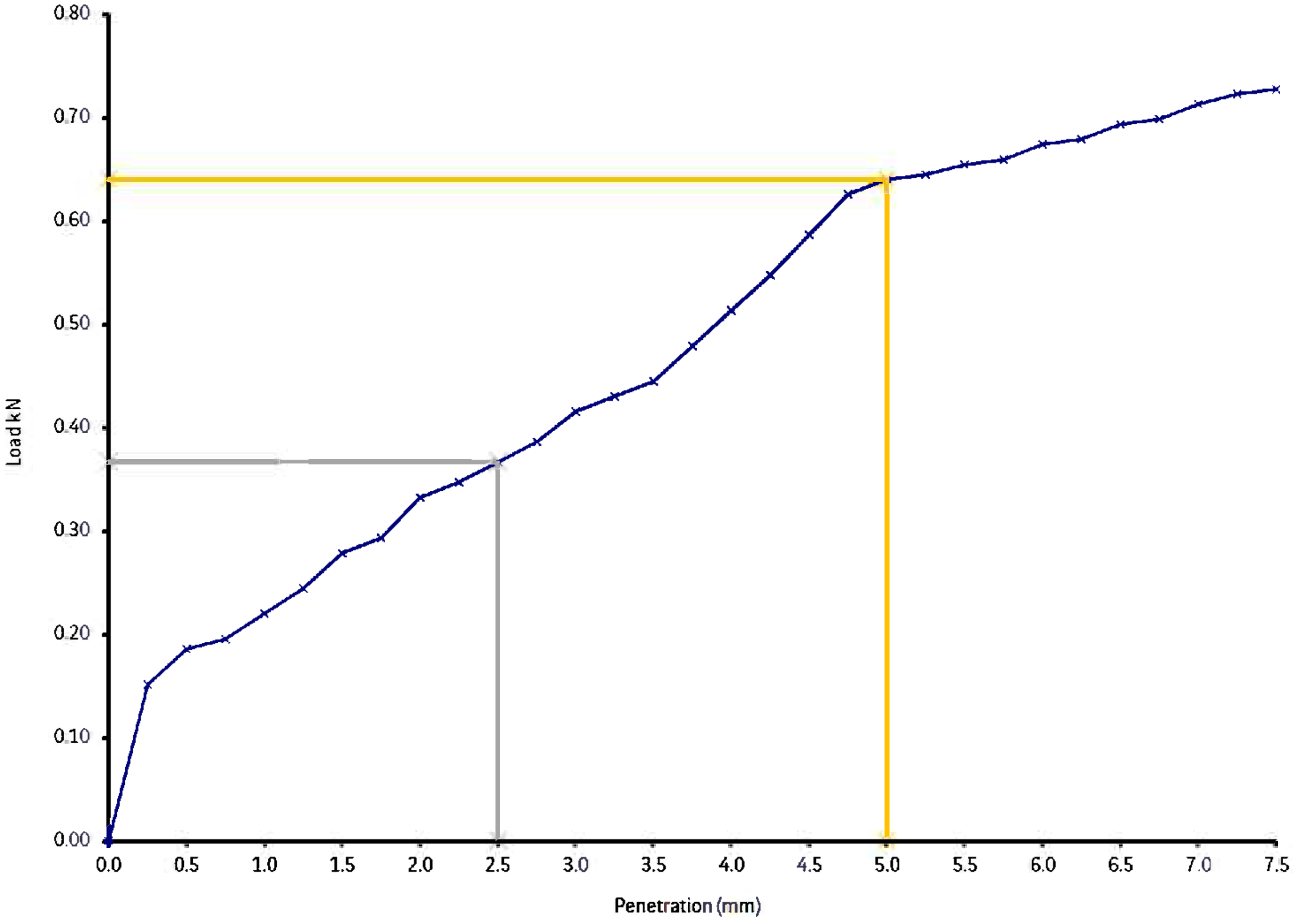


General remarks
Site conditions: Cloudy

Preliminary	SE Engineer		
	Not UKAS		Print date 04/11/2021
	Revision No. 3.00	Issue Date 22/10/2020	

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**In Situ California Bearing Ratio Test**	Hole ID TP_FE_002
Project No.	TE8364		Test Depth 0.50m
Engineer	Mott MacDonald Bentley		Test Number 1
Employer	Barhale Limited	BS1377: Part 9: 1990: 4.3	Test Date 21/09/2021
Description	Brown CLAY.		



CBR values %

Penetration	CBR	Accepted CBR
2.50 mm	2.8	3.2
5.00 mm	3.2	
Curve correction	No	

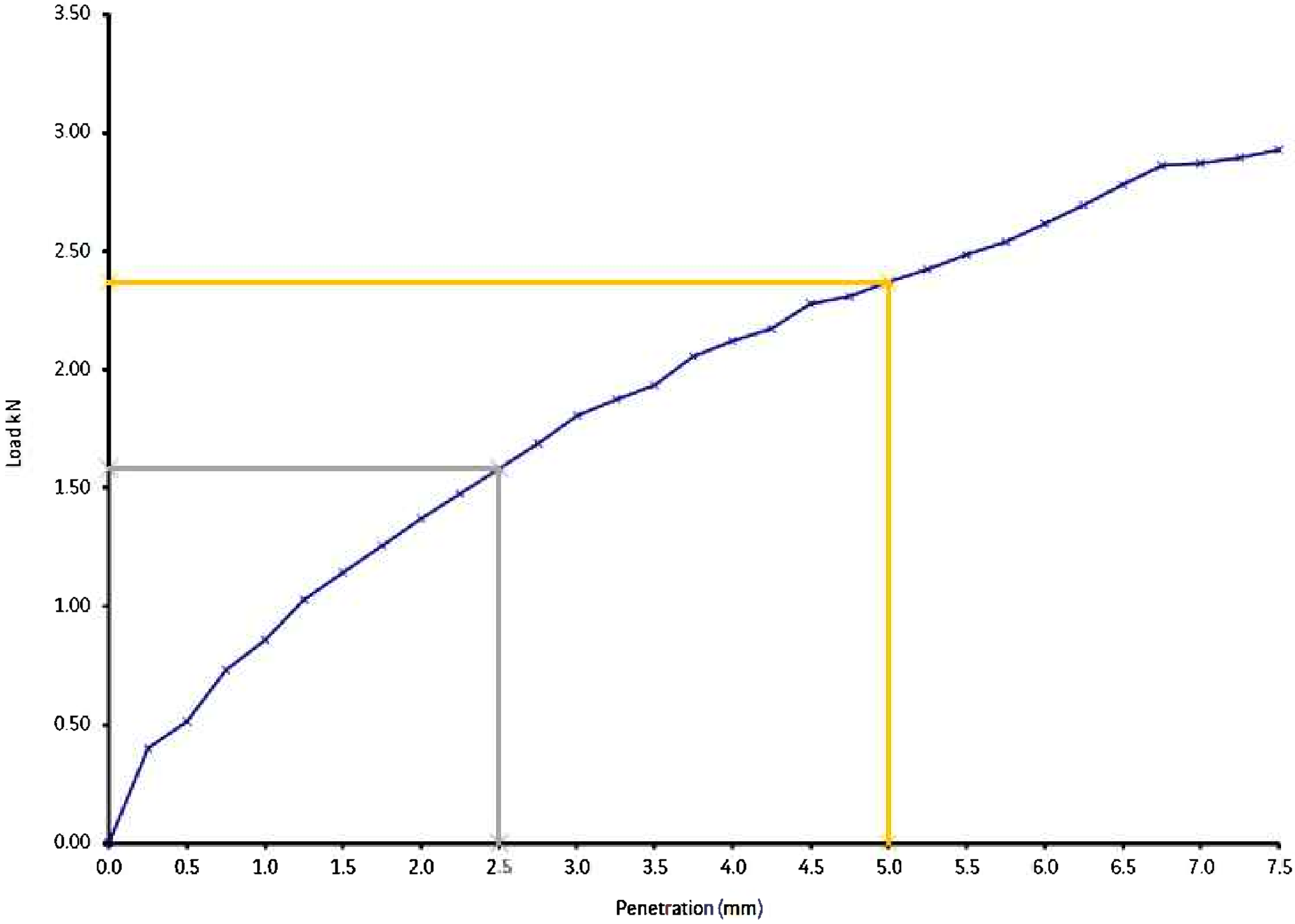
Natural moisture content	49	%
Seating load	1	N
Surcharge	10.5	kPa
Kentledge used		

Plunger

General remarks
Site conditions: Sunny

Preliminary
SE Engineer
Not UKAS
Print date 04/11/2021
Revision No. 3.00
Issue Date 22/10/2020
SOIL ENGINEERING

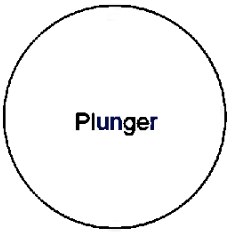
Project Name	Cambridge Waste Water Treatment Plant Relocation	**In Situ California Bearing Ratio Test**	Hole ID TP_FE_003
Project No.	TE8364		Test Depth 0.50m
Engineer	Mott MacDonald Bentley		Test Number 1
Employer	Barhale Limited	BS1377: Part 9: 1990: 4.3	Test Date 24/08/2021
Description	Brown calcareous CLAY.		



CBR values %

Penetration	CBR	Accepted CBR
2.50 mm	12	12
5.00 mm	12	
Curve correction	No	

Natural moisture content	11	%
Seating load	6	N
Surcharge	10.5	kPa
Kentledge used		

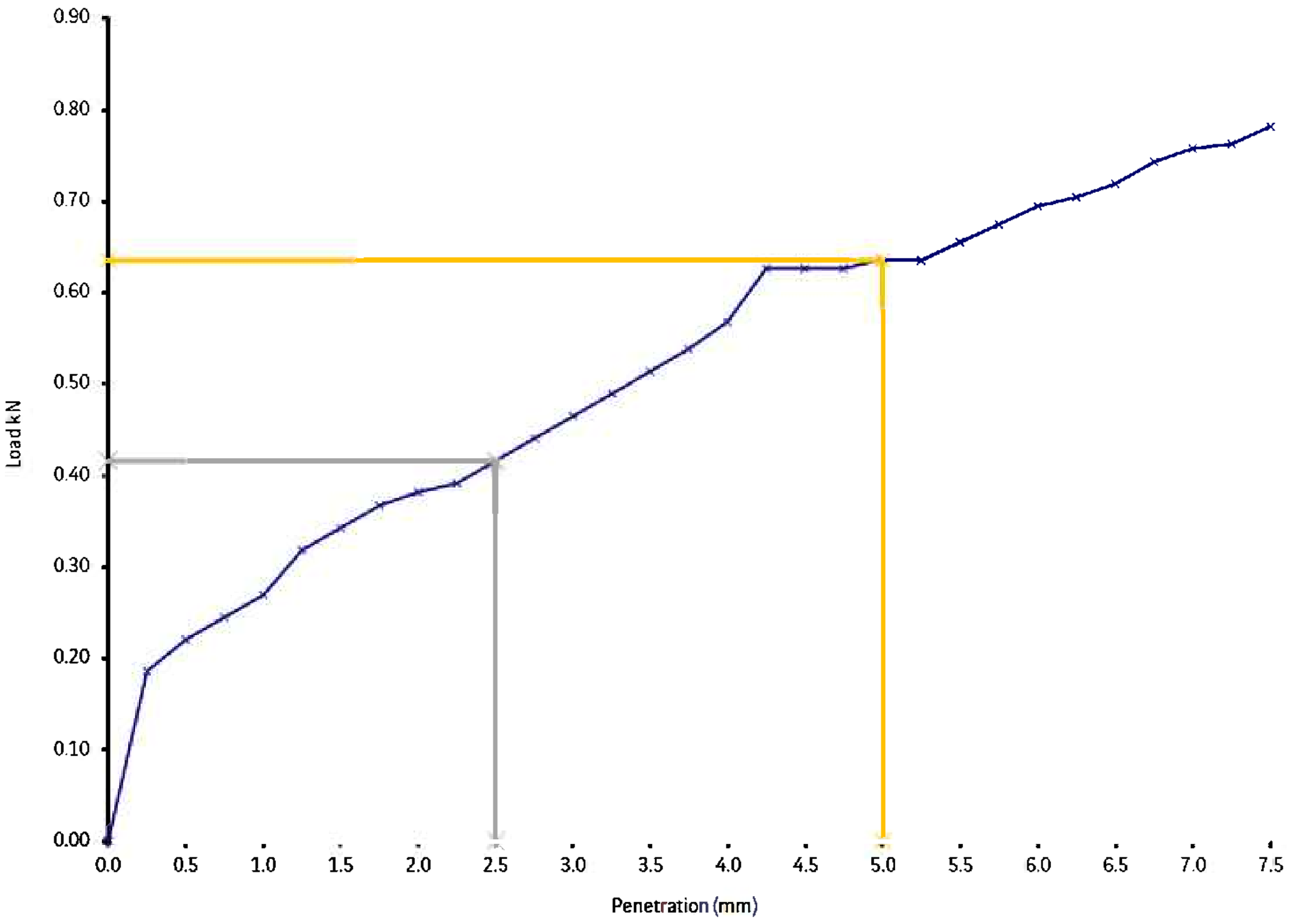


General remarks

Site conditions: Warm and sunny

Preliminary	SE Engineer		SOIL ENGINEERING
	Not UKAS	Print date 04/11/2021	
	Revision No. 3.00	Issue Date 22/10/2020	

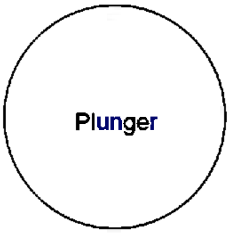
Project Name	Cambridge Waste Water Treatment Plant Relocation	**In Situ California Bearing Ratio Test**	Hole ID TP_FE_004
Project No.	TE8364		Test Depth 0.50m
Engineer	Mott MacDonald Bentley		Test Number 2
Employer	Barhale Limited	BS1377: Part 9: 1990: 4.3	Test Date 08/08/2021
Description	Brown calcareous CLAY.		



CBR values %

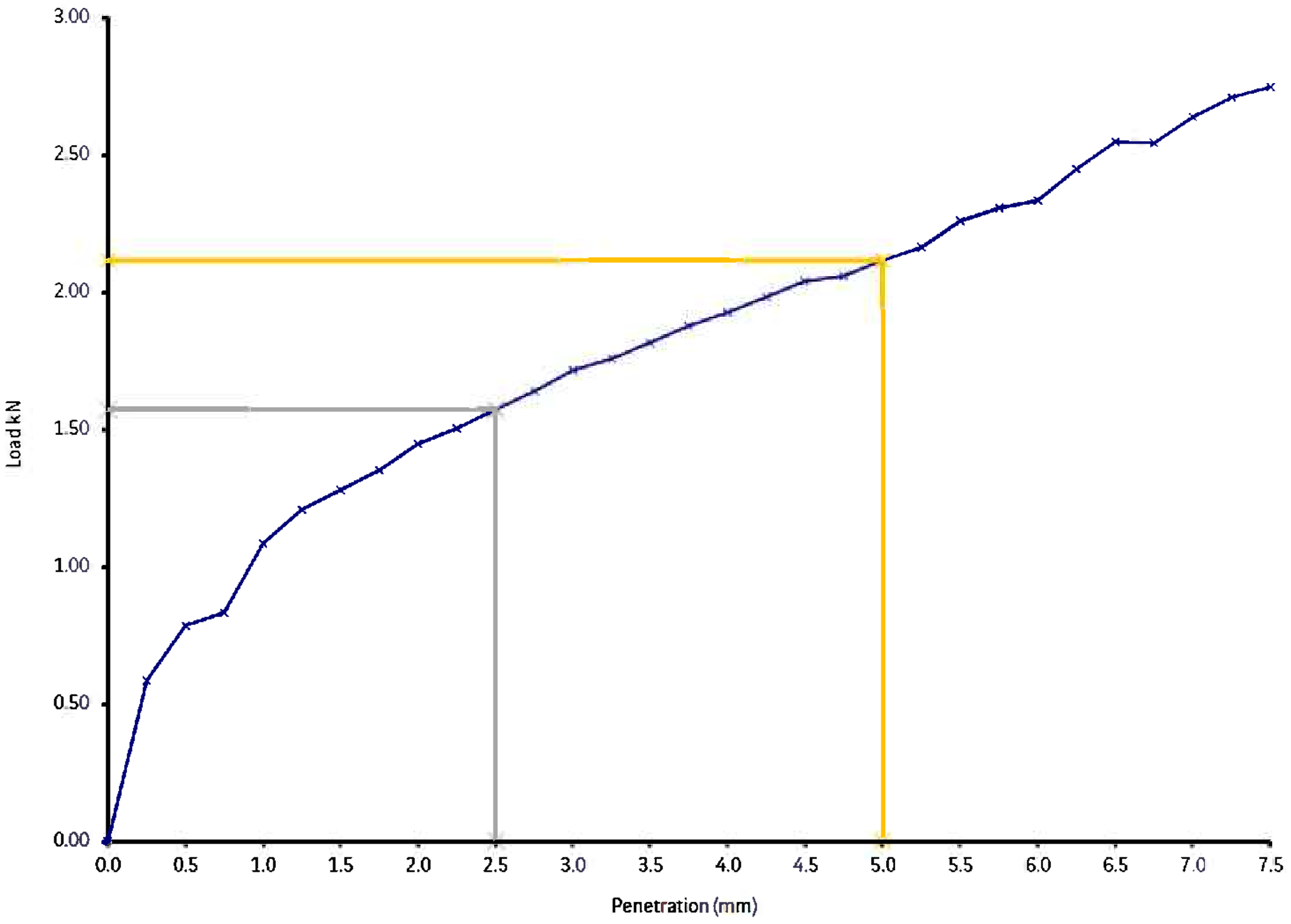
Penetration	CBR	Accepted CBR
2.50 mm	3.2	3.2
5.00 mm	3.2	
Curve correction	No	

Natural moisture content	14	%
Seating load	1	N
Surcharge	10.5	kPa
Kentledge used		



General remarks
Site conditions: Cloudy

Project Name	Cambridge Waste Water Treatment Plant Relocation	**In Situ California Bearing Ratio Test**	Hole ID TP_FE_005
Project No.	TE8364		Test Depth 0.50m
Engineer	Mott MacDonald Bentley		Test Number 1
Employer	Barhale Limited	BS1377: Part 9: 1990: 4.3	Test Date 26/08/2021
Description	Brown calcareous CLAY.		



CBR values %

Penetration	CBR	Accepted CBR
2.50 mm	12	12
5.00 mm	11	
Curve correction	No	

Natural moisture content	13	%
Seating load	1	N
Surcharge	10.5	kPa
Kentledge used		

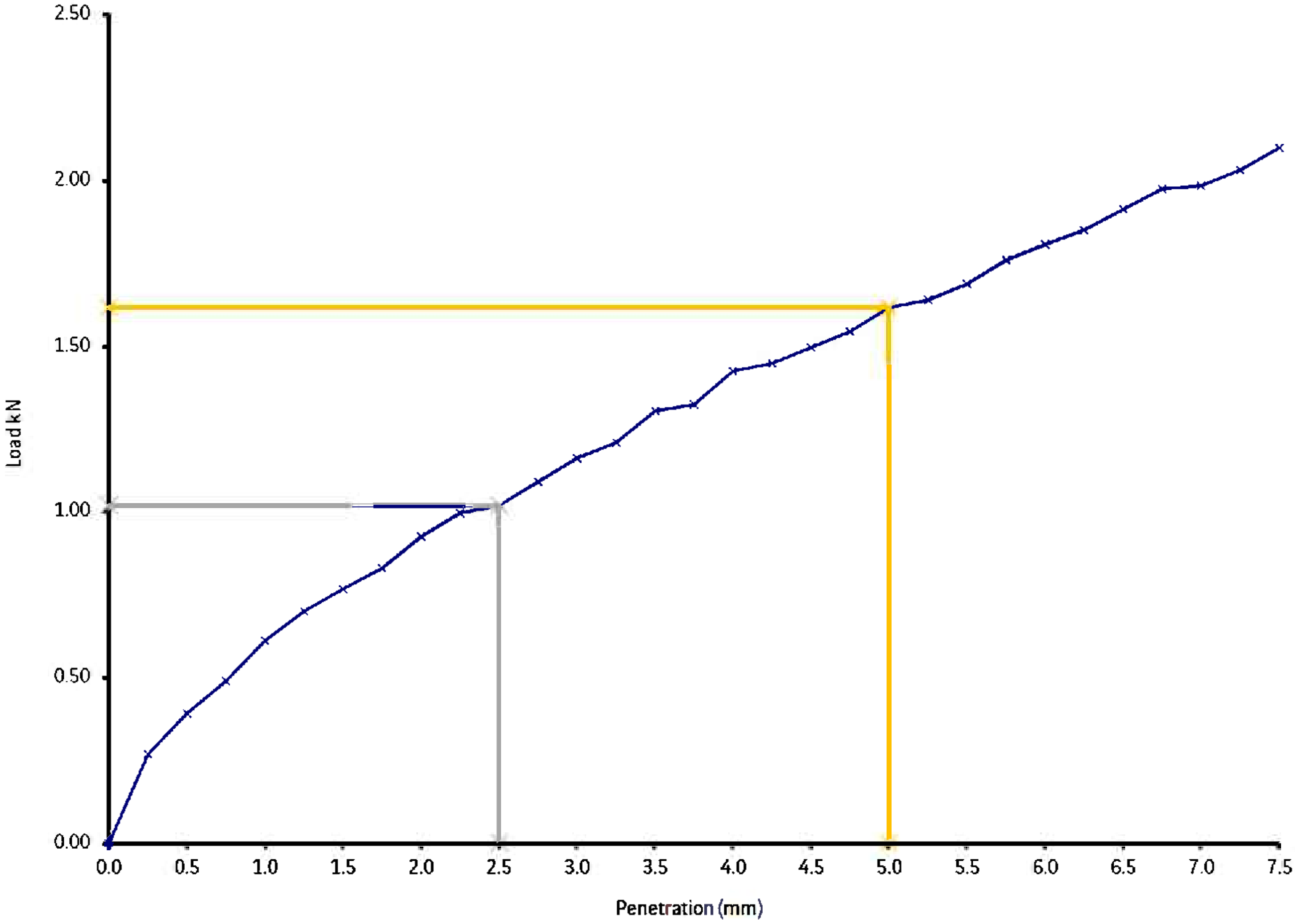
Plunger

General remarks
Site conditions: Cloudy

Preliminary	SE Engineer		
	Not UKAS		Print date 04/11/2021
	Revision No. 3.00	Issue Date 22/10/2020	

SOIL ENGINEERING

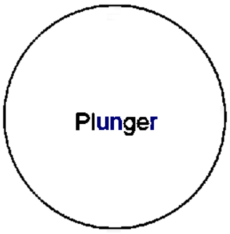
Project Name	Cambridge Waste Water Treatment Plant Relocation	**In Situ California Bearing Ratio Test**	Hole ID TP_FE_006
Project No.	TE8364		Test Depth 0.50m
Engineer	Mott MacDonald Bentley		Test Number 1
Employer	Barhale Limited	BS1377: Part 9: 1990: 4.3	Test Date 24/08/2021
Description	Brown calcareous CLAY.		



CBR values %

Penetration	CBR	Accepted CBR
2.50 mm	7.7	8.1
5.00 mm	8.1	
Curve correction	No	

Natural moisture content	12	%
Seating load	1	N
Surcharge	10.5	kPa
Kentledge used		



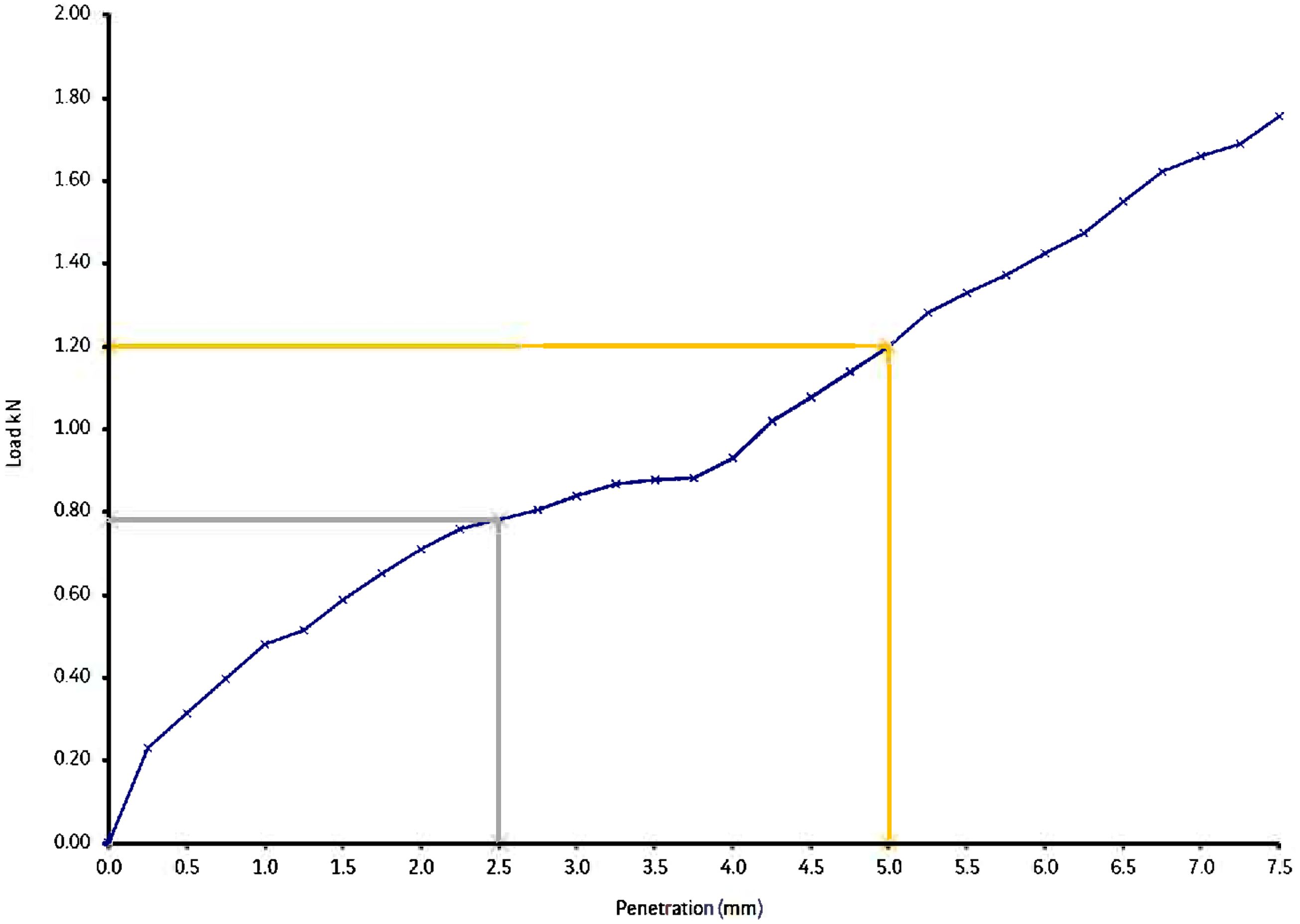
General remarks

Site conditions: Cloudy

Preliminary	SE Engineer		
	Not UKAS		Print date 04/11/2021
	Revision No. 3.00	Issue Date 22/10/2020	

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**In Situ California Bearing Ratio Test**	Hole ID TP_STW_003
Project No.	TE8364		Test Depth 0.50m
Engineer	Mott MacDonald Bentley		Test Number 1
Employer	Barhale Limited	BS1377: Part 9: 1990: 4.3	Test Date 02/09/2021
Description	CHALK/CLAY.		



CBR values %

Penetration	CBR	Accepted CBR
2.50 mm	5.9	6.0
5.00 mm	6.0	
Curve correction	No	

Natural moisture content	7	%
Seating load	1	N
Surcharge	10.5	kPa
Kentledge used		

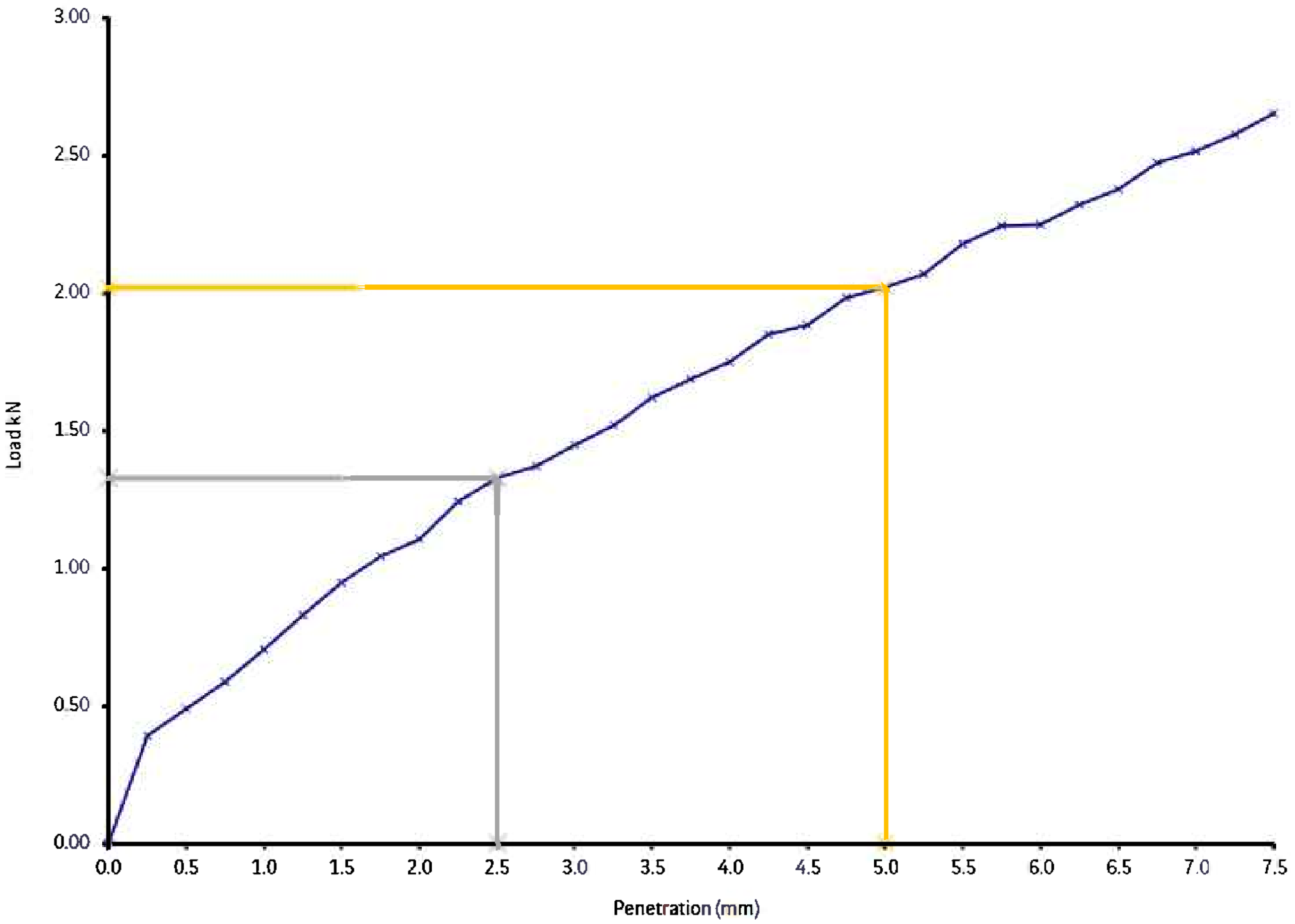
Plunger

General remarks
Site conditions: cloudy

Preliminary	SE Engineer		
	Not UKAS		Print date 04/11/2021
	Revision No. 3.00	Issue Date 22/10/2020	

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**In Situ California Bearing Ratio Test**	Hole ID TP_STW_004
Project No.	TE8364		Test Depth 0.50m
Engineer	Mott MacDonald Bentley		Test Number 1
Employer	Barhale Limited	BS1377: Part 9: 1990: 4.3	Test Date 27/08/2021
Description	Brown calcareous CLAY.		



CBR values %

Penetration	CBR	Accepted CBR
2.50 mm	10	10
5.00 mm	10	
Curve correction	No	

Natural moisture content	9.3	%
Seating load	1	N
Surcharge	10.5	kPa
Kentledge used		

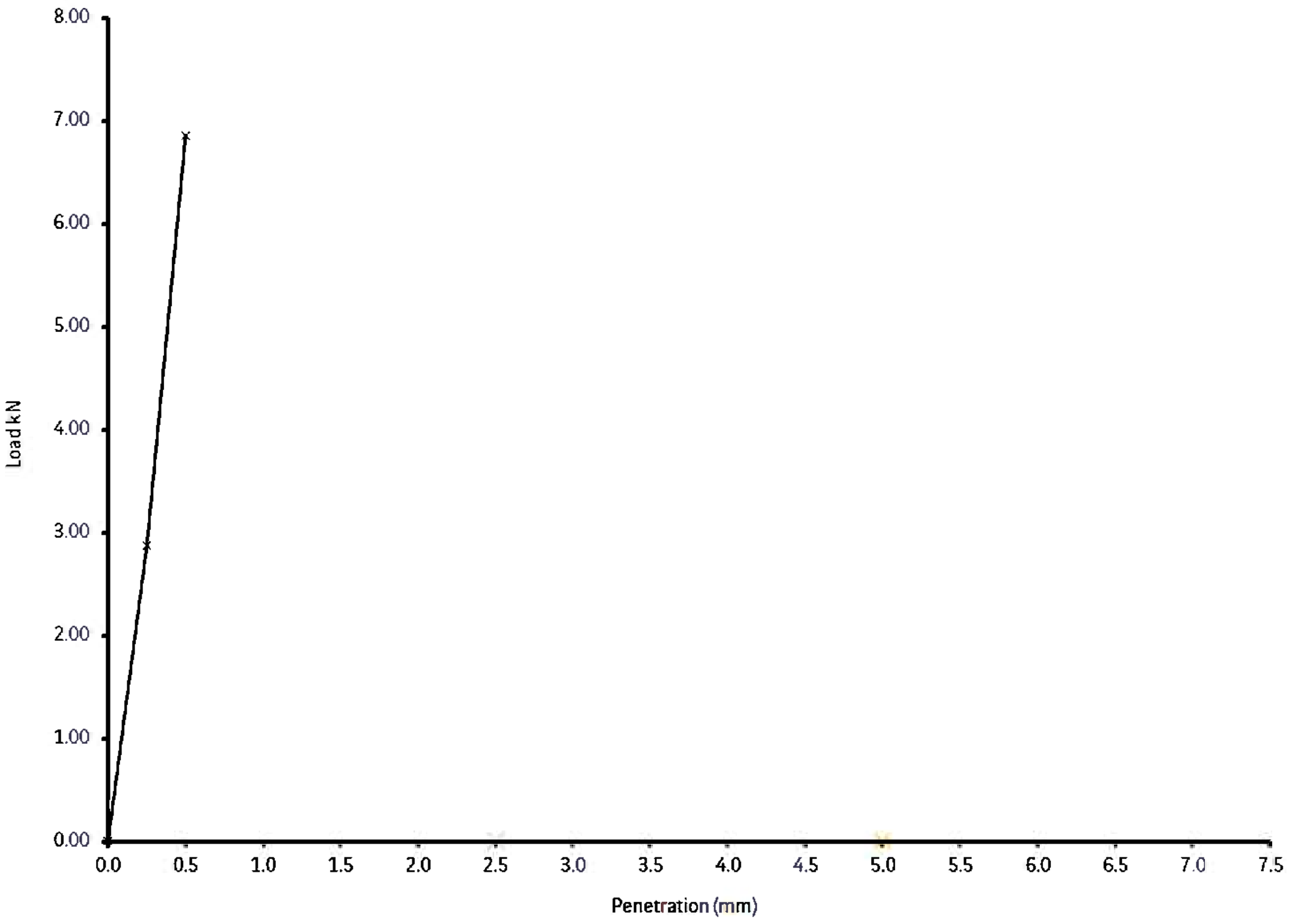
Plunger

General remarks
Site conditions: Cloudy

Preliminary	SE Engineer		
	Not UKAS		Print date 04/11/2021
	Revision No. 3.00	Issue Date 22/10/2020	

soil engineering

Project Name	Cambridge Waste Water Treatment Plant Relocation	**In Situ California Bearing Ratio Test**	Hole ID TP_STW_005
Project No.	TE8364		Test Depth 0.50m
Engineer	Mott MacDonald Bentley		Test Number 2
Employer	Barhale Limited	BS1377: Part 9: 1990: 4.3	Test Date 03/09/2021
Description	Gravelly CHALK/ CLAY.		



CBR values %

Penetration	CBR
2.50 mm	
5.00 mm	
Curve correction	No

Natural moisture content	6.4	%
Seating load	1	N
Surcharge	10.5	kPa
Kentledge used		

Plunger

General remarks

Site conditions: Cloudy

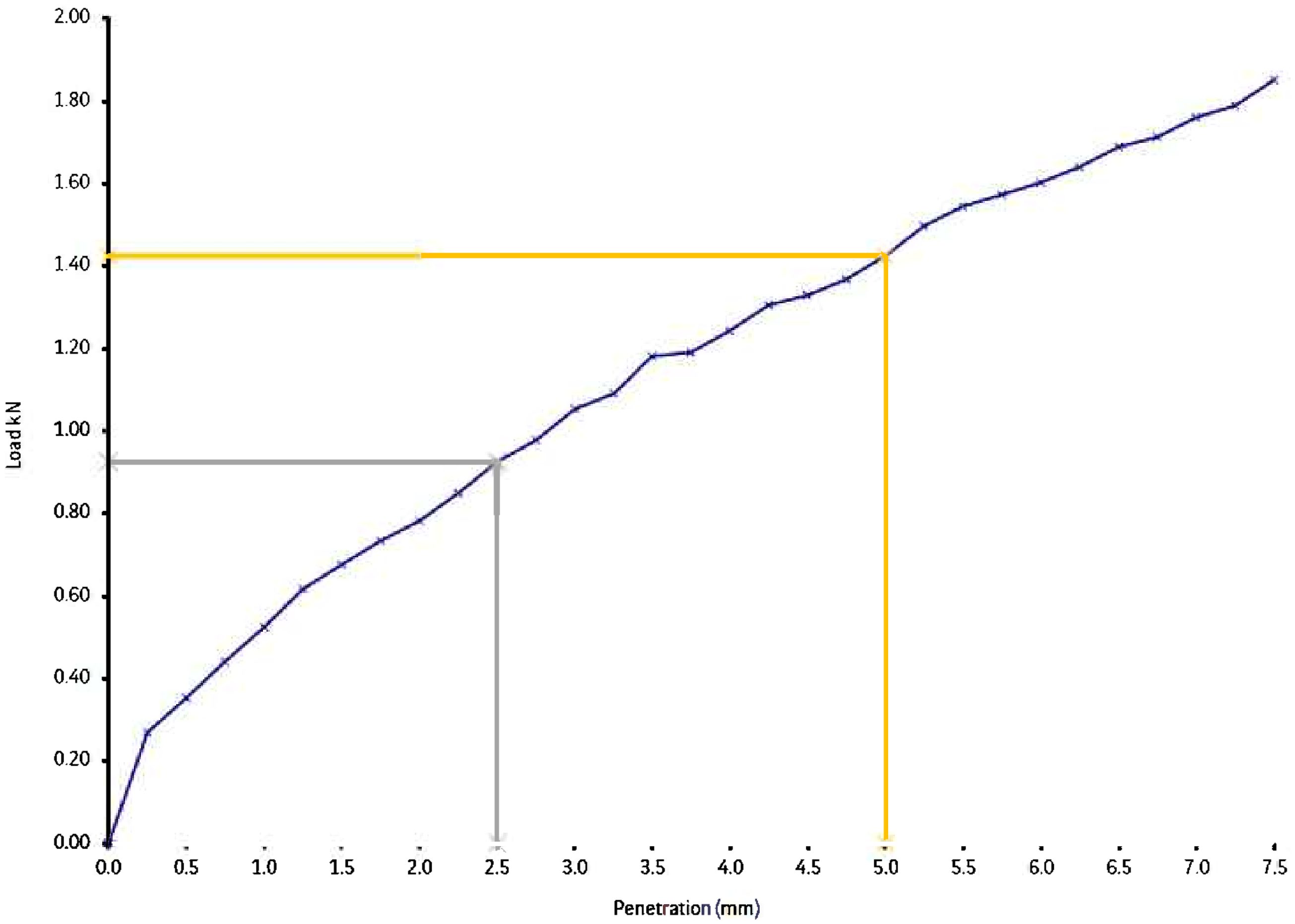
Test stopped at ring limit.

Preliminary	SE Engineer		
	Not UKAS		Print date 04/11/2021
	Revision No. 3.00	Issue Date 22/10/2020	

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**In Situ California Bearing Ratio Test**	Hole ID TP_STW_006
Project No.	TE8364		Test Depth 0.50m
Engineer	Mott MacDonald Bentley		Test Number 1
Employer	Barhale Limited	BS1377: Part 9: 1990: 4.3	Test Date 31/08/2021

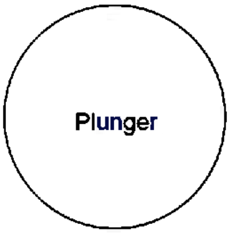
Description Brown calcareous CLAY.



CBR values %

Penetration	CBR	Accepted CBR
2.50 mm	7.0	7.1
5.00 mm	7.1	
Curve correction	No	

Natural moisture content	8.5	%
Seating load	1	N
Surcharge	10.5	kPa
Kentledge used		



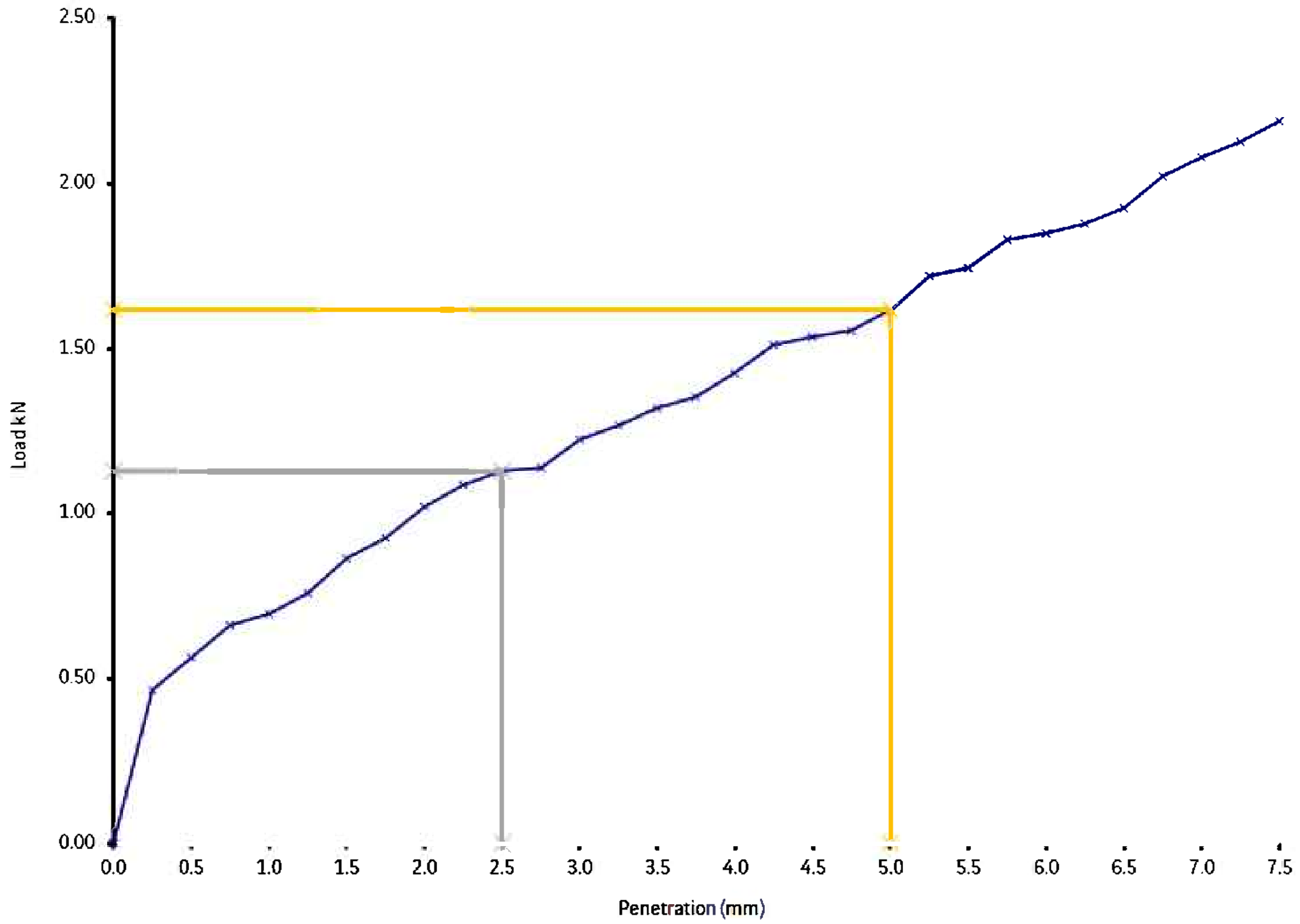
General remarks

Site conditions: Cloudy

Preliminary	SE Engineer		soil engineering
	Not UKAS	Print date 04/11/2021	
	Revision No. 3.00	Issue Date 22/10/2020	

Project Name	Cambridge Waste Water Treatment Plant Relocation	**In Situ California Bearing Ratio Test**	Hole ID TP_STW_007
Project No.	TE8364		Test Depth 0.50m
Engineer	Mott MacDonald Bentley		Test Number 1
Employer	Barhale Limited	BS1377: Part 9: 1990: 4.3	Test Date 31/08/2021

Description Brown calcareous CLAY.



CBR values %

Penetration	CBR	Accepted CBR
2.50 mm	8.6	8.6
5.00 mm	8.1	
Curve correction	No	

Natural moisture content	7.5	%
Seating load	1	N
Surcharge	10.5	kPa
Kentledge used		

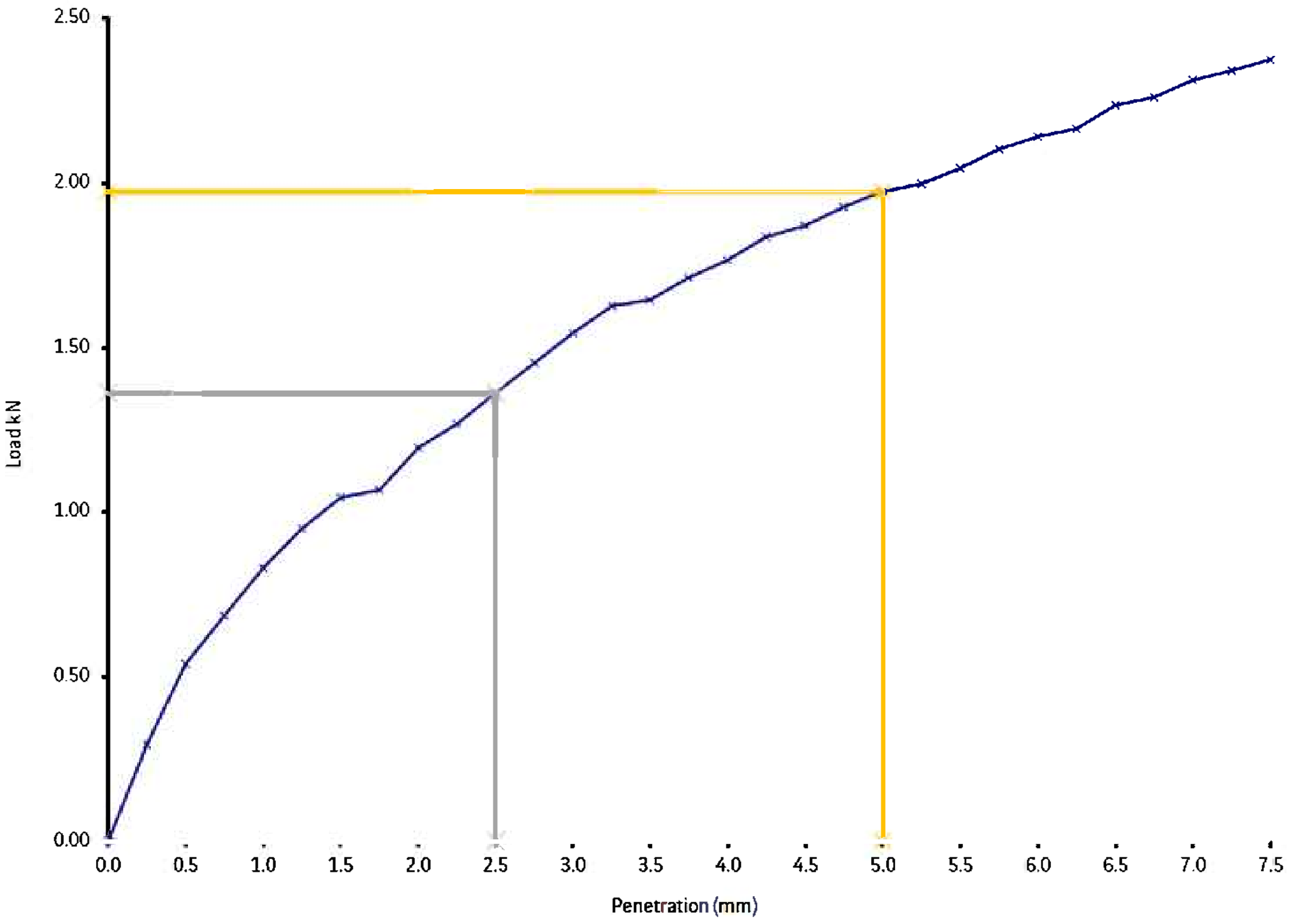
Plunger

General remarks
Site conditions: Cloudy

Preliminary	SE Engineer		
	Not UKAS		Print date 04/11/2021
	Revision No. 3.00	Issue Date 22/10/2020	

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**In Situ California Bearing Ratio Test**	Hole ID TP_STW_010
Project No.	TE8364		Test Depth 0.50m
Engineer	Mott MacDonald Bentley		Test Number 1
Employer	Barhale Limited	BS1377: Part 9: 1990: 4.3	Test Date 01/09/2021
Description	Brown calcareous CLAY.		



CBR values %

Penetration	CBR	Accepted CBR
2.50 mm	10	10
5.00 mm	9.9	
Curve correction	No	

Natural moisture content	11	%
Seating load	1	N
Surcharge	10.5	kPa
Kentledge used		

Plunger

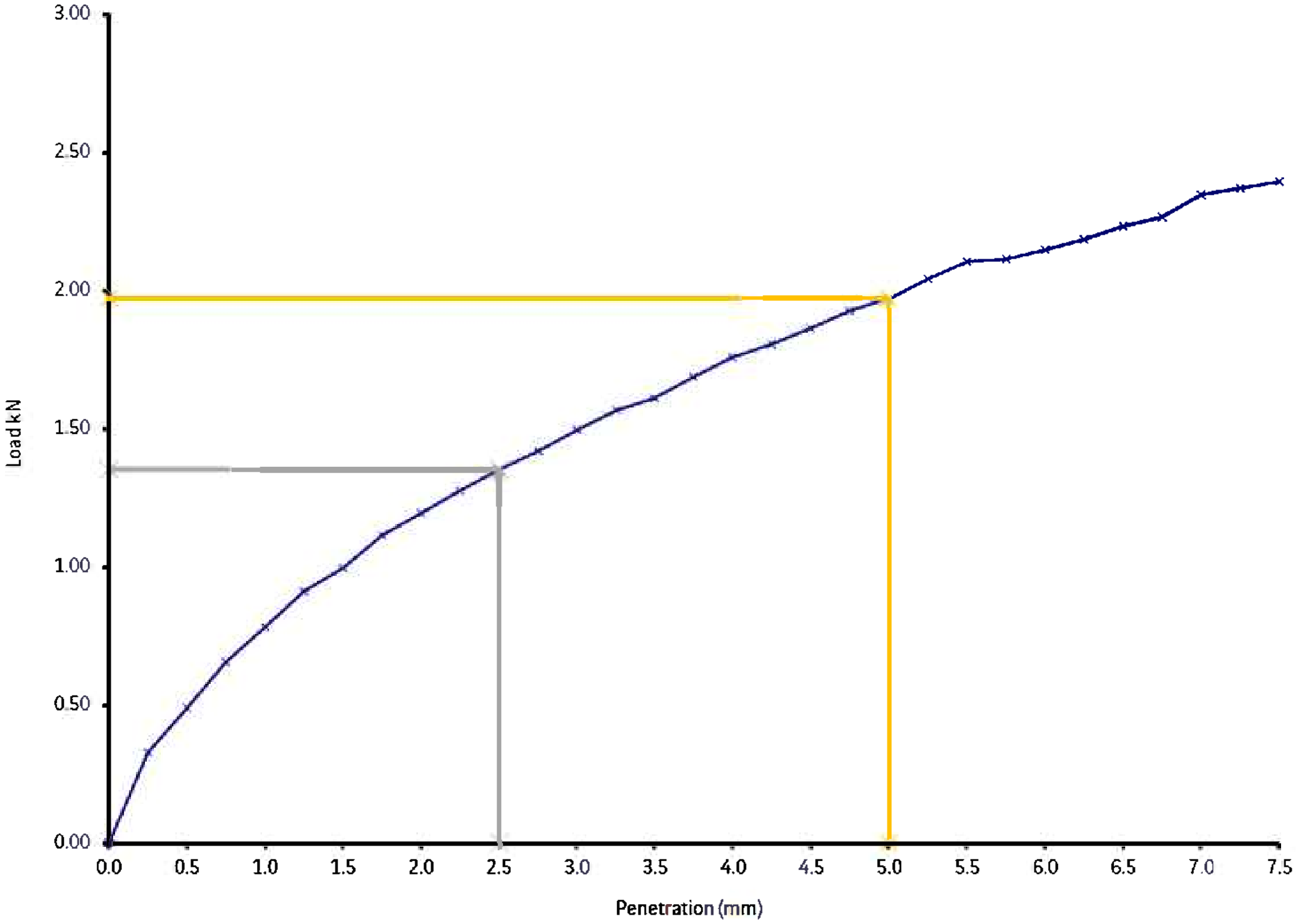
General remarks
Site conditions: Cloudy

Preliminary	SE Engineer		
	Not UKAS		Print date 04/11/2021
	Revision No. 3.00	Issue Date 22/10/2020	

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**In Situ California Bearing Ratio Test**	Hole ID TP_STW_011
Project No.	TE8364		Test Depth 0.50m
Engineer	Mott MacDonald Bentley		Test Number 1
Employer	Barhale Limited	BS1377: Part 9: 1990: 4.3	Test Date 01/09/2021

Description Brown calcareous CLAY.



CBR values %

Penetration	CBR	Accepted CBR
2.50 mm	10	10
5.00 mm	9.9	
Curve correction	No	

Natural moisture content	6.2	%
Seating load	1	N
Surcharge	10.5	kPa
Kentledge used		

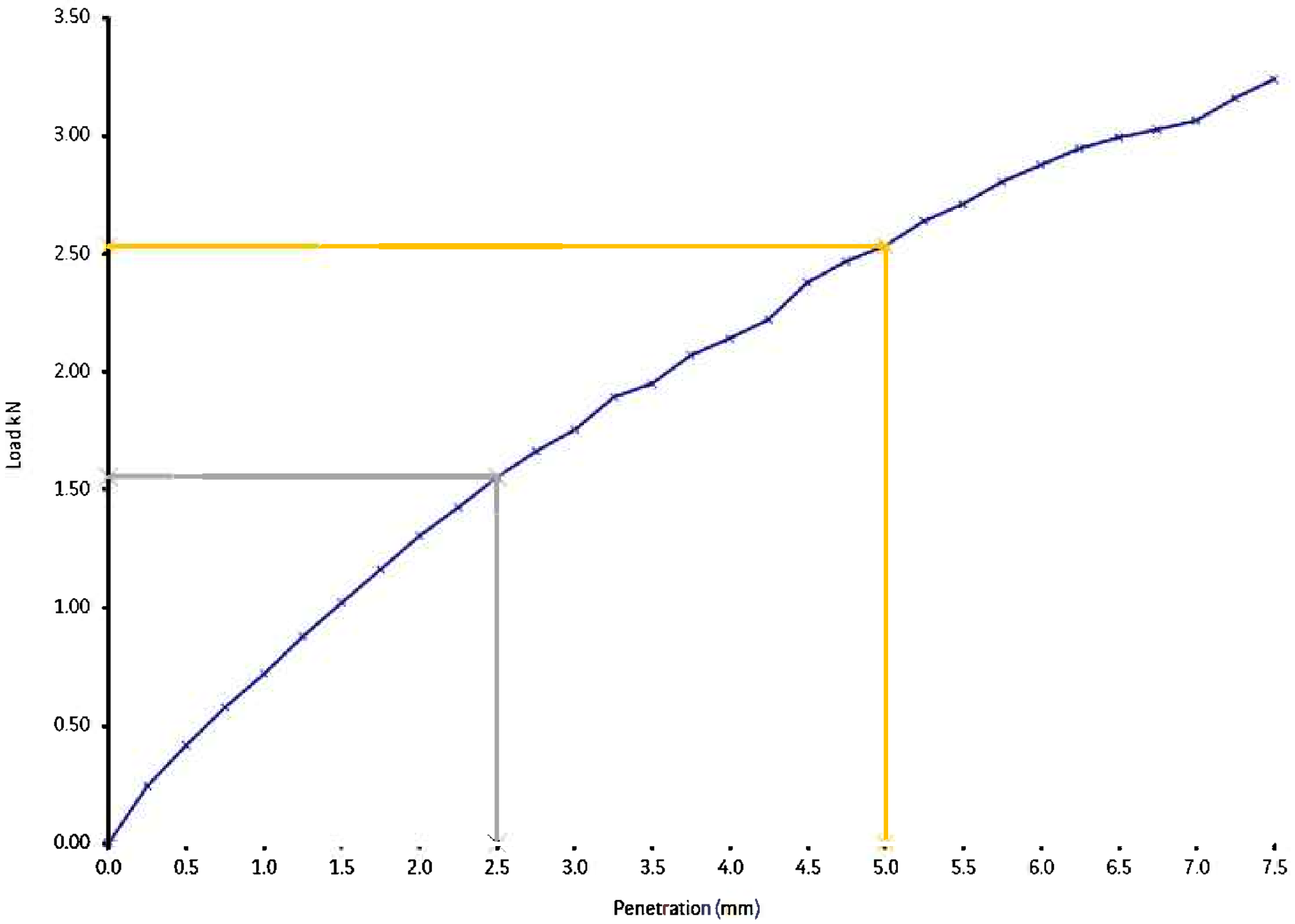
Plunger

General remarks
Site conditions: Cloudy

Preliminary	SE Engineer		
	Not UKAS		Print date 04/11/2021
	Revision No. 3.00	Issue Date 22/10/2020	

soil engineering

Project Name	Cambridge Waste Water Treatment Plant Relocation	**In Situ California Bearing Ratio Test**	Hole ID TP_STW_012
Project No.	TE8364		Test Depth 0.50m
Engineer	Mott MacDonald Bentley		Test Number 1
Employer	Barhale Limited	BS1377: Part 9: 1990: 4.3	Test Date 03/09/2021
Description	Brown CLAY.		



CBR values %

Penetration	CBR	Accepted CBR
2.50 mm	12	13
5.00 mm	13	
Curve correction	No	

Natural moisture content	5.5	%
Seating load	1	N
Surcharge	10.5	kPa
Kentledge used		

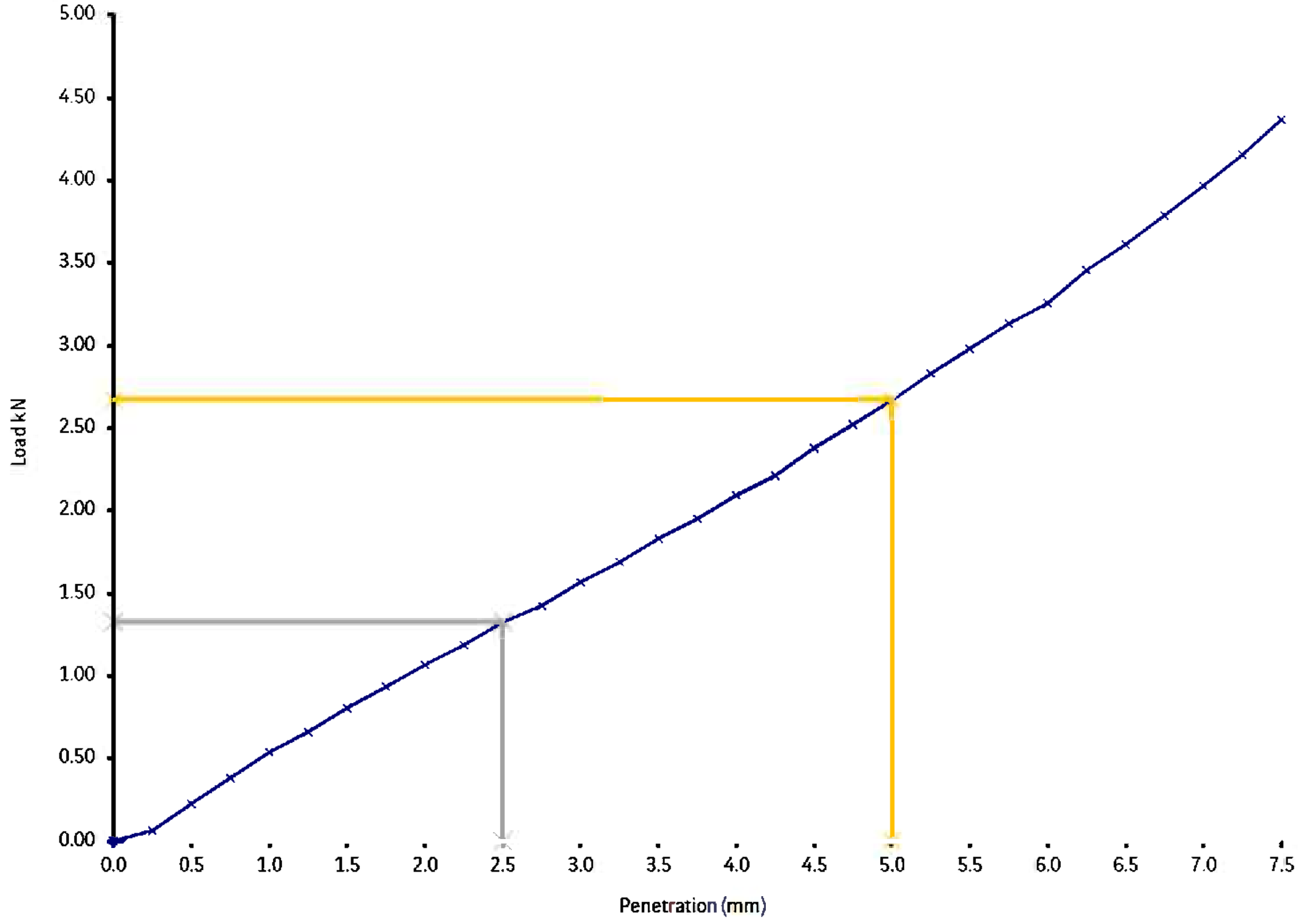
Plunger

General remarks
Site conditions: Cloudy

Preliminary	SE Engineer		
	Not UKAS		Print date 04/11/2021
	Revision No. 3.00	Issue Date 22/10/2020	

SOIL ENGINEERING

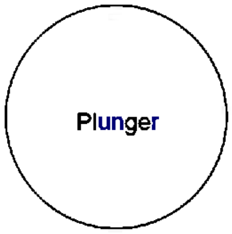
Project Name	Cambridge Waste Water Treatment Plant Relocation	**In Situ California Bearing Ratio Test**	Hole ID TP_STW_013
Project No.	TE8364		Test Depth 0.50m
Engineer	Mott MacDonald Bentley		Test Number 1
Employer	Barhale Limited	BS1377: Part 9: 1990: 4.3	Test Date 06/09/2021
Description	Off white CHALK and calcareous CLAY.		



CBR values %

Penetration	CBR	Accepted CBR
2.50 mm	10	13
5.00 mm	13	
Curve correction	No	

Natural moisture content	11	%
Seating load	1	N
Surcharge	10.5	kPa
Kentledge used		

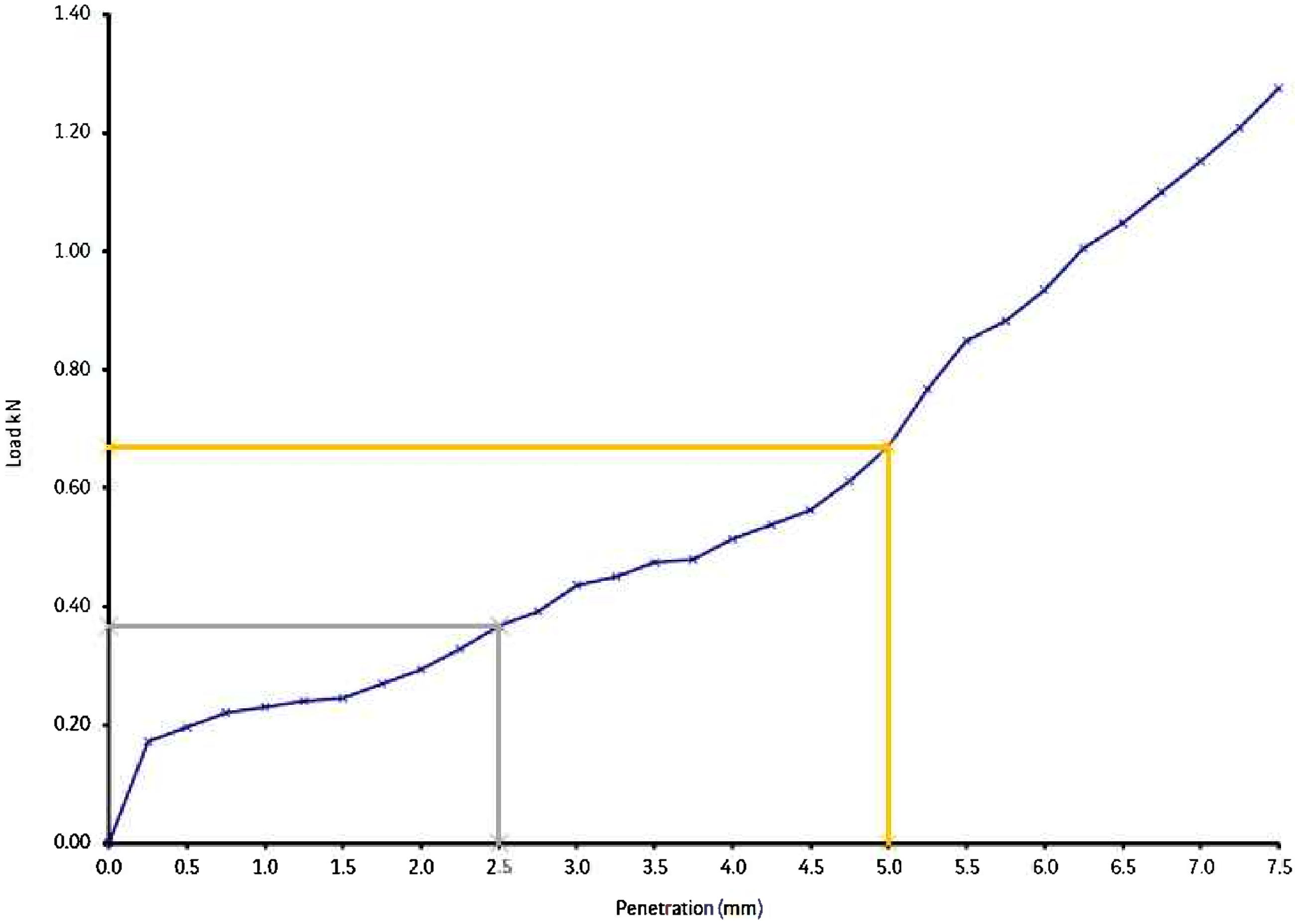


General remarks

Site conditions: Dry/ sunny

Preliminary	SE Engineer		SOIL ENGINEERING
	Not UKAS	Print date 04/11/2021	
	Revision No. 3.00	Issue Date 22/10/2020	

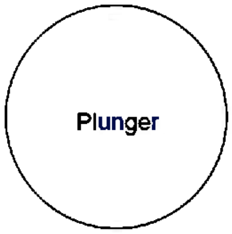
Project Name	Cambridge Waste Water Treatment Plant Relocation	**In Situ California Bearing Ratio Test**	Hole ID TP_STW_014
Project No.	TE8364		Test Depth 0.50m
Engineer	Mott MacDonald Bentley		Test Number 1
Employer	Barhale Limited	BS1377: Part 9: 1990: 4.3	Test Date 07/09/2021
Description	Brown CLAY.		



CBR values %

Penetration	CBR	Accepted CBR
2.50 mm	2.8	3.4
5.00 mm	3.4	
Curve correction	No	

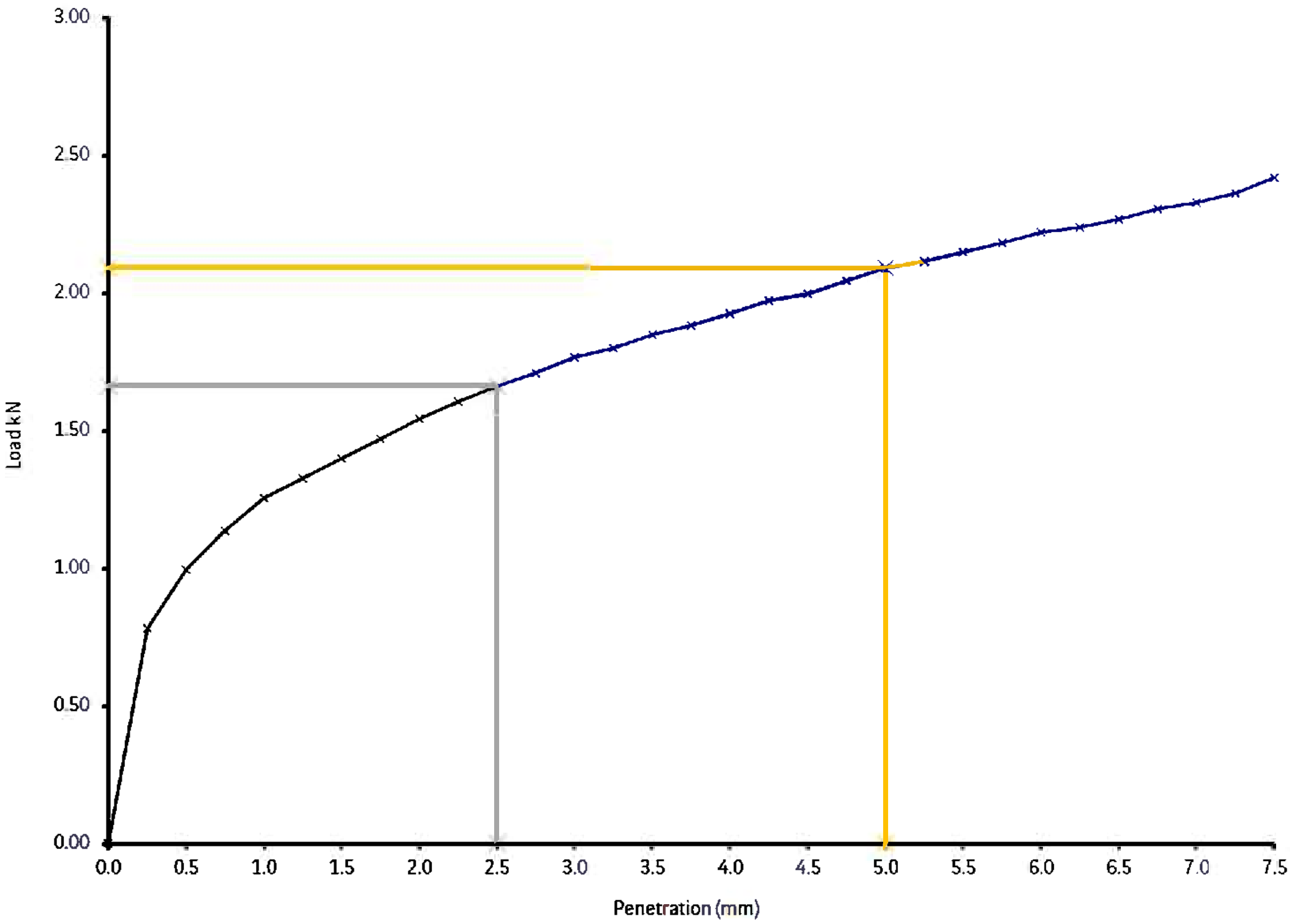
Natural moisture content	11	%
Seating load	1	N
Surcharge	10.5	kPa
Kentledge used		



General remarks
Site conditions: Cloudy

Preliminary	SE Engineer		soil engineering
	Not UKAS	Print date 04/11/2021	
	Revision No. 3.00	Issue Date 22/10/2020	

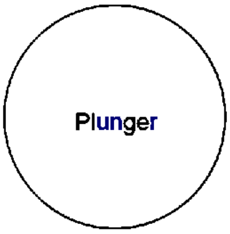
Project Name	Cambridge Waste Water Treatment Plant Relocation	**In Situ California Bearing Ratio Test**	Hole ID TP_STW_015
Project No.	TE8364		Test Depth 0.50m
Engineer	Mott MacDonald Bentley		Test Number 1
Employer	Barhale Limited	BS1377: Part 9: 1990: 4.3	Test Date 07/09/2021
Description	Brown CLAY.		



CBR values %

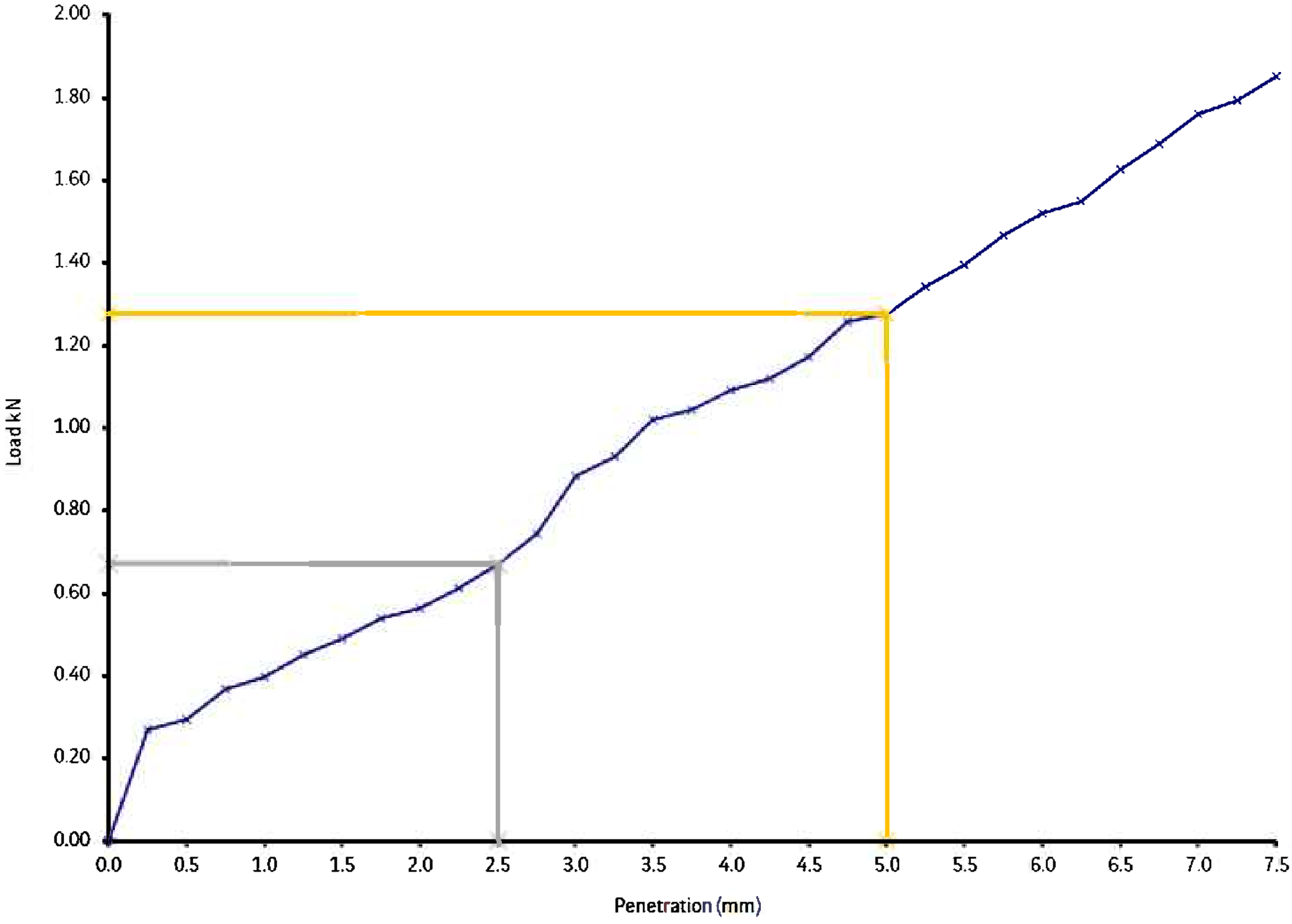
Penetration	CBR	Accepted CBR
2.50 mm	13	13
5.00 mm	10	
Curve correction	No	

Natural moisture content	11	%
Seating load	1	N
Surcharge	10.5	kPa
Kentledge used		



General remarks
Site conditions: cloudy

Project Name	Cambridge Waste Water Treatment Plant Relocation	**In Situ California Bearing Ratio Test**	Hole ID TP_STW_016
Project No.	TE8364		Test Depth 0.50m
Engineer	Mott MacDonald Bentley		Test Number 1
Employer	Barhale Limited	BS1377: Part 9: 1990: 4.3	Test Date 08/09/2021
Description	Brown CLAY.		



CBR values %

Penetration	CBR	Accepted CBR
2.50 mm	5.1	6.4
5.00 mm	6.4	
Curve correction	No	

Natural moisture content	10	%
Seating load	1	N
Surcharge	10.5	kPa
Kentledge used		

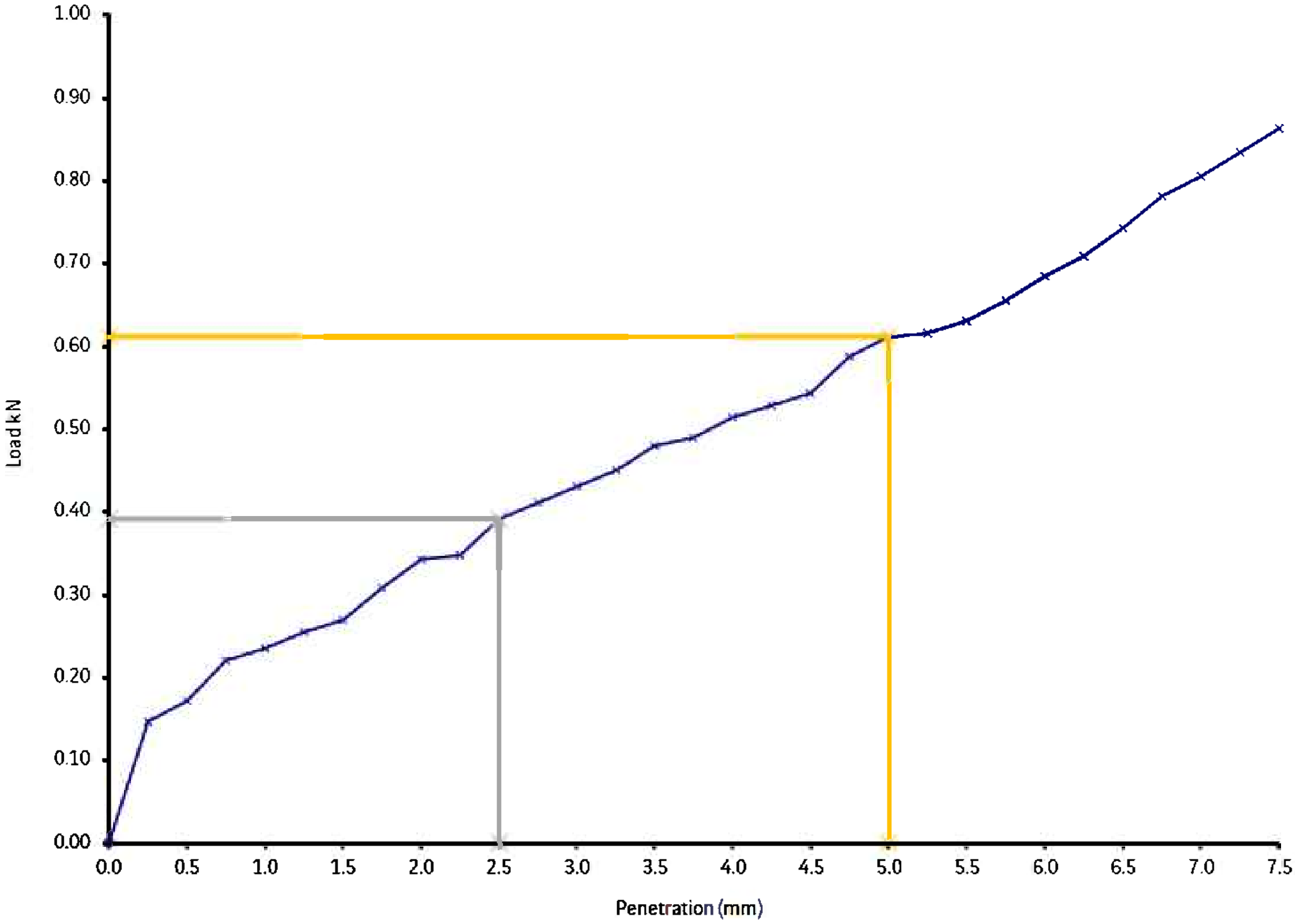
Plunger

General remarks
Site conditions: Sunny

Preliminary	SE Engineer		
	Not UKAS		Print date 04/11/2021
	Revision No. 3.00	Issue Date 22/10/2020	

soil engineering

Project Name	Cambridge Waste Water Treatment Plant Relocation	**In Situ California Bearing Ratio Test**	Hole ID TP_STW_017
Project No.	TE8364		Test Depth 0.50m
Engineer	Mott MacDonald Bentley		Test Number 1
Employer	Barhale Limited	BS1377: Part 9: 1990: 4.3	Test Date 10/09/2021
Description	Brown CLAY.		



CBR values %

Penetration	CBR	Accepted CBR
2.50 mm	3.0	3.1
5.00 mm	3.1	
Curve correction	No	

Natural moisture content	12	%
Seating load	1	N
Surcharge	10.5	kPa
Kentledge used		

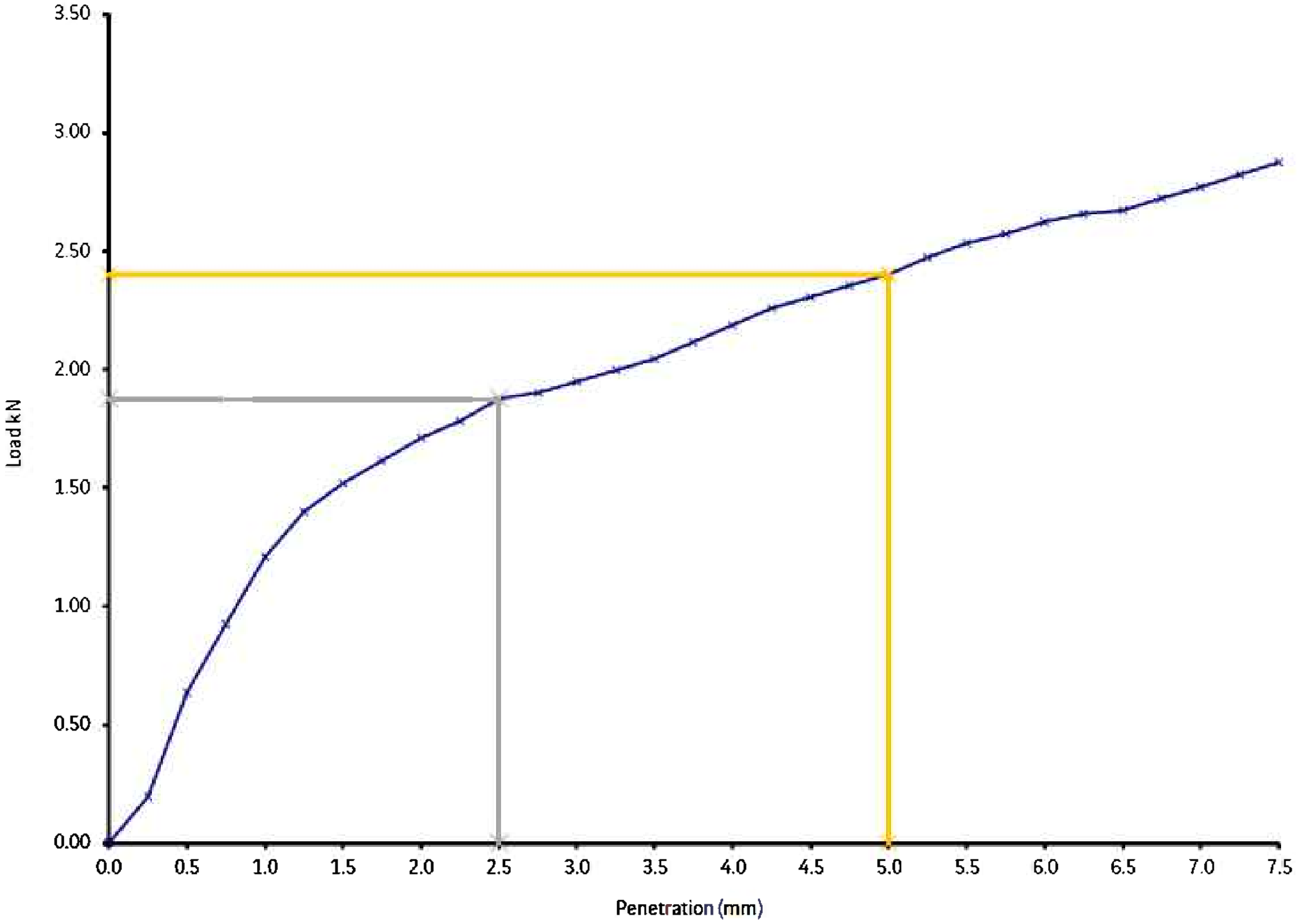
Plunger

General remarks

Site conditions: Cloudy

Preliminary	SE Engineer		soil engineering
	Not UKAS	Print date 04/11/2021	
	Revision No. 3.00	Issue Date 22/10/2020	

Project Name	Cambridge Waste Water Treatment Plant Relocation	**In Situ California Bearing Ratio Test**	Hole ID TP_STW_018
Project No.	TE8364		Test Depth 0.50m
Engineer	Mott MacDonald Bentley		Test Number 1
Employer	Barhale Limited	BS1377: Part 9: 1990: 4.3	Test Date 09/09/2021
Description	Brown CLAY.		



CBR values %

Penetration	CBR	Accepted CBR
2.50 mm	14	14
5.00 mm	12	
Curve correction	No	

Natural moisture content	7	%
Seating load	1	N
Surcharge	10.5	kPa
Kentledge used		

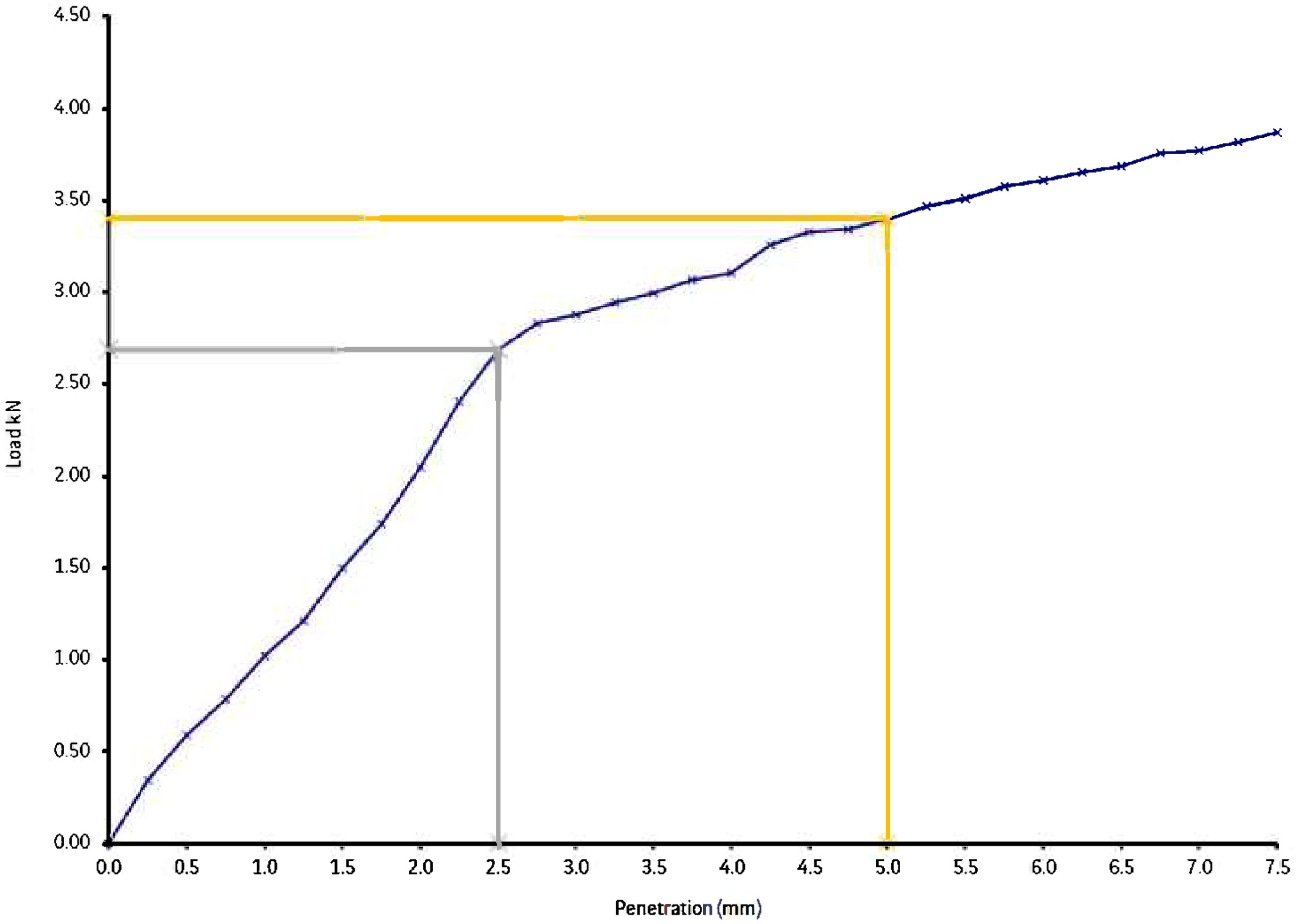
Plunger

General remarks
Site conditions: Cloudy

Preliminary	SE Engineer		
	Not UKAS		Print date 04/11/2021
	Revision No. 3.00	Issue Date 22/10/2020	

Soil Engineering

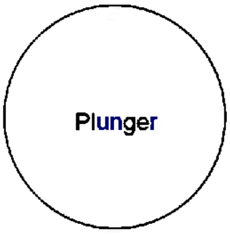
Project Name	Cambridge Waste Water Treatment Plant Relocation	**In Situ California Bearing Ratio Test**	Hole ID TP_STW_019
Project No.	TE8364		Test Depth 0.50m
Engineer	Mott MacDonald Bentley		Test Number 1
Employer	Barhale Limited	BS1377: Part 9: 1990: 4.3	Test Date 10/09/2021
Description	Brown CLAY.		



CBR values %

Penetration	CBR	Accepted CBR
2.50 mm	20	20
5.00 mm	17	
Curve correction	No	

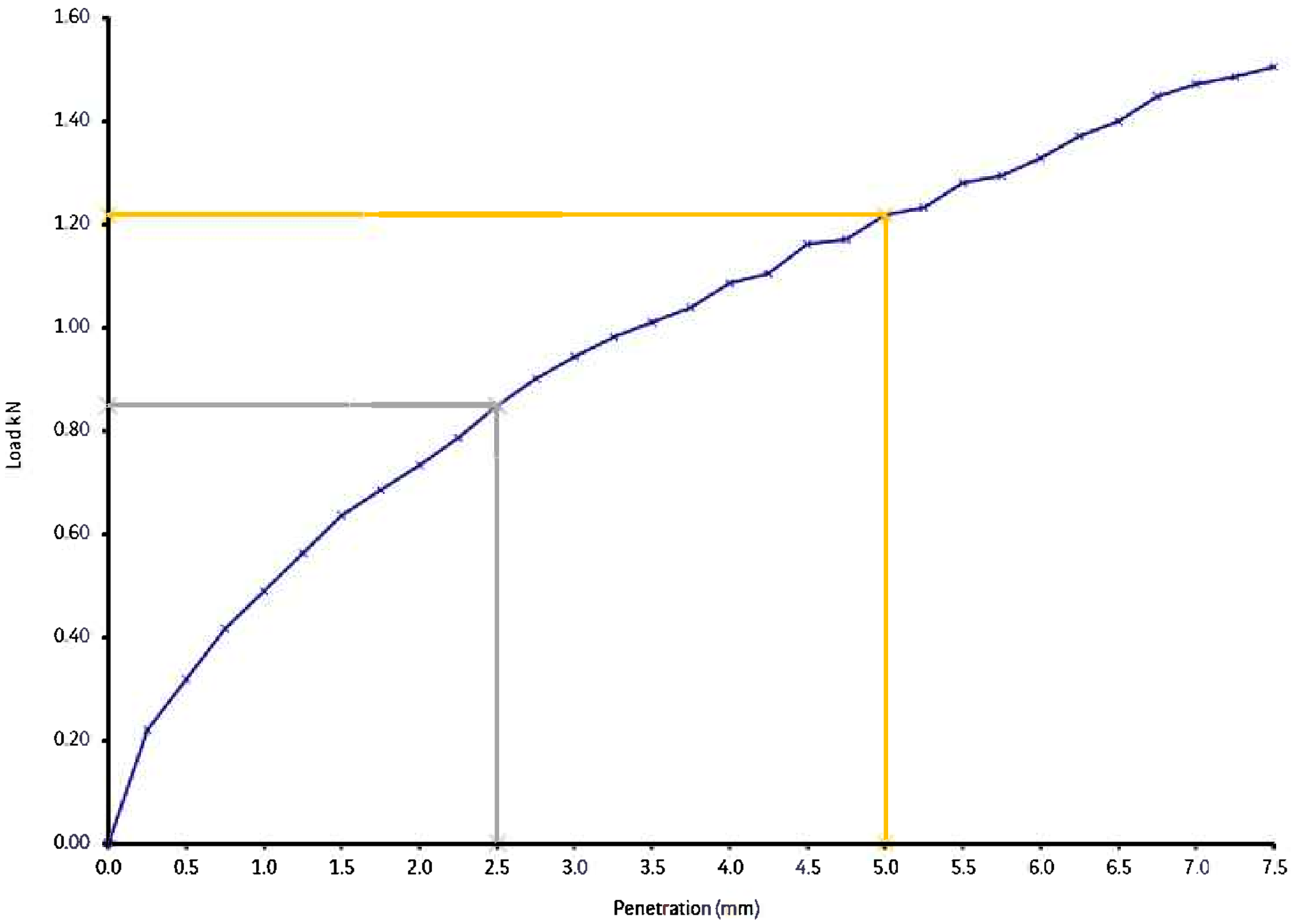
Natural moisture content	7.5	%
Seating load	1	N
Surcharge	10.5	kPa
Kentledge used		



General remarks
Site conditions: Cloudy

Preliminary	SE Engineer		SOIL ENGINEERING
	Not UKAS	Print date 04/11/2021	
	Revision No. 3.00	Issue Date 22/10/2020	

Project Name	Cambridge Waste Water Treatment Plant Relocation	**In Situ California Bearing Ratio Test**	Hole ID TP_STW_020
Project No.	TE8364		Test Depth 0.50m
Engineer	Mott MacDonald Bentley		Test Number 1
Employer	Barhale Limited	BS1377: Part 9: 1990: 4.3	Test Date 13/09/2021
Description	Clayey CHALK.		



CBR values %

Penetration	CBR	Accepted CBR
2.50 mm	6.4	6.4
5.00 mm	6.1	
Curve correction	No	

Natural moisture content	13	%
Seating load	1	N
Surcharge	10.5	kPa
Kentledge used		

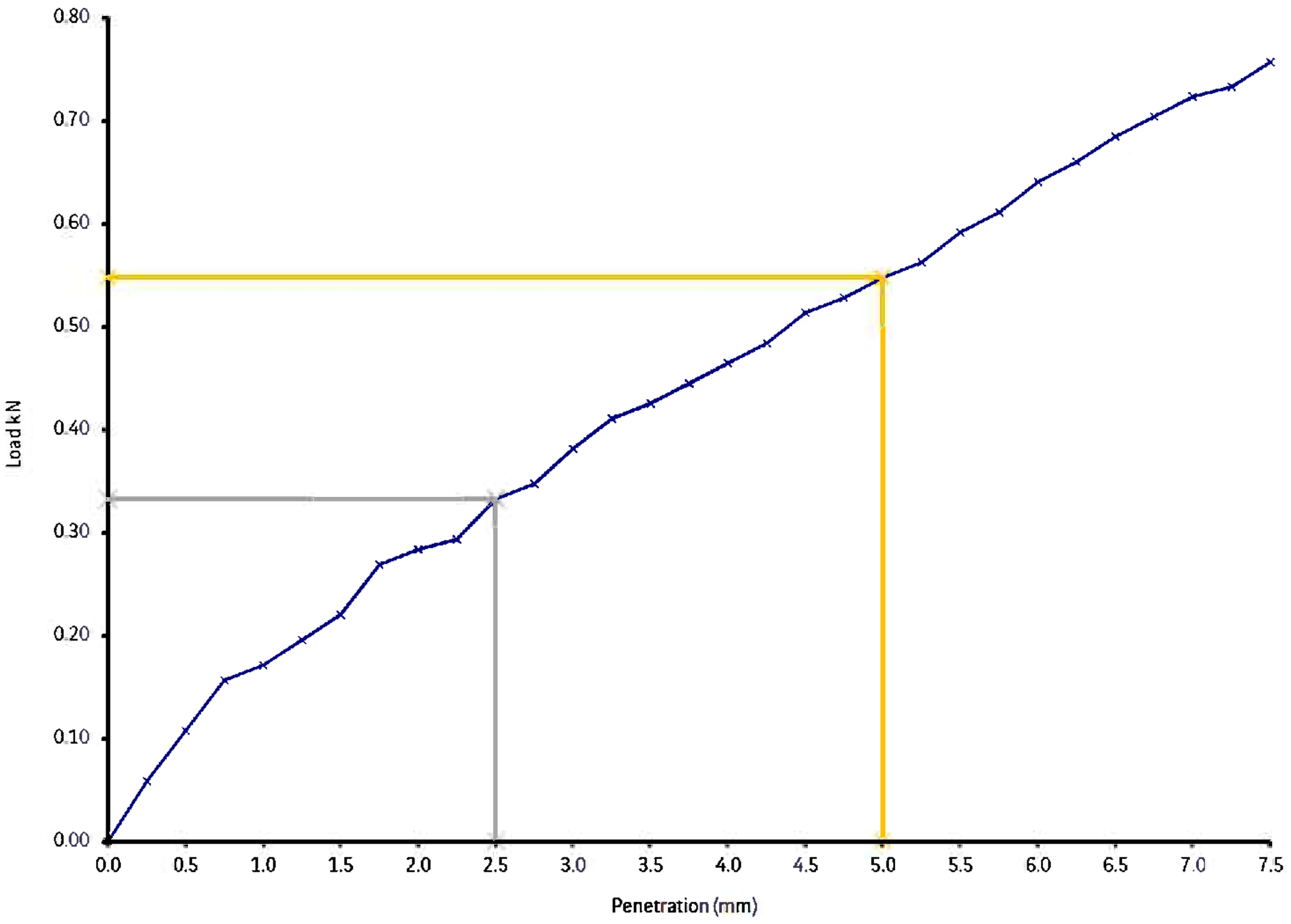
Plunger

General remarks
Site conditions: Sunny

Preliminary	SE Engineer		
	Not UKAS		Print date 04/11/2021
	Revision No. 3.00	Issue Date 22/10/2020	

soil engineering

Project Name	Cambridge Waste Water Treatment Plant Relocation	# In Situ California Bearing Ratio Test	Hole ID TP_STW_021
Project No.	TE8364		Test Depth 0.50m
Engineer	Mott MacDonald Bentley		Test Number 1
Employer	Barhale Limited	BS1377: Part 9: 1990: 4.3	Test Date 13/09/2021
Description	Brown CLAY.		



CBR values %

Penetration	CBR	Accepted CBR
2.50 mm	2.5	2.7
5.00 mm	2.7	
Curve correction	No	

Natural moisture content	11	%
Seating load	1	N
Surcharge	10.5	kPa
Kentledge used		

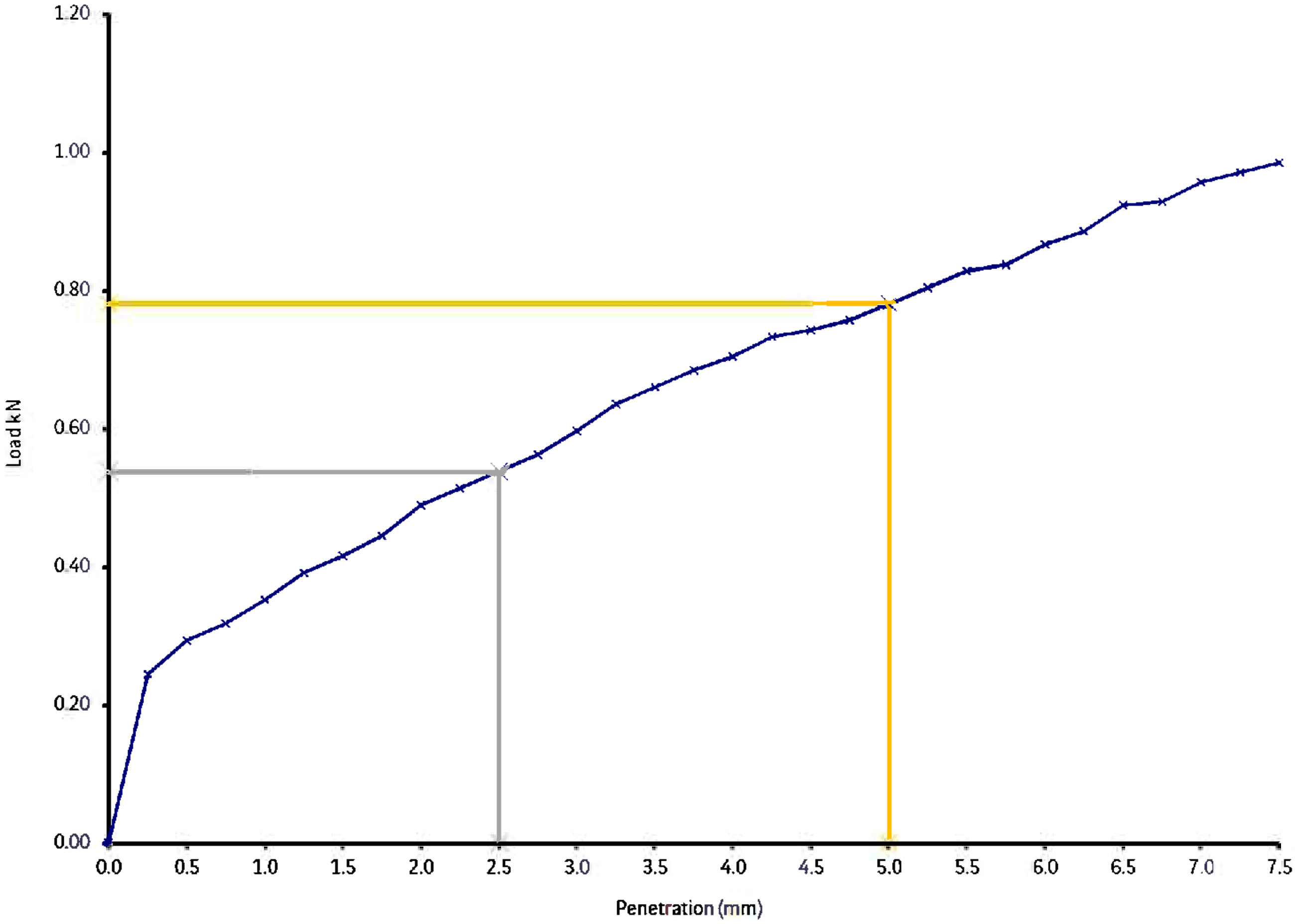
Plunger

General remarks
Site conditions: Sunny

Preliminary	SE Engineer		
	Not UKAS		Print date 04/11/2021
	Revision No. 3.00	Issue Date 22/10/2020	

SOIL ENGINEERING

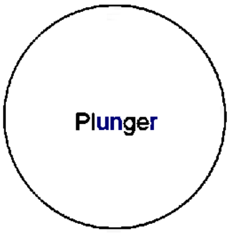
Project Name	Cambridge Waste Water Treatment Plant Relocation	**In Situ California Bearing Ratio Test**	Hole ID TP_STW_022
Project No.	TE8364		Test Depth 0.50m
Engineer	Mott MacDonald Bentley		Test Number 1
Employer	Barhale Limited	BS1377: Part 9: 1990: 4.3	Test Date 14/09/2021
Description	Brown CLAY.		



CBR values %

Penetration	CBR	Accepted CBR
2.50 mm	4.1	4.1
5.00 mm	3.9	
Curve correction	No	

Natural moisture content	16	%
Seating load	1	N
Surcharge	10.5	kPa
Kentledge used		



General remarks
Site conditions: Very heavy rain

Preliminary	SE Engineer		
	Not UKAS		Print date 04/11/2021
	Revision No. 3.00	Issue Date 22/10/2020	

soil engineering

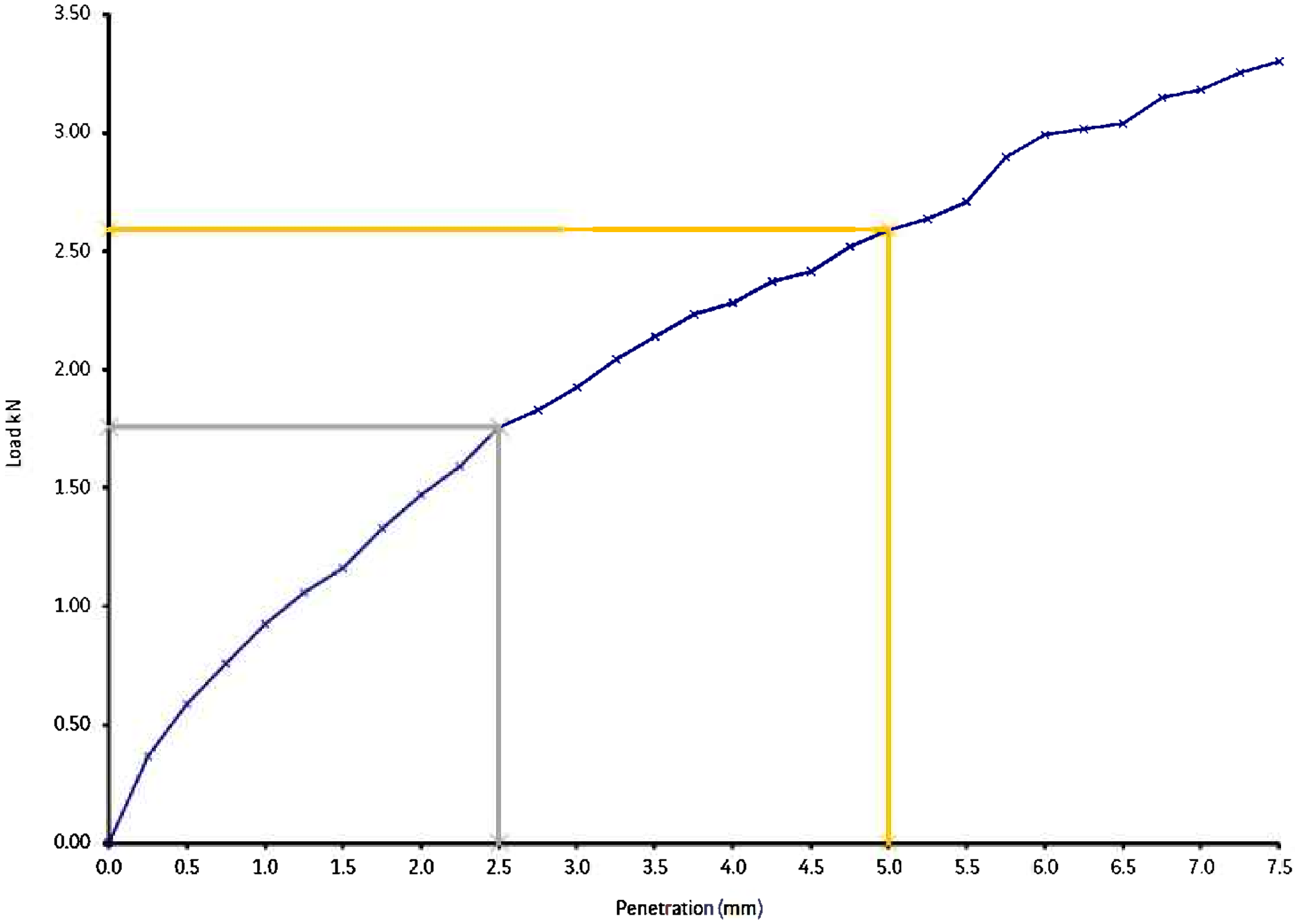
Project Name	Cambridge Waste Water Treatment Plant Relocation
Project No.	TE8364
Engineer	Mott MacDonald Bentley
Employer	Barhale Limited

In Situ California Bearing Ratio Test

BS1377: Part 9: 1990: 4.3

Hole ID	TP_STW_031
Test Depth	0.50m
Test Number	1
Test Date	15/09/2021

Description Chalky CLAY.



CBR values %

Penetration	CBR	Accepted CBR
2.50 mm	13	13
5.00 mm	13	
Curve correction	No	

Natural moisture content	9.7	%
Seating load	1	N
Surcharge	10.5	kPa
Kentledge used		

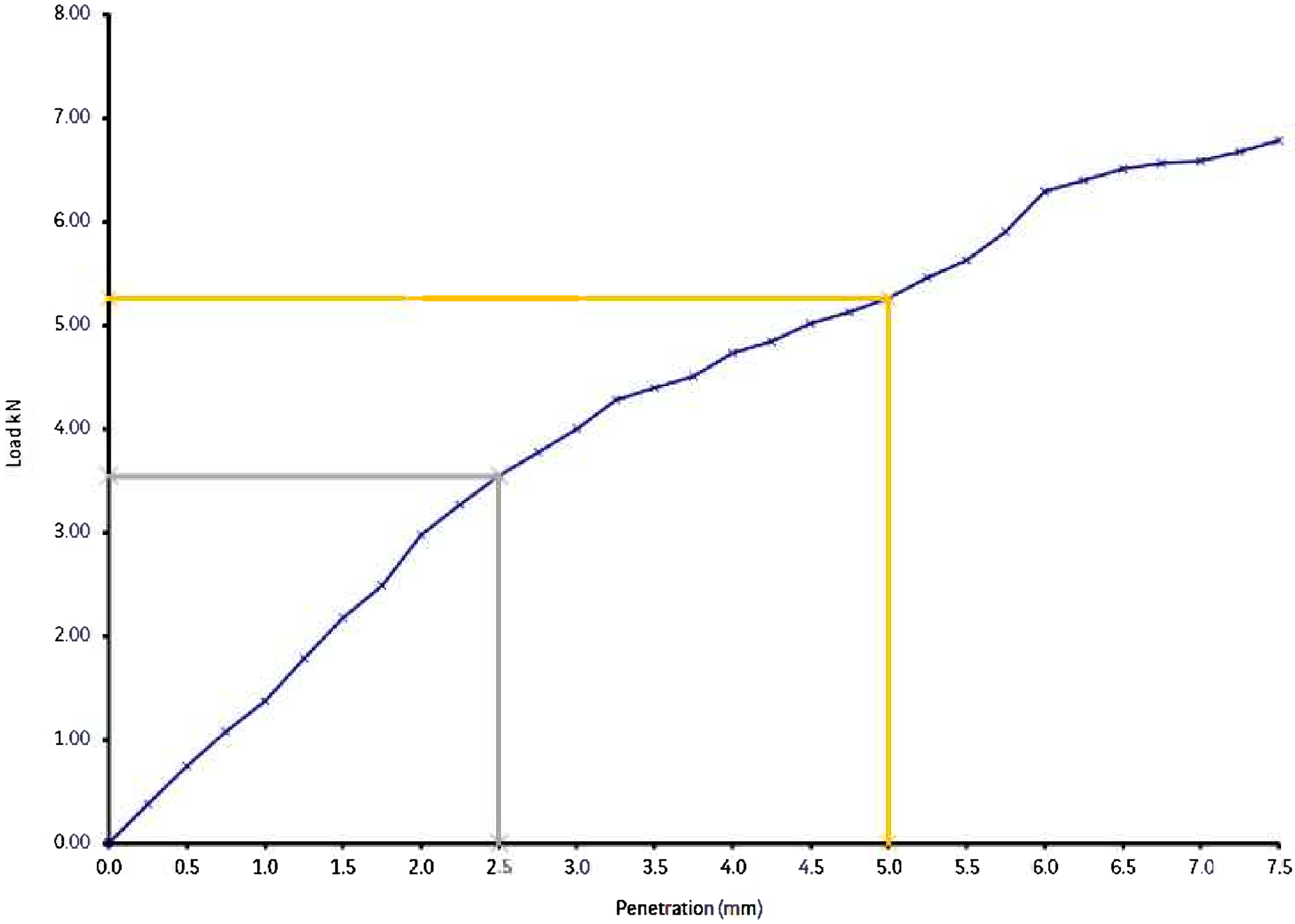
Plunger

General remarks
Site conditions: Clear

Preliminary	SE Engineer		
	Not UKAS		Print date 04/11/2021
	Revision No. 3.00	Issue Date 22/10/2020	

SOIL ENGINEERING

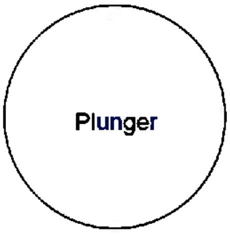
Project Name	Cambridge Waste Water Treatment Plant Relocation	**In Situ California Bearing Ratio Test**	Hole ID TP_STW_032
Project No.	TE8364		Test Depth 0.50m
Engineer	Mott MacDonald Bentley		Test Number 2
Employer	Barhale Limited	BS1377: Part 9: 1990: 4.3	Test Date 13/09/2021
Description	Chalky CLAY.		



CBR values %

Penetration	CBR	Accepted CBR
2.50 mm	27	27
5.00 mm	26	
Curve correction	No	

Natural moisture content	13	%
Seating load	6	N
Surcharge	10.5	kPa
Kentledge used		



General remarks
Site conditions: Cloudy

Preliminary	SE Engineer		
	Not UKAS		Print date 04/11/2021
	Revision No. 3.00	Issue Date 22/10/2020	

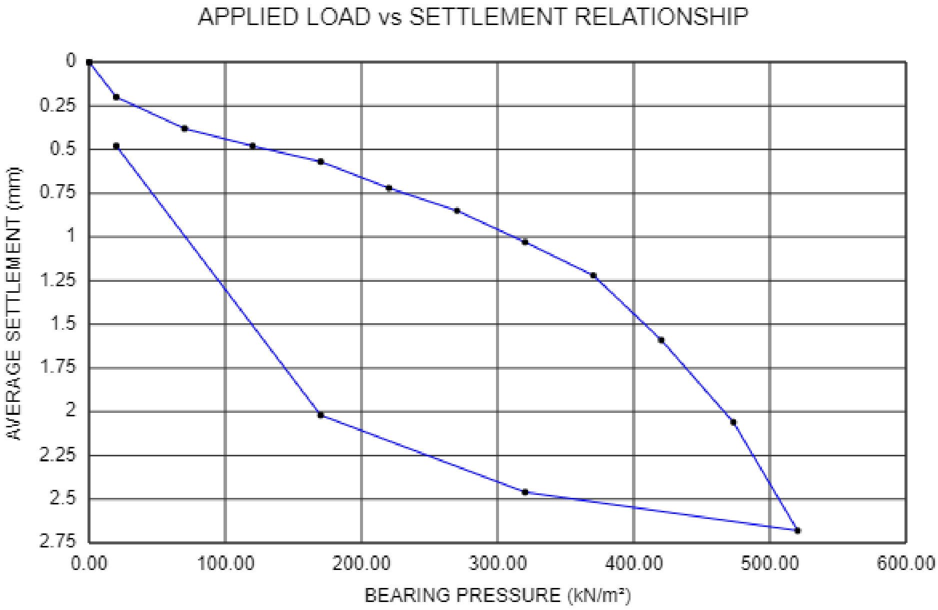
soil engineering

Construction Testing Solutions

TEST REPORT:	**Determination of Load vs Settlement (Incremental Loading)** In-house Test Procedures STP S8 and Design Guidance for Road Pavement Foundations (DRAFT HD25) IAN 73/06 Revision 1 (2009)		
REPORT NUMBER:	C1054343 / 153995.1.1.1		
CLIENT REF:	MD3225	CLIENT:	Soil Engineering Geoservices Ltd
DATE COMPLETED:	20/10/2021	ADDRESS:	Henderson House, Higgs Lane, Burscough, Lancashire, L40 8JS
TESTED BY:	Callum Clarkson	SITE:	Cambridge
LOCATION:	TP_STW_012 Depth 1.5m	MATERIAL:	Brown Chalky Clay
DISTANCE FROM EDGE OF PLATE TO WALL:	1000 mm	SUPPLIER:	Site Won
TEST METHOD:	Incremental Plate Loading	SOURCE:	Site Won
SAMPLING PLAN:	Standard Requirements	SAMPLE TAKEN:	No

Equipment Details	
Type of Kentledge:	25T Excavator
Plate Diameter:	600 mm
Plate Area:	0.282743 m^2
Plate Correction:	0.80

Results	**Cycle 1**	**Cycle 2**
Max applied pressure:	520 kN/m^2	0.0 kN/m^2
Max settlement:	2.68 mm	0.00 mm
Modulus of subgrade K762:	241 $kN/m^2/mm$	> 13 $kN/m^2/mm$



Remarks:
Test results reported relate only to the items tested.
This report shall not be reproduced except in full without approval of the Laboratory.
Amended report. This test report supersedes test report version 2 - location Adjustment

TEST REPORT: **Determination of Load vs Settlement (Incremental Loading)**
In-house Test Procedures STP S8 and Design Guidance for Road Pavement Foundations (DRAFT HD25) IAN 73/06 Revision 1 (2009)

REPORT NUMBER: C1054343 / 153995.1.1.1

TEST RESULTS

LOAD APPLIED TO PLATE	AVERAGE BEARING PRESSURE	GAUGE READING			GAUGE SETTLEMENT			AVERAGE SETTLEMENT
		1	2	3	1	2	3	
kN	kN/m^2	mm			mm			mm
0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.0	21.2	-0.26	-0.13	-0.20	0.26	0.13	0.20	0.20
20.0	70.7	-0.59	-0.17	-0.38	0.59	0.17	0.38	0.38
34.0	120.3	-0.65	-0.23	-0.55	0.65	0.23	0.55	0.48
48.0	169.8	-0.79	-0.27	-0.65	0.79	0.27	0.65	0.57
62.0	219.3	-0.98	-0.39	-0.79	0.98	0.39	0.79	0.72
76.0	268.8	-1.16	-0.50	-0.90	1.16	0.50	0.90	0.85
91.0	321.8	-1.39	-0.63	-1.06	1.39	0.63	1.06	1.03
105.0	371.4	-1.74	-0.73	-1.18	1.74	0.73	1.18	1.22
119.0	420.9	-2.07	-1.13	-1.58	2.07	1.13	1.58	1.59
134.0	473.9	-2.44	-1.71	-2.04	2.44	1.71	2.04	2.06
147.0	519.9	-3.00	-2.33	-2.72	3.00	2.33	2.72	2.68
91.0	321.8	-2.82	-2.09	-2.47	2.82	2.09	2.47	2.46
48.0	169.8	-2.57	-1.59	-1.91	2.57	1.59	1.91	2.02
6.0	21.2	-1.44	0.00	0.00	1.44	0.00	0.00	0.48

Remarks:
Test results reported relate only to the items tested.
This report shall not be reproduced except in full without approval of the Laboratory.
Amended report. This test report supersedes test report version 2 - location Adjustment

For and on behalf of CTS
James Browne - Testing Services Manager

[redacted]

Approved Signatory
03-Nov-21

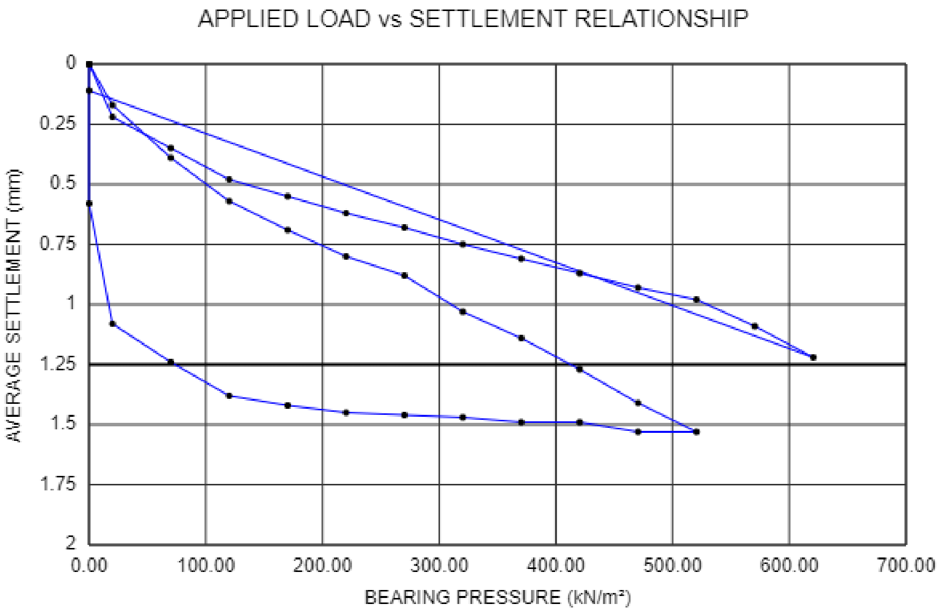
UKAS TESTING
4161

TEST REPORT:	**Determination of Load vs Settlement (Incremental Loading)** In-house Test Procedures STP S8 and Design Guidance for Road Pavement Foundations (DRAFT HD25) IAN 73/06 Revision 1 (2009)		
REPORT NUMBER:	C1054343 / 153996.1.1.1		
CLIENT REF:	MD3225	CLIENT:	Soil Engineering Geoservices Ltd
DATE COMPLETED:	21/10/2021	ADDRESS:	Henderson House, Higgs Lane, Burscough, Lancashire, L40 8JS
TESTED BY:	Callum Clarkson	SITE:	Cambridge
LOCATION:	TP_STW_005 Depth 1m	MATERIAL:	Brown, chalky Clay
DISTANCE FROM EDGE OF PLATE TO WALL:	1000 mm	SUPPLIER:	Site won
TEST METHOD:	Incremental Plate Loading	SOURCE:	Site won
SAMPLING PLAN:	Client Specification	SAMPLE TAKEN:	No

Equipment Details

Type of Kentledge:	25T excavator
Plate Diameter:	600 mm
Plate Area:	0.282743 m^2
Plate Correction:	0.80

Results	**Cycle 1**	**Cycle 2**
Max applied pressure:	520 kN/m^2	621 kN/m^2
Max settlement:	1.53 mm	1.22 mm
Avg Bearing Pressure (P) at 1.25mm penetration:	413 kN/m^2	> 621 kN/m^2
Modulus of subgrade K762:	266 $kN/m^2/mm$	> 399 $kN/m^2/mm$
Equivalent C.B.R Value at 1.25mm penetration:	153.3%	> 310.8%
Plate recovery:	62%	91%



Equivalent C.B.R Value: Cycle 1: 153.3 % , Cycle 2: > 310.8 %

Remarks:
Test results reported relate only to the items tested.
This report shall not be reproduced except in full without approval of the Laboratory.
Amended report. This test report supersedes test report version 3 - location Adjustment

TEST REPORT: **Determination of Load vs Settlement (Incremental Loading)**
In-house Test Procedures STP S8 and Design Guidance for Road Pavement Foundations (DRAFT HD25) IAN 73/06 Revision 1 (2009)

REPORT NUMBER: C1054343 / 153996.1.1.1

TEST RESULTS

LOAD APPLIED TO PLATE	AVERAGE BEARING PRESSURE	GAUGE READING			GAUGE SETTLEMENT			AVERAGE SETTLEMENT
		1	2	3	1	2	3	
kN	kN/m^2	mm			mm			mm
0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.0	21.2	-0.24	-0.15	-0.13	0.24	0.15	0.13	0.17
20.0	70.7	-0.62	-0.29	-0.27	0.62	0.29	0.27	0.39
34.0	120.3	-0.98	-0.39	-0.34	0.98	0.39	0.34	0.57
48.0	169.8	-1.17	-0.51	-0.39	1.17	0.51	0.39	0.69
62.0	219.3	-1.35	-0.59	-0.46	1.35	0.59	0.46	0.80
76.0	268.8	-1.50	-0.65	-0.50	1.50	0.65	0.50	0.88
91.0	321.8	-1.65	-0.80	-0.65	1.65	0.80	0.65	1.03
105.0	371.4	-1.85	-0.85	-0.72	1.85	0.85	0.72	1.14
119.0	420.9	-1.99	-0.98	-0.84	1.99	0.98	0.84	1.27
133.0	470.4	-2.16	-1.10	-0.97	2.16	1.10	0.97	1.41
147.0	519.9	-2.30	-1.20	-1.10	2.30	1.20	1.10	1.53
133.0	470.4	-2.30	-1.20	-1.10	2.30	1.20	1.10	1.53
119.0	420.9	-2.28	-1.10	-1.08	2.28	1.10	1.08	1.49
105.0	371.4	-2.28	-1.11	-1.09	2.28	1.11	1.09	1.49
91.0	321.8	-2.24	-1.10	-1.07	2.24	1.10	1.07	1.47
76.0	268.8	-2.23	-1.10	-1.06	2.23	1.10	1.06	1.46
62.0	219.3	-2.20	-1.10	-1.05	2.20	1.10	1.05	1.45
48.0	169.8	-2.16	-1.06	-1.03	2.16	1.06	1.03	1.42
34.0	120.3	-2.10	-1.00	-1.03	2.10	1.00	1.03	1.38
20.0	70.7	-1.93	-0.82	-0.98	1.93	0.82	0.98	1.24
6.0	21.2	-1.66	-0.76	-0.83	1.66	0.76	0.83	1.08
0.0	0.0	-1.03	-0.34	-0.38	1.03	0.34	0.38	0.58
0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.0	21.2	-0.33	-0.09	-0.24	0.33	0.09	0.24	0.22
20.0	70.7	-0.56	-0.12	-0.37	0.56	0.12	0.37	0.35
34.0	120.3	-0.75	-0.26	-0.44	0.75	0.26	0.44	0.48
48.0	169.8	-0.87	-0.27	-0.50	0.87	0.27	0.50	0.55
62.0	219.3	-0.98	-0.31	-0.57	0.98	0.31	0.57	0.62
76.0	268.8	-1.08	-0.34	-0.63	1.08	0.34	0.63	0.68
91.0	321.8	-1.18	-0.38	-0.70	1.18	0.38	0.70	0.75
105.0	371.4	-1.25	-0.42	-0.75	1.25	0.42	0.75	0.81
119.0	420.9	-1.33	-0.46	-0.81	1.33	0.46	0.81	0.87
133.0	470.4	-1.42	-0.50	-0.87	1.42	0.50	0.87	0.93
147.0	519.9	-1.48	-0.54	-0.92	1.48	0.54	0.92	0.98
161.0	569.4	-1.61	-0.64	-1.01	1.61	0.64	1.01	1.09

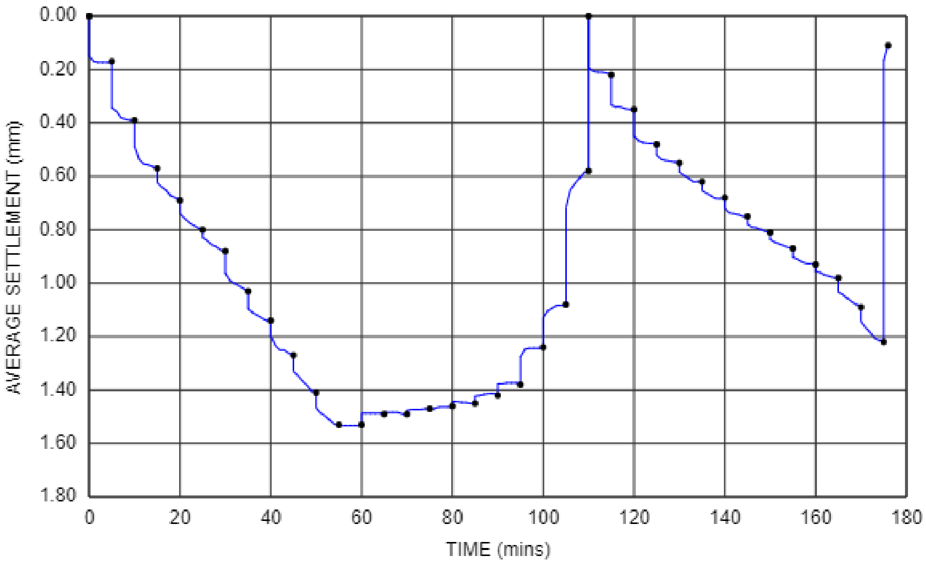
Remarks:
Test results reported relate only to the items tested.
This report shall not be reproduced except in full without approval of the Laboratory.
Amended report. This test report supersedes test report version 3 - location Adjustment

TEST REPORT: **Determination of Load vs Settlement (Incremental Loading)**
In-house Test Procedures STP S8 and Design Guidance for Road Pavement Foundations (DRAFT HD25) IAN 73/06 Revision 1 (2009)

REPORT NUMBER: C1054343 / 153996.1.1.1

175.0	618.9	-1.81	-0.73	-1.12	1.81	0.73	1.12	1.22
0.0	0.0	-0.22	-0.10	0.00	0.22	0.10	0.00	0.11

SETTLEMENT RELATIONSHIP vs TIME



Remarks:
Test results reported relate only to the items tested.
This report shall not be reproduced except in full without approval of the Laboratory.
Amended report. This test report supersedes test report version 3 - location Adjustment

For and on behalf of CTS
James Browne - Testing Services Manager
[redacted]

Approved Signatory
03-Nov-21

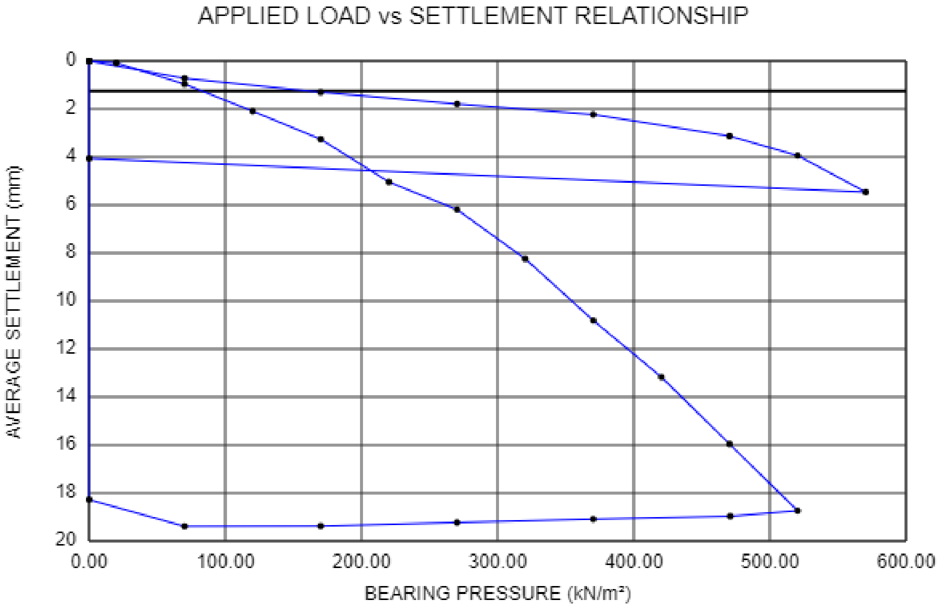
UKAS TESTING
4161

TEST REPORT:	**Determination of Load vs Settlement (Incremental Loading)** In-house Test Procedures STP S8 and Design Guidance for Road Pavement Foundations (DRAFT HD25) IAN 73/06 Revision 1 (2009)		
REPORT NUMBER:	C1054343 / 153996.1.1.2		
CLIENT REF:	MD3225	CLIENT:	Soil Engineering Geoservices Ltd
DATE COMPLETED:	21/10/2021	ADDRESS:	Henderson House, Higgs Lane, Burscough, Lancashire, L40 8JS
TESTED BY:	Callum Clarkson	SITE:	Cambridge
LOCATION:	TP_STW_014 Depth 1m	MATERIAL:	Brown, sandy, chalky Clay
DISTANCE FROM EDGE OF PLATE TO WALL:	1000 mm	SUPPLIER:	Site won
TEST METHOD:	Incremental Plate Loading	SOURCE:	Site won
SAMPLING PLAN:	Client Specification	SAMPLE TAKEN:	No

Equipment Details

Type of Kentledge:	25T excavator
Plate Diameter:	600 mm
Plate Area:	0.282743 m^2
Plate Correction:	0.80

Results	**Cycle 1**	**Cycle 2**
Max applied pressure:	520 kN/m^2	571 kN/m^2
Max settlement:	19.39 mm	5.46 mm
Avg Bearing Pressure (P) at 1.25mm penetration:	83 kN/m^2	162 kN/m^2
Modulus of subgrade K762:	53 $kN/m^2/mm$	104 $kN/m^2/mm$
Equivalent C.B.R Value at 1.25mm penetration:	9.5%	30.3%
Plate recovery:	5.7%	26%



Equivalent C.B.R Value: Cycle 1: 9.5 % , Cycle 2: 30.3 %

Remarks:
Test results reported relate only to the items tested.
This report shall not be reproduced except in full without approval of the Laboratory.
Amended report. This test report supersedes test report version 2 - location Adjustment

TEST REPORT: **Determination of Load vs Settlement (Incremental Loading)**
In-house Test Procedures STP S8 and Design Guidance for Road Pavement Foundations (DRAFT HD25) IAN 73/06 Revision 1 (2009)

REPORT NUMBER: C1054343 / 153996.1.1.2

TEST RESULTS

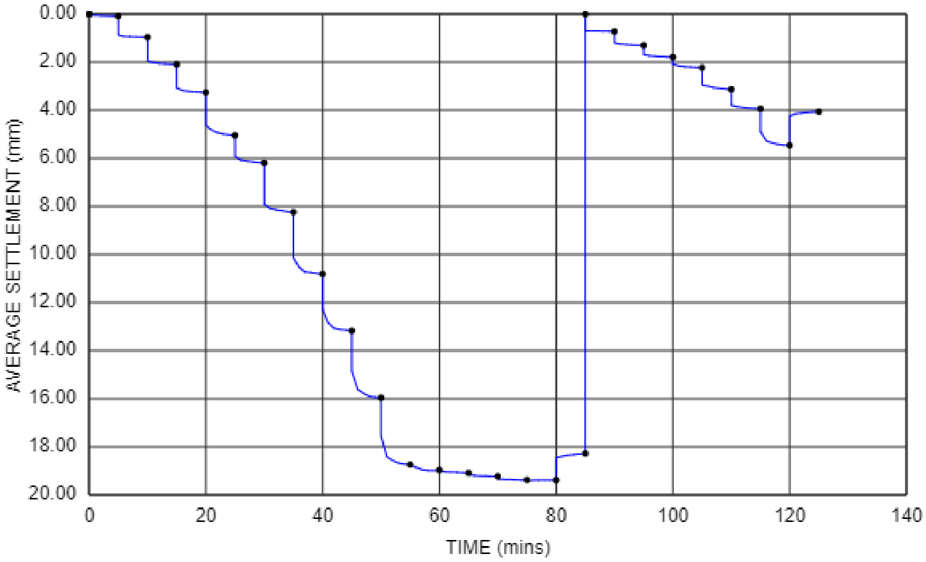
LOAD APPLIED TO PLATE	AVERAGE BEARING PRESSURE	GAUGE READING			GAUGE SETTLEMENT			AVERAGE SETTLEMENT
		1	2	3	1	2	3	
kN	kN/m^2	mm			mm			mm
0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.0	21.2	-0.11	-0.09	-0.05	0.11	0.09	0.05	0.08
20.0	70.7	-0.98	-1.12	-0.79	0.98	1.12	0.79	0.96
34.0	120.3	-2.00	-2.41	-1.87	2.00	2.41	1.87	2.09
48.0	169.8	-3.12	-3.74	-2.92	3.12	3.74	2.92	3.26
62.0	219.3	-4.93	-5.67	-4.53	4.93	5.67	4.53	5.04
76.0	268.8	-6.12	-6.90	-5.55	6.12	6.90	5.55	6.19
91.0	321.8	-8.34	-9.00	-7.38	8.34	9.00	7.38	8.24
105.0	371.4	-11.16	-11.63	-9.64	11.16	11.63	9.64	10.81
119.0	420.9	-13.81	-13.98	-11.71	13.81	13.98	11.71	13.17
133.0	470.4	-17.17	-16.71	-14.01	17.17	16.71	14.01	15.96
147.0	519.9	-21.18	-19.11	-15.92	21.18	19.11	15.92	18.74
133.0	470.4	-21.39	-19.30	-16.22	21.39	19.30	16.22	18.97
105.0	371.4	-21.45	-19.36	-16.47	21.45	19.36	16.47	19.09
76.0	268.8	-21.55	-19.45	-16.70	21.55	19.45	16.70	19.23
48.0	169.8	-21.64	-19.54	-16.97	21.64	19.54	16.97	19.38
20.0	70.7	-21.47	-19.52	-17.18	21.47	19.52	17.18	19.39
0.0	0.0	-20.21	-18.70	-15.93	20.21	18.70	15.93	18.28
0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20.0	70.7	-0.84	-0.69	-0.62	0.84	0.69	0.62	0.72
48.0	169.8	-1.56	-1.24	-1.09	1.56	1.24	1.09	1.30
76.0	268.8	-2.26	-1.63	-1.48	2.26	1.63	1.48	1.79
105.0	371.4	-2.95	-2.03	-1.71	2.95	2.03	1.71	2.23
133.0	470.4	-4.55	-2.84	-2.01	4.55	2.84	2.01	3.13
147.0	519.9	-5.96	-3.61	-2.26	5.96	3.61	2.26	3.94
161.0	569.4	-8.25	-4.96	-3.18	8.25	4.96	3.18	5.46
0.0	0.0	-6.39	-3.63	-2.16	6.39	3.63	2.16	4.06

Remarks:
Test results reported relate only to the items tested.
This report shall not be reproduced except in full without approval of the Laboratory.
Amended report. This test report supersedes test report version 2 - location Adjustment

TEST REPORT: **Determination of Load vs Settlement (Incremental Loading)**
In-house Test Procedures STP S8 and Design Guidance for Road Pavement Foundations (DRAFT HD25) IAN 73/06 Revision 1 (2009)

REPORT NUMBER: C1054343 / 153996.1.1.2

SETTLEMENT RELATIONSHIP vs TIME



Remarks:
Test results reported relate only to the items tested.
This report shall not be reproduced except in full without approval of the Laboratory.
Amended report. This test report supersedes test report version 2 - location Adjustment

For and on behalf of CTS
James Browne - Testing Services Manager

[redacted]

Approved Signatory
03-Nov-21

UKAS TESTING
4161

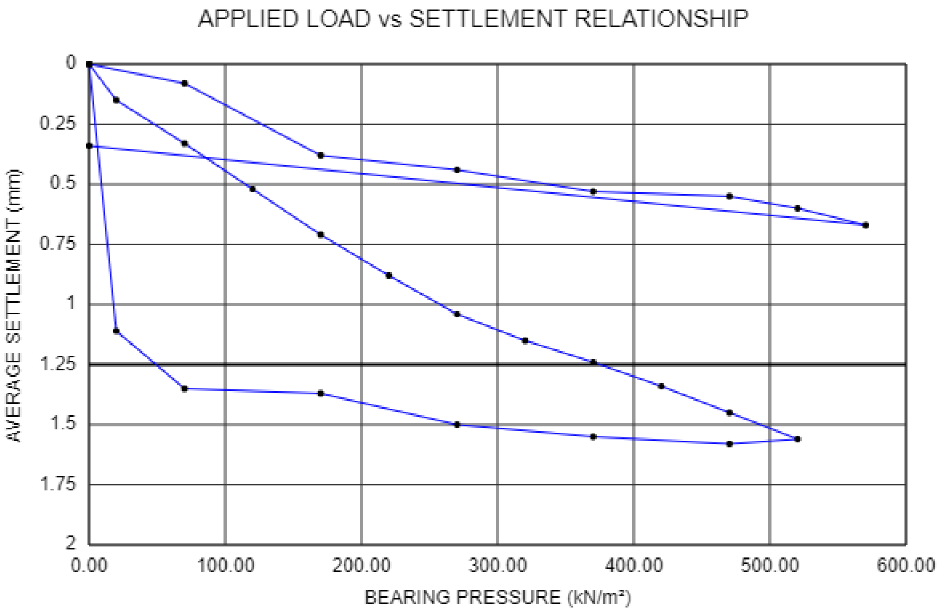
Construction Testing Solutions

TEST REPORT:	**Determination of Load vs Settlement (Incremental Loading)** In-house Test Procedures STP S8 and Design Guidance for Road Pavement Foundations (DRAFT HD25) IAN 73/06 Revision 1 (2009)		
REPORT NUMBER:	C1054343 / 153997.1.1.1		
CLIENT REF:	MD3225	CLIENT:	Soil Engineering Geoservices Ltd
DATE COMPLETED:	22/10/2021	ADDRESS:	Henderson House, Higgs Lane, Burscough, Lancashire, L40 8JS
TESTED BY:	Callum Clarkson	SITE:	Cambridge
LOCATION:	TP_STW_015 Depth 1m	MATERIAL:	Brown, chalky Clay
DISTANCE FROM EDGE OF PLATE TO WALL:	1000 mm	SUPPLIER:	Site won
TEST METHOD:	Incremental Plate Loading	SOURCE:	Site won
SAMPLING PLAN:	Client Specification	SAMPLE TAKEN:	No

Equipment Details

Type of Kentledge:	25T excavator
Plate Diameter:	600 mm
Plate Area:	0.282743 m^2
Plate Correction:	0.80

Results	**Cycle 1**	**Cycle 2**
Max applied pressure:	520 kN/m^2	571 kN/m^2
Max settlement:	1.58 mm	0.67 mm
Avg Bearing Pressure (P) at 1.25mm penetration:	374 kN/m^2	> 571 kN/m^2
Modulus of subgrade K762:	241 kN/m^2/mm	> 367 kN/m^2/mm
Equivalent C.B.R Value at 1.25mm penetration:	129.1%	> 268.6%
Plate recovery:	100%	50%



Equivalent C.B.R Value: Cycle 1: 129.1 % , Cycle 2: > 268.6 %

Remarks:
Test results reported relate only to the items tested.
This report shall not be reproduced except in full without approval of the Laboratory.
Amended report. This test report supersedes test report version 2 - location Adjustment

TEST REPORT: **Determination of Load vs Settlement (Incremental Loading)**
In-house Test Procedures STP S8 and Design Guidance for Road Pavement Foundations (DRAFT HD25) IAN 73/06 Revision 1 (2009)

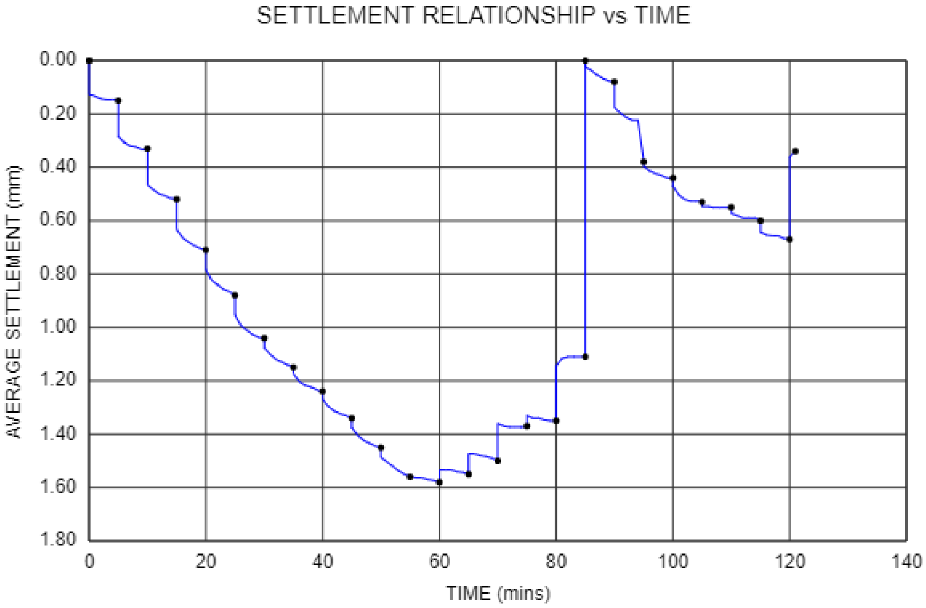
REPORT NUMBER: C1054343 / 153997.1.1.1

TEST RESULTS

LOAD APPLIED TO PLATE	AVERAGE BEARING PRESSURE	GAUGE READING			GAUGE SETTLEMENT			AVERAGE SETTLEMENT
		1	2	3	1	2	3	
kN	kN/m^2	mm			mm			mm
0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.0	21.2	-0.23	-0.14	-0.07	0.23	0.14	0.07	0.15
20.0	70.7	-0.41	-0.38	-0.21	0.41	0.38	0.21	0.33
34.0	120.3	-0.56	-0.62	-0.37	0.56	0.62	0.37	0.52
48.0	169.8	-0.80	-0.79	-0.54	0.80	0.79	0.54	0.71
62.0	219.3	-1.02	-0.95	-0.66	1.02	0.95	0.66	0.88
76.0	268.8	-1.22	-1.12	-0.79	1.22	1.12	0.79	1.04
91.0	321.8	-1.32	-1.22	-0.91	1.32	1.22	0.91	1.15
105.0	371.4	-1.42	-1.31	-1.00	1.42	1.31	1.00	1.24
119.0	420.9	-1.53	-1.40	-1.09	1.53	1.40	1.09	1.34
133.0	470.4	-1.64	-1.52	-1.20	1.64	1.52	1.20	1.45
147.0	519.9	-1.77	-1.64	-1.26	1.77	1.64	1.26	1.56
133.0	470.4	-1.80	-1.67	-1.27	1.80	1.67	1.27	1.58
105.0	371.4	-1.81	-1.58	-1.26	1.81	1.58	1.26	1.55
76.0	268.8	-1.80	-1.43	-1.27	1.80	1.43	1.27	1.50
48.0	169.8	-1.63	-1.36	-1.13	1.63	1.36	1.13	1.37
20.0	70.7	-1.55	-1.41	-1.09	1.55	1.41	1.09	1.35
6.0	21.2	-1.23	-1.18	-0.92	1.23	1.18	0.92	1.11
0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20.0	70.7	-0.10	-0.08	-0.06	0.10	0.08	0.06	0.08
48.0	169.8	-0.59	-0.28	-0.26	0.59	0.28	0.26	0.38
76.0	268.8	-0.66	-0.35	-0.31	0.66	0.35	0.31	0.44
105.0	371.4	-0.75	-0.46	-0.37	0.75	0.46	0.37	0.53
133.0	470.4	-0.77	-0.48	-0.40	0.77	0.48	0.40	0.55
147.0	519.9	-0.83	-0.52	-0.44	0.83	0.52	0.44	0.60
161.0	569.4	-0.93	-0.56	-0.51	0.93	0.56	0.51	0.67
0.0	0.0	-0.48	-0.25	-0.28	0.48	0.25	0.28	0.34

Remarks:
Test results reported relate only to the items tested.
This report shall not be reproduced except in full without approval of the Laboratory.
Amended report. This test report supersedes test report version 2 - location Adjustment

TEST REPORT:	**Determination of Load vs Settlement (Incremental Loading)** In-house Test Procedures STP S8 and Design Guidance for Road Pavement Foundations (DRAFT HD25) IAN 73/06 Revision 1 (2009)
REPORT NUMBER:	C1054343 / 153997.1.1.1



Remarks:
Test results reported relate only to the items tested.
This report shall not be reproduced except in full without approval of the Laboratory.
Amended report. This test report supersedes test report version 2 - location Adjustment

For and on behalf of CTS
James Browne - Testing Services Manager

[redacted]

Approved Signatory
03-Nov-21

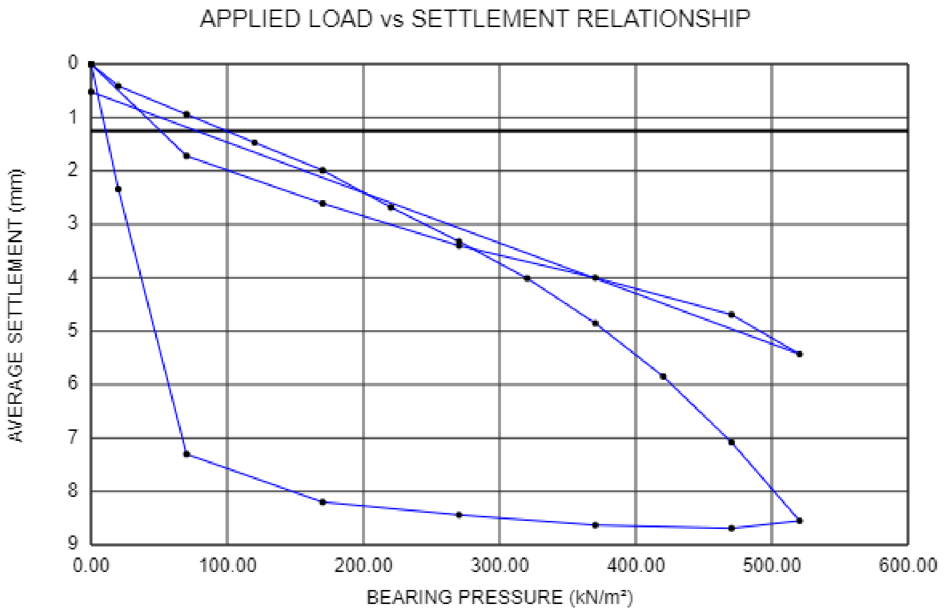
UKAS TESTING
4161

TEST REPORT:	**Determination of Load vs Settlement (Incremental Loading)** In-house Test Procedures STP S8 and Design Guidance for Road Pavement Foundations (DRAFT HD25) IAN 73/06 Revision 1 (2009)		
REPORT NUMBER:	C1054343 / 153997.1.1.2		
CLIENT REF:	MD3225	CLIENT:	Soil Engineering Geoservices Ltd
DATE COMPLETED:	22/10/2021	ADDRESS:	Henderson House, Higgs Lane, Burscough, Lancashire, L40 8JS
TESTED BY:	Callum Clarkson	SITE:	Cambridge
LOCATION:	TP_STW_016 Depth 1.5m	MATERIAL:	Brown, chalky Clay
DISTANCE FROM EDGE OF PLATE TO WALL:	1000 mm	SUPPLIER:	Site won
TEST METHOD:	Incremental Plate Loading	SOURCE:	Site won
SAMPLING PLAN:	Client Specification	SAMPLE TAKEN:	No

Equipment Details

Type of Kentledge:	25T excavator
Plate Diameter:	600 mm
Plate Area:	0.282743 m^2
Plate Correction:	0.80

Results	**Cycle 1**	**Cycle 2**
Max applied pressure:	520 kN/m^2	520 kN/m^2
Max settlement:	8.69 mm	5.43 mm
Avg Bearing Pressure (P) at 1.25mm penetration:	99 kN/m^2	51 kN/m^2
Modulus of subgrade K762:	64 $kN/m^2/mm$	33 $kN/m^2/mm$
Equivalent C.B.R Value at 1.25mm penetration:	12.9%	4.1%
Plate recovery:	100%	90%



Equivalent C.B.R Value: Cycle 1: 12.9 % , Cycle 2: 4.1 %

Remarks:
Test results reported relate only to the items tested.
This report shall not be reproduced except in full without approval of the Laboratory.
Amended report. This test report supersedes test report version 2 - location Adjustment

TEST REPORT: **Determination of Load vs Settlement (Incremental Loading)**
In-house Test Procedures STP S8 and Design Guidance for Road Pavement Foundations (DRAFT HD25) IAN 73/06 Revision 1 (2009)

REPORT NUMBER: C1054343 / 153997.1.1.2

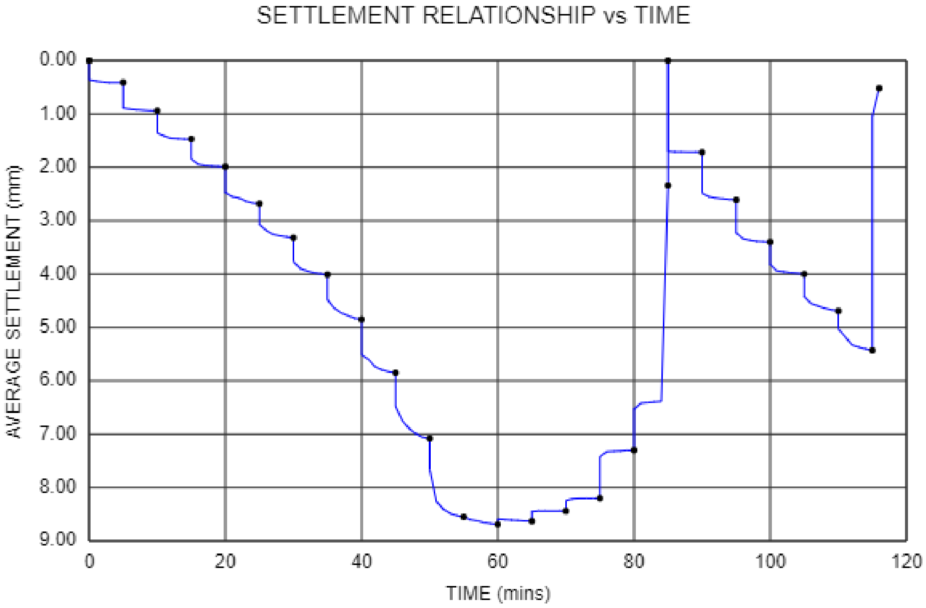
TEST RESULTS

LOAD APPLIED TO PLATE	AVERAGE BEARING PRESSURE	GAUGE READING			GAUGE SETTLEMENT			AVERAGE SETTLEMENT
		1	2	3	1	2	3	
kN	kN/m^2	mm			mm			mm
0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.0	21.2	-0.34	-0.36	-0.54	0.34	0.36	0.54	0.41
20.0	70.7	-0.90	-0.79	-1.13	0.90	0.79	1.13	0.94
34.0	120.3	-1.61	-1.19	-1.62	1.61	1.19	1.62	1.47
48.0	169.8	-2.36	-1.56	-2.06	2.36	1.56	2.06	1.99
62.0	219.3	-3.43	-1.99	-2.63	3.43	1.99	2.63	2.68
76.0	268.8	-4.30	-2.47	-3.20	4.30	2.47	3.20	3.32
91.0	321.8	-5.21	-2.96	-3.86	5.21	2.96	3.86	4.01
105.0	371.4	-6.15	-3.65	-4.74	6.15	3.65	4.74	4.85
119.0	420.9	-7.28	-4.48	-5.79	7.28	4.48	5.79	5.85
133.0	470.4	-8.67	-5.50	-7.07	8.67	5.50	7.07	7.08
147.0	519.9	-10.48	-6.61	-8.55	10.48	6.61	8.55	8.55
133.0	470.4	-10.63	-6.77	-8.67	10.63	6.77	8.67	8.69
105.0	371.4	-10.58	-6.70	-8.60	10.58	6.70	8.60	8.63
76.0	268.8	-10.35	-6.56	-8.41	10.35	6.56	8.41	8.44
48.0	169.8	-10.07	-6.42	-8.12	10.07	6.42	8.12	8.20
20.0	70.7	-9.07	-5.75	-7.09	9.07	5.75	7.09	7.30
6.0	21.2	-8.07	-5.01	6.05	8.07	5.01	-6.05	2.34
0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20.0	70.7	-1.61	-1.51	-2.03	1.61	1.51	2.03	1.72
48.0	169.8	-2.57	-2.32	-2.93	2.57	2.32	2.93	2.61
76.0	268.8	-3.42	-2.99	-3.80	3.42	2.99	3.80	3.40
105.0	371.4	-4.10	-3.49	-4.40	4.10	3.49	4.40	4.00
133.0	470.4	-4.99	-4.04	-5.04	4.99	4.04	5.04	4.69
147.0	519.9	-6.23	-4.55	-5.50	6.23	4.55	5.50	5.43
0.0	0.0	-1.15	-0.30	-0.10	1.15	0.30	0.10	0.52

Remarks:
Test results reported relate only to the items tested.
This report shall not be reproduced except in full without approval of the Laboratory.
Amended report. This test report supersedes test report version 2 - location Adjustment

TEST REPORT: **Determination of Load vs Settlement (Incremental Loading)**
In-house Test Procedures STP S8 and Design Guidance for Road Pavement Foundations (DRAFT HD25) IAN 73/06 Revision 1 (2009)

REPORT NUMBER: C1054343 / 153997.1.1.2



Remarks:
Test results reported relate only to the items tested.
This report shall not be reproduced except in full without approval of the Laboratory.
Amended report. This test report supersedes test report version 2 - location Adjustment

For and on behalf of CTS
James Browne - Testing Services Manager
[redacted]

Approved Signatory
03-Nov-21

UKAS TESTING
4161

Construction Testing Solutions

Soil Engineering Geoservices Ltd
Henderson House
Langley Place
Higgins Lane
Burscough
Lancaster
L40 8JS

Quarry Farm View
Bowbridge Lane
Newark
Notts
NG24 3BZ
Tel: (01636) 705100
Email: enquiries@constructiontesting.co.uk
Web: www.constructiontesting.co.uk

UKAS TESTING 4161

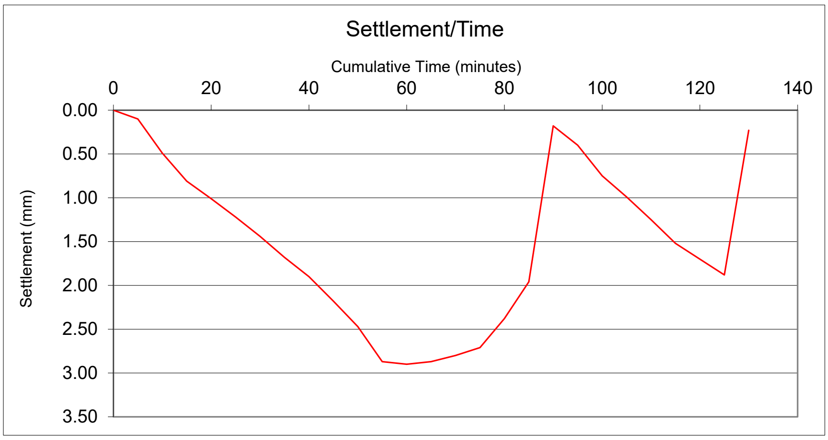
Low Fen Drove - Right turn off Horningsea Road, Cambridge, CB5 8TB

Determination of Vertical Deformation - Plate Loading Test BS1377: Part 9: 1990	Contract Test Reference: MD3225/3 Clients Reference: **MD3225/3**	**REPORT NO: WVY-51547A - R1** Report Date: 26/10/2021

TEST REPORT

Material Description:	Yellowish White firm to stiff chalk	Date Tested:	25/10/2021
Test Location:	TP_STW_019 Depth 1.5m	Supplier/Source:	Insitu/Site Won
Weather:	Clear, mild, light wind		

Cumulative Time (minutes)	Mean Bearing Pressure kPa	Average Settlement (mm)
0.0	0.0	0
5.0	20.2	0.10
10.0	70.4	0.49
15.0	121.0	0.81
20.0	171.5	1.01
25.0	221.8	1.22
30.0	272.2	1.44
35.0	322.6	1.68
40.0	373.1	1.90
45.0	423.4	2.18
50.0	473.8	2.47
55.0	524.2	2.87
60.0	470.0	2.90
65.0	369.9	2.87
70.0	269.9	2.80
75.0	170.1	2.71
80.0	70.4	2.38
90.0	20.2	0.18
95.0	70.4	0.40
100.0	171.5	0.75
105.0	272.0	0.99
110.0	372.8	1.25
115.0	473.6	1.52
120.0	524.2	1.70
125.0	562.3	1.88
130.0	0.0	0.23



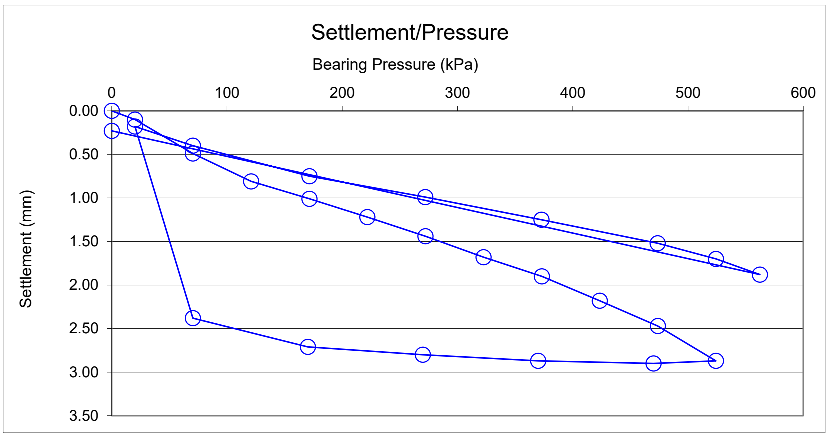


Plate Diameter	**600 mm**	Maximum Applied Pressure	**562.3 kPa**
Reaction Load	**25T Excavator**	Maximum Settlement	**2.9 mm**
Depth of Test	**1500 mm**	Moisture Content (BS1377: Part 2: 1990)	**Not Taken**
Distance from edge of plate to wall of excavation (mm)	**2000**		

Testing carried out at client's site location.

Authorised Signatory

Notes: 1 - One kPa is equivalent to One kN/m^2

Initial load applied by test equipment calculated to be less than 0.8 kN

** End of report **

Soil Engineering Geoservices Ltd
Henderson House
Langley Place
Higgins Lane
Burscough
Lancaster
L40 8JS

Low Fen Drove - Right turn off Horningsea Road, Cambridge, CB5 8TB

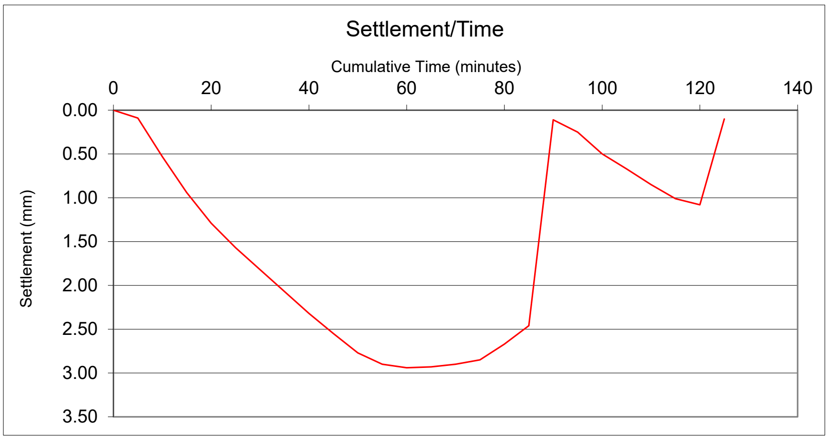
Construction Testing Solutions
Quarry Farm View
Bowbridge Lane
Newark
Notts
NG24 3BZ
Tel: (01636) 705100
Email: enquiries@constructiontesting.co.uk
Web: www.constructiontesting.co.uk

Determination of Vertical Deformation - Plate Loading Test BS1377: Part 9: 1990	Contract Test Reference: MD3225/3 Clients Reference: MD3225/3	**REPORT NO:**	**WVY-51547B - R1**
		Report Date:	26/10/2021

TEST REPORT

Material Description:	Yellowish White firm to stiff chalk	Date Tested:	25/10/2021
Test Location:	TP_STW_018 Depth 1.5m	Supplier/Source:	Insitu/Site Won
Weather:	Clear, mild, light wind		

Cumulative Time (minutes)	Mean Bearing Pressure kPa	Average Settlement (mm)
0.0	0.0	0
5.0	20.2	0.09
10.0	70.4	0.53
15.0	121.0	0.94
20.0	171.2	1.29
25.0	221.8	1.57
30.0	272.0	1.82
35.0	322.6	2.07
40.0	372.8	2.32
45.0	423.4	2.55
50.0	473.6	2.77
55.0	495.9	2.90
60.0	470.0	2.94
65.0	369.9	2.93
70.0	269.9	2.90
75.0	170.1	2.85
80.0	70.4	2.67
90.0	20.2	0.11
95.0	70.4	0.25
100.0	171.5	0.50
105.0	272.0	0.67
110.0	372.8	0.85
115.0	473.6	1.01
120.0	495.1	1.08
125.0	0.0	0.10



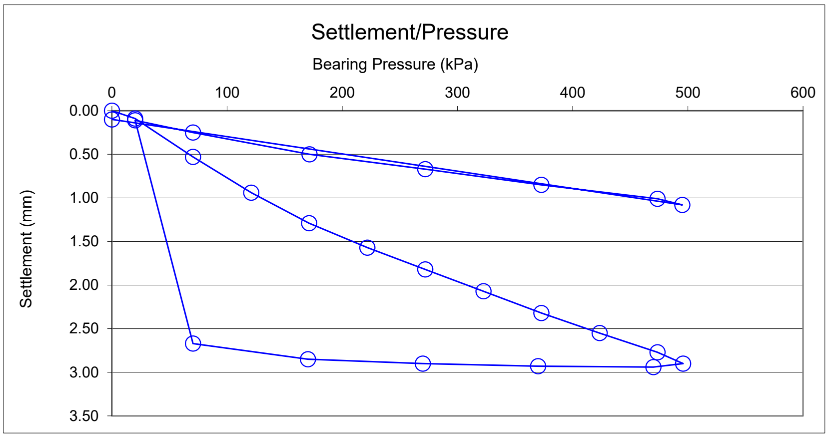


Plate Diameter	**600 mm**	Maximum Applied Pressure	**495.9 kPa**
Reaction Load	**25T Excavator**	Maximum Settlement	**2.94 mm**
Depth of Test	**1500 mm**	Moisture Content (BS1377: Part 2: 1990)	**Not Taken**
Distance from edge of plate to wall of excavation (mm)	**2000**		

Results relate only to the sample(s) as tested.
This report may not be reproduced other than in full without the prior written approval of the issuing laboratory.
The laboratory does not apply a conformity statement to test reports as standard, unless specifically requested by the customer.
Testing carried out at client's site location.

Authorised Signatory

Notes: 1 - One kPa is equivalent to One kN/m^2

Initial load applied by test equipment calculated to be less than 0.8 kN

** End of report **

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Photo Ionisation Results**
Project No.	TE8364	
Engineer	Mott MacDonald Bentley	
Client	Barhale Limited	

Hole ID	Sample Depth m	Sample Type	Sample Ref.	Test Number	Test Date yyyy-mm-dd	PID ppm	Temp. ℃	Weather	Remarks	PID Device Type
BH_STW_001	0.30	ES	1	1	2021-07-16	0.3	25.0	Sunny		Mini RAE Lite
BH_STW_001	0.70	ES	4	1	2021-07-16	0.4	25.0	Sunny		Mini RAE Lite
BH_STW_001	1.00	ES	5	1	2021-07-16	0.4	25.0	Sunny		Mini RAE Lite
BH_STW_023	0.20	ES	2	1	2021-07-20	0.2	27.0	Sunny		Mini RAE Lite
BH_STW_023	0.60	ES	8	1	2021-07-20	0.3	27.0	Sunny		Mini RAE Lite
BH_STW_023	0.20	ES	2	1	2021-07-20	0.2	27.0	Sunny		Mini RAE Lite
BH_STW_015	0.20	ES	2	1	2021-07-22	0.3	27.0	Sunny		Mini RAE Lite
BH_STW_015	0.50	ES	5	1	2021-07-22	0.2	27.0	Sunny		Mini RAE Lite
BH_STW_015	0.90	ES	8	1	2021-07-22	0.3	27.0	Sunny		Mini RAE Lite
BH_STW_009	0.20	ES	2	1	2021-07-28	0.1	20.0	Sunny		Mini RAE Lite
BH_STW_009	0.60	ES	5	1	2021-07-28	0.1	20.0	Sunny		Mini RAE Lite
BH_STW_009	1.10	ES	8	1	2021-07-28	0.1	20.0	Sunny		Mini RAE Lite
BH_STW_026	0.20	ES	2	1	2021-07-28	0.2	20.0	Sunny		Mini RAE Lite
BH_STW_026	0.50	ES	5	1	2021-07-28	0.2	20.0	Sunny		Mini RAE Lite
BH_STW_026	1.10	ES	8	1	2021-07-28	0.1	20.0	Sunny		Mini RAE Lite
BH_TUN_004	0.20	ES	2	1	2021-07-28	0.9	20.0	Sunny		Mini RAE Lite
BH_TUN_004	0.50	ES	5	1	2021-07-28	0.6	20.0	Sunny		Mini RAE Lite
BH_TUN_004	1.10	ES	8	1	2021-07-28	0.4	20.0	Sunny		Mini RAE Lite
BH_TUN_004A	0.20	ES	2	1	2021-07-28	0.5	20.0	Sunny		Mini RAE Lite
BH_TUN_004A	0.50	ES	5	1	2021-07-28	0.5	20.0	Sunny		Mini RAE Lite
BH_TUN_004A	0.80	ES	8	1	2021-07-28	0.4	20.0	Sunny		Mini RAE Lite
BH_TUN_005	0.20	ES	2	1	2021-07-29	0.5	20.0	Sunny		Mini RAE Lite
BH_TUN_005	0.50	ES	5	1	2021-07-29	0.6	20.0	Sunny		Mini RAE Lite
BH_STW_024	0.20	ES	2	1	2021-07-30	0.5	20.0	Sunny		Mini RAE Lite
BH_STW_024	0.40	ES	5	1	2021-07-30	1.1	20.0	Sunny		Mini RAE Lite
BH_STW_024	1.10	ES	8	1	2021-07-30	1.1	20.0	Sunny		Mini RAE Lite
BH_STW_031A	0.20	ES	2	1	2021-08-02	0.4	19.0	Sunny		Mini RAE Lite
BH_STW_031A	0.50	ES	5	1	2021-08-02	0.5	19.0	Sunny		Mini RAE Lite
BH_STW_031A	1.10	ES	8	1	2021-08-02	0.4	19.0	Sunny		Mini RAE Lite
BH_STW_006	0.20	ES	2	1	2021-08-04	1.5	20.0	Sunny		Mini RAE Lite
BH_STW_006	0.50	ES	5	1	2021-08-04	0.7	20.0	Sunny		Mini RAE Lite
BH_STW_006	1.10	ES	8	1	2021-08-04	0.8	20.0	Sunny		Mini RAE Lite
BH_STW_017	0.40	ES	2	1	2021-08-04	0.4	20.0	Sunny		Mini RAE Lite

Checked By:	Approved By:	SOIL ENGINEERING
Date:	Date:	

Project Name	Cambridge Waste Water Treatment Plant Relocation
Project No.	TE8364
Engineer	Mott MacDonald Bentley
Client	Barhale Limited

Photo Ionisation Results

Hole ID	Sample Depth m	Sample Type	Sample Ref.	Test Number	Test Date yyyy-mm-dd	PID ppm	Temp. °C	Weather	Remarks	PID Device Type
BH_STW_017	0.50	ES	5	1	2021-08-04	0.4	20.0	Sunny		Mini RAE Lite
BH_STW_017	1.10	ES	8	1	2021-08-04	1.7	20.0	Sunny		Mini RAE Lite
BH_STW_004	0.20	ES	2	1	2021-08-05	1.5	20.0	Sunny		Mini RAE Lite
BH_STW_004	0.50	ES	5	1	2021-08-05	0.9	20.0	Sunny		Mini RAE Lite
BH_STW_004	1.10	ES	8	1	2021-08-05	0.8	20.0	Sunny		Mini RAE Lite
BH_FE_006	0.20	ES	2	1	2021-08-09	0.7	17.0	Raining		Mini RAE Lite
BH_FE_006	0.50	ES	5	1	2021-08-09	0.6	17.0	Raining		Mini RAE Lite
BH_FE_006	1.10	ES	8	1	2021-08-09	0.6	17.0	Raining		Mini RAE Lite
BH_STW_012A	0.20	ES	2	1	2021-08-09	0.3	17.0	Raining		Mini RAE Lite
BH_STW_012A	0.60	ES	5	1	2021-08-09	0.4	17.0	Raining		Mini RAE Lite
BH_STW_012A	1.00	ES	8	1	2021-08-09	0.4	17.0	Raining		Mini RAE Lite
BH_FE_005	0.20	ES	2	1	2021-08-10	1.1	21.0	Sunny		Mini RAE Lite
BH_FE_005	0.50	ES	5	1	2021-08-10	0.9	21.0	Sunny		Mini RAE Lite
BH_FE_005	1.10	ES	8	1	2021-08-10	0.8	21.0	Sunny		Mini RAE Lite
BH_STW_016	0.20	ES	2	1	2021-08-10	0.3	21.0	Sunny		Mini RAE Lite
BH_STW_016	0.60	ES	5	1	2021-08-10	0.4	21.0	Sunny		Mini RAE Lite
BH_STW_016	1.20	ES	8	1	2021-08-10	0.4	21.0	Sunny		Mini RAE Lite
BH_FE_002	0.20	ES	2	1	2021-08-12	1.7	20.0	Sunny		Mini RAE Lite
BH_FE_002	0.50	ES	5	1	2021-08-12	1.3	20.0	Sunny		Mini RAE Lite
BH_FE_002	1.10	ES	8	1	2021-08-12	0.9	20.0	Sunny		Mini RAE Lite
BH_STW_013A	0.20	ES	1	1	2021-08-12	0.5	20.0	Sunny		Mini RAE Lite
BH_STW_013A	0.50	ES	4	1	2021-08-12	0.8	20.0	Sunny		Mini RAE Lite
BH_STW_013A	1.00	ES	7	1	2021-08-12	0.3	20.0	Sunny		Mini RAE Lite
BH_FE_003	0.20	ES	2	1	2021-08-13	1.2	16.0	Overcast		Mini RAE Lite
BH_FE_003	0.50	ES	5	1	2021-08-13	0.9	16.0	Overcast		Mini RAE Lite
BH_FE_003	1.10	ES	8	1	2021-08-13	0.7	16.0	Overcast		Mini RAE Lite
BH_STW_021	0.20	ES	2	1	2021-08-13	0.7	16.0	Overcast		Mini RAE Lite
BH_STW_021	0.50	ES	5	1	2021-08-13	0.6	16.0	Overcast		Mini RAE Lite
BH_STW_021	1.10	ES	8	1	2021-08-13	0.6	16.0	Overcast		Mini RAE Lite
BH_FE_004A	0.20	ES	2	1	2021-08-16	1.1	16.0	Cloudy		Mini RAE Lite
BH_FE_004A	0.50	ES	5	1	2021-08-16	0.9	16.0	Cloudy		Mini RAE Lite
BH_FE_004A	1.10	ES	8	1	2021-08-16	0.9	16.0	Cloudy		Mini RAE Lite
BH_TUN_003	0.20	ES	2	1	2021-08-16	1.7	16.0	Cloudy		Mini RAE Lite

Checked By:	Approved By:
Date:	Date:

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Form No. SE-EMS-F-001 Revision No. 2.00 Issue Date 19/02/2015

Project Name Cambridge Waste Water Treatment Plant Relocation
Project No. TE8364
Engineer Mott MacDonald Bentley
Client Barhale Limited

Photo Ionisation Results

Hole ID	Sample Depth m	Sample Type	Sample Ref.	Test Number	Test Date yyyy-mm-dd	PID ppm	Temp. °C	Weather	Remarks	PID Device Type
BH_TUN_003	0.50	ES	5	1	2021-08-16	1.4	16.0	Cloudy		Mini RAE Lite
BH_TUN_003	1.10	ES	8	1	2021-08-16	1.1	16.0	Cloudy		Mini RAE Lite
BH_STW_019A	0.20	ES	2	1	2021-08-17	0.9	18.0	Overcast		Mini RAE Lite
BH_STW_019A	0.50	ES	5	1	2021-08-17	0.7	18.0	Overcast		Mini RAE Lite
BH_STW_019A	1.10	ES	8	1	2021-08-17	0.6	18.0	Overcast		Mini RAE Lite
BH_FE_001	0.20	ES	2	1	2021-08-18	1.3	20.0	Sunny		Mini RAE Lite
BH_FE_001	0.50	ES	5	1	2021-08-18	1.1	20.0	Sunny		Mini RAE Lite
BH_FE_001	1.10	ES	8	1	2021-08-18	0.7	20.0	Sunny		Mini RAE Lite
BH_OUT_001	0.20	ES	2	1	2021-08-19	1.7	22.0	Overcast		Mini RAE Lite
BH_OUT_001	0.50	ES	5	1	2021-08-19	1.6	22.0	Overcast		Mini RAE Lite
BH_OUT_001	1.10	ES	8	1	2021-08-19	1.6	22.0	Overcast		Mini RAE Lite
BH_TPS_001	0.20	ES	2	1	2021-08-23	0.9	18.0	Overcast		Mini RAE Lite
BH_TPS_001	0.50	ES	5	1	2021-08-23	0.7	18.0	Overcast		Mini RAE Lite
BH_TPS_001	1.10	ES	8	1	2021-08-23	0.7	18.0	Overcast		Mini RAE Lite
BH_TUN_002	0.20	ES	2	1	2021-08-23		18.0	Overcast		Mini RAE Lite
BH_TUN_002	0.50	ES	5	1	2021-08-23		18.0	Overcast		Mini RAE Lite
BH_TUN_002	1.10	ES	8	1	2021-08-23	1.4	18.0	Overcast		Mini RAE Lite
BH_TPS_002	0.20	ES	2	1	2021-08-24	1.1	18.0	Sunny		Mini RAE Lite
BH_TPS_002	0.50	ES	5	1	2021-08-24	0.9	18.0	Sunny		Mini RAE Lite
BH_TPS_002	1.10	ES	8	1	2021-08-24	0.9	18.0	Sunny		Mini RAE Lite
TP_FE_003	0.25	ES	1	1	2021-08-24	0.4	18.0	Sunny		Mini RAE Lite
TP_FE_003	0.50	ES	3	1	2021-08-24	0.5	18.0	Sunny		Mini RAE Lite
TP_FE_003	2.00	ES	6	1	2021-08-24	0.5	18.0	Sunny		Mini RAE Lite
TP_FE_003	2.80	ES	8	1	2021-08-24	0.5	18.0	Sunny		Mini RAE Lite
BH_TPS_003	0.20	ES	2	1	2021-08-25	1.0	17.0	Cloudy		Mini RAE Lite
BH_TPS_003	0.50	ES	5	1	2021-08-25	0.9	17.0	Cloudy		Mini RAE Lite
BH_TPS_003	1.10	ES	8	1	2021-08-25	0.8	17.0	Cloudy		Mini RAE Lite
BH_STW_003A	0.20	ES	2	1	2021-08-26	0.9	17.0	Overcast		Mini RAE Lite
BH_STW_003A	0.50	ES	5	1	2021-08-26	0.7	17.0	Overcast		Mini RAE Lite
BH_STW_003A	1.10	ES	8	1	2021-08-26	0.7	17.0	Overcast		Mini RAE Lite
BH_TPS_004	0.20	ES	2	1	2021-08-26	0.9	16.0	Overcast		Mini RAE Lite
BH_TPS_004	0.50	ES	5	1	2021-08-26	0.7	16.0	Overcast		Mini RAE Lite
BH_TPS_004	1.10	ES	8	1	2021-08-26	0.7	16.0	Overcast		Mini RAE Lite

Checked By:
Date:

Approved By:
Date:

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	
Project No.	TE8364	
Engineer	Mott MacDonald Bentley	
Client	Barhale Limited	

Photo Ionisation Results

Hole ID	Sample Depth m	Sample Type	Sample Ref.	Test Number	Test Date yyyy-mm-dd	PID ppm	Temp. °C	Weather	Remarks	PID Device Type
BH_TUN_005Ab	0.20	ES	2	1	2021-08-26	1.6	16.0	Overcast		Mini RAE Lite
BH_TUN_005Ab	0.50	ES	5	1	2021-08-26	1.4	16.0	Overcast		Mini RAE Lite
BH_TUN_005Ab	1.10	ES	8	1	2021-08-26	1.4	16.0	Overcast		Mini RAE Lite
BH_STW_011A	0.20	ES	2	1	2021-08-31	1.2	13.0	Overcast		Mini RAE Lite
BH_STW_011A	0.50	ES	5	1	2021-08-31	0.9	13.0	Overcast		Mini RAE Lite
BH_STW_011A	1.10	ES	8	1	2021-08-31	0.8	13.0	Overcast		Mini RAE Lite
TP_STW_007	0.20	ES	1	1	2021-08-31	<0.1	13.0	Overcast		Mini RAE Lite
TP_STW_007	0.50	ES	3	1	2021-08-31	<0.1	13.0	Overcast		Mini RAE Lite
TP_STW_007	1.00	ES	5	1	2021-08-31	<0.1	13.0	Overcast		Mini RAE Lite
TP_STW_007	1.50	ES	7	1	2021-08-31	<0.1	13.0	Overcast		Mini RAE Lite
BH_STW_020	0.20	ES	2	1	2021-09-03	1.2	20.0	Sunny		Mini RAE Lite
BH_STW_020	0.50	ES	5	1	2021-09-03	1.0	20.0	Sunny		Mini RAE Lite
BH_STW_020	1.10	ES	8	1	2021-09-03	0.9	20.0	Sunny		Mini RAE Lite
BH_STW_022A	0.20	ES	2	1	2021-09-03	1.1	19.0	Sunny		Mini RAE Lite
BH_STW_022A	0.50	ES	5	1	2021-09-03	1.0	19.0	Sunny		Mini RAE Lite
BH_STW_022A	1.10	ES	8	1	2021-09-03	0.9	19.0	Sunny		Mini RAE Lite
BH_TUN_001A	0.20	ES	2	1	2021-09-06	2.3	18.0	Sunny		Mini RAE Lite
BH_TUN_001A	0.50	ES	5	1	2021-09-06	2.0	18.0	Sunny		Mini RAE Lite
BH_TUN_001A	1.10	ES	8	1	2021-09-06	1.3	18.0	Sunny		Mini RAE Lite
TP_STW_014	0.30	ES	1	1	2021-09-07	0.6	18.0	Sunny		Mini RAE Lite
TP_STW_014	0.80	ES	3	1	2021-09-07	0.5	18.0	Sunny		Mini RAE Lite
TP_STW_014	1.20	ES	4	1	2021-09-07	1.2	18.0	Sunny		Mini RAE Lite
BH_TUN_004C	0.20	ES	2	1	2021-09-16	1.7	21.0	Sunny		Mini RAE Lite
BH_TUN_004C	0.50	ES	5	1	2021-09-16	1.7	21.0	Sunny		Mini RAE Lite
BH_TUN_004C	1.10	ES	8	1	2021-09-16	1.4	21.0	Sunny		Mini RAE Lite
BH_TUN_006	0.20	ES	2	1	2021-09-16	0.6	14.0	Sunny		Mini RAE Lite
BH_TUN_006	0.50	ES	5	1	2021-09-16	1.4	14.0	Sunny		Mini RAE Lite
BH_TUN_006	1.10	ES	8	1	2021-09-16	1.3	14.0	Sunny		Mini RAE Lite
BH_TUN_018	0.20	ES	2	1	2021-09-20	0.9	16.0	Cloudy		Mini RAE Lite
BH_TUN_018	0.50	ES	5	1	2021-09-20	0.9	16.0	Cloudy		Mini RAE Lite
BH_TUN_018	1.10	ES	8	1	2021-09-20	0.7	16.0	Cloudy		Mini RAE Lite
BH_TUN_010	0.20	ES	2	1	2021-10-15	0.9	16.0	Overcast		Mini RAE Lite
BH_TUN_010	0.50	ES	5	1	2021-10-15	0.8	16.0	Overcast		Mini RAE Lite

	Checked By:	Approved By:	
	Date:	Date:	SOIL ENGINEERING

Project Name Cambridge Waste Water Treatment Plant Relocation
Project No. TE8364
Engineer Mott MacDonald Bentley
Client Barhale Limited

Photo Ionisation Results

Hole ID	Sample Depth m	Sample Type	Sample Ref.	Test Number	Test Date yyyy-mm-dd	PID ppm	Temp. °C	Weather	Remarks	PID Device Type
BH_TUN_010	1.10	ES	8	1	2021-10-15	0.8	16.0	Overcast		Mini RAE Lite

Checked By:
Date:

Approved By:
Date:

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Stuart Wells Limited

Cambridge WWTPR Pumping Test Report

Contract Name:	Cambridge WWTPR
Client Name:	Soil Engineering Ltd
Groundwater & Dewatering Specialist:	Stuart Wells Limited (SWL)
Report No:	SWL21-122-01-PT-02
Location ID	Step Test Abstraction Wells: BH_TPS_001b, BH_TPS_002b, BH_TPS_003b, BH_TPS_004b Constant Rate Test Abstraction Well: BH_TPS_004b Additional Observation Wells: BH_STW_009, BH_STW_010b, BH_STW_015, BH_TUN_018.

Revision	Date	Description	Prepared By (SWL)	Checked By (SWL)
01	26/11/2020	Submission	James Pettengell	Mark Pickett
02	20/12/2021	Updated as per clients' comments	James Pettengell	Mark Pickett

For: Soil Engineering Parkside Lane Dewsbury Road Leeds LS11 5SX	Contact: Name: Matthew Bellhouse Regional Manager (South) Telephone: [redacted] Email : [redacted]@soil-engineering.co.uk
By: Stuart Wells Ltd Hargham Road Shropham Norfolk NR17 1DT	Contact: Dr Mark Pickett Technical Director Telephone: [redacted] Email: [redacted]@stuartwells.co.uk

CONTENTS

TABLES

FIGURES

1. Introduction

Stuart Wells Ltd. (*hereafter referred to as SWL*) were appointed by Soil Engineering Ltd. (*the client*) to undertake a pumping test in accordance with BS EN ISO 22282-4:2012 and BS ISO 14686:2003.

The pumping test scope was outlined in Mott MacDonald specification referenced: 421008-01 Rev C dated April 2021 (*herein referred to as the specification*) and 'EA CONSENT TO INVESTIGATE A GROUNDWATER SOURCE: Consent no: 660/12/952 dated 08 July 2021. It was defined that the purpose of this test was to determine the hydraulic properties the West Melbury Chalk Formation. The testing was undertaken to determine what groundwater control techniques will be required during shaft construction.

Initially, the pumping test was to comprise of a step test in each of the 4 no. abstraction wells. This would be undertaken to identify the highest yielding abstraction well, which would subsequently be used to abstract groundwater from during the constant rate test. Abstracted groundwater was discharged to ground approximately 70 m from the pumping well.

The pumping test sequence involved; pre-test monitoring of groundwater levels, an equipment test, followed by 6 no. step-tests and a 7-day constant rate test. Groundwater levels were monitored in accordance with BS EN ISO 22282-4:2012, both manually and electronically using dataloggers in the pumping well and groundwater monitoring points. The configuration of the pumping test is shown in Figure 1. Atmospheric pressure was measured using a barometric logger.

This report details the activities and the results of the testing carried out.

2. Ground Conditions

TABLE 1: Summary of ground conditions encountered

Geotechnical Unit	Description of Strata	Elevation (mOD)	
		from	to
Topsoil	Sandy slightly gravelly CLAY	10.09	9.79
Superficial Deposits	variable SAND/Variable CLAY	9.79	9.54
West Melbury Chalk Formation	Structureless Chalk becoming weak high-density Chalk	9.54	-0.81
Cambridge Greensand Formation	Siltstone/variable CLAY	-0.81	-1.11
Gault Clay Formation	CLAY	-1.11	-36.36
Lower Greensand Formation	variable CLAY/Variable SAND	-36.36	Proven to -39.22

For site specific ground conditions encountered during this investigation phase, please refer to the full borehole logs prepared by Soil Engineering.

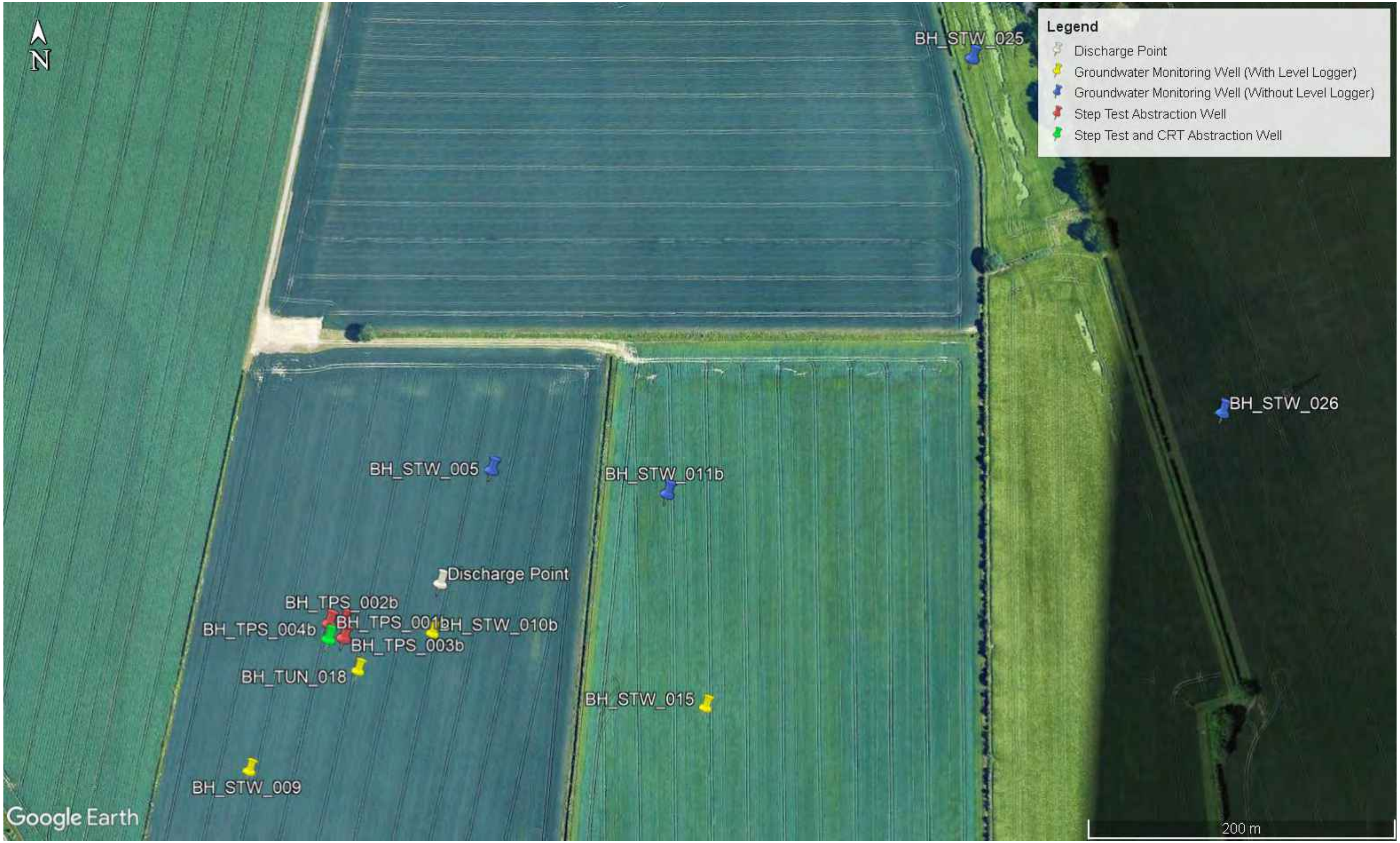


Figure 1: Pumping Test Location Map

3. Scope of Works

The programme of works undertaken at site is summarised in Table 1. Detailed information on specific project tasks is included in subsequent sections.

TABLE 2: Programme of Works

Date	Activity
13th October 2021	Installation of Groundwater Loggers.
13th to 21st October 2021	Mobilisation: Setting up of Testing Equipment Setting up of generators and pumping equipment
21st October 2021	Equipment Testing BH_TPS_004b An equipment test, which comprised of determining the well yield and pump suitability, as well as general equipment checks.
22nd October 2021	Step-Test BH_TPS_004b Step 1 at 0.125 l/s Step 2 at 0.25 l/s Step 3 at 0.375 l/s Step 4 at 0.5 l/s
25th October 2021	Equipment Testing BH_TPS_002b An equipment test, which comprised of determining the well yield and pump suitability, as well as general equipment checks.
26th October 2021	Step-Test BH_TPS_002b Step 1 at 0.05 l/s Step 2 at 0.10 l/s Step 3 at 0.15 l/s Step 4 at 0.20 l/s
27th October 2021	Step-Test BH_TPS_002b Step 1 at 0.20 l/s
27th October 2021	Equipment Testing BH_TPS_003b An equipment test, which comprised of determining the well yield and pump suitability, as well as general equipment checks.
28th October 2021	Step-Test BH_TPS_003b Step 1 at 0.125 l/s Step 2 at 0.25 l/s Step 3 at 0.375 l/s Step 4 at 0.5 l/s
29th October 2021	Step-Test BH_TPS_003b Step 1 at 0.5 l/s
29th October 2021	Equipment Testing BH_TPS_001b An equipment test, which comprised of determining the well yield and pump suitability, as well as general equipment checks.
1st November 2021	Step-Test BH_TPS_001b Step 1 at 0.066 l/s
2nd November 2021	Constant Rate Test BH_TPS_004b Constant Rate Pumping Test undertaken at 0.36 l/s.
4th November 2021	Constant Rate Test BH_TPS_004b Constant Rate Pumping Test flow rate reduced to 0.25 l/s
9th November 2021	End of Constant Rate Test
9th to 11th November 2021	Recovery Monitoring
11th November 2021	Datalogger Download and reset

3.1. Groundwater Level Monitoring

Groundwater monitoring was completed at a number of monitoring points during the pumping test. They are summarised in Table 2 below.

TABLE 3: Groundwater Monitoring

Location Identification	Detail	Designation
BH_TPS_001b	SWL Level logger	Step test and monitoring well
BH_TPS_002b	SWL Level logger	Step test and monitoring well
BH_TPS_003b	SWL Level logger	Step test and monitoring well
BH_TPS_004b	SWL Level logger	Step test and pumping well during constant rate test
BH_STW_009	SWL Level logger	monitoring well
BH_STW_010b	SWL Level logger	monitoring well
BH_STW_015	SWL Level logger	monitoring well
BH_TUN_018	SWL Level logger	monitoring well
BH_STW_005	Manual data	monitoring well
BH_STW_011b	Manual data	monitoring well
BH_STW_025	Manual data	monitoring well
BH_STW_026	Manual data	monitoring well
Barologger	Barometric pressure datalogger	barometric calibration

3.2. Pumping Test Equipment

Equipment used during testing is summarised as follows:

- 1 no. 415v submersible borehole pump 11.6mBTOC on WellMaster riser.
- A duty 20kVA Silenced generator was used to power the borehole pump, with bunded fuel tank, auto-mains failure (AMF) panel and standby generator.
- Electronic level-loggers were used at the abstraction well and monitoring wells to record continuous water level readings for the duration of the testing period.
- Manual water level readings were recorded using a Manual Dip Tape.
- Flow rate was monitored using 1 no. electronic flowmeter (Mag 2000) and 1 no. mechanical flowmeter.
- Approximately 70 metres of Bauer discharge pipeline, with scour protection at discharge point.

4. Results

The following section presents a summary of the results obtained during the pumping test. The full testing results are included in the associated excel file 'SWL21-122 -01 Cambridge WWTPR Pumping Test Data'.

4.1. Pre-test Monitoring

Pre-test groundwater monitoring data was collected from SWL level loggers installed in all wells. The results are summarised in Table 3 and shown in the hydrograph, Figure 2. Please note, as explained in Section 4.6, pre-test monitoring was not completed at monitoring well BH_STW_015.

TABLE 4: Summary of Pre-Test Groundwater Level Monitoring

Location Identification	Groundwater Depth (mBGL)
BH_TPS_001b	4.30 to 4.35
BH_TPS_002b	4.14 to 4.19
BH_TPS_003b	4.82 to 4.86
BH_TPS_004b	4.09 to 4.13
BH_STW_009	4.80 to 4.85
BH_STW_010b	4.36 to 4.42
BH_TUN_018	4.48 to 4.53
BH_STW_015	n/a

4.2. Equipment Test

After the installation of the submersible borehole pump in each abstraction well, an equipment test was undertaken to determine that all site equipment was working correctly, this comprised of 1 no. pumping phase. The equipment tests in the 4 no. abstraction wells were undertaken between the 21st and 29th October 2021.

4.3. Step Test

A series of 6 no. step tests were undertaken in each of the 4 no. abstraction wells (BH_TPS_001b, BH_TPS_002b, BH_TPS_003b and BH_TPS_004b). The purpose of the step tests was to determine, which of the wells had the highest yield, and it would be this well that would be utilised as the abstraction well for the purpose of the constant rate test.

The details of each completed step test including test dates and flow rates are summarised in the Table 4 below. After each step test, groundwater levels were left to recover overnight prior to next step test and the constant rate test.

The Step Test results are presented in the hydrograph, Figure 2 (time-water level).

TABLE 5: Summary of Step Tests

Location Identification	Step test Date	No. steps	Flow rate(s) (l/s)
BH_TPS_001b	01/11/2021	1	0.066
BH_TPS_002b	26/10/2021	4	0.05, 0.10, 0.15, 0.20
BH_TPS_002b (Additional Step test upon client's request)	27/10/2021	1	0.20
BH_TPS_003b	28/10/2021	4	0.125, 0.25, 0.375, 0.50
BH_TPS_003b (Additional Step test upon client's request)	29/10/2021	1	0.50
BH_TPS_004b	22/10/2021	4	0.125, 0.25, 0.375, 0.5

4.4. Constant Rate Test (CRT)

The CRT was started on 2nd November 2021 at 11:00 and completed at 11:00 on 9th November 2021. Initially, the first two days of the test were undertaken at a flow rate of 0.36 l/s. However, on the third day it was noted that this flow rate was too great for the well to maintain for the full duration of the test. As a result, on the 4th November 2021, it was agreed between Mott MacDonald, Soil Engineering and SWL to reduce the abstraction flow rate to 0.25 l/s for the remainder of the pumping test.

Please find a summary of water depths and drawdown achieved during the CRT in Table 5. The results of the pumping test are also presented in the hydrographs, Figure 3 (time-water level). While Figure 4 presents a semi-log plot of the distance drawdown.

TABLE 6: Summary of Constant Rate Test Drawdown

Well No.	Easting	Northing	Distance from pumped well (m)	Maximum Change (m)
Pumping Well (BH_TPS_004b)	549425.40	261019.03	0.10	6.79
BH_TPS_001b	549425.67	261029.07	10.04	0.75
BH_TPS_003b	549435.45	261019.05	10.05	0.54
BH_TPS_002b	549435.44	261029.23	14.31	0.70
BH_STW_010b	549493.73	261023.34	68.47	0.35
BH_STW_015	549671.50	260975.20	249.97	0.13
BH_STW_009	549374.10	260933.60	99.65	0.15
BH_TUN_018	549445.42	260999.33	28.09	0.02
BH_STW_005	549531.13	261127.75	151.65	0.08
BH_STW_011b	549645.96	261113.4	239.90	0.05
BH_STW_025	549843.67	261395.68	562.86	0.10
BH_STW_026	550007.1	261165.69	599.90	0.05

4.5. Recovery Monitoring

Recovery monitoring was completed upon completion of the CRT on the 9th November 2021 through to the 11th November 2021. The results of the recovery monitoring are presented in the hydrographs, Figure 3 (time-water level).

4.6. Additional Commentary

- Upon request of the client, additional single step tests were undertaken in BH_TPS_002b and BH_TPS_003b. These additional step tests were completed at a flow rate of 0.20 l/s and 0.50 l/s respectively.
- Prior to beginning the Constant Rate Test, SWL was requested by the client to include an additional monitoring well, BH_STW_015. As a result, data was not collected during Pre-Test Monitoring or Step Tests.
- As is shown in Figure 3, over the course of the night on the 03rd November 2021, the groundwater level fell below the installation depth of the monitoring probe. As a result, between 23:21 03rd to 09:00 04th November 2021, the data ‘flat lines’. Therefore, it was decided to reduce the flow rate from 0.36 l/s to 0.25 l/s on the 4th November 2021 at 09:00. The reduction in flow rate was necessary to bring the groundwater level back above the monitoring probe and the test could continue.

Yours faithfully,

Prepared by:	Reviewed and Approved by:
[redacted]	[redacted]
James Pettengell	Dr. Mark Pickett
BSc, MSc (Hons)	PhD, MCSM, BEng (Hons) FGS
Geotechnical Engineer	Technical Director
For & behalf of Stuart Wells Ltd	For & behalf of Stuart Wells Ltd

Figure 2
Soil Engineering Limited/ Cambridge WWTPR
Pre-Test Monitoring and Step Test at BH_TPS_001b, BH_TPS_002b, BH_TPS_003b, BH_TPS_004b
Time-Water Level Hydrograph
13/10/2021 to 02/11/2021

Stuart Wells Limited

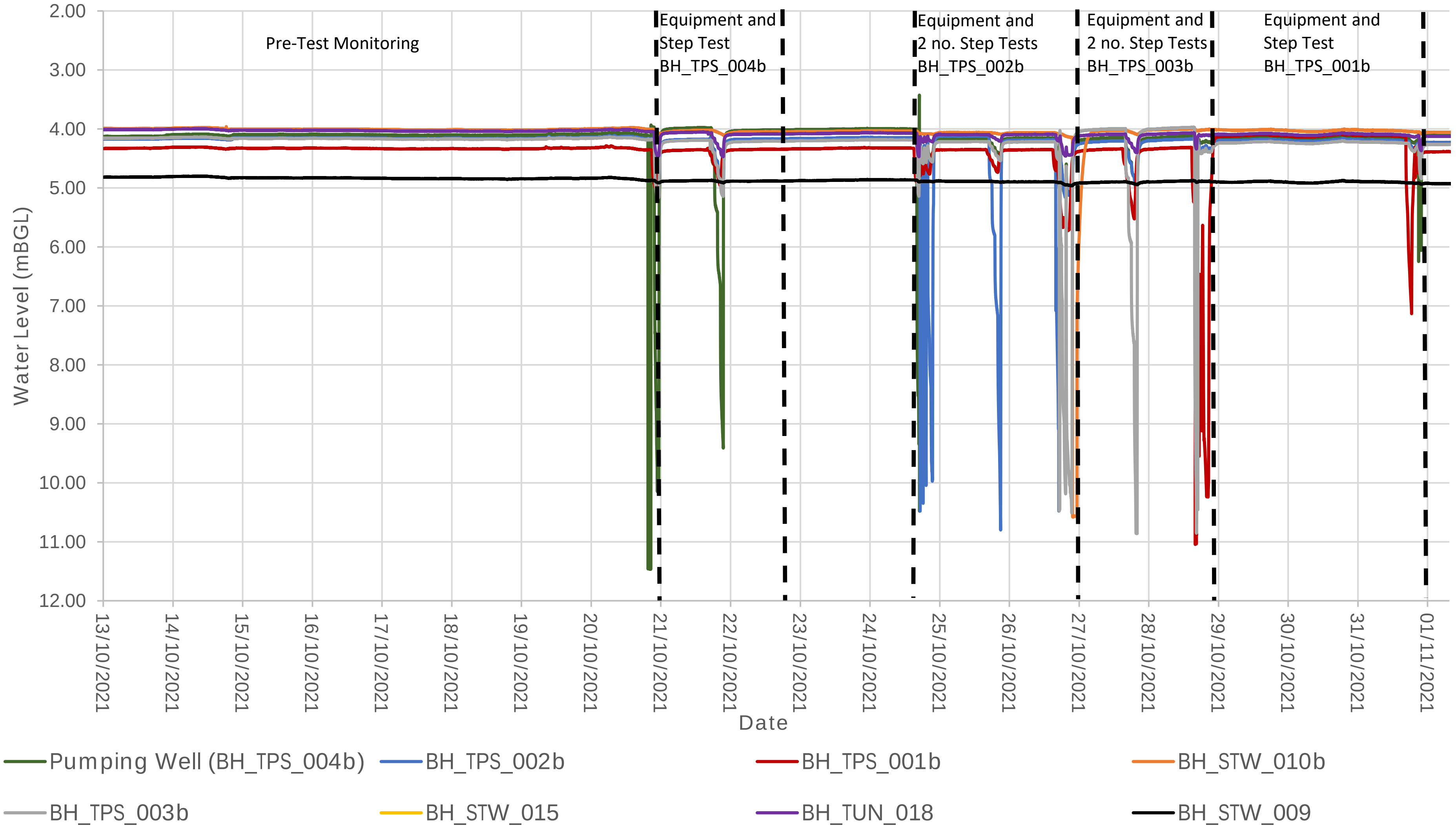


Figure 3
Soil Engineering Limited/ Cambridge WWTPR
BH_TPS_004b Constant Rate Pumping Test
Time-Water Level Hydrograph
02/11/2021 to 09/11/2021

Stuart Wells Limited

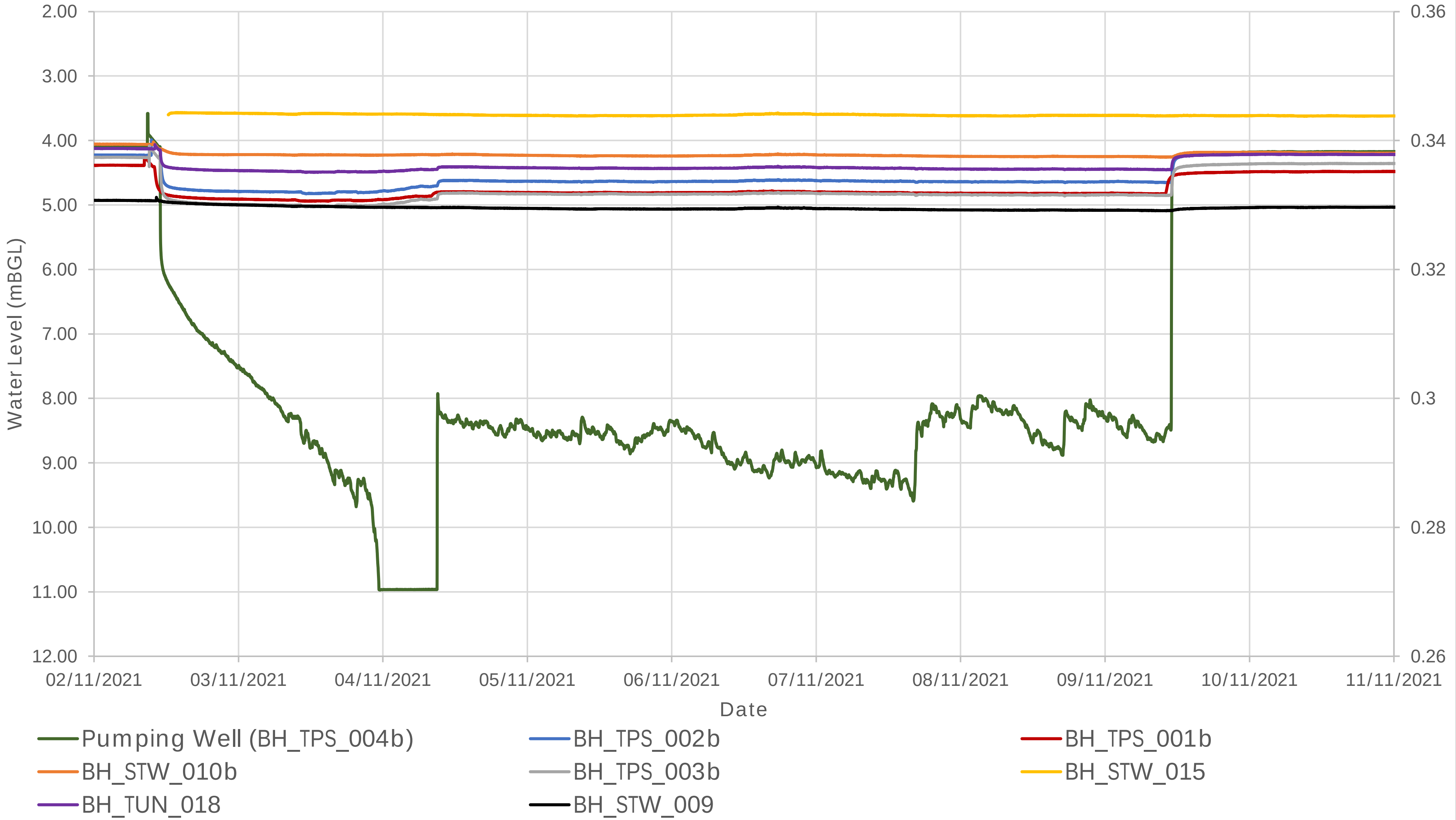
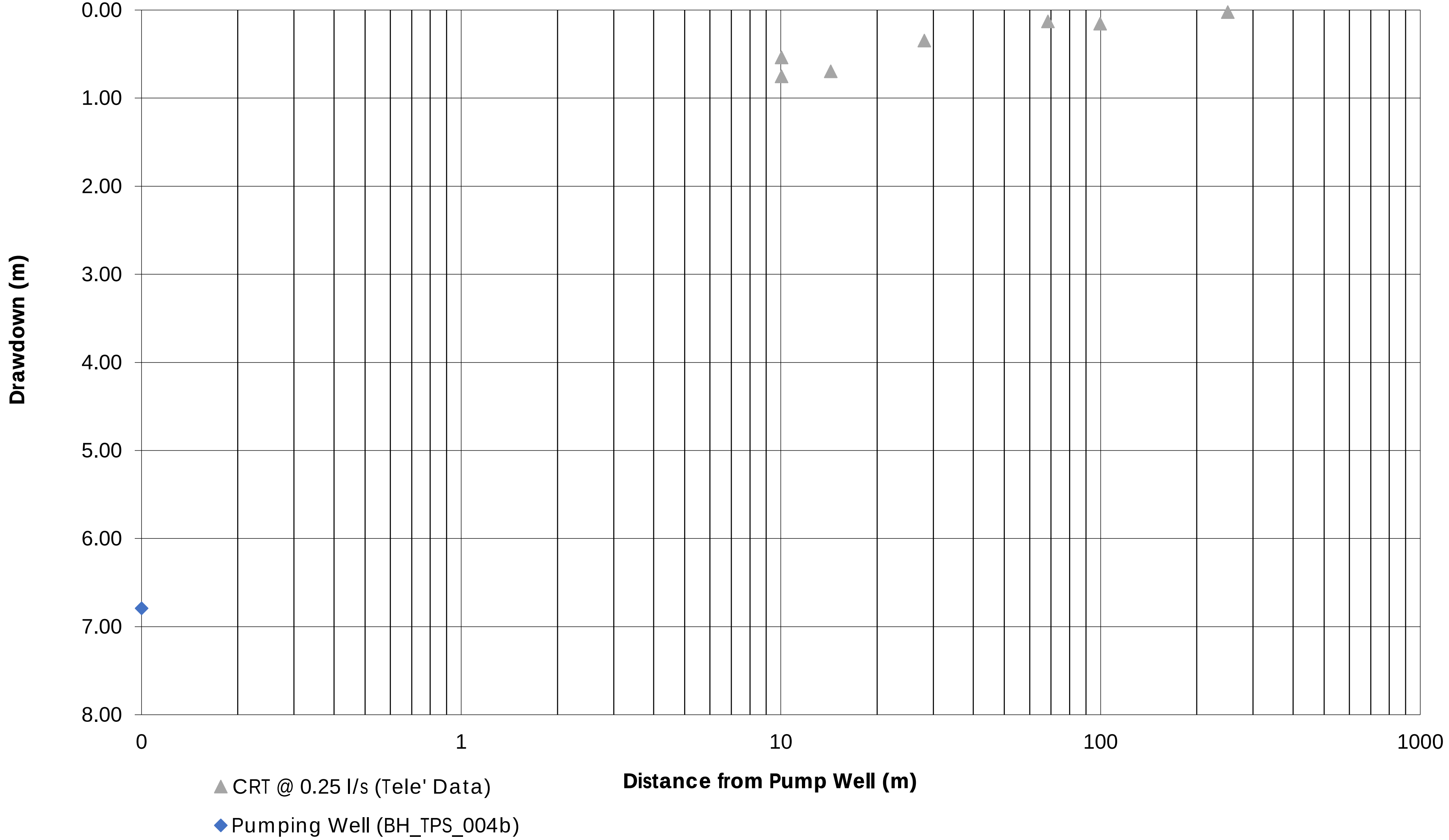


Figure 4
Soil Engineering Ltd- Cambridge WWTPR
BH_TPS_004b - Constant Rate Pumping Test
Semi-log Distance Drawdown Plot
02/11/2021 to 09/11/2021



Inspection Pit Infiltration Test

BS EN ISO 22282-2: 2012

Project Name	Cambridge Waste Water Treatment Plant Relocation	Hole ID	BH_FE_001
Project No.	TE8364	Ground Level	4.08m AOD
Engineer	Mott MacDonald Bentley	Date	18/08/2021
Client	Barhale Limited	Page	1 of 2

Description	0.30m to 1.00m: Firm sandy slightly gravelly CLAY. 1.00m to 1.20m: Slightly sandy angular to sub rounded fine to coarse GRAVEL of flint.
Type of test	Borehole
Installation type	

All depths are relative to ground level.

Initial ground water level	1.09	m	Top of test section	0.00	m
Height of casing above surface	0.00	m	Bottom of test section	1.20	m
Length of test section	1.20	m	Water level at end of test	0.90	m
Diameter of test section		mm	Diameter of casing/standpipe		mm
Quality of water used	Clean and fresh		Test start time	12:37	
Weather	Cloudy		Test finish time	01:55	

Time Minutes	Depth to water m	H	ln H_0/H	Time Minutes	Depth to water m	H	Log H/H0
0	0.00			55	0.84		
0.5	0.41			58	0.85		
1	0.46			61	0.86		
1.5	0.48			64	0.87		
2	0.50			67	0.87		
2.5	0.52			70	0.88		
3	0.54			73	0.88		
3.5	0.55			76	0.89		
4	0.56			79	0.90		
4.5	0.58						
5	0.59						
6	0.60						
7	0.62						
8	0.63						
9	0.64						
10	0.64						
12	0.65						
14	0.66						
16	0.67						
18	0.68						
20	0.70						
25	0.72						
28	0.74						
31	0.76						
34	0.77						
37	0.78						
40	0.79						
43	0.80						
46	0.81						
49	0.82						
52	0.83						

Remarks

Test performed in inspection pit as instructed by Client. Inspection pit dimensions: 240mm x 260mm x 1.20m.

Recorded by: D. Tiernan

SOIL ENGINEERING

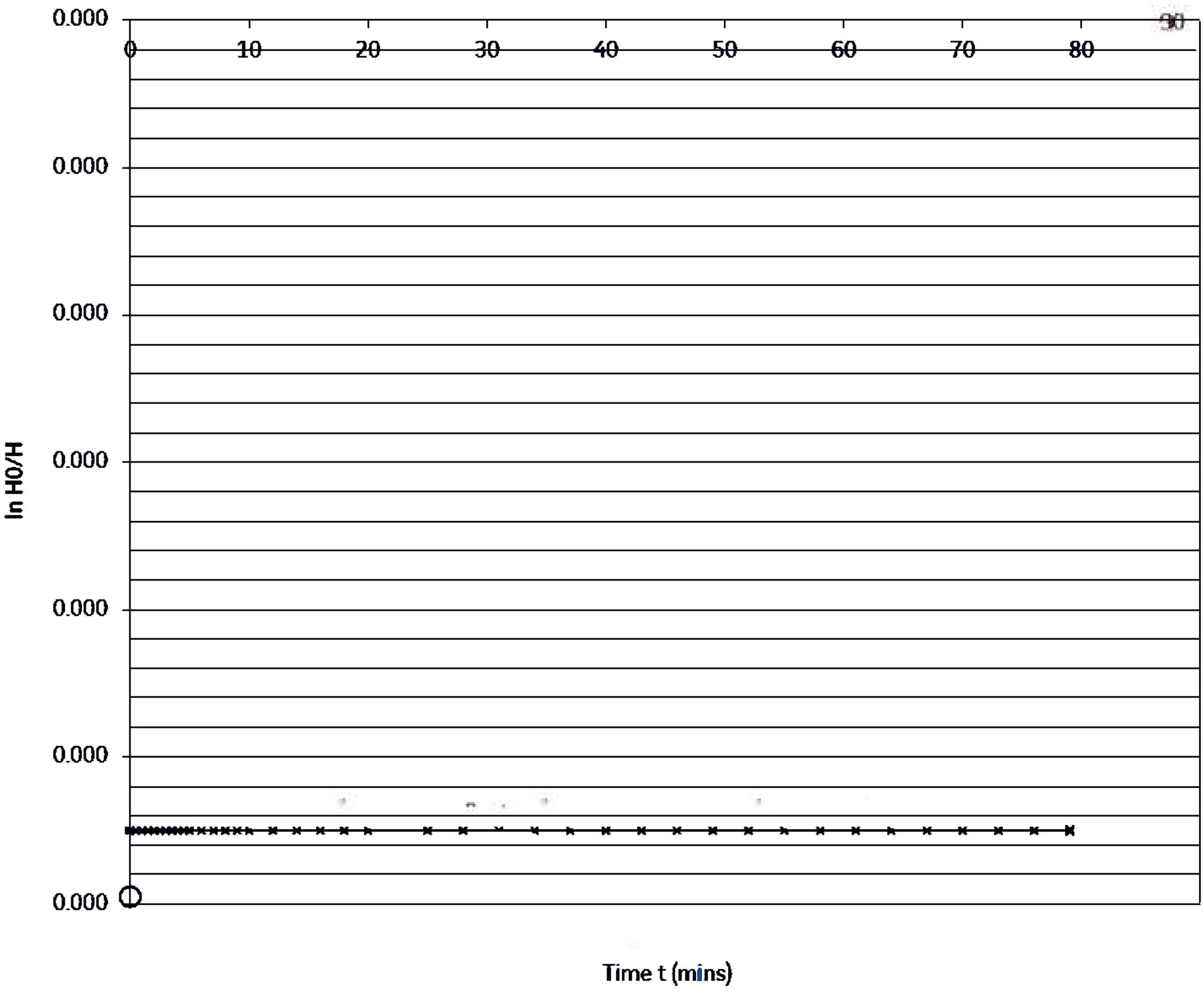
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Inspection Pit Infiltration Test**	Hole ID BH_FE_001
Project No.	TE8364		Ground Level 4.08m AOD
Engineer	Mott MacDonald Bentley		Date 18/08/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 2 of 2

Description 0.30m to 1.00m: Firm sandy slightly gravelly CLAY. 1.00m to 1.20m: Slightly sandy angular to sub rounded fine to coarse GRAVEL of flint.

Type of test	Borehole	Installation type			
Initial ground water level	1.09	m	Top of test section	0.00	m BGL
Height of casing above surface	0.00	m	Bottom of test section	1.20	m BGL
Length of test section	1.20	m	Water level at end of test	0.90	m
Diameter of test section		mm	Diameter of casing/standpipe		mm

Quality of water used	Clean and fresh	Test start time	12:37
Weather	Cloudy	Test finish time	01:55



Dimensions of inspection pit 0.26m x 0.24m x 1.20m
Water level start of test 0.35m; end of test 0.90m
Volume of outflow (v) 0.03432m^3
Surface area through which outflow occurs (a) 0.6124m^2
Test time (t) 4740secs
Soil Infiltration rate f = v/(a.t)

f = 1.18×10^{-5} m/s

Recorded by: D Tiernan

Form No.	SE-PGR-F-003	Revision No.	3.04	Issue Date	24/01/2014

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_STW_003A
Project No.	TE8364		Ground Level 10.25m AOD
Engineer	Mott MacDonald Bentley		Date 27/08/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2

Description	1.40m to 7.00m: Alternating Structureless CHALK and Grade B3/B4 CHALK

Type of test	Borehole	Installation type			
All depths are relative to ground level.					
Initial ground water level	5.46	m	Top of test section	1.45	m
Height of casing above surface	0.22	m	Bottom of test section	7.00	m
Length of test section	5.55	m	Water level at end of test	5.03	m
Diameter of test section	146	mm	Diameter of casing/standpipe	146	mm
Quality of water used	Clean and fresh		Test start time	09:03	
Weather	Cloudy		Test finish time	10:13	

Time Minutes	Depth to water m	H	$\ln H_0/H$	Time Minutes	Depth to water m	H	Log H/H0
0	0.00	5.46	0.00	55	4.91	0.55	2.30
0.5	0.18	5.28	0.03	58	4.94	0.52	2.35
1	0.25	5.21	0.05	61	4.97	0.49	2.41
1.5	0.35	5.11	0.07	64	5.00	0.46	2.47
2	0.46	5.00	0.09	67	5.02	0.44	2.52
2.5	0.65	4.81	0.13	70	5.03	0.43	2.54
3	0.78	4.68	0.15				
3.5	0.88	4.58	0.18				
4	0.97	4.49	0.20				
4.5	1.06	4.40	0.22				
5	1.18	4.28	0.24				
6	1.39	4.07	0.29				
7	1.54	3.92	0.33				
8	1.69	3.77	0.37				
9	1.89	3.57	0.42				
10	2.04	3.42	0.47				
12	2.16	3.30	0.50				
14	2.36	3.10	0.57				
16	2.47	2.99	0.60				
18	2.58	2.88	0.64				
20	3.11	2.35	0.84				
25	3.43	2.03	0.99				
28	3.69	1.77	1.13				
31	3.94	1.52	1.28				
34	4.13	1.33	1.41				
37	4.31	1.15	1.56				
40	4.46	1.00	1.70				
43	4.61	0.85	1.86				
46	4.69	0.77	1.96				
49	4.77	0.69	2.07				
52	4.85	0.61	2.19				

Remarks

Recorded by: D. Tiernan

soil engineering

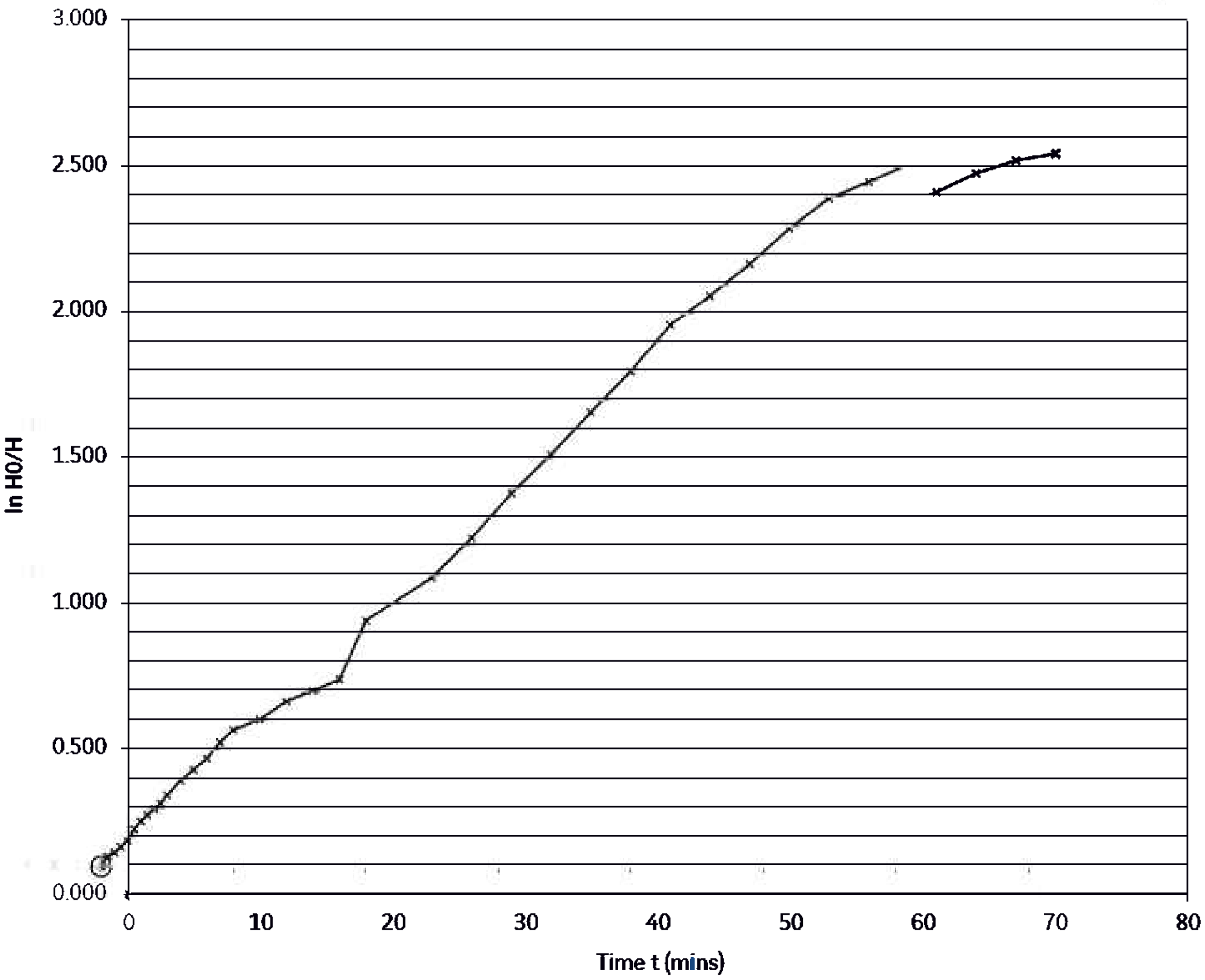
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	# Borehole Falling Head Permeability Test	Hole ID BH_STW_003A
Project No.	TE8364		Ground Level 10.25m AOD
Engineer	Mott MacDonald Bentley		Date 27/08/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 2 of 2

Description 1.40m to 7.00m: Alternating Structureless CHALK and Grade B3/B4 CHALK

Type of test	Borehole	Installation type			
Initial ground water level	5.46	m	Top of test section	1.45	m BGL
Height of casing above surface	0.22	m	Bottom of test section	7.00	m BGL
Length of test section	5.55	m	Water level at end of test	5.03	m
Diameter of test section	146	mm	Diameter of casing/standpipe	146	mm

Quality of water used	Clean and fresh	Test start time	09:03
Weather	Cloudy	Test finish time	10:13



using Velocity graph method $k = \alpha . S/F$ = 1.26×10^{-6} m/s

where α= 0.000605 m/s

S= 0.0167m

F= 8.047m

Recorded by: D Tiernan			SOIL ENGINEERING
Form No. SE-PGR-F-003	Revision No. 3.04	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_STW_005B
Project No.	TE8364		Ground Level 9.31m AOD
Engineer	Mott MacDonald Bentley		Date 06/09/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2

Description	CHALK recovered as very stiff gravelly calcareous CLAY.

Type of test	Borehole	Installation type	

All depths are relative to ground level.

Initial ground water level	4.80	m	Top of test section	6.20	m
Height of casing above surface	0.00	m	Bottom of test section	6.20	m
Length of test section	0.00	m	Water level at end of test	2.50	m
Diameter of test section	200	mm	Diameter of casing/standpipe	200	mm

Quality of water used	Clean and fresh	Test start time	12:00
Weather	Cloudy	Test finish time	13:00

Time Minutes	Depth to water m	H	ln H_0/H	Time Minutes	Depth to water m	H	Log H/H0
0	0.00	4.80	0.00				
0.25	0.10	4.70	0.02				
0.5	0.15	4.65	0.03				
0.75	0.17	4.63	0.04				
1	0.20	4.60	0.04				
1.5	0.26	4.54	0.06				
2	0.31	4.49	0.07				
2.5	0.37	4.43	0.08				
3	0.42	4.38	0.09				
3.5	0.46	4.34	0.10				
4	0.51	4.29	0.11				
4.5	0.57	4.23	0.13				
5	0.60	4.20	0.13				
6	0.70	4.10	0.16				
7	0.77	4.03	0.17				
8	0.84	3.96	0.19				
10	0.99	3.81	0.23				
12	1.12	3.68	0.27				
14	1.19	3.61	0.28				
16	1.25	3.55	0.30				
18	1.42	3.38	0.35				
20	1.57	3.23	0.40				
25	1.78	3.02	0.46				
30	1.98	2.82	0.53				
40	2.16	2.64	0.60				
50	2.36	2.44	0.68				
60	2.50	2.30	0.74				

Remarks

Recorded by: D Cundill

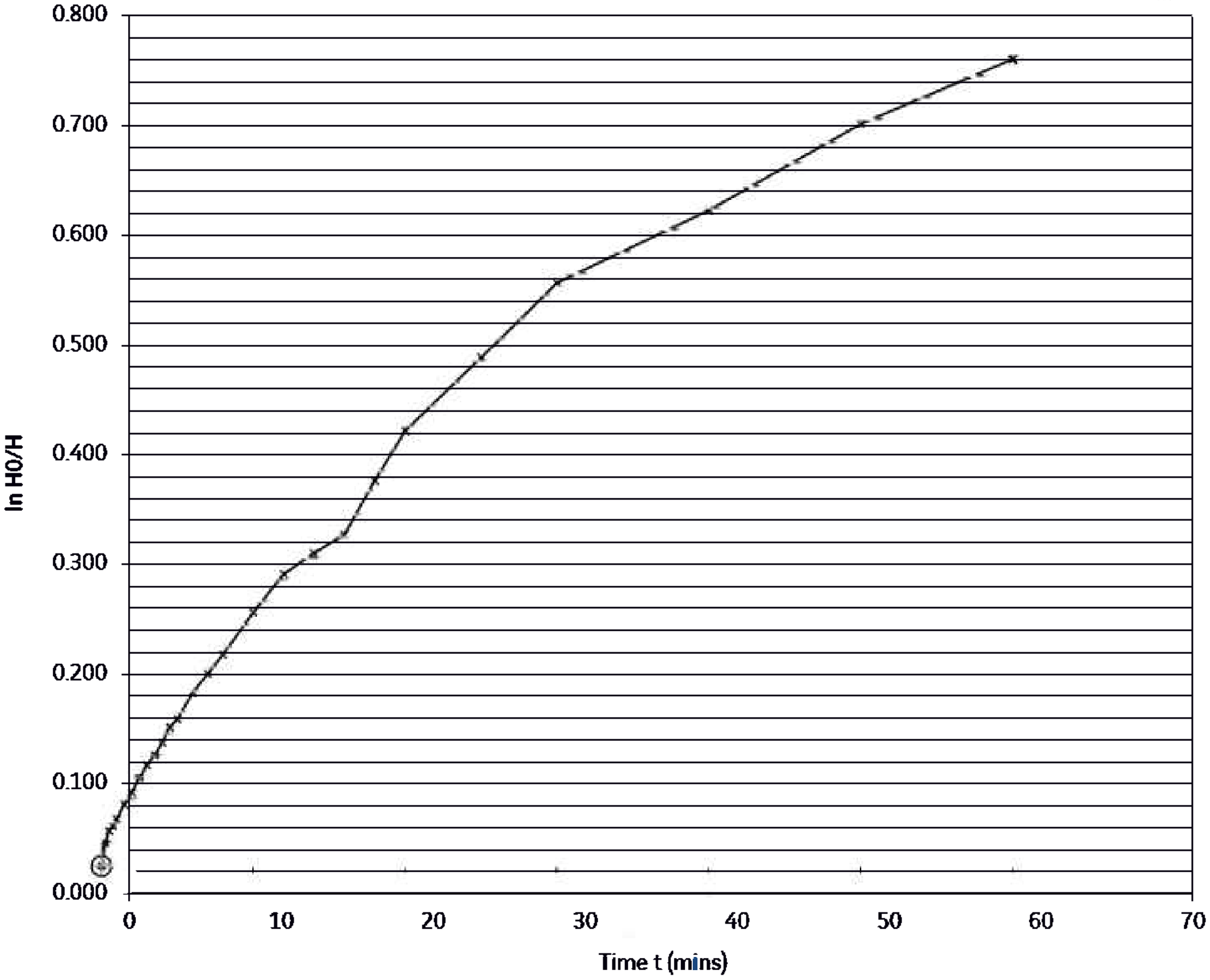
SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_STW_005B
Project No.	TE8364		Ground Level 9.31m AOD
Engineer	Mott MacDonald Bentley		Date 06/09/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 2 of 2

Description CHALK recovered as very stiff gravelly calcareous CLAY.

Type of test Borehole	Installation type				
Initial ground water level	4.80	m	Top of test section	6.20	m BGL
Height of casing above surface	0.00	m	Bottom of test section	6.20	m BGL
Length of test section	0.00	m	Water level at end of test	2.50	m
Diameter of test section	200	mm	Diameter of casing/standpipe	200	mm

Quality of water used	Clean and fresh	Test start time	12:00
Weather	Cloudy	Test finish time	13:00



using Velocity graph method $k = \alpha . S/F$ = 5.11×10^{-6} m/s

where α= *0.000204 m/s*

S= *0.0314m*

F= 1.256m

Recorded by: D Cundill			SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_STW_013A
Project No.	TE8364		Ground Level 6.89m AOD
Engineer	Mott MacDonald Bentley		Date 13/08/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2

Description 1.40m to 3.70m: Structureless CHALK composed of very stiff fissured calcareous CLAY. Grade Dm.

Type of test	Borehole	Installation type				
All depths are relative to ground level.						
Initial ground water level	1.95	m	Top of test section	1.20	m	
Height of casing above surface	0.20	m	Bottom of test section	3.50	m	
Length of test section	2.30	m	Water level at end of test	0.67	m	
Diameter of test section	200	mm	Diameter of casing/standpipe	200	mm	
Quality of water used	Clean and fresh		Test start time	10:10		
Weather	Cloudy		Test finish time	11:40		

Time Minutes	Depth to water m	H	ln H_0/H	Time Minutes	Depth to water m	H	Log H/H0
0	-0.20	2.15	0.00				
0.5	-0.19	2.14	0.00				
1	-0.19	2.14	0.01				
1.5	-0.18	2.13	0.01				
2	-0.18	2.13	0.01				
2.5	-0.17	2.12	0.01				
3	-0.17	2.12	0.02				
3.5	-0.16	2.11	0.02				
4	-0.16	2.11	0.02				
4.5	-0.15	2.10	0.02				
5	-0.14	2.09	0.03				
6	-0.13	2.08	0.03				
7	-0.12	2.07	0.04				
8	-0.11	2.06	0.05				
9	-0.09	2.04	0.05				
10	-0.08	2.03	0.06				
12	-0.06	2.01	0.07				
14	-0.03	1.98	0.08				
16	-0.01	1.96	0.10				
18	0.02	1.94	0.11				
20	0.04	1.91	0.12				
25	0.10	1.86	0.15				
30	0.15	1.80	0.18				
40	0.24	1.71	0.23				
50	0.34	1.61	0.29				
60	0.43	1.52	0.35				
70	0.51	1.44	0.40				
80	0.59	1.36	0.46				
90	0.67	1.28	0.52				

Remarks

Recorded by: C. Howard

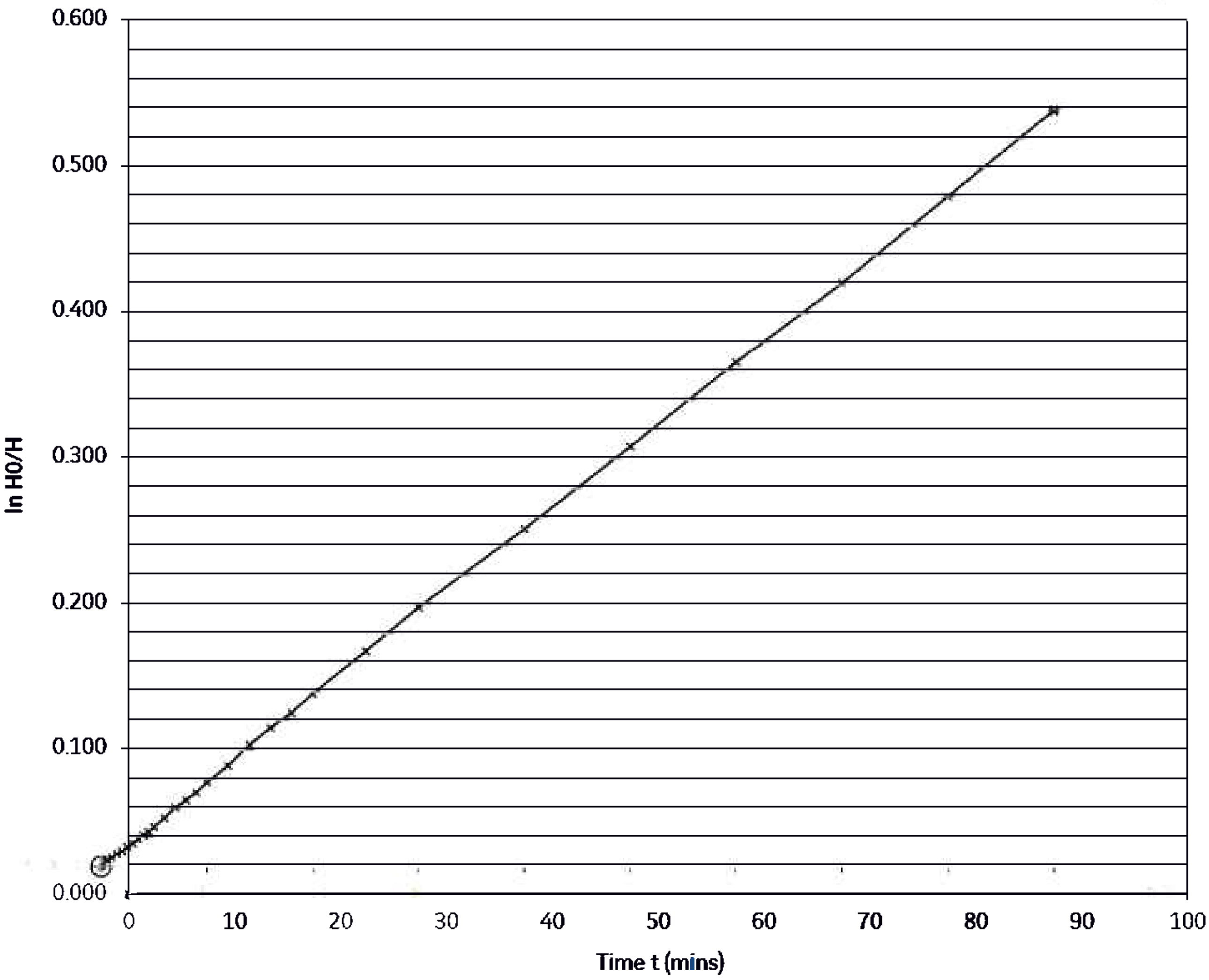
SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_STW_013A
Project No.	TE8364		Ground Level 6.89m AOD
Engineer	Mott MacDonald Bentley		Date 13/08/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 2 of 2

Description	1.40m to 3.70m: Structureless CHALK composed of very stiff fissured calcareous CLAY. Grade Dm.

Type of test Borehole	Installation type					
Initial ground water level	1.95	m	Top of test section	1.20	m BGL
Height of casing above surface	0.20	m	Bottom of test section	3.50	m BGL
Length of test section	2.30	m	Water level at end of test	0.67	m
Diameter of test section	200	mm	Diameter of casing/standpipe	200	mm

Quality of water used	Clean and fresh	Test start time	10:10
Weather	Cloudy	Test finish time	11:40



using Velocity graph method $k = \alpha . S/F$ = 6.55×10^{-7} m/s

where α= *0.000096 m/s*

S= *0.0314m*

F= 4.607m

Recorded by: C. Howard			SOIL ENGINEERING
Form No. SE-PGR-F-003	Revision No. 3.04	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_STW_013B
Project No.	TE8364		Ground Level 6.96m AOD
Engineer	Mott MacDonald Bentley		Date 08/09/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2

Description	CHALK recovered as stiff gravelly calcareous CLAY.

Type of test	Borehole	Installation type	

All depths are relative to ground level.

Initial ground water level	4.80	m	Top of test section	4.20	m
Height of casing above surface	0.00	m	Bottom of test section	4.20	m
Length of test section	0.00	m	Water level at end of test	2.00	m
Diameter of test section	200	mm	Diameter of casing/standpipe	200	mm

Quality of water used	Clean and fresh	Test start time	14:00
Weather	Cloudy	Test finish time	15:00

Time Minutes	Depth to water m	H	ln H_0/H	Time Minutes	Depth to water m	H	Log H/H0
0	0.00	4.80	0.00				
0.25	0.09	4.71	0.02				
0.5	0.15	4.65	0.03				
0.75	0.26	4.54	0.06				
1	0.30	4.50	0.06				
1.5	0.49	4.31	0.11				
2	0.60	4.20	0.13				
2.5	0.68	4.12	0.15				
3	0.76	4.04	0.17				
3.5	0.84	3.96	0.19				
4	0.92	3.88	0.21				
4.5	1.00	3.80	0.23				
5	1.08	3.72	0.25				
6	1.15	3.65	0.27				
7	1.23	3.57	0.30				
8	1.30	3.50	0.32				
10	1.37	3.43	0.34				
12	1.43	3.37	0.35				
14	1.55	3.25	0.39				
16	1.64	3.16	0.42				
18	1.71	3.09	0.44				
20	1.78	3.02	0.46				
25	1.84	2.96	0.48				
30	1.89	2.91	0.50				
40	1.93	2.87	0.51				
50	1.96	2.84	0.52				
60	2.00	2.80	0.54				

Remarks

Recorded by: D Cundill

soil engineering

Part of the Bachy Soletanche Group

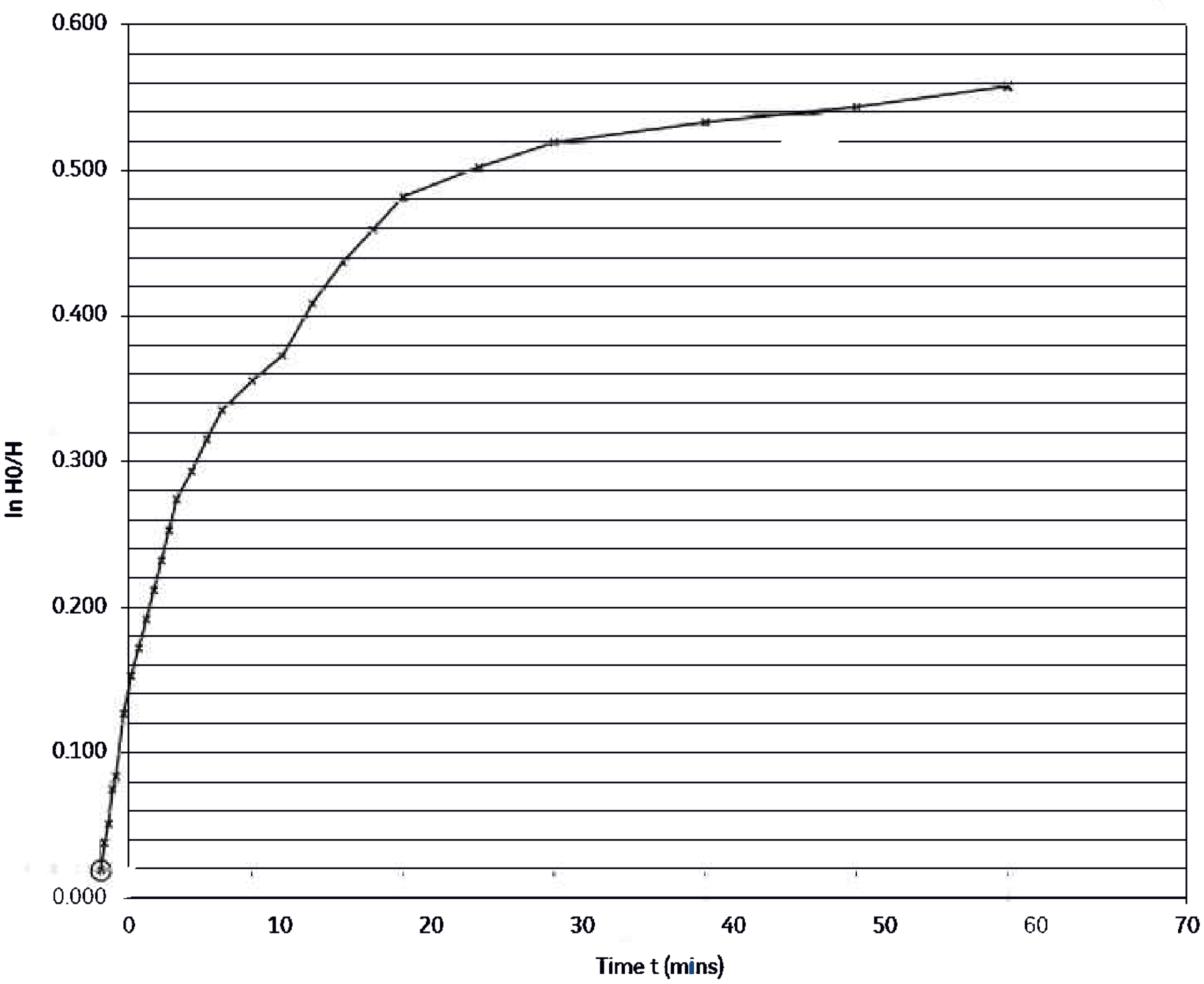
Form No. SE-PGR-F-002 Revision No. 3.03 Issue Date 01/09/2010

Project Name	Cambridge Waste Water Treatment Plant Relocation	# Borehole Falling Head Permeability Test	Hole ID BH_STW_013B
Project No.	TE8364		Ground Level 6.96m AOD
Engineer	Mott MacDonald Bentley		Date 08/09/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 2 of 2

Description	CHALK recovered as stiff gravelly calcareous CLAY.

Type of test	Borehole	Installation type			
Initial ground water level	4.80 m		Top of test section	4.20	m BGL
Height of casing above surface	0.00 m		Bottom of test section	4.20	m BGL
Length of test section	0.00 m		Water level at end of test	2.00	m
Diameter of test section	200 mm		Diameter of casing/standpipe	200	mm

Quality of water used	Clean and fresh	Test start time	14:00
Weather	Cloudy	Test finish time	15:00



using Velocity graph method $k = \alpha . S/F$ = 9.65×10^{-6} m/s

where α= *0.000386 m/s*

S= *0.0314m*

F= 1.256m

Recorded by: D Cundill			SOIL engineering Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_STW_018
Project No.	TE8364		Ground Level 10.37m AOD
Engineer	Mott MacDonald Bentley		Date 15/09/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2

Description	2.20m to 6.20m: Structureless CHALK composed of firm gravelly calcareous CLAY. 6.20m to 7.50m: CIRIA Grade B3 CHALK composed of extremely to very weak low density calcareous SITLSTONE.
Type of test	Borehole Installation type

All depths are relative to ground level.

Initial ground water level	3.28	m	Top of test section	2.10	m
Height of casing above surface	0.10	m	Bottom of test section	7.40	m
Length of test section	5.30	m	Water level at end of test	3.22	m
Diameter of test section	146	mm	Diameter of casing/standpipe	146	mm

Quality of water used	Clean and fresh	Test start time	15:15
Weather	Dry	Test finish time	16:15

Time Minutes	Depth to water m	H	ln H_0/H	Time Minutes	Depth to water m	H	Log H/H0
0	-0.10	3.38	0.00				
0.25	0.09	3.19	0.06				
0.5	0.37	2.91	0.15				
0.75	0.57	2.71	0.22				
1	0.77	2.51	0.30				
1.5	0.94	2.34	0.37				
2	1.20	2.08	0.49				
2.5	1.42	1.86	0.60				
3	1.57	1.71	0.68				
3.5	1.73	1.55	0.78				
4	1.86	1.42	0.87				
4.5	1.97	1.31	0.95				
5	2.06	1.22	1.02				
6	2.28	1.00	1.22				
7	2.44	0.84	1.39				
8	2.61	0.67	1.62				
9	2.76	0.52	1.87				
10	2.84	0.44	2.04				
15	3.11	0.17	2.99				
20	3.17	0.11	3.43				
25	3.22	0.06	4.03				
30	3.22	0.06	4.03				
40	3.22	0.06	4.03				
50	3.22	0.06	4.03				
60	3.22	0.06	4.03				

Remarks

Recorded by: T. Wigstow

soil engineering

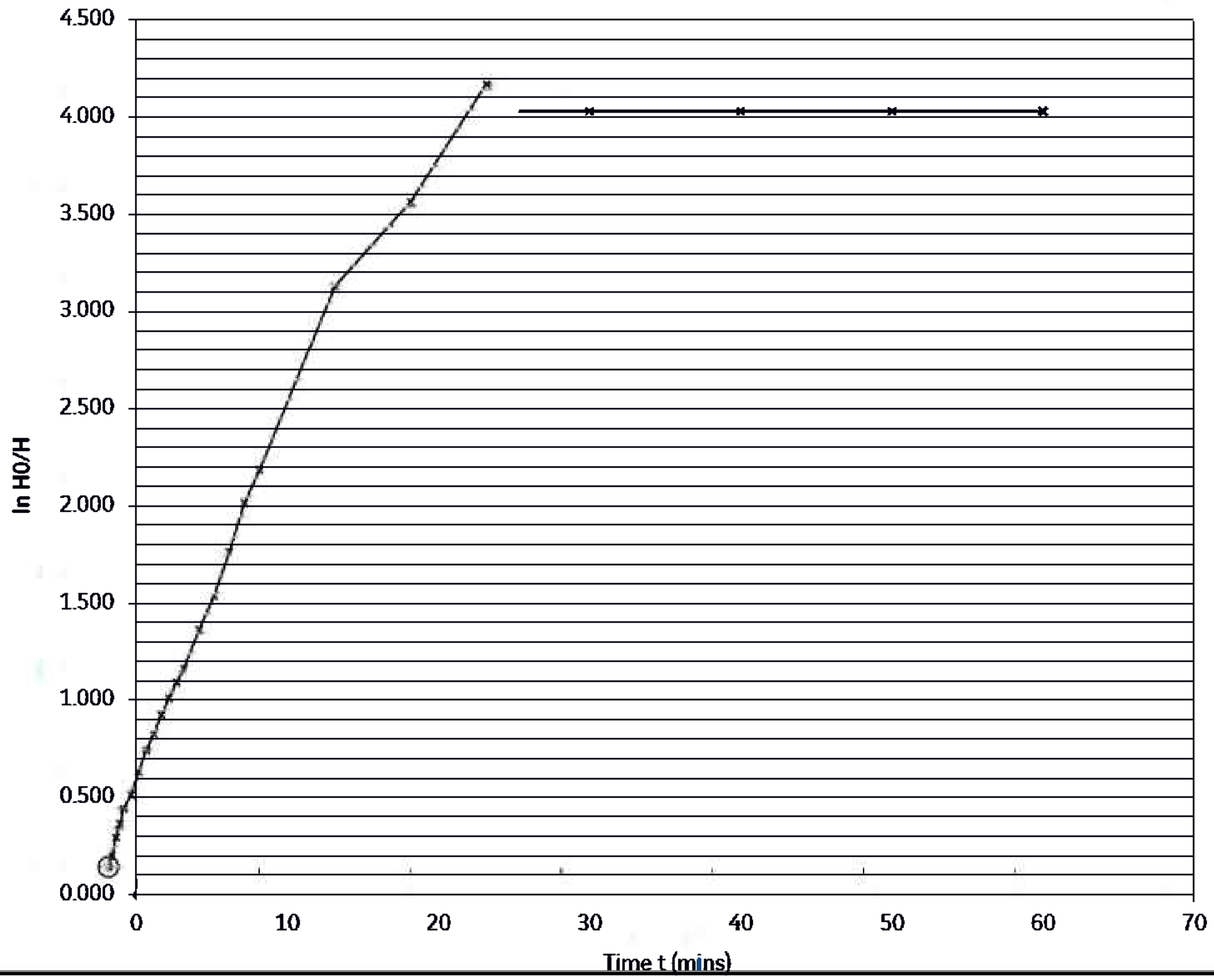
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	# Borehole Falling Head Permeability Test	Hole ID BH_STW_018
Project No.	TE8364		Ground Level 10.37m AOD
Engineer	Mott MacDonald Bentley		Date 15/09/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 2 of 2

Description	2.20m to 6.20m: Structureless CHALK composed of firm gravelly calcareous CLAY. 6.20m to 7.50m: CIRIA Grade B3 CHALK composed of extremely to very weak low density calcareous SITLSTONE.

Type of test	Borehole	Installation type			
Initial ground water level	3.28	m	Top of test section	2.10	m BGL
Height of casing above surface	0.10	m	Bottom of test section	7.40	m BGL
Length of test section	5.30	m	Water level at end of test	3.22	m
Diameter of test section	146	mm	Diameter of casing/standpipe	146	mm

Quality of water used	Clean and fresh	Test start time	15:15
Weather	Dry	Test finish time	16:15



using Velocity graph method $k = \alpha \,.S/F$ = 5.79×10^{-6} m/s

where $\alpha = 0.00269$ m/s

$S = 0.0167$m

$F = 7.768$m

Recorded by: T. Wigstow			SOIL ENGINEERING Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_STW_022A
Project No.	TE8364		Ground Level 8.46m AOD
Engineer	Mott MacDonald Bentley		Date 06/09/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2

Description 3.00m to 7.00m: Structureless CHALK composed of firm gravelly calcareous CLAY. Grade Dm.

Type of test Borehole Installation type

All depths are relative to ground level.

Initial ground water level	2.04	m	Top of test section	2.80	m
Height of casing above surface	0.20	m	Bottom of test section	6.80	m
Length of test section	4.00	m	Water level at end of test	1.97	m
Diameter of test section	200	mm	Diameter of casing/standpipe	200	mm
Quality of water used	Clean and fresh		Test start time	12:15	
Weather	Cloudy		Test finish time	13:15	

Time Minutes	Depth to water m	H	$\ln H_0/H$	Time Minutes	Depth to water m	H	Log H/H0
0	1.25	0.79	0.00				
0.5	1.25	0.79	0.00				
1	1.58	0.46	0.54				
1.5	1.74	0.30	0.97				
2	1.84	0.20	1.37				
2.5	1.87	0.17	1.54				
3	1.90	0.14	1.73				
3.5	1.91	0.13	1.80				
4	1.92	0.12	1.88				
4.5	1.93	0.11	1.97				
5	1.93	0.11	1.97				
6	1.94	0.10	2.07				
7	1.94	0.10	2.07				
8	1.95	0.10	2.12				
9	1.95	0.10	2.12				
10	1.95	0.09	2.17				
15	1.96	0.08	2.29				
20	1.97	0.08	2.35				
25	1.97	0.08	2.35				
30	1.97	0.08	2.35				
40	1.97	0.08	2.35				
50	1.97	0.08	2.35				
60	1.97	0.08	2.35				

Remarks

Recorded by: T. Wigstow

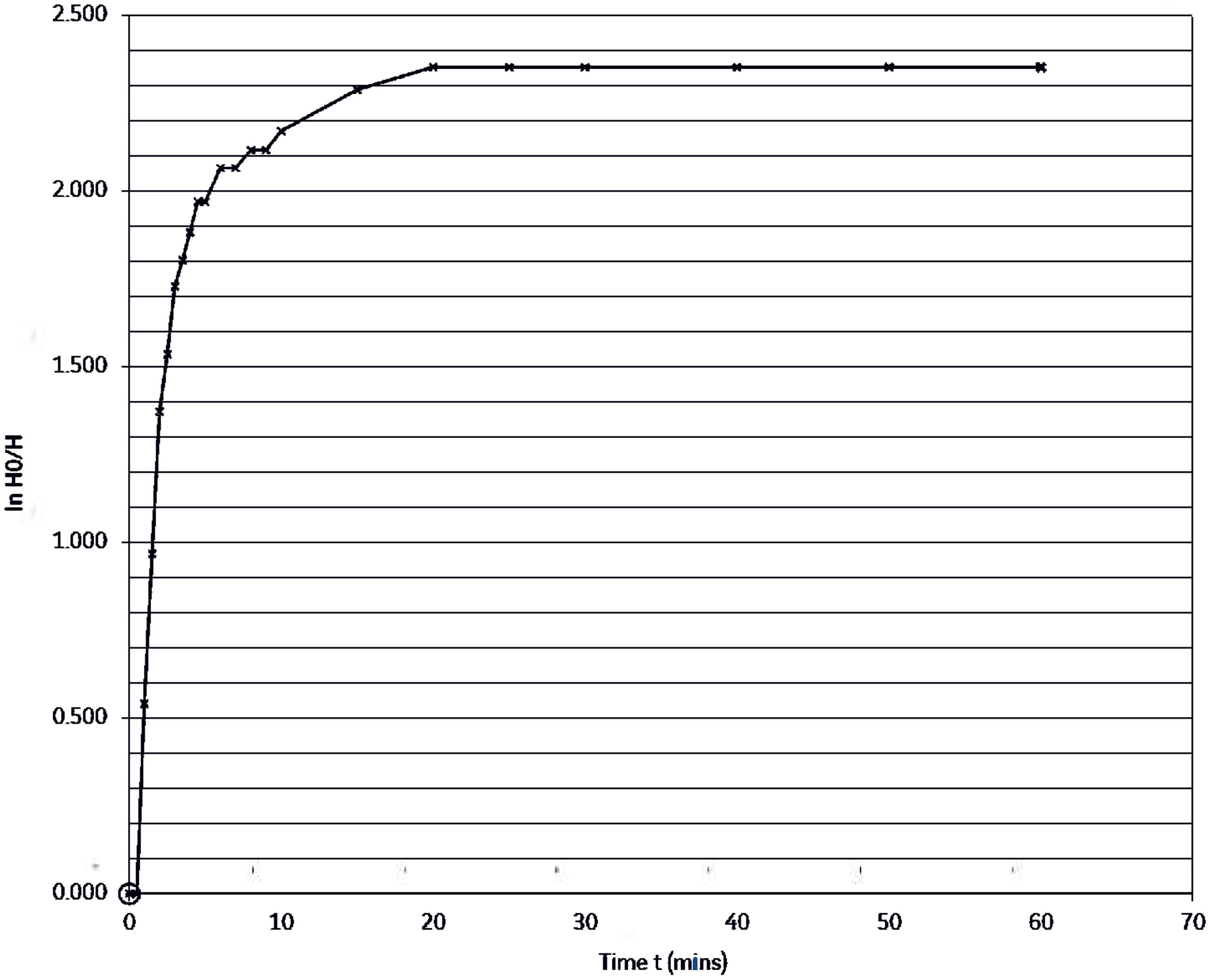
SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_STW_022A
Project No.	TE8364		Ground Level 8.46m AOD
Engineer	Mott MacDonald Bentley		Date 06/09/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 2 of 2

Description	3.00m to 7.00m: Structureless CHALK composed of firm gravelly calcareous CLAY. Grade Dm.

Type of test Borehole	Installation type					
Initial ground water level	2.04	m	Top of test section	2.80	m BGL
Height of casing above surface	0.20	m	Bottom of test section	6.80	m BGL
Length of test section	4.00	m	Water level at end of test	1.97	m
Diameter of test section	200	mm	Diameter of casing/standpipe	200	mm

Quality of water used	Clean and fresh	Test start time	12:15
Weather	Cloudy	Test finish time	13:15



using Velocity graph method $k = \alpha . S/F$ = 9.05 x 10^{-6} m/s

where α= *0.00196 m/s*

S= *0.0314m*

F= 6.810m

Recorded by: T. Wigstow			SOIL ENGINEERING Part of the Bachy Soletanche Group
Form No. SE-PGR-F-003	Revision No. 3.04	Issue Date 24/01/2014	

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_TUN_001A
Project No.	TE8364		Ground Level 6.91m AOD
Engineer	Mott MacDonald Bentley		Date 06/09/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2

Description 3.70m to 4.20m: SAND & GRAVEL (Driller's Description)

Type of test Borehole Installation type

All depths are relative to ground level.

Initial ground water level	0.95	m	Top of test section	2.92	m
Height of casing above surface	0.78	m	Bottom of test section	3.42	m
Length of test section	0.50	m	Water level at end of test	0.30	m
Diameter of test section	150	mm	Diameter of casing/standpipe	150	mm

Quality of water used	Clean and fresh	Test start time	14:34
Weather	Fine	Test finish time	15:41

Time Minutes	Depth to water m	H	ln H_0/H	Time Minutes	Depth to water m	H	Log H/H0
0	-0.27	1.22	0.00	55	0.23	0.72	0.53
0.5	-0.26	1.21	0.01	58	0.25	0.70	0.56
1	-0.24	1.19	0.02	61	0.26	0.69	0.57
1.5	-0.23	1.18	0.03	64	0.28	0.67	0.60
2	-0.22	1.17	0.04	67	0.30	0.65	0.63
2.5	-0.21	1.16	0.05				
3	-0.20	1.15	0.06				
3.5	-0.19	1.14	0.07				
4	-0.18	1.13	0.08				
4.5	-0.18	1.13	0.08				
5	-0.17	1.12	0.09				
6	-0.15	1.10	0.10				
7	-0.14	1.09	0.11				
8	-0.13	1.08	0.12				
9	-0.12	1.07	0.13				
10	-0.11	1.06	0.14				
12	-0.10	1.05	0.15				
14	-0.08	1.03	0.17				
16	-0.07	1.02	0.18				
18	-0.06	1.01	0.19				
20	-0.04	0.99	0.21				
25	-0.02	0.97	0.23				
28	0.01	0.94	0.26				
31	0.04	0.91	0.29				
34	0.07	0.88	0.33				
37	0.09	0.86	0.35				
40	0.12	0.83	0.39				
43	0.14	0.81	0.41				
46	0.16	0.79	0.43				
49	0.18	0.77	0.46				
52	0.21	0.74	0.50				

Remarks

Recorded by: D. Tiernan

SOIL ENGINEERING
Part of the Bachy Soletanche Group

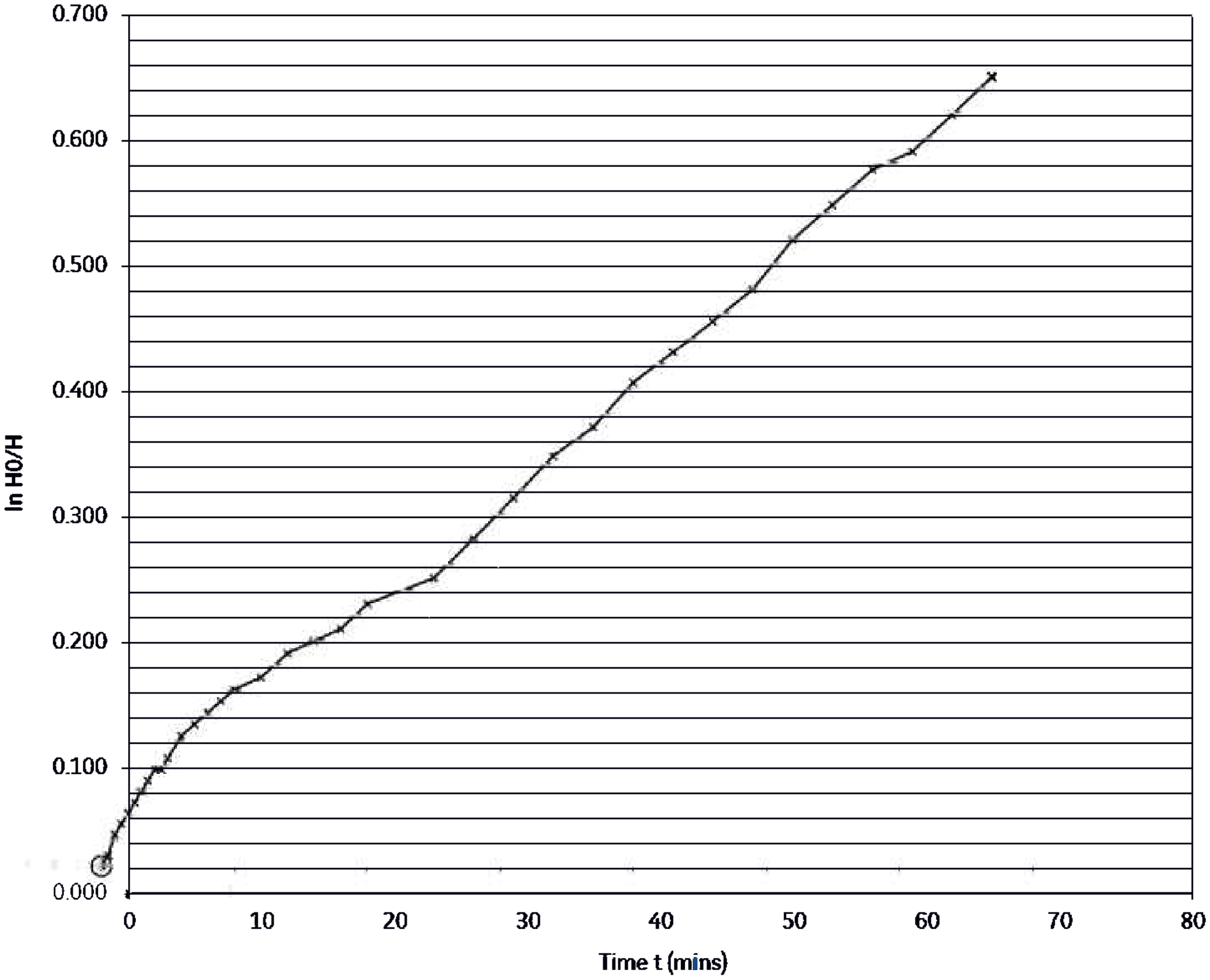
Form No. SE-PGR-F-002 Revision No. 3.03 Issue Date 01/09/2010

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_TUN_001A
Project No.	TE8364		Ground Level 6.91m AOD
Engineer	Mott MacDonald Bentley		Date 06/09/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 2 of 2

Description 3.70m to 4.20m: SAND & GRAVEL (Driller's Description)

Type of test Borehole	Installation type					
Initial ground water level	0.95	m	Top of test section	2.92	m BGL
Height of casing above surface	0.78	m	Bottom of test section	3.42	m BGL
Length of test section	0.50	m	Water level at end of test	0.30	m
Diameter of test section	150	mm	Diameter of casing/standpipe	150	mm

Quality of water used	Clean and fresh	Test start time	14:34
Weather	Fine	Test finish time	15:41



using Velocity graph method $k = \alpha . S/F$ = 1.69×10^{-6} m/s

where α= 0.000157 m/s

S= 0.0177m

F= 1.636m

Recorded by: D Tiernan

SOIL ENGINEERING

Part of the Bachy Soletanche Group

Form No. SE-PGR-F-003 Revision No. 3.04 Issue Date 24/01/2014

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Hole ID**	BH_TUN_006
Project No.	TE8364	**Ground Level**	9.15m AOD
Engineer	Mott MacDonald Bentley	**Date**	21/09/2021
Client	Barhale Limited	**Page**	1 of 2

Borehole Falling Head Permeability Test

BS EN ISO 22282-2: 2012

Description: Brown fine to corase SAND and angular to subrounded fine coarse GRAVEL of flint.

Type of test: Borehole

Installation type:

All depths are relative to ground level.

Initial ground water level	3.80	m	Top of test section	5.20	m
Height of casing above surface	0.00	m	Bottom of test section	5.20	m
Length of test section	0.00	m	Water level at end of test	2.15	m
Diameter of test section	200	mm	Diameter of casing/standpipe	200	mm

Quality of water used	Clean and fresh	Test start time	14:00
Weather	Fine	Test finish time	15:00

Time Minutes	Depth to water m	H	ln H_0/H	Time Minutes	Depth to water m	H	Log H/H0
0	0.00	3.80	0.00				
0.5	0.05	3.75	0.01				
1	0.10	3.70	0.03				
1.5	0.15	3.65	0.04				
2	0.20	3.60	0.05				
2.5	0.30	3.50	0.08				
3	0.40	3.40	0.11				
3.5	0.45	3.35	0.13				
4	0.50	3.30	0.14				
4.5	0.55	3.25	0.16				
5	0.60	3.20	0.17				
6	0.70	3.10	0.20				
7	0.80	3.00	0.24				
8	0.89	2.91	0.27				
10	0.99	2.81	0.30				
12	1.10	2.70	0.34				
14	1.20	2.60	0.38				
16	1.50	2.30	0.50				
18	1.55	2.25	0.52				
20	1.60	2.20	0.55				
25	1.75	2.05	0.62				
30	1.90	1.90	0.69				
40	2.00	1.80	0.75				
50	2.10	1.70	0.80				
60	2.15	1.65	0.83				

Remarks

Recorded by: D Cundill

SOIL ENGINEERING
Part of the Bachy Soletanche Group

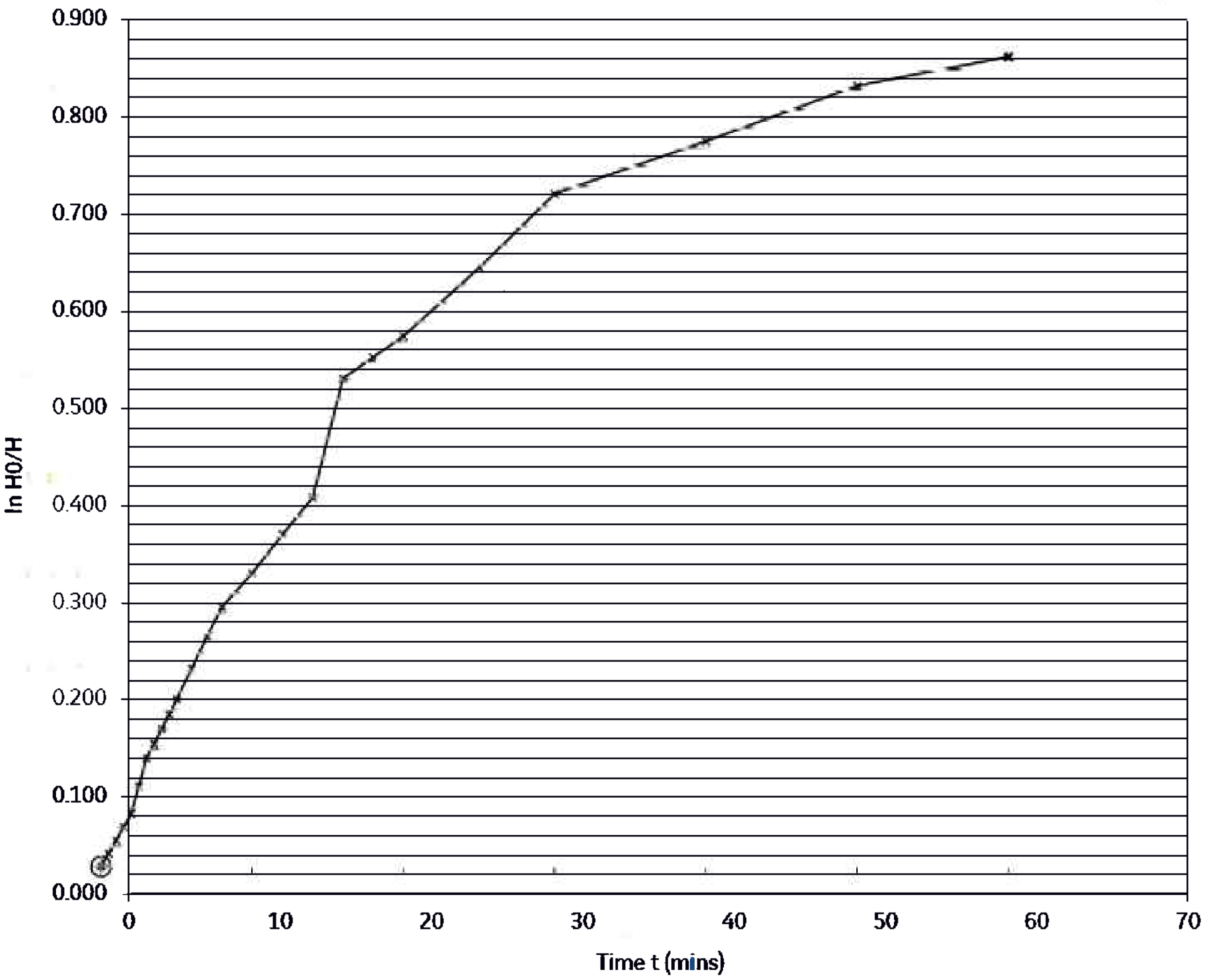
Form No. SE-PGR-F-002 Revision No. 3.03 Issue Date 01/09/2010

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_TUN_006
Project No.	TE8364		Ground Level 9.15m AOD
Engineer	Mott MacDonald Bentley		Date 21/09/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 2 of 2

Description	Brown fine to corase SAND and angular to subrounded fine coarse GRAVEL of flint.

Type of test	Borehole	Installation type				
Initial ground water level	3.80	m	Top of test section	5.20	m BGL
Height of casing above surface	0.00	m	Bottom of test section	5.20	m BGL
Length of test section	0.00	m	Water level at end of test	2.15	m
Diameter of test section	200	mm	Diameter of casing/standpipe	200	mm

Quality of water used	Clean and fresh	Test start time	14:00
Weather	Fine	Test finish time	15:00



using Velocity graph method $k = \alpha . S/F$ = $9.63 \text{ x } 10^{-6}$ m/s

where α= *0.000385 m/s*

S= *0.0314m*

F= 1.256m

Recorded by: D Cundill			SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_TUN_011
Project No.	TE8364		Ground Level 6.57m AOD
Engineer	Mott MacDonald Bentley		Date 06/10/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2

Description	2.00m to 4.00m: Very weak medium density CHALK. 4.00m to 4 20m: slightly sandy slightly gravelly CLAY. 4.20m to 5.20m: Stiff fissured CLAY.
Type of test	Borehole Installation type

All depths are relative to ground level.

Initial ground water level	2.50	m	Top of test section	2.00	m
Height of casing above surface	0.20	m	Bottom of test section	5.00	m
Length of test section	3.00	m	Water level at end of test	2.45	m
Diameter of test section	200	mm	Diameter of casing/standpipe	200	mm
Quality of water used	Clean and fresh		Test start time	09:15	
Weather	Fine		Test finish time	10:15	

Time Minutes	Depth to water m	H	ln H_0/H	Time Minutes	Depth to water m	H	Log H/H0
0	-0.20	2.70	0.00				
0.33	-0.02	2.52	0.07				
0.5	0.07	2.43	0.11				
0.75	0.15	2.35	0.14				
1	0.22	2.28	0.17				
1.5	0.48	2.02	0.29				
2	0.57	1.93	0.34				
2.5	0.68	1.82	0.39				
3	0.76	1.74	0.44				
3.5	0.84	1.66	0.49				
4	0.91	1.59	0.53				
4.5	1.10	1.40	0.66				
5	1.22	1.28	0.75				
6	1.44	1.06	0.93				
7	1.61	0.89	1.11				
8	1.77	0.73	1.31				
9	1.96	0.54	1.61				
10	2.14	0.36	2.01				
12	2.26	0.24	2.42				
14	2.41	0.09	3.40				
16	2.42	0.08	3.52				
18	2.43	0.07	3.65				
20	2.44	0.06	3.81				
25	2.45	0.05	3.99				
30	2.45	0.05	3.99				
40	2.45	0.05	3.99				
50	2.45	0.05	3.99				
60	2.45	0.05	3.99				

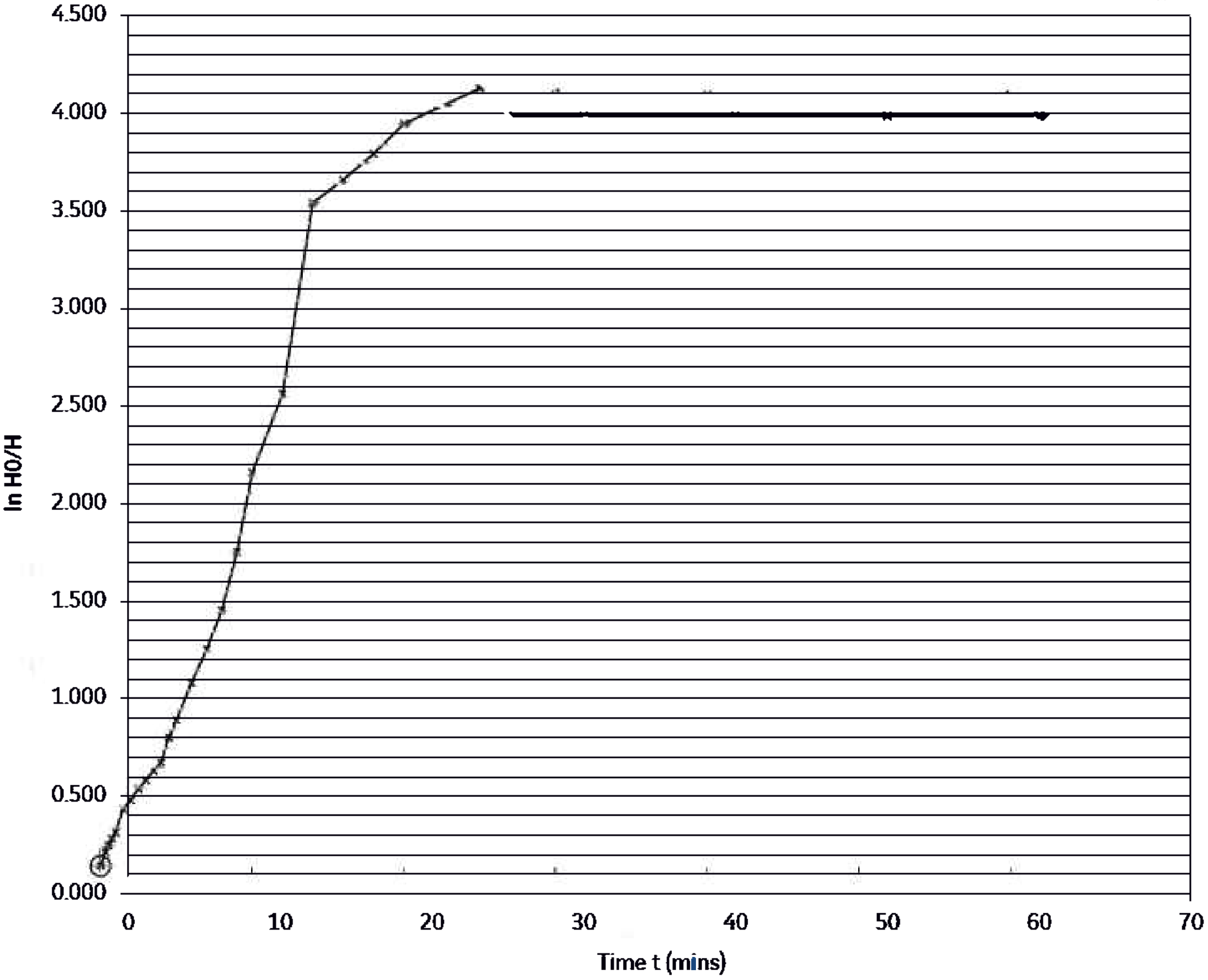
Remarks

Recorded by: D Cundill			SOIL ENGINEERING Part of the Bachy Soletanche Group
Form No. SE-PGR-F-002	Revision No. 3.03	Issue Date 01/09/2010	

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test** BS EN ISO 22282-2: 2012	Hole ID BH_TUN_011
Project No.	TE8364		Ground Level 6.57m AOD
Engineer	Mott MacDonald Bentley		Date 06/10/2021
Client	Barhale Limited		Page 2 of 2

Description	2.00m to 4.00m: Very weak medium density CHALK. 4.00m to 4 20m: slightly sandy slightly gravelly CLAY. 4.20m to 5.20m: Stiff fissured CLAY.

Type of test	Borehole	Installation type			
Initial ground water level	2.50 m		Top of test section	2.00	m BGL
Height of casing above surface	0.20 m		Bottom of test section	5.00	m BGL
Length of test section	3.00 m		Water level at end of test	2.45	m
Diameter of test section	200 mm		Diameter of casing/standpipe	200	mm
Quality of water used	Clean and fresh		Test start time	09:15	
Weather	Fine		Test finish time	10:15	



using Velocity graph method $k = \alpha .S/F$ = 1.51 x 10^{-5} m/s

where α= *0.002659 m/s*

S= *0.0314m*

F= 5.539m

Recorded by: D Cundill			SOIL ENGINEERING
Form No. SE-PGR-F-003	Revision No. 3.04	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation		Hole ID BH_TUN_018
Project No.	TE8364		Ground Level 10.28m AOD
Engineer	Mott MacDonald Bentley		Date 06/10/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2

Borehole Falling Head Permeability Test

Description	2.80m to 3.44m: Structureless CHALK. 3.44m to 6.20m: Extremely weak to very weak low to medium density CHALK.
Type of test	Borehole
Installation type	

All depths are relative to ground level.

Initial ground water level	3.53	m	Top of test section	2.60	m
Height of casing above surface	0.20	m	Bottom of test section	6.00	m
Length of test section	3.40	m	Water level at end of test	3.45	m
Diameter of test section	200	mm	Diameter of casing/standpipe	200	mm

Quality of water used	Clean and fresh	Test start time	08:00
Weather	Fine	Test finish time	09:00

Time Minutes	Depth to water m	H	ln H_0/H	Time Minutes	Depth to water m	H	Log H/H0
0	-0.22	3.75	0.00	55	3.37	0.16	3.15
0.5	-0.35	3.88	-0.03	58	3.41	0.12	3.44
1	-0.25	3.78	-0.01	61	3.45	0.08	3.85
1.5	-0.15	3.68	0.02				
2	-0.05	3.58	0.05				
2.5	0.03	3.50	0.07				
3	0.14	3.39	0.10				
3.5	0.24	3.29	0.13				
4	0.33	3.20	0.16				
4.5	0.41	3.12	0.18				
5	0.49	3.04	0.21				
6	0.62	2.91	0.25				
7	0.80	2.73	0.32				
8	0.94	2.59	0.37				
9	1.09	2.44	0.43				
10	1.19	2.34	0.47				
12	1.42	2.11	0.58				
14	1.62	1.91	0.67				
16	1.82	1.71	0.79				
18	2.00	1.53	0.90				
20	2.14	1.39	0.99				
25	2.49	1.04	1.28				
28	2.63	0.90	1.43				
31	2.78	0.75	1.61				
34	2.91	0.62	1.80				
37	3.02	0.51	2.00				
40	3.10	0.43	2.17				
43	3.16	0.37	2.32				
46	3.23	0.30	2.53				
49	3.27	0.26	2.67				
52	3.32	0.21	2.88				

Remarks

Recorded by: D Cundill

SOIL ENGINEERING

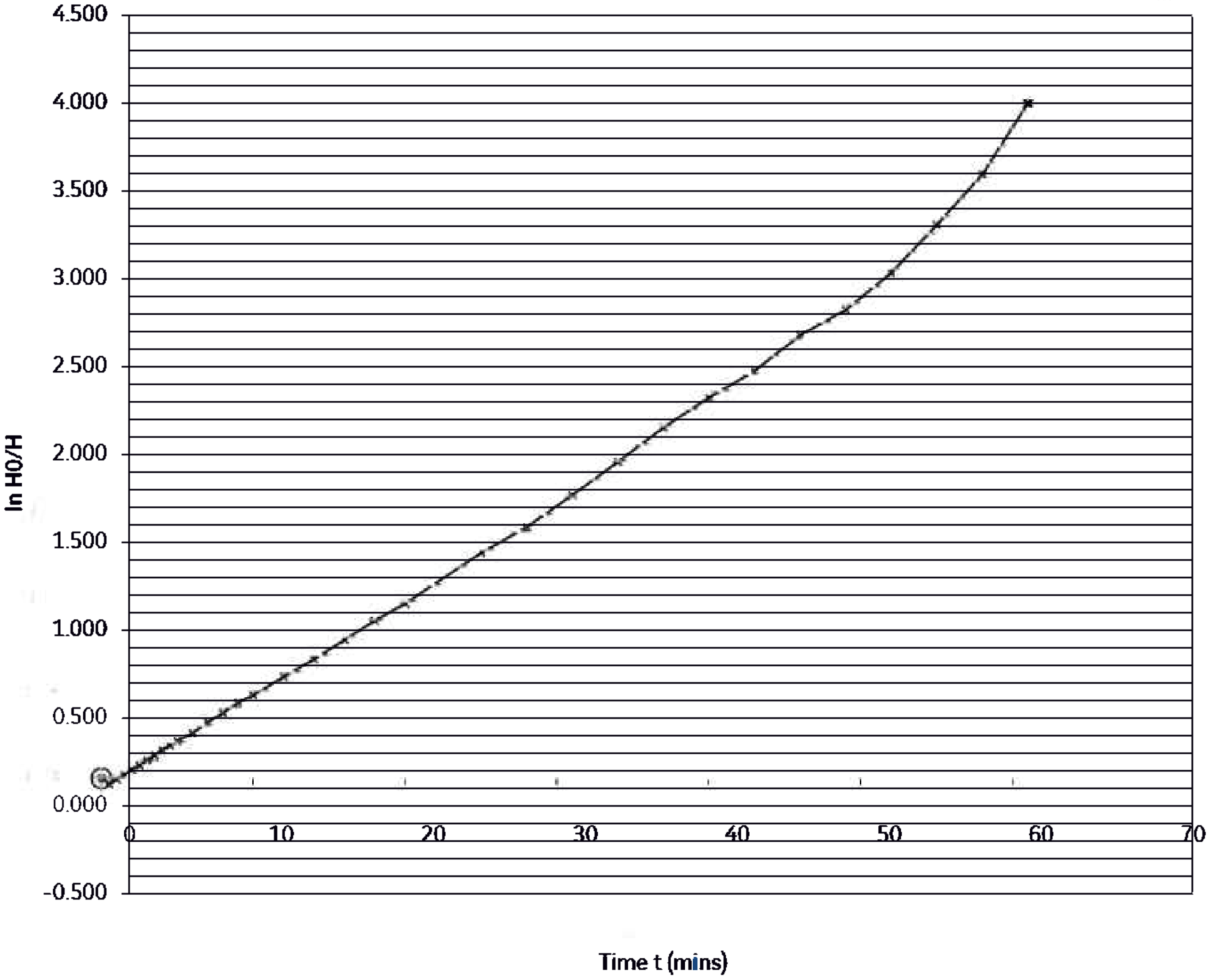
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_TUN_018
Project No.	TE8364		Ground Level 10.28m AOD
Engineer	Mott MacDonald Bentley		Date 06/10/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 2 of 2

Description: 2.80m to 3.44m: Structureless CHALK. 3.44m to 6.20m: Extremely weak to very weak low to medium density CHALK.

Type of test	Borehole	Installation type			
Initial ground water level	3.53	m	Top of test section	2.60	m BGL
Height of casing above surface	0.20	m	Bottom of test section	6.00	m BGL
Length of test section	3.40	m	Water level at end of test	3.45	m
Diameter of test section	200	mm	Diameter of casing/standpipe	200	mm

Quality of water used	Clean and fresh	Test start time	08:00
Weather	Fine	Test finish time	09:00



using Velocity graph method $k = \alpha . S/F$ = 4.79×10^{-6} m/s

where α= *0.000924 m/s*

S= *0.0314m*

F= 6.055m

Recorded by: D Cundill			SOIL ENGINEERING
Form No. SE-PGR-F-003	Revision No. 3.04	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_STW_005A
Project No.	TE8364		Ground Level 9.30m AOD
Engineer	Mott MacDonald Bentley		Date 11/11/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 1

Description Extremely weak to weak low to medium density light grey CHALK composed of calcareous SILTSTONE.

Type of test	Standpipe	Installation type	Well point or hole extended in uniform soil

All depths are relative to ground level.

Initial ground water level	3.32	m	Top of test section	1.00	m
Height of casing above surface	0.57	m	Bottom of test section	10.00	m
Length of test section	9.00	m	Water level at end of test	3.32	m
Diameter of test section	146	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Clean and fresh	Test start time	12:00
Weather	Fine	Test finish time	13:00

Time Minutes	Depth to water m	H	ln H_0/H		Time Minutes	Depth to water m	H	Log H/H0

Remarks

Test failed - put 100 litres of water into standpipe, water level did not change.

Recorded by: Andrew Yuen

SOIL ENGINEERING

Form No.	SE PGR F 002	Revision No.	3.03	Issue Date	01/09/2010	Part of the Bachy Soletanche Group

Borehole Rising Head Permeability Test

BS EN ISO 22282-2: 2012

Project Name	Cambridge Waste Water Treatment Plant Relocation
Project No.	TE8364
Engineer	Mott MacDonald Bentley
Client	Barhale Limited
Hole ID	BH_STW_005A
Ground Level	9.30m AOD
Date	27/10/2021
Page	1 of 2
Description	Extremely weak to weak low to medium density light grey CHALK composed of calcareous SILTSTONE.

Type of test	Standpipe	Installation type	Well point or hole extended in uniform soil

All depths are relative to ground level.

Initial ground water level	3.46	m	Top of test section	1.00	m
Height of casing above surface	0.57	m	Bottom of test section	10.00	m
Length of test section	9.00	m	Water level at end of test	3.46	m
Diameter of test section	146	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Water from borehole	Test start time	12:50
Weather	Fine	Test finish time	13:02

Time Minutes	Depth to water m	H	ln H_0/H		Time Minutes	Depth to water m	H	Log H/H0
0	4.65	1.19	0.00					
0.5	4.02	0.56	0.75					
1	3.78	0.32	1.31					
1.5	3.74	0.28	1.45					
2	3.64	0.18	1.89					
2.5	3.63	0.17	1.95					
3	3.58	0.12	2.29					
3.5	3.56	0.10	2.48					
4	3.54	0.08	2.70					
4.5	3.53	0.07	2.83					
5	3.51	0.05	3.17					
6	3.51	0.05	3.17					
7	3.49	0.03	3.68					
8	3.48	0.02	4.09					
9	3.48	0.02	4.09					
10	3.47	0.01	4.78					
12	3.46	0.00						

Remarks

Purged 100 litres over 20 minutes

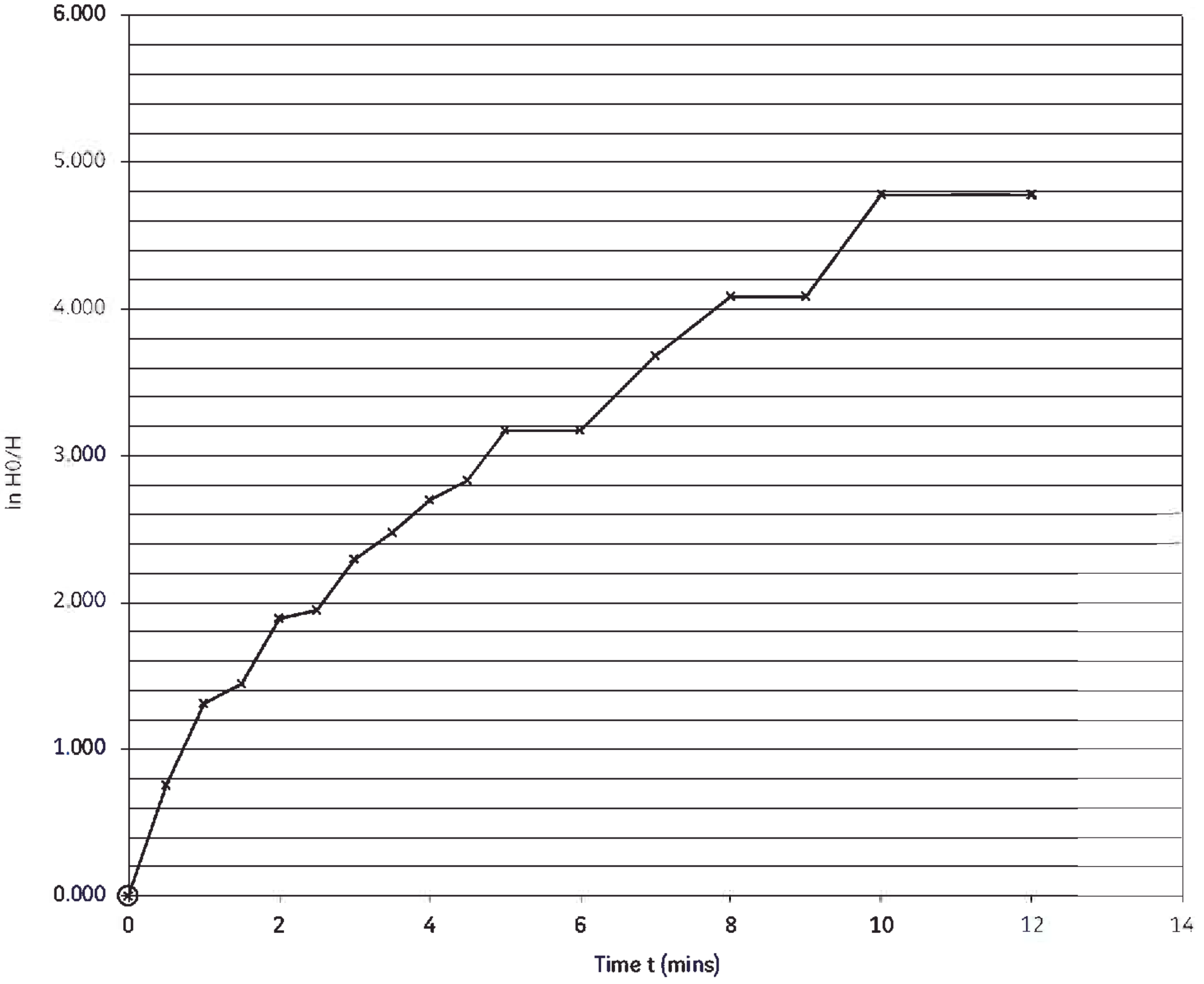
Recorded by: Andrew Yuen

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test**	Hole ID BH_STW_005A
Project No.	TE8364		Ground Level 9.30m AOD
Engineer	Mott MacDonald Bentley		Date 27/10/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 2 of 2
Description	Extremely weak to weak low to medium density light grey CHALK composed of calcareous SILTSTONE.		

Type of test	Standpipe	Installation type	Well point or hole extended in uniform soil		
Initial ground water level	3.46	m	Top of test section	1.00	m BGL
Height of casing above surface	0.57	m	Bottom of test section	10.00	m BGL
Length of test section	9.00	m	Water level at end of test	3.46	m
Diameter of test section	146	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Water from borehole	Test start time	12:50
Weather	Fine	Test finish time	13:02



using Velocity graph method $k = \alpha . S/F$ = 1.33×10^{-6} m/s

where $\alpha = 0.007967\ sec^{-1}$

$S = 0.001963 m^2$

$F = 11.739m$

Recorded by: Andrew Yuen			SOIL ENGINEERING
Form No. SE PGR F 003	Revision No. 3.04	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test**	Hole ID BH_STW_005A
Project No.	TE8364		Ground Level 9.30m AOD
Engineer	Mott MacDonald Bentley		Date 27/10/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2

Description Extremely weak to weak low to medium density light grey CHALK composed of calcareous SILTSTONE.

Type of test Standpipe Installation type Well point or hole extended in uniform soil

All depths are relative to ground level.

Initial ground water level	3.46	m	Top of test section	1.00	m
Height of casing above surface	0.57	m	Bottom of test section	10.00	m
Length of test section	9.00	m	Water level at end of test	3.48	m
Diameter of test section	146	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Water from borehole	Test start time	16:00
Weather	Fine	Test finish time	16:12

Time Minutes	Depth to water m	H	ln H_0/H		Time Minutes	Depth to water m	H	Log H/H0
0	4.67	1.21	0.00					
0.5	4.11	0.65	0.62					
1	3.81	0.35	1.24					
1.5	3.77	0.31	1.36					
2	3.68	0.22	1.70					
2.5	3.66	0.20	1.80					
3	3.62	0.16	2.02					
3.5	3.58	0.12	2.31					
4	3.56	0.10	2.49					
4.5	3.55	0.09	2.60					
5	3.54	0.08	2.72					
6	3.52	0.06	3.00					
7	3.51	0.05	3.19					
8	3.49	0.03	3.70					
9	3.49	0.03	3.70					
10	3.48	0.02	4.10					

Remarks

Purged 100 litres over 20 minutes

Recorded by: Andrew Yuen

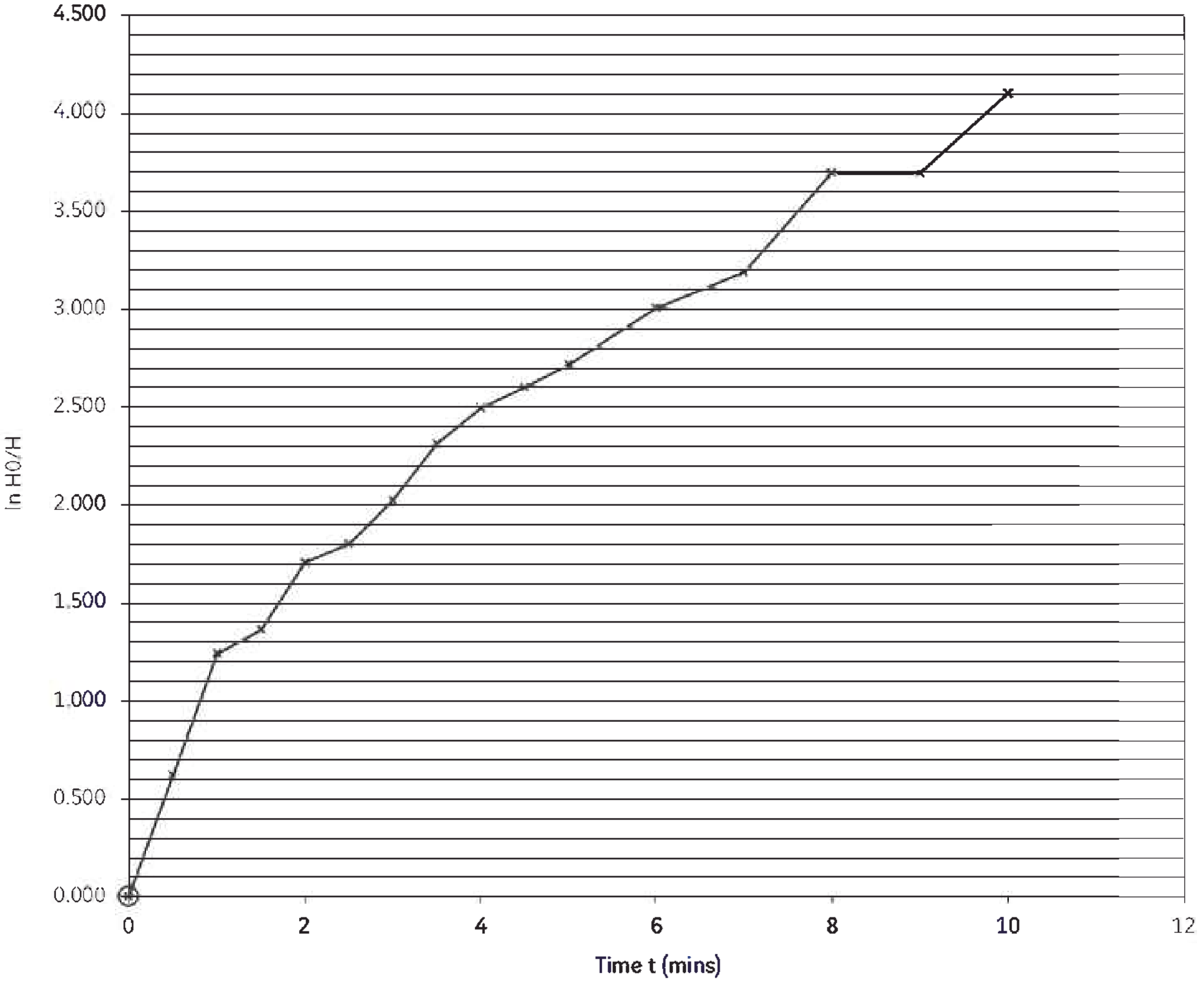
SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test** BS EN ISO 22282-2: 2012	Hole ID BH_STW_005A
Project No.	TE8364		Ground Level 9.30m AOD
Engineer	Mott MacDonald Bentley		Date 27/10/2021
Client	Barhale Limited		Page 2 of 2

Description	Extremely weak to weak low to medium density light grey CHALK composed of calcareous SILTSTONE.

Type of test	Standpipe	Installation type	Well point or hole extended in uniform soil			
Initial ground water level	3.46	m	Top of test section	1.00	m BGL	
Height of casing above surface	0.57	m	Bottom of test section	10.00	m BGL	
Length of test section	9.00	m	Water level at end of test	3.48	m	
Diameter of test section	146	mm	Diameter of casing/standpipe	50	mm	

Quality of water used	Water from borehole	Test start time	16:00
Weather	Fine	Test finish time	16:12



using Velocity graph method $k = \alpha . S/F$ = 1.14×10^{-6} m/s

where α= 0.006838 sec-1

S= 0.001963m2

F= 11.739m

Recorded by: Andrew Yuen			SOIL ENGINEERING
Form No. SE PGR F 003	Revision No. 3.04	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_STW_010B
Project No.	TE8364		Ground Level 10.26m AOD
Engineer	Mott MacDonald Bentley		Date 15/11/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2

Description	Firm to stiff dark grey sandy CLAY (CAMBRIDGE GREENSAND MEMBER), overlying very stiff fissured laminated dark grey CLAY at 11.90m.

Type of test	Standpipe	Installation type	

All depths are relative to ground level.

Initial ground water level	4.37	m	Top of test section	11.50	m
Height of casing above surface	0.33	m	Bottom of test section	12.00	m
Length of test section	0.50	m	Water level at end of test	2.31	m
Diameter of test section	200	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Clean and fresh	Test start time	08:00
Weather	Fine	Test finish time	09:00

Time Minutes	Depth to water m	H	ln H_0/H	Time Minutes	Depth to water m	H	Log H/H0
0	0.00	4.37	0.00				
0.5	0.05	4.32	0.01				
1	0.10	4.27	0.02				
1.5	0.15	4.22	0.03				
2	0.18	4.19	0.04				
2.5	0.20	4.17	0.05				
3	0.24	4.13	0.06				
3.5	0.30	4.07	0.07				
4	0.32	4.05	0.08				
4.5	0.34	4.03	0.08				
5	0.36	4.01	0.09				
6	0.40	3.97	0.10				
7	0.46	3.91	0.11				
8	0.52	3.85	0.13				
9	0.57	3.80	0.14				
10	0.61	3.76	0.15				
12	0.71	3.66	0.18				
14	0.80	3.57	0.20				
16	0.89	3.48	0.23				
18	0.98	3.39	0.25				
20	1.06	3.31	0.28				
25	1.26	3.11	0.34				
30	1.44	2.93	0.40				
40	1.78	2.59	0.52				
50	2.08	2.29	0.65				
60	2.31	2.06	0.75				

Remarks

Recorded by: Andrew Yuen

SOIL ENGINEERING

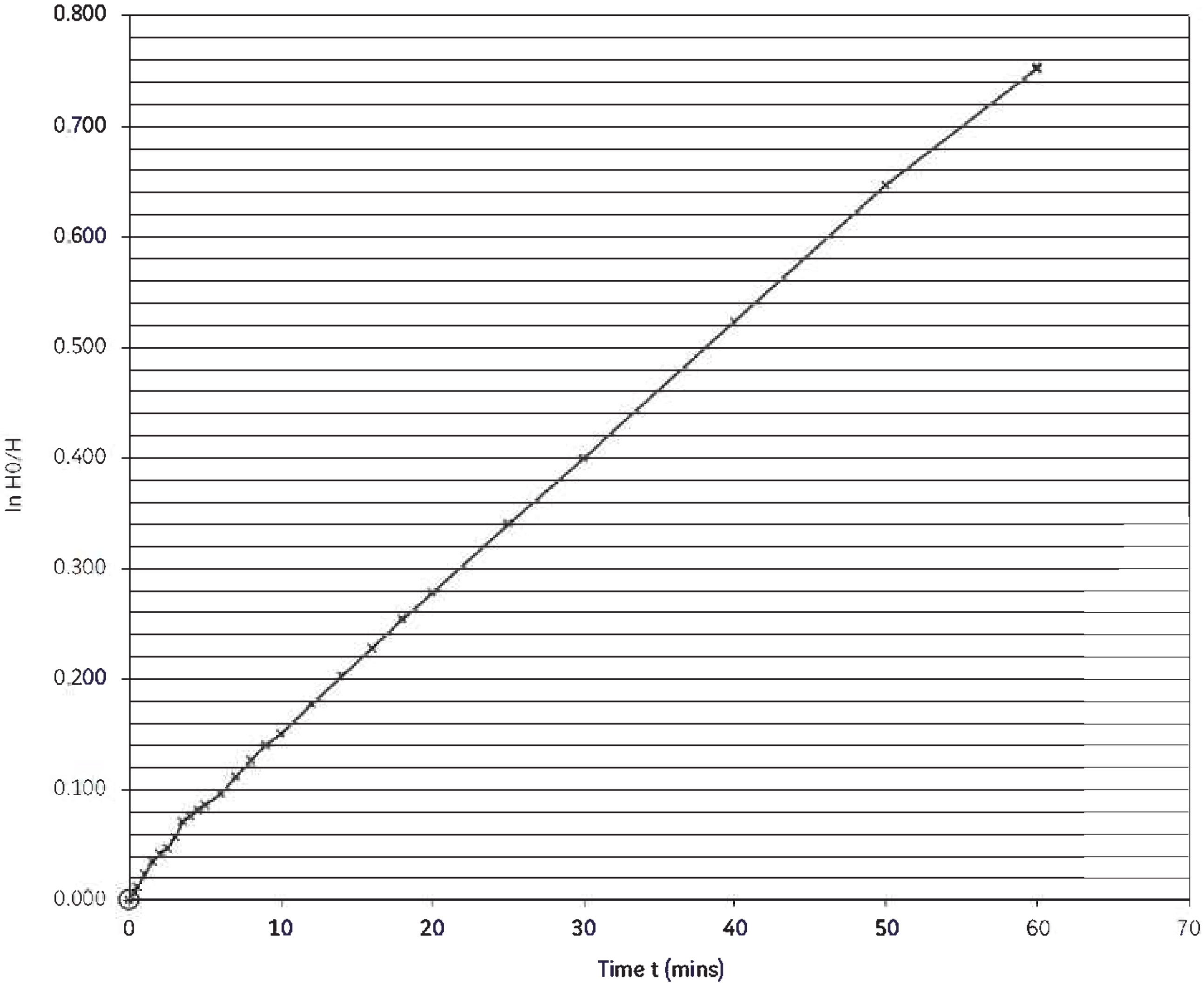
Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_STW_010B
Project No.	TE8364		Ground Level 10.26m AOD
Engineer	Mott MacDonald Bentley		Date 15/11/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 2 of 2

Description	Firm to stiff dark grey sandy CLAY (CAMBRIDGE GREENSAND MEMBER), overlying very stiff fissured laminated dark grey CLAY at 11.90m.

Type of test	Standpipe	Installation type	

Initial ground water level	4.37	m	Top of test section	11.50	m BGL
Height of casing above surface	0.33	m	Bottom of test section	12.00	m BGL
Length of test section	0.50	m	Water level at end of test	2.31	m
Diameter of test section	200	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Clean and fresh	Test start time	08:00
Weather	Fine	Test finish time	09:00



using Velocity graph method $k = \alpha . S/F$ = 2.15×10^{-7} m/s

where $\alpha = 0.0002089\ sec^{-1}$

$S = 0.001963 m^2$

$F = 1.906m$

Recorded by: Andrew Yuen			SOIL ENGINEERING
			Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test**	Hole ID BH_STW_010B
Project No.	TE8364		Ground Level 10.26m AOD
Engineer	Mott MacDonald Bentley		Date 27/10/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2

Description: Firm to stiff dark grey sandy CLAY (CAMBRIDGE GREENSAND MEMBER), overlying very stiff fissured laminated dark grey CLAY at 11.90m.

Type of test: Standpipe — Installation type

All depths are relative to ground level.

Initial ground water level	4.23	m	Top of test section	11.50	m
Height of casing above surface	0.33	m	Bottom of test section	12.00	m
Length of test section	0.50	m	Water level at end of test	7.21	m
Diameter of test section	200	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Water from borehole	Test start time	11:00
Weather	Fine	Test finish time	12:00

Time Minutes	Depth to water m	H	ln H_0/H	Time Minutes	Depth to water m	H	Log H/H0
0	12.00	7.77	0.00				
0.5	10.82	6.59	0.16				
1	10.65	6.42	0.19				
1.5	10.62	6.39	0.20				
2	10.55	6.32	0.21				
2.5	10.51	6.28	0.21				
3	10.48	6.25	0.22				
3.5	10.45	6.22	0.22				
4	10.42	6.19	0.23				
4.5	10.39	6.16	0.23				
5	10.36	6.13	0.24				
6	10.29	6.06	0.25				
7	10.23	6.00	0.26				
8	10.16	5.93	0.27				
9	10.10	5.87	0.28				
10	10.05	5.82	0.29				
12	9.93	5.70	0.31				
14	9.83	5.60	0.33				
16	9.72	5.49	0.35				
18	9.67	5.44	0.36				
20	9.29	5.06	0.43				
25	8.87	4.64	0.52				
30	8.62	4.39	0.57				
40	8.13	3.90	0.69				
50	7.67	3.44	0.81				
60	7.21	2.98	0.96				

Remarks

Well dry after <1 minute of purging

Recorded by: Andrew Yuen

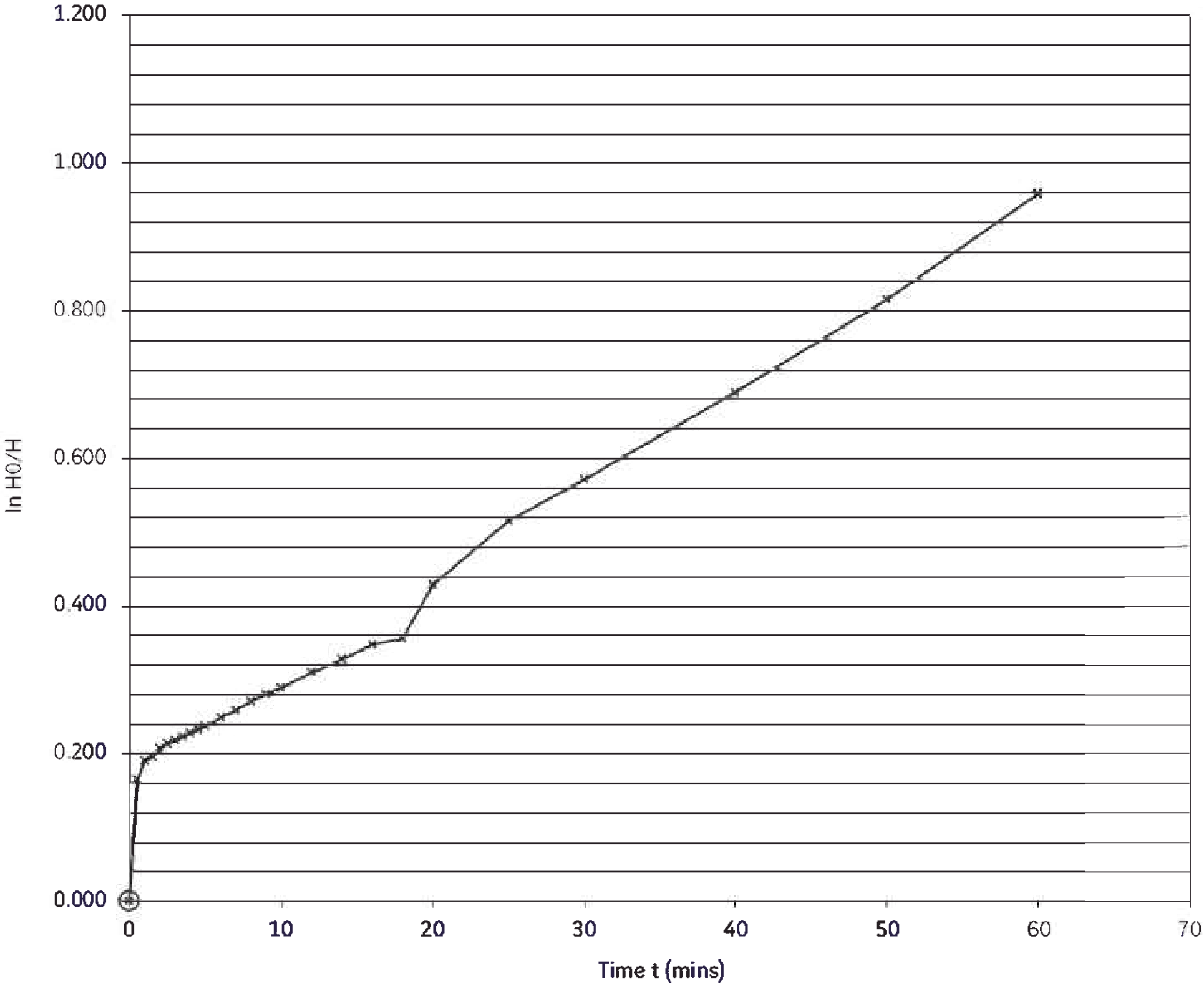
SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test**	Hole ID BH_STW_010B
Project No.	TE8364		Ground Level 10.26m AOD
Engineer	Mott MacDonald Bentley		Date 27/10/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 2 of 2

Description	Firm to stiff dark grey sandy CLAY (CAMBRIDGE GREENSAND MEMBER), overlying very stiff fissured laminated dark grey CLAY at 11.90m.
Type of test	Standpipe Installation type

Initial ground water level	4.23	m	Top of test section	11.50	m BGL
Height of casing above surface	0.33	m	Bottom of test section	12.00	m BGL
Length of test section	0.50	m	Water level at end of test	7.21	m
Diameter of test section	200	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Water from borehole	Test start time	11:00
Weather	Fine	Test finish time	12:00



using Velocity graph method $k = \alpha . S/F$ = 2.74×10^{-7} m/s

where $\alpha = 0.0002661\ sec^{-1}$

$S = 0.001963 m2$

$F = 1.906m$

Recorded by: Andrew Yuen			SOIL ENGINEERING
			Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test**	Hole ID BH_STW_010B
Project No.	TE8364		Ground Level 10.26m AOD
Engineer	Mott MacDonald Bentley		Date 11/11/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2

Description	Firm to stiff dark grey sandy CLAY (CAMBRIDGE GREENSAND MEMBER), overlying very stiff fissured laminated dark grey CLAY at 11.90m.
Type of test	Standpipe Installation type

All depths are relative to ground level.

Initial ground water level	4.34	m	Top of test section	11.50	m
Height of casing above surface	0.33	m	Bottom of test section	12.00	m
Length of test section	0.50	m	Water level at end of test	6.81	m
Diameter of test section	200	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Water from borehole	Test start time	14:00
Weather	Fine	Test finish time	15:00

Time Minutes	Depth to water m	H	H/H0	Time Minutes	Depth to water m	H	H/H0
0	12.00	7.66	1.00				
0.5	11.01	6.67	0.87				
1	10.81	6.47	0.84				
1.5	10.72	6.38	0.83				
2	10.65	6.31	0.82				
2.5	10.60	6.26	0.82				
3	10.56	6.22	0.81				
3.5	10.53	6.19	0.81				
4	10.50	6.16	0.80				
4.5	10.48	6.14	0.80				
5	10.46	6.12	0.80				
6	10.38	6.04	0.79				
7	10.30	5.96	0.78				
8	10.22	5.88	0.77				
9	10.13	5.79	0.76				
10	10.02	5.68	0.74				
12	9.71	5.37	0.70				
14	9.50	5.16	0.67				
16	9.21	4.87	0.64				
18	9.01	4.67	0.61				
20	8.79	4.45	0.58				
25	8.32	3.98	0.52				
30	7.98	3.64	0.48				
40	7.32	2.98	0.39				
50	7.03	2.69	0.35				
60	6.81	2.47	0.32				

Remarks

Recorded by: Andrew Yuen

SOIL ENGINEERING

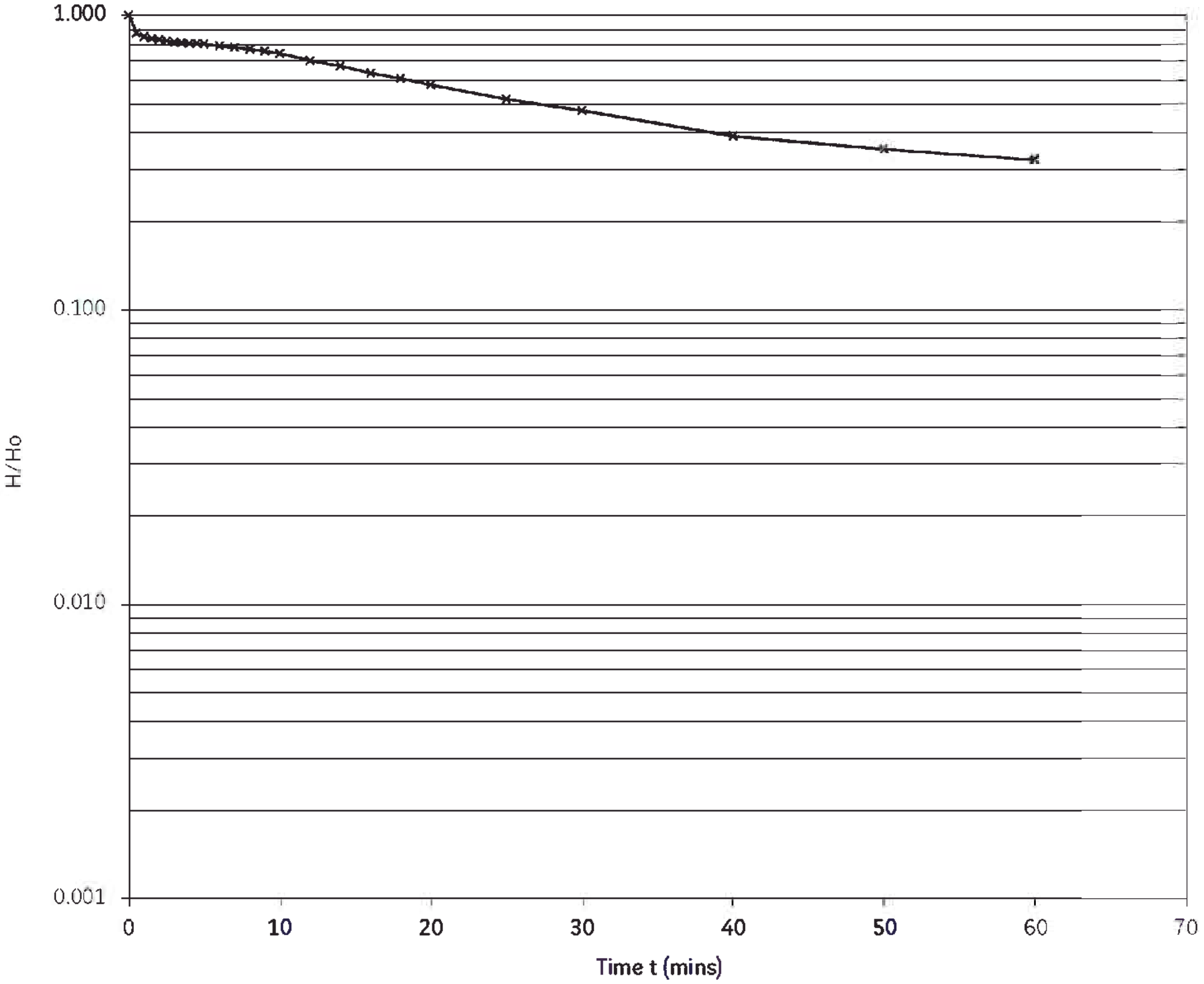
Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test**	Hole ID BH_STW_010B
Project No.	TE8364		Ground Level 10.26m AOD
Engineer	Mott MacDonald Bentley		Date 11/11/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 2 of 2

Description: Firm to stiff dark grey sandy CLAY (CAMBRIDGE GREENSAND MEMBER), overlying very stiff fissured laminated dark grey CLAY at 11.90m.

Type of test: Standpipe Installation type

Initial ground water level	4.34	m	Top of test section	11.50	m BGL
Height of casing above surface	0.33	m	Bottom of test section	12.00	m BGL
Length of test section	0.50	m	Water level at end of test	6.81	m
Diameter of test section	200	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Water from borehole	Test start time	14:00
Weather	Fine	Test finish time	15:00



using Hvorslev method

$$k = \frac{r^2 . \ln(L/R)}{2.L t_o} = 3.73 \times 10^{-7} \text{ m/s}$$

where
$r = 0.025m$
$L = 0.5m$
$R = 0.10m$
$t_o = 2700$ secs

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_STW_011B
Project No.	TE8364		Ground Level 8.93m AOD
Engineer	Mott MacDonald Bentley		Date 15/11/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2

Description CHALK.

Type of test Standpipe Installation type

All depths are relative to ground level.

Initial ground water level	3.35	m	Top of test section	1.50	m
Height of casing above surface	0.19	m	Bottom of test section	9.70	m
Length of test section	8.20	m	Water level at end of test	3.16	m
Diameter of test section	200	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Clean and fresh	Test start time	09:00
Weather	Fine	Test finish time	10:00

Time Minutes	Depth to water m	H	ln H_0/H	Time Minutes	Depth to water m	H	Log H/H0
0	-0.19	3.54	0.00				
0.5	0.21	3.14	0.12				
1	0.66	2.69	0.27				
1.5	0.93	2.42	0.38				
2	1.17	2.18	0.48				
2.5	1.38	1.97	0.59				
3	1.57	1.78	0.69				
3.5	1.72	1.63	0.78				
4	1.88	1.47	0.88				
4.5	1.88	1.47	0.88				
5	1.89	1.46	0.89				
6	1.91	1.44	0.90				
7	1.95	1.40	0.93				
8	1.98	1.37	0.95				
9	2.01	1.34	0.97				
10	2.04	1.31	0.99				
12	2.12	1.23	1.06				
14	2.18	1.17	1.11				
16	2.25	1.10	1.17				
18	2.32	1.03	1.23				
20	2.38	0.97	1.29				
25	2.51	0.84	1.44				
30	2.67	0.68	1.65				
40	2.94	0.41	2.16				
50	3.11	0.24	2.69				
60	3.16	0.19	2.92				

Remarks

Put 25 litres of water to top of standpipe.

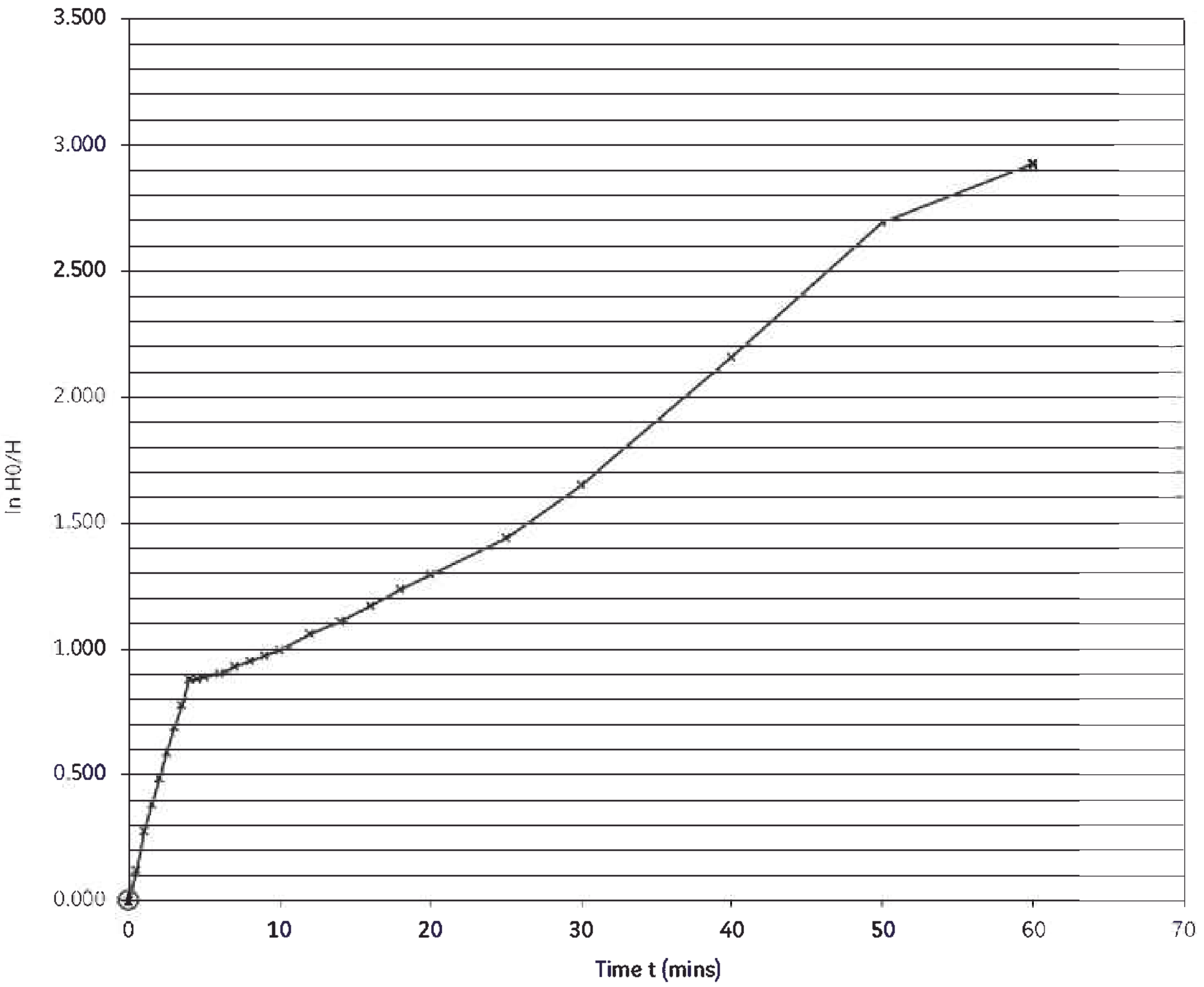
Recorded by: Andrew Yuen

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_STW_011B
Project No.	TE8364		Ground Level 8.93m AOD
Engineer	Mott MacDonald Bentley		Date 15/11/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 2 of 2
Description	CHALK.		

Type of test	Standpipe	Installation type				
Initial ground water level	3.35	m	Top of test section	1.50	m BGL	
Height of casing above surface	0.19	m	Bottom of test section	9.70	m BGL	
Length of test section	8.20	m	Water level at end of test	3.16	m	
Diameter of test section	200	mm	Diameter of casing/standpipe	50	mm	

Quality of water used	Clean and fresh	Test start time	09:00
Weather	Fine	Test finish time	10:00



using Velocity graph method $k = \alpha . S/F$ = 1.02×10^{-7} m/s

where $\alpha = 0.0006089\ sec^{-1}$

$S = 0.001963m^2$

$F = 11.686m$

Recorded by: Andrew Yuen			SOIL ENGINEERING
Form No. SE PGR F 003	Revision No. 3.04	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Borehole Rising Head Permeability Test

Project Name	Cambridge Waste Water Treatment Plant Relocation	Hole ID BH_STW_011B
Project No.	TE8364	Ground Level 8.93m AOD
Engineer	Mott MacDonald Bentley	Date 27/10/2021
Client	Barhale Limited	Page 1 of 2
	BS EN ISO 22282-2: 2012	
Description	CHALK.	

Type of test	Standpipe	Installation type				
All depths are relative to ground level.						
Initial ground water level	3.28	m	Top of test section	1.50	m	
Height of casing above surface	0.19	m	Bottom of test section	9.70	m	
Length of test section	8.20	m	Water level at end of test	3.33	m	
Diameter of test section	200	mm	Diameter of casing/standpipe	50	mm	

Quality of water used	Water from borehole	Test start time	12:00
Weather	Cloudy	Test finish time	12:40

Time Minutes	Depth to water m	H	ln H_0/H		Time Minutes	Depth to water m	H	Log H/H0
0	7.28	4.00	0.00					
0.5	7.00	3.72	0.07					
1	6.59	3.31	0.19					
1.5	5.78	2.50	0.47					
2	5.49	2.21	0.59					
2.5	5.20	1.92	0.73					
3	5.00	1.72	0.84					
3.5	4.79	1.51	0.97					
4	4.57	1.29	1.13					
4.5	4.41	1.13	1.26					
5	4.22	0.94	1.45					
6	4.01	0.73	1.70					
7	3.88	0.60	1.90					
8	3.78	0.50	2.08					
9	3.73	0.45	2.18					
10	3.68	0.40	2.30					
12	3.62	0.34	2.47					
14	3.56	0.28	2.66					
16	3.52	0.24	2.81					
18	3.45	0.17	3.16					
20	3.40	0.12	3.51					
25	3.39	0.11	3.59					
30	3.33	0.05	4.38					

Remarks

Purged 25 litres in 5 minutes

Recorded by: Andrew Yuen

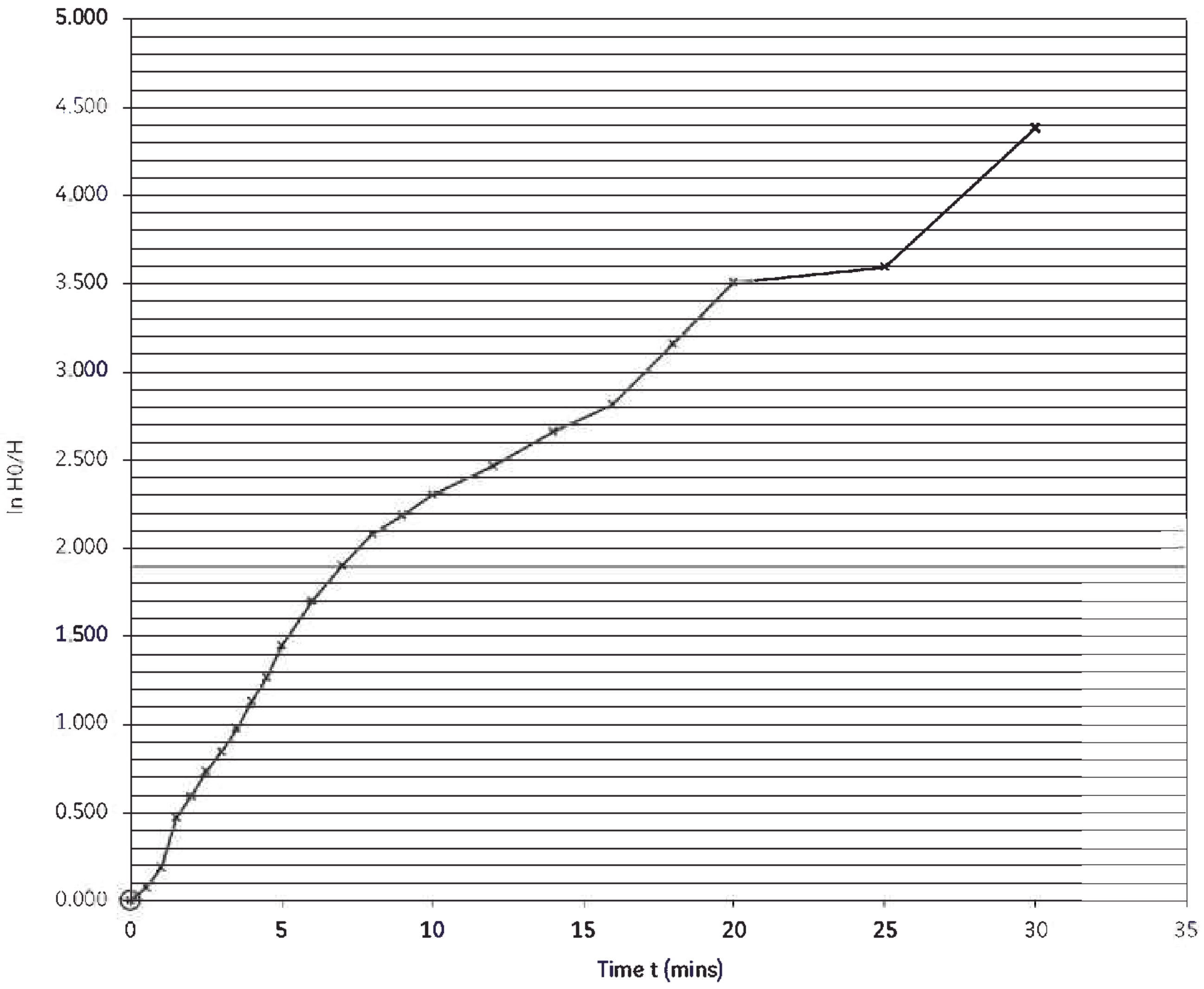
SOIL ENGINEERING

Form No.	SE PGR F 002	Revision No.	3.03	Issue Date	01/09/2010	Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test** BS EN ISO 22282-2: 2012	Hole ID BH_STW_011B
Project No.	TE8364		Ground Level 8.93m AOD
Engineer	Mott MacDonald Bentley		Date 27/10/2021
Client	Barhale Limited		Page 2 of 2
Description	CHALK.		

Type of test	Standpipe	Installation type				
Initial ground water level	3.28	m	Top of test section	1.50	m BGL	
Height of casing above surface	0.19	m	Bottom of test section	9.70	m BGL	
Length of test section	8.20	m	Water level at end of test	3.33	m	
Diameter of test section	200	mm	Diameter of casing/standpipe	50	mm	

Quality of water used	Water from borehole	Test start time	12:00
Weather	Cloudy	Test finish time	12:40



using Velocity graph method $k = \alpha . S/F$ = 4.09×10^{-7} m/s

where $\alpha = 0.002434\ sec^{-1}$

$S = 0.001963 m^2$

$F = 11.686m$

Recorded by: Andrew Yuen

SOIL ENGINEERING

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test**	Hole ID BH_STW_011B
Project No.	TE8364		Ground Level 8.93m AOD
Engineer	Mott MacDonald Bentley		Date 27/10/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2
Description	CHALK.		

Type of test	Standpipe	Installation type					
All depths are relative to ground level.							
Initial ground water level		3.28	m	Top of test section		1.50	m
Height of casing above surface		0.19	m	Bottom of test section		9.70	m
Length of test section		8.20	m	Water level at end of test		3.31	m
Diameter of test section		200	mm	Diameter of casing/standpipe		50	mm
Quality of water used	Water from borehole			Test start time		15:00	
Weather	Fine			Test finish time		15:50	

Time Minutes	Depth to water m	H	ln H_0/H	Time Minutes	Depth to water m	H	Log H/H0
0	7.31	4.03	0.00				
0.5	7.05	3.77	0.07				
1	6.63	3.35	0.18				
1.5	5.81	2.53	0.47				
2	5.53	2.25	0.58				
2.5	5.24	1.96	0.72				
3	5.03	1.75	0.83				
3.5	4.82	1.54	0.96				
4	4.64	1.36	1.09				
4.5	4.50	1.22	1.19				
5	4.27	0.99	1.40				
6	4.10	0.82	1.59				
7	3.92	0.64	1.84				
8	3.80	0.52	2.05				
9	3.76	0.48	2.13				
10	3.71	0.43	2.24				
12	3.68	0.40	2.31				
14	3.62	0.34	2.47				
16	3.55	0.27	2.70				
18	3.48	0.20	3.00				
20	3.42	0.14	3.36				
25	3.40	0.12	3.51				
30	3.36	0.08	3.92				
40	3.31	0.03	4.90				

Remarks

Purged 25 litres in 5 minutes

Recorded by: Andrew Yuen

SOIL ENGINEERING

Part of the Bachy Soletanche Group

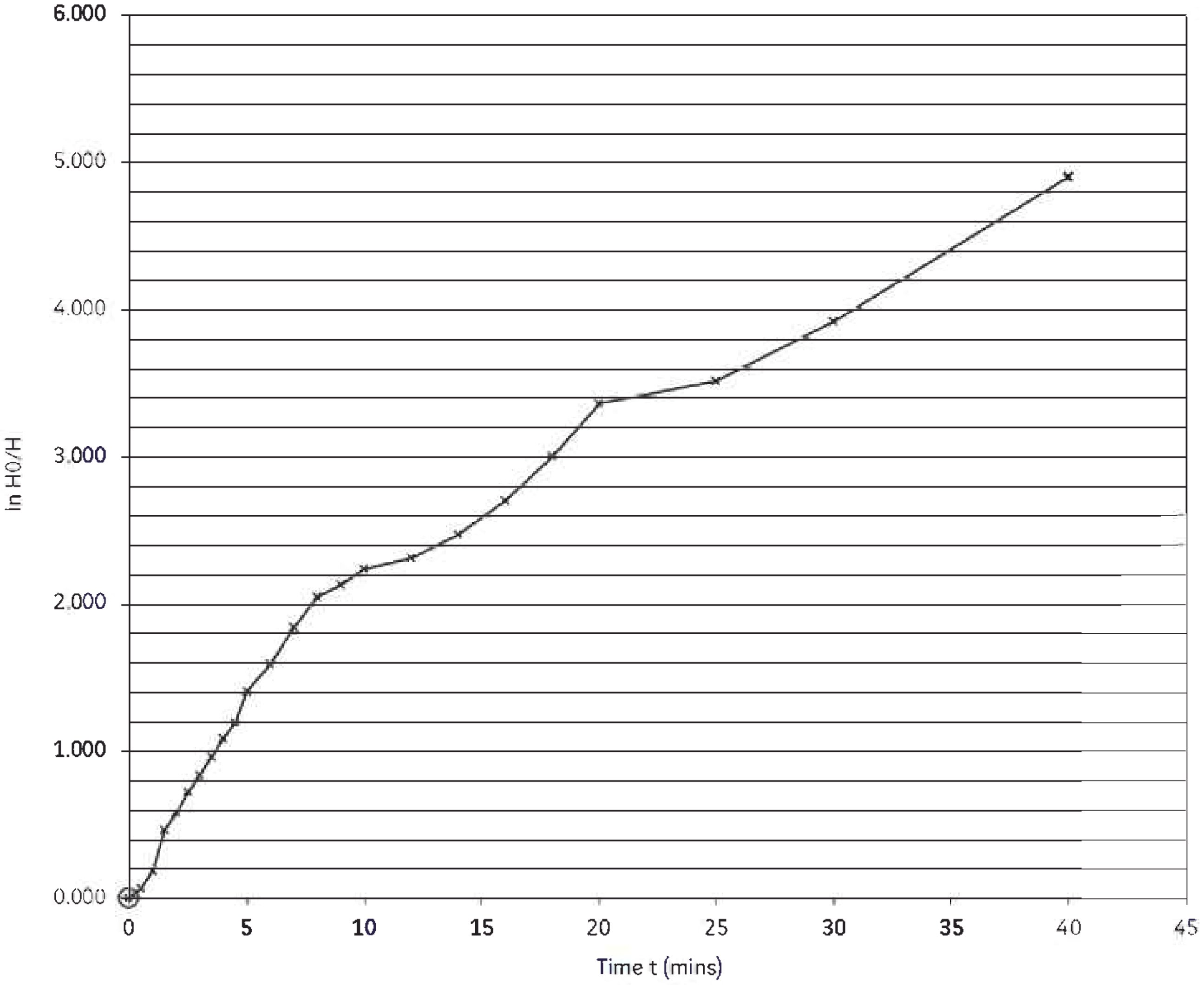
Form No.	SE PGR F 002	Revision No.	3.03	Issue Date	01/09/2010

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test** BS EN ISO 22282-2: 2012	Hole ID BH_STW_011B
Project No.	TE8364		Ground Level 8.93m AOD
Engineer	Mott MacDonald Bentley		Date 27/10/2021
Client	Barhale Limited		Page 2 of 2

Description CHALK.

Type of test	Standpipe	Installation type				
Initial ground water level	3.28	m	Top of test section	1.50	m BGL	
Height of casing above surface	0.19	m	Bottom of test section	9.70	m BGL	
Length of test section	8.20	m	Water level at end of test	3.31	m	
Diameter of test section	200	mm	Diameter of casing/standpipe	50	mm	

Quality of water used	Water from borehole	Test start time	15:00
Weather	Fine	Test finish time	15:50



using Velocity graph method $k = \alpha . S/F$ = 3.43×10^{-7} m/s

where $\alpha = 0.002042\ sec^{-1}$

$S = 0.001963m$

$F = 11.686m$

Recorded by: Andrew Yuen			SOIL ENGINEERING
Form No. SE PGR F 003	Revision No. 3.04	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_STW_022B
Project No.	TE8364		Ground Level 8.51m AOD
Engineer	Mott MacDonald Bentley		Date 15/11/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2

Description	Firm greenish grey slightly sandy slightly gravelly CLAY. (CAMBRIDGE GREENSAND MEMBER)

Type of test	Standpipe	Installation type				
All depths are relative to ground level.						
Initial ground water level	2.30	m	Top of test section	11.30	m	
Height of casing above surface	0.16	m	Bottom of test section	11.70	m	
Length of test section	0.40	m	Water level at end of test	1.98	m	
Diameter of test section	150	mm	Diameter of casing/standpipe	50	mm	

Quality of water used	Clean and fresh	Test start time	08:15
Weather	Fine	Test finish time	08:17

Time Minutes	Depth to water m	H	H/H0		Time Minutes	Depth to water m	H	H/H0
0	0.00	2.30	1.00					
0.5	1.34	0.96	0.42					
1	1.98	0.32	0.14					

Remarks

Recorded by: Andrew Yuen

SOIL ENGINEERING

Form No.	SE PGR F 002	Revision No.	3.03x	Issue Date	19/09/2017	Part of the Bachy Soletanche Group

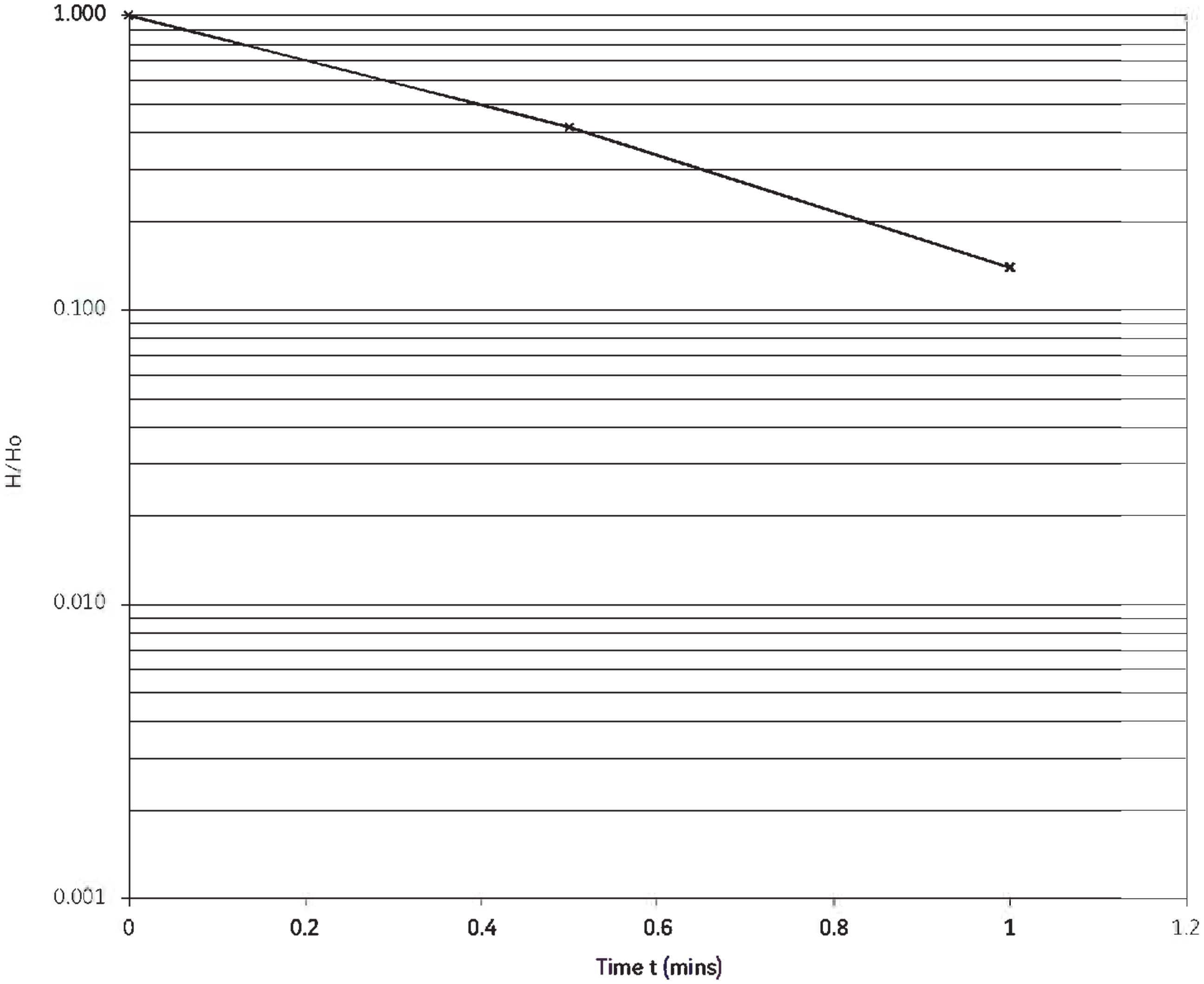
Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_STW_022B
Project No.	TE8364		Ground Level 8.51m AOD
Engineer	Mott MacDonald Bentley		Date 15/11/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 2 of 2

Description Firm greenish grey slightly sandy slightly gravelly CLAY. (CAMBRIDGE GREENSAND MEMBER)

Type of test Standpipe Installation type

Initial ground water level	2.30	m	Top of test section	11.30	m BGL
Height of casing above surface	0.16	m	Bottom of test section	11.70	m BGL
Length of test section	0.40	m	Water level at end of test	1.98	m
Diameter of test section	150	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Clean and fresh	Test start time	08:15
Weather	Fine	Test finish time	08:17



using Hvorslev method $k = \frac{r^2 . ln(L/R)}{2.L t_o}$ = 3.74×10^{-5} m/s

where $r = 0.025m$
$L = 0.4m$
$R = 0.075m$
$t_o = 35$ secs

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test**	Hole ID BH_STW_022B
Project No.	TE8364		Ground Level 8.51m AOD
Engineer	Mott MacDonald Bentley		Date 12/11/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2

Description Firm greenish grey slightly sandy slightly gravelly CLAY. (CAMBRIDGE GREENSAND MEMBER)

Type of test Standpipe Installation type

All depths are relative to ground level.					
Initial ground water level	2.28	m	Top of test section	11.30	m
Height of casing above surface	0.16	m	Bottom of test section	11.70	m
Length of test section	0.40	m	Water level at end of test	2.30	m
Diameter of test section	150	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Water from borehole	Test start time	11:30
Weather	Raining	Test finish time	11:34

Time Minutes	Depth to water m	H	H/H0	Time Minutes	Depth to water m	H	H/H0
0	6.22	3.94	1.00				
0.5	5.60	3.32	0.84				
1	4.42	2.14	0.54				
1.5	2.91	0.63	0.16				
2	2.52	0.24	0.06				
2.5	2.33	0.05	0.01				
3	2.30	0.02	0.01				

Remarks

Purged 25 litres in 5 minutes.

Recorded by: Andrew Yuen

SOIL ENGINEERING

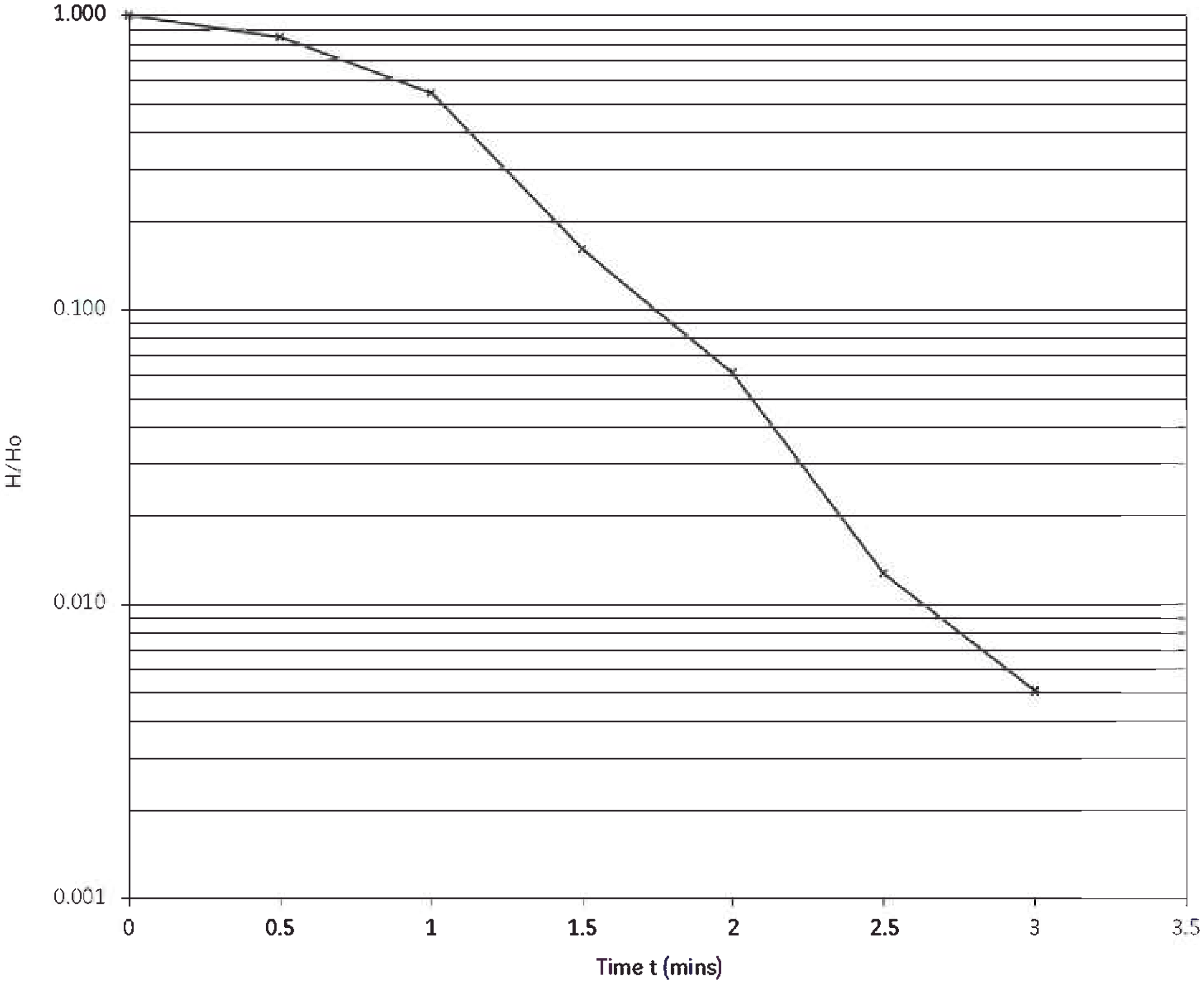
Form No.	SE PGR F 002	Revision No.	3.03x	Issue Date	19/09/2017

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test** BS EN ISO 22282-2: 2012	Hole ID BH_STW_022B
Project No.	TE8364		Ground Level 8.51m AOD
Engineer	Mott MacDonald Bentley		Date 12/11/2021
Client	Barhale Limited		Page 2 of 2
Description	Firm greenish grey slightly sandy slightly gravelly CLAY. (CAMBRIDGE GREENSAND MEMBER)		

Type of test	Standpipe	Installation type			
Initial ground water level	2.28	m	Top of test section	11.30	m BGL
Height of casing above surface	0.16	m	Bottom of test section	11.70	m BGL
Length of test section	0.40	m	Water level at end of test	2.30	m
Diameter of test section	150	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Water from borehole	Test start time	11:30
Weather	Raining	Test finish time	11:34



using Hvorslev method

$$k = \frac{r^2 . \ln(L/R)}{2.L t_o} = 1.79 \times 10^{-5} \text{ m/s}$$

where $r = 0.025m$
$L = 0.4m$
$R = 0.075m$
$t_o = 73$ secs

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test**	Hole ID BH_STW_022B
Project No.	TE8364		Ground Level 8.51m AOD
Engineer	Mott MacDonald Bentley		Date 12/11/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2

Description Firm greenish grey slightly sandy slightly gravelly CLAY. (CAMBRIDGE GREENSAND MEMBER)

Type of test Standpipe Installation type

All depths are relative to ground level.					
Initial ground water level	2.28	m	Top of test section	11.30	m
Height of casing above surface	0.16	m	Bottom of test section	11.70	m
Length of test section	0.40	m	Water level at end of test	2.31	m
Diameter of test section	150	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Water from borehole	Test start time	11:30
Weather	Raining	Test finish time	11:34

Time Minutes	Depth to water m	H	H/H0	Time Minutes	Depth to water m	H	H/H0
0	6.25	3.97	1.00				
0.5	5.68	3.40	0.86				
1	4.54	2.26	0.57				
1.5	3.05	0.77	0.19				
2	2.66	0.38	0.10				
2.5	2.39	0.11	0.03				
3	2.31	0.03	0.01				

Remarks

Purged 25 litres in 5 minutes.

Recorded by: Andrew Yuen

SOIL ENGINEERING

Form No.	SE PGR F 002	Revision No.	3.03x	Issue Date	19/09/2017

Part of the Bachy Soletanche Group

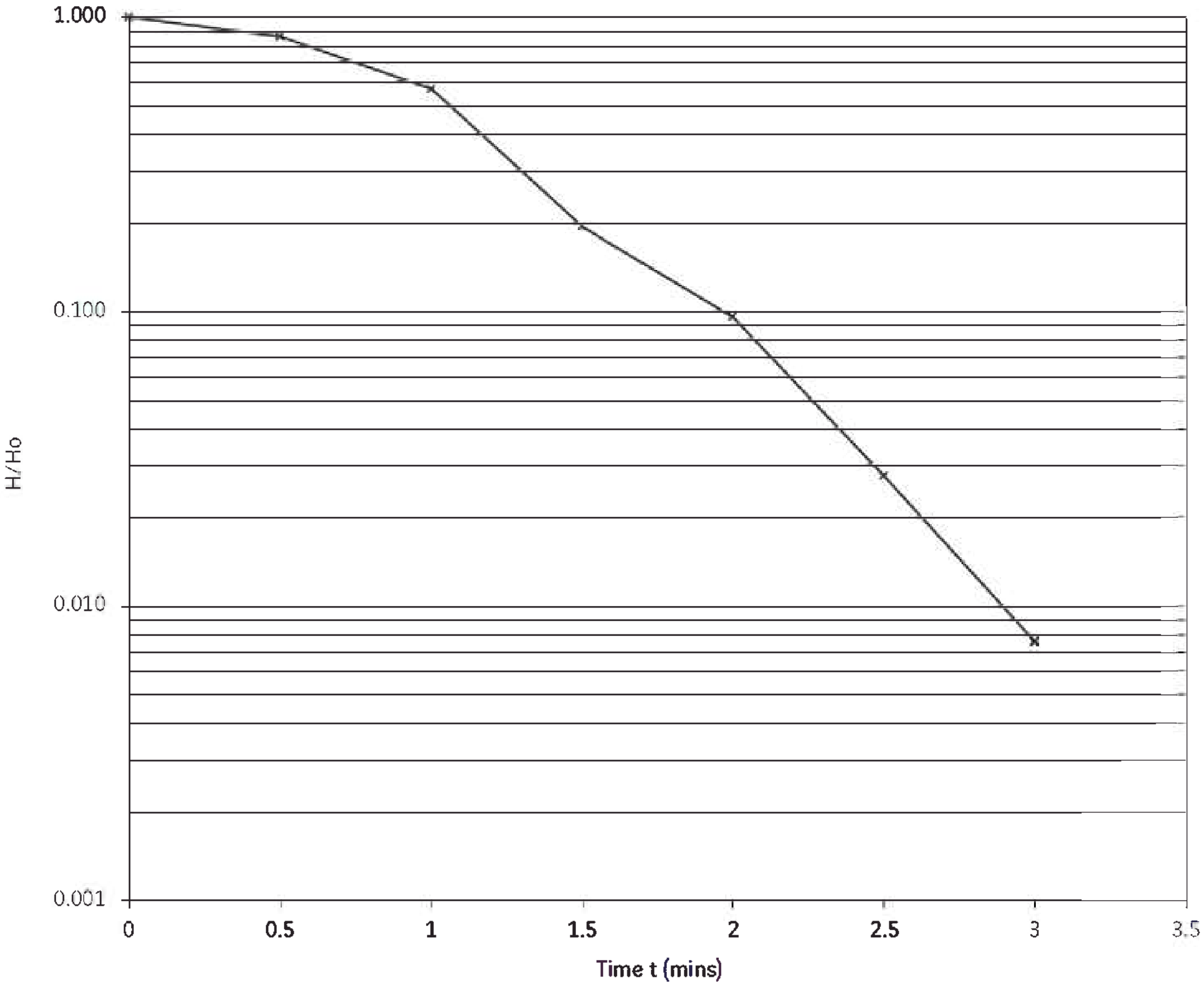
Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test**	Hole ID BH_STW_022B
Project No.	TE8364		Ground Level 8.51m AOD
Engineer	Mott MacDonald Bentley		Date 12/11/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 2 of 2

Description Firm greenish grey slightly sandy slightly gravelly CLAY. (CAMBRIDGE GREENSAND MEMBER)

Type of test Standpipe Installation type

Initial ground water level	2.28	m	Top of test section	11.30	m BGL
Height of casing above surface	0.16	m	Bottom of test section	11.70	m BGL
Length of test section	0.40	m	Water level at end of test	2.31	m
Diameter of test section	150	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Water from borehole	Test start time	11:30
Weather	Raining	Test finish time	11:34



using Hvorslev method $k = \frac{r^2 .ln(L/R)}{2.Lt_o}$ = 1.72 x 10^{-5} m/s

where $r = 0.025m$
$L = 0.4m$
$R = 0.075m$
$t_o = 76$ secs

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_STW_031B
Project No.	TE8364		Ground Level 11.60m AOD
Engineer	Mott MacDonald Bentley		Date 15/11/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2
Description	Very stiff greenish grey slightly sandy slightly gravelly CLAY (CAMBRIDGE GREENSAND MEMBER)		

Type of test	Standpipe	Installation type				
All depths are relative to ground level.						
Initial ground water level	5.46	m	Top of test section	13.10	m	
Height of casing above surface	N/A	m	Bottom of test section	13.60	m	
Length of test section	0.50	m	Water level at end of test	5.30	m	
Diameter of test section	150	mm	Diameter of casing/standpipe	50	mm	
Quality of water used	Clean and fresh		Test start time	08:00		
Weather	Fine		Test finish time	09:00		

Time Minutes	Depth to water m	H	Log H/H0	Time Minutes	Depth to water m	H	Log H/H0
0	4.05	1.41	0.00				
0.5	4.47	0.99	0.35				
1	5.12	0.34	1.42				
1.5	5.14	0.32	1.48				
2	5.16	0.30	1.55				
2.5	5.17	0.29	1.58				
3	5.17	0.29	1.58				
3.5	5.17	0.29	1.58				
4	5.17	0.29	1.58				
4.5	5.18	0.28	1.62				
5	5.18	0.28	1.62				
6	5.18	0.28	1.62				
7	5.18	0.28	1.62				
8	5.18	0.28	1.62				
9	5.18	0.28	1.62				
10	5.18	0.28	1.62				
12	5.19	0.27	1.65				
14	5.19	0.27	1.65				
16	5.19	0.27	1.65				
18	5.19	0.27	1.65				
20	5.20	0.26	1.69				
25	5.20	0.26	1.69				
30	5.20	0.26	1.69				
40	5.24	0.22	1.86				
50	5.26	0.20	1.95				
60	5.30	0.16	2.18				

Remarks

Unable to fill water to top of standpipe - put 100 litres of water into standpipe, start of test at 4.05m.

Recorded by: Andrew Yuen

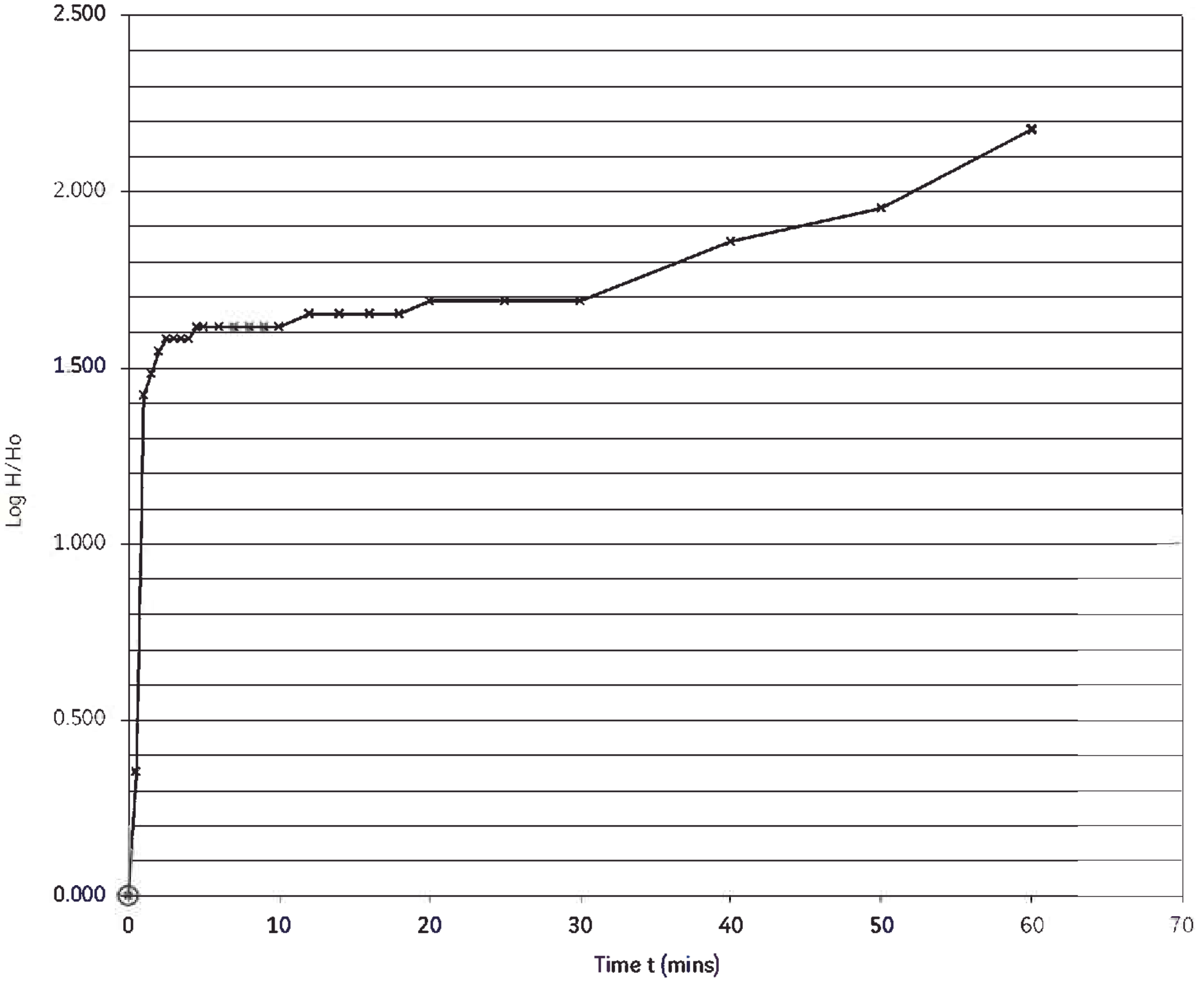
SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test** BS EN ISO 22282-2: 2012	Hole ID BH_STW_031B
Project No.	TE8364		Ground Level 11.60m AOD
Engineer	Mott MacDonald Bentley		Date 15/11/2021
Client	Barhale Limited		Page 2 of 2

Description Very stiff greenish grey slightly sandy slightly gravelly CLAY (CAMBRIDGE GREENSAND MEMBER)

Type of test Standpipe	Installation type				
Initial ground water level	5.46	m	Top of test section	13.10	m BGL
Height of casing above surface	N/A	m	Bottom of test section	13.60	m BGL
Length of test section	0.50	m	Water level at end of test	5.30	m
Diameter of test section	150	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Clean and fresh	Test start time	08:00
Weather	Fine	Test finish time	09:00



using Velocity graph method $k = \alpha . S/F$ = 2.53 x 10^{-7} m/s

where α= $0.000213\ sec^{-1}$

S= $0.001963m^2$

F= 1.655m

Recorded by: Andrew Yuen			SOIL ENGINEERING
Form No. SE PGR F 003	Revision No. 3.04	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Borehole Rising Head Permeability Test

Project Name	Cambridge Waste Water Treatment Plant Relocation	Hole ID BH_STW_031B
Project No.	TE8364	Ground Level 11.60m AOD
Engineer	Mott MacDonald Bentley	Date 11/11/2021
Client	Barhale Limited	Page 1 of 2

BS EN ISO 22282-2: 2012

Description Very stiff greenish grey slightly sandy slightly gravelly CLAY (CAMBRIDGE GREENSAND MEMBER)

Type of test Standpipe Installation type

All depths are relative to ground level.

Initial ground water level	5.05	m	Top of test section	13.10	m
Height of casing above surface	N/A	m	Bottom of test section	13.60	m
Length of test section	0.50	m	Water level at end of test	8.85	m
Diameter of test section	150	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Water from borehole	Test start time	10:00
Weather	Raining	Test finish time	11:00

Time Minutes	Depth to water m	H	Log H/H0	Time Minutes	Depth to water m	H	Log H/H0
0	9.12	4.07	0.00				
0.5	9.09	4.04	0.01				
1	9.07	4.02	0.01				
1.5	9.06	4.01	0.01				
2	9.05	4.00	0.02				
2.5	9.04	3.99	0.02				
3	9.03	3.98	0.02				
3.5	9.02	3.97	0.02				
4	9.02	3.97	0.02				
4.5	9.02	3.97	0.02				
5	9.01	3.96	0.03				
6	9.00	3.95	0.03				
7	9.00	3.95	0.03				
8	9.00	3.95	0.03				
9	9.00	3.95	0.03				
10	9.00	3.95	0.03				
12	9.00	3.95	0.03				
14	9.00	3.95	0.03				
16	8.99	3.94	0.03				
18	8.99	3.94	0.03				
20	8.97	3.92	0.04				
25	8.96	3.91	0.04				
30	8.94	3.89	0.05				
40	8.91	3.86	0.05				
50	8.87	3.82	0.06				
60	8.85	3.80	0.07				

Remarks

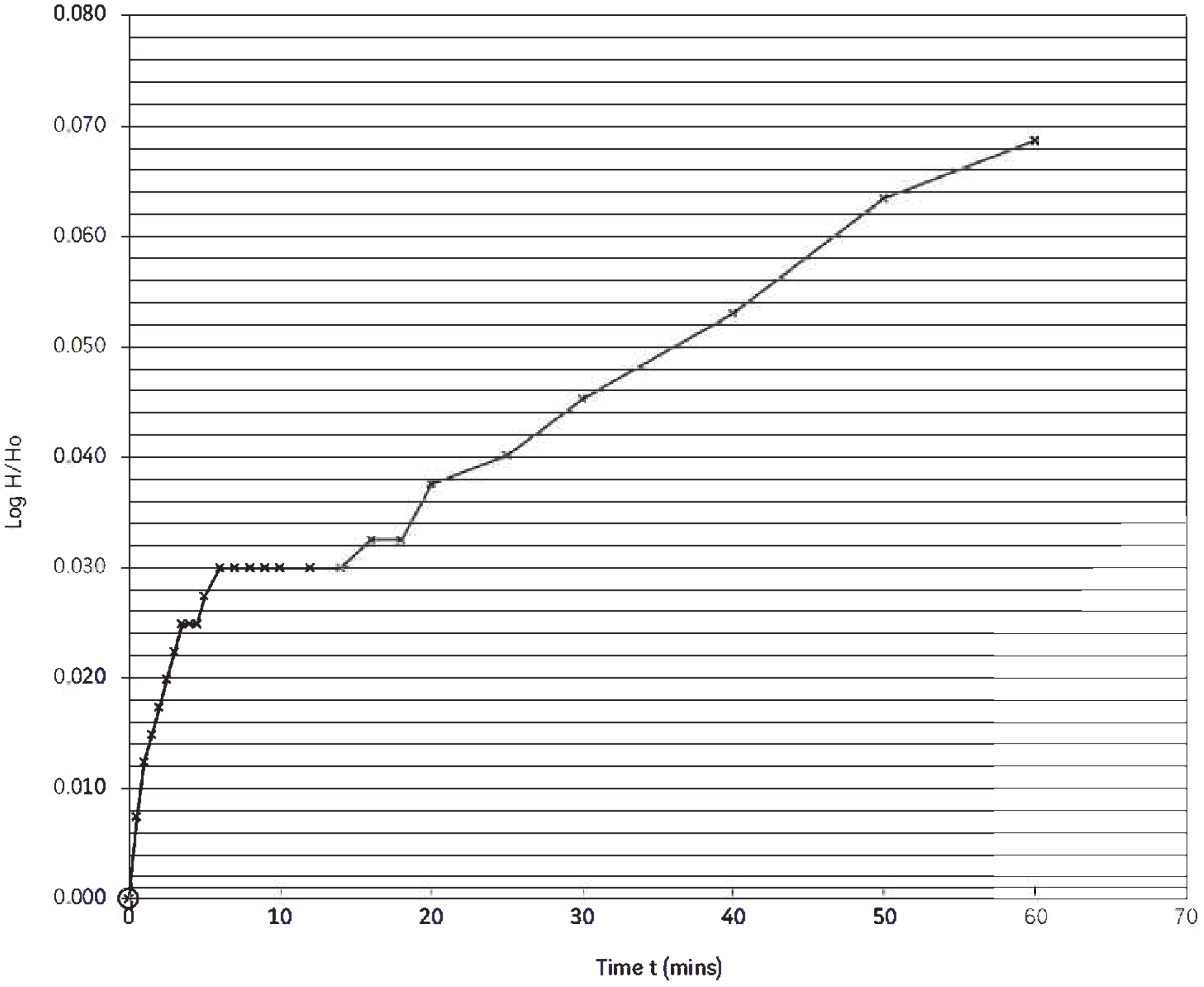
Purged 20 litres in 5 minutes.

Recorded by: Andrew Yuen

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test** BS EN ISO 22282-2: 2012	Hole ID BH_STW_031B
Project No.	TE8364		Ground Level 11.60m AOD
Engineer	Mott MacDonald Bentley		Date 11/11/2021
Client	Barhale Limited		Page 2 of 2
Description	Very stiff greenish grey slightly sandy slightly gravelly CLAY (CAMBRIDGE GREENSAND MEMBER)		

Type of test	Standpipe	Installation type			
Initial ground water level	5.05 m		Top of test section	13.10	m BGL
Height of casing above surface	N/A m		Bottom of test section	13.60	m BGL
Length of test section	0.50 m		Water level at end of test	8.85	m
Diameter of test section	150 mm		Diameter of casing/standpipe	50	mm
Quality of water used	Water from borehole		Test start time	10:00	
Weather	Raining		Test finish time	11:00	



using Velocity graph method $k = \alpha . S/F$ = 1.44×10^{-8} m/s

where $\alpha = 1.204 \times 10^{-5}\ sec^{-1}$

$S = 0.001963m^2$

F= 1.636m

Recorded by: Andrew Yuen			SOIL ENGINEERING
Form No. SE PGR F 003	Revision No. 3.04	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test**	Hole ID BH_STW_031B
Project No.	TE8364		Ground Level 11.60m AOD
Engineer	Mott MacDonald Bentley		Date 12/11/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2

Description: Very stiff greenish grey slightly sandy slightly gravelly CLAY (CAMBRIDGE GREENSAND MEMBER)

Type of test: Standpipe   Installation type

All depths are relative to ground level.

Initial ground water level	5.41	m	Top of test section	13.10	m
Height of casing above surface	N/A	m	Bottom of test section	13.60	m
Length of test section	0.50	m	Water level at end of test	8.81	m
Diameter of test section	150	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Water from borehole	Test start time	08:00
Weather	Raining	Test finish time	09:00

Time Minutes	Depth to water m	H	Log H/H0		Time Minutes	Depth to water m	H	Log H/H0
0	9.00	3.59	0.00					
0.5	8.96	3.55	0.01					
1	8.94	3.53	0.02					
1.5	8.94	3.53	0.02					
2	8.93	3.52	0.02					
2.5	8.93	3.52	0.02					
3	8.93	3.52	0.02					
3.5	8.92	3.51	0.02					
4	8.92	3.51	0.02					
4.5	8.91	3.50	0.03					
5	8.91	3.50	0.03					
6	8.90	3.49	0.03					
7	8.90	3.49	0.03					
8	8.90	3.49	0.03					
9	8.90	3.49	0.03					
10	8.89	3.48	0.03					
12	8.89	3.48	0.03					
14	8.89	3.48	0.03					
16	8.88	3.47	0.03					
18	8.88	3.47	0.03					
20	8.87	3.46	0.04					
25	8.87	3.46	0.04					
30	8.86	3.45	0.04					
40	8.85	3.44	0.04					
50	8.83	3.42	0.05					
60	8.81	3.40	0.05					

Remarks

Purged 20 litres in 5 minutes.

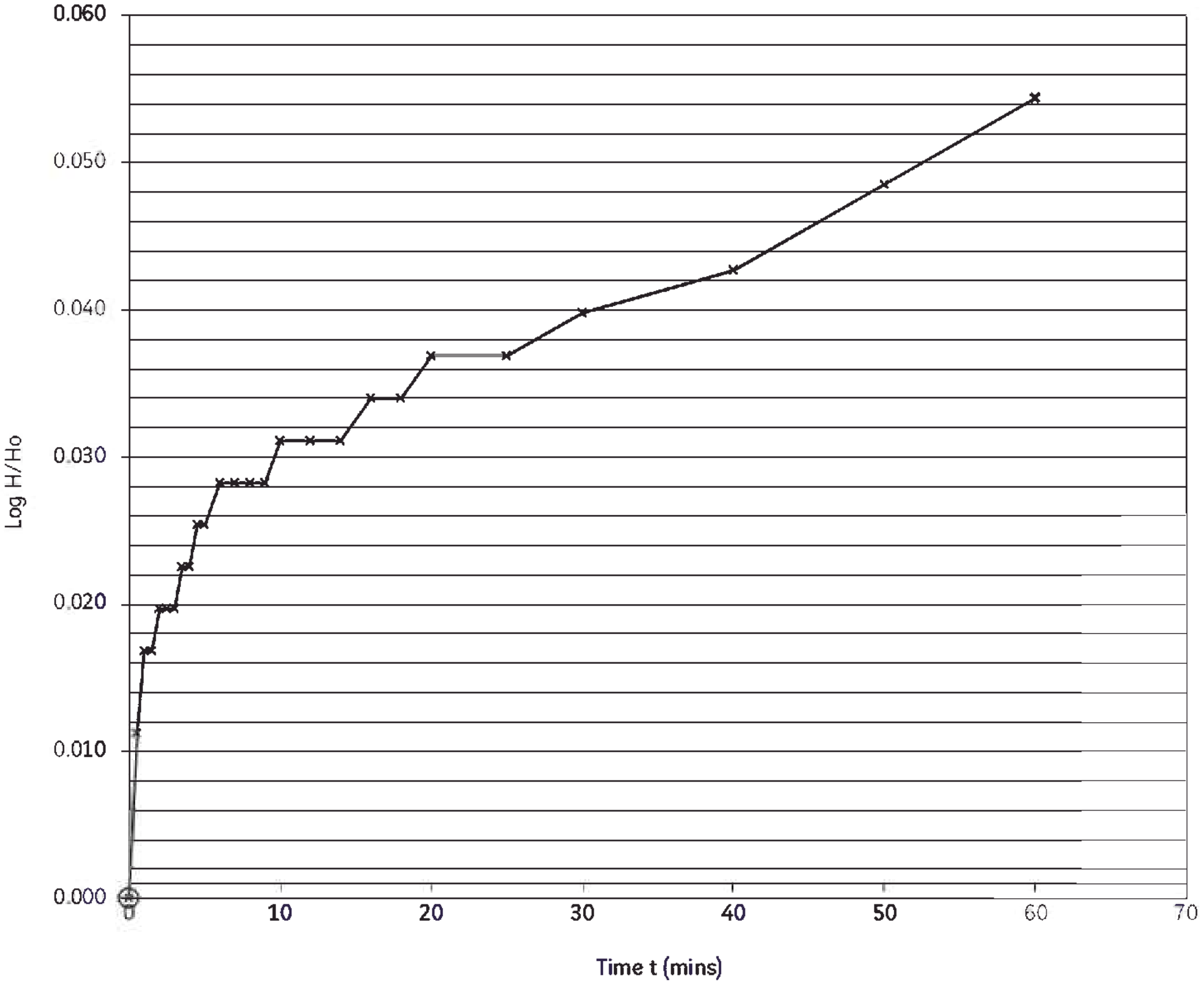
Recorded by: Andrew Yuen

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test** BS EN ISO 22282-2: 2012	Hole ID BH_STW_031B
Project No.	TE8364		Ground Level 11.60m AOD
Engineer	Mott MacDonald Bentley		Date 12/11/2021
Client	Barhale Limited		Page 2 of 2
Description	Very stiff greenish grey slightly sandy slightly gravelly CLAY (CAMBRIDGE GREENSAND MEMBER)		

Type of test	Standpipe	Installation type			
Initial ground water level	5.41	m	Top of test section	13.10	m BGL
Height of casing above surface	N/A	m	Bottom of test section	13.60	m BGL
Length of test section	0.50	m	Water level at end of test	8.81	m
Diameter of test section	150	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Water from borehole	Test start time	08:00
Weather	Raining	Test finish time	09:00



using Velocity graph method $k = \alpha . S/F$ = 9.62×10^{-9} m/s

where $\alpha = 8.025 \times 10^{-6}\ sec^{-1}$

$S = 0.001963 m^2$

$F = 1.636m$

Recorded by: Andrew Yuen			SOIL ENGINEERING
Form No. SE PGR F 003	Revision No. 3.04	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_TUN_005B
Project No.	TE8364		Ground Level 6.69m AOD
Engineer	Mott MacDonald Bentley		Date 01/11/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2
Description	Firm thinly laminated fissured bluish grey CLAY. (GAULT CLAY FORMATION)		

Type of test	Standpipe	Installation type				
All depths are relative to ground level.						
Initial ground water level	1.94	m		Top of test section	7.00	m
Height of casing above surface	0.54	m		Bottom of test section	10.00	m
Length of test section	3.00	m		Water level at end of test	1.89	m
Diameter of test section	200	mm		Diameter of casing/standpipe	50	mm
Quality of water used	Clean and fresh			Test start time	09:00	
Weather	Fine			Test finish time	10:00	

Time Minutes	Depth to water m	H	H/H0	Time Minutes	Depth to water m	H	H/H0
0	-0.54	2.48	1.00				
0.5	-0.44	2.38	0.96				
1	-0.34	2.28	0.92				
1.5	-0.26	2.20	0.89				
2	-0.14	2.08	0.84				
2.5	-0.08	2.02	0.81				
3	0.01	1.93	0.78				
3.5	0.07	1.87	0.75				
4	0.13	1.81	0.73				
4.5	0.21	1.73	0.70				
5	0.29	1.65	0.67				
6	0.75	1.19	0.48				
7	0.80	1.14	0.46				
8	0.86	1.08	0.44				
9	0.97	0.97	0.39				
10	1.04	0.90	0.36				
12	1.16	0.78	0.31				
14	1.29	0.65	0.26				
16	1.38	0.56	0.23				
18	1.45	0.49	0.20				
20	1.52	0.42	0.17				
25	1.61	0.33	0.13				
30	1.69	0.25	0.10				
40	1.80	0.14	0.06				
50	1.85	0.09	0.04				
60	1.89	0.05	0.02				

Remarks

Recorded by: Andrew Yuen

SOIL ENGINEERING

Form No.	SE PGR F 002	Revision No.	3.03x	Issue Date	19/09/2017

Part of the Bachy Soletanche Group

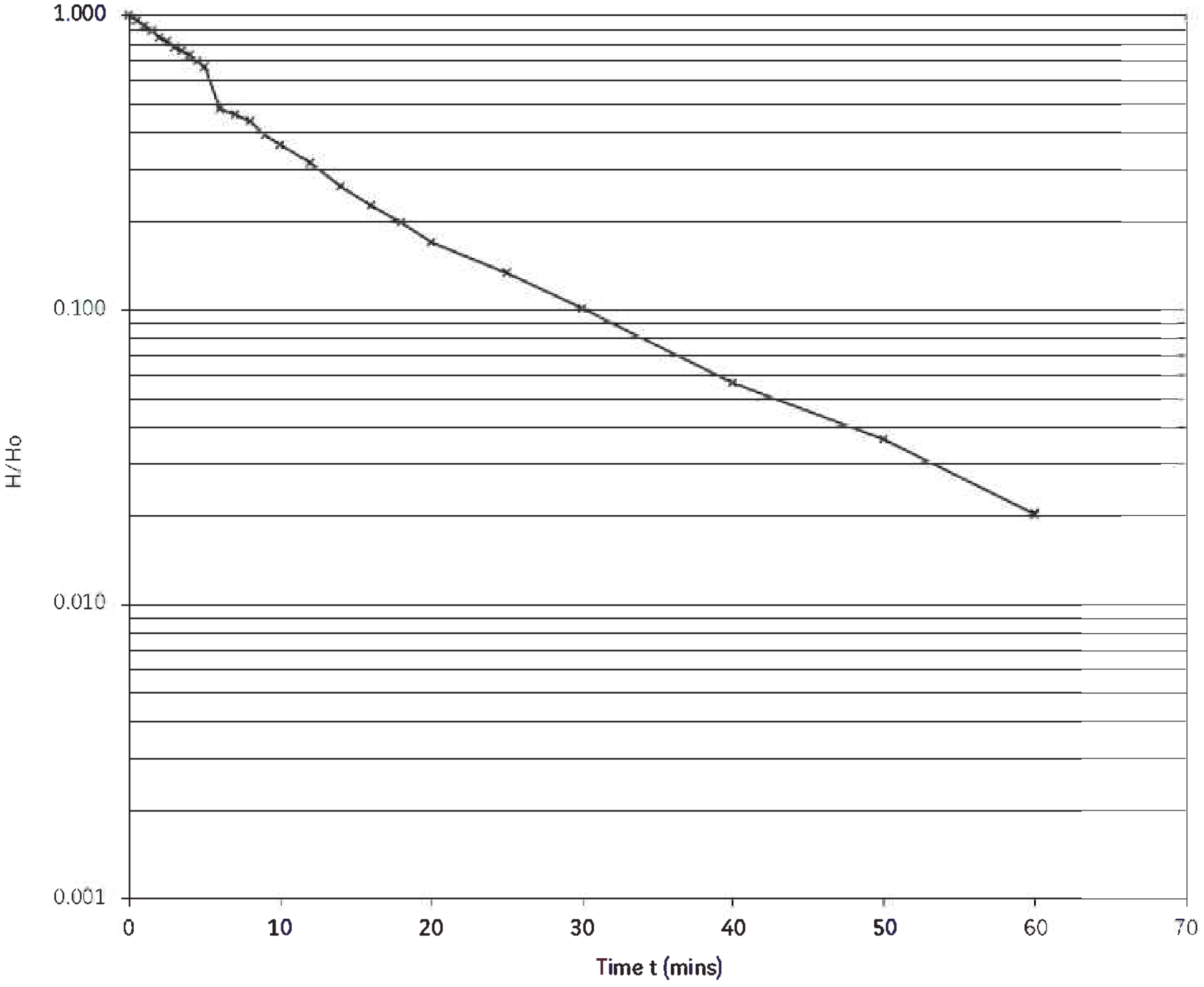
Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_TUN_005B
Project No.	TE8364		Ground Level 6.69m AOD
Engineer	Mott MacDonald Bentley		Date 01/11/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 2 of 2

Description Firm thinly laminated fissured bluish grey CLAY. (GAULT CLAY FORMATION)

Type of test Standpipe Installation type

Initial ground water level	1.94	m	Top of test section	7.00	m BGL
Height of casing above surface	0.54	m	Bottom of test section	10.00	m BGL
Length of test section	3.00	m	Water level at end of test	1.89	m
Diameter of test section	200	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Clean and fresh	Test start time	09:00
Weather	Fine	Test finish time	10:00



using Hvorslev method $k = \frac{r^2.ln(L/R)}{2.Lt_o} = 6.12 \times 10^{-7}$ m/s

where
r= *0.025m*
L= *3m*
R= 0.1m
t_o= 580 secs

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test**	Hole ID BH_TUN_005B
Project No.	TE8364		Ground Level 6.69m AOD
Engineer	Mott MacDonald Bentley		Date 26/10.2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2

Description Firm thinly laminated fissured bluish grey CLAY. (GAULT CLAY FORMATION)

Type of test Standpipe Installation type

All depths are relative to ground level.

Initial ground water level	1.90	m	Top of test section	7.00	m
Height of casing above surface	0.80	m	Bottom of test section	10.00	m
Length of test section	3.00	m	Water level at end of test	9.50	m
Diameter of test section	200	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Water from borehole	Test start time	09:00
Weather	Fine	Test finish time	10:00

Time Minutes	Depth to water m	H	Log H/H0		Time Minutes	Depth to water m	H	Log H/H0
0	10.00	8.10	0.00					
0.5	9.98	8.08	0.00					
1	9.91	8.01	0.01					
1.5	9.88	7.98	0.01					
2	9.84	7.94	0.02					
2.5	9.77	7.87	0.03					
3	9.71	7.81	0.04					
3.5	9.67	7.77	0.04					
4	9.65	7.75	0.04					
4.5	9.64	7.74	0.05					
5	9.58	7.68	0.05					
6	9.56	7.66	0.06					
7	9.54	7.64	0.06					
8	9.54	7.64	0.06					
9	9.54	7.64	0.06					
10	9.54	7.64	0.06					
12	9.53	7.63	0.06					
14	9.53	7.63	0.06					
16	9.53	7.63	0.06					
18	9.53	7.63	0.06					
20	9.53	7.63	0.06					
25	9.53	7.63	0.06					
30	9.52	7.62	0.06					
40	9.52	7.62	0.06					
50	9.51	7.61	0.06					
60	9.50	7.60	0.06					

Remarks

Well dry after purging for <2 minutes.

Recorded by: Andrew Yuen

SOIL ENGINEERING

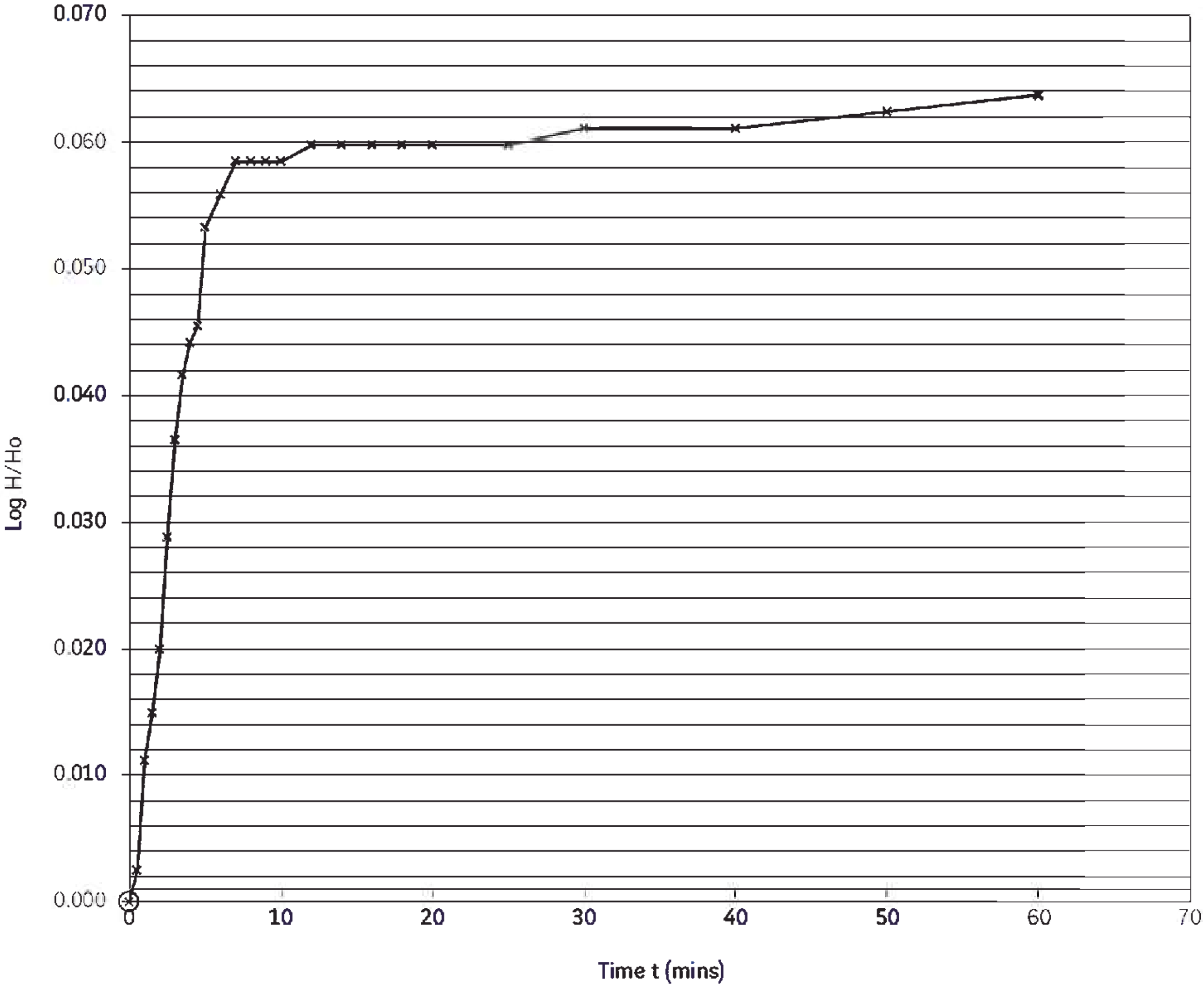
Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test**	Hole ID BH_TUN_005B
Project No.	TE8364		Ground Level 6.69m AOD
Engineer	Mott MacDonald Bentley		Date 26/10.2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 2 of 2

Description Firm thinly laminated fissured bluish grey CLAY. (GAULT CLAY FORMATION)

Type of test Standpipe Installation type

Initial ground water level	1.90	m	Top of test section	7.00	m BGL
Height of casing above surface	0.80	m	Bottom of test section	10.00	m BGL
Length of test section	3.00	m	Water level at end of test	9.50	m
Diameter of test section	200	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Water from borehole	Test start time	09:00
Weather	Fine	Test finish time	10:00



using Velocity graph method $k = \alpha . S/F$ = 8.75×10^{-10} m/s

where $\alpha = 2.469 \times 10^{-6}\ sec^{-1}$

$S = 0.001963 m^2$

$F = 5.539m$

Recorded by: Andrew Yuen

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test**	Hole ID BH_TUN_005B
Project No.	TE8364		Ground Level 6.69m AOD
Engineer	Mott MacDonald Bentley		Date 29/10/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2

Description	Firm thinly laminated fissured bluish grey CLAY. (GAULT CLAY FORMATION)

Type of test	Standpipe	Installation type	Well point or hole extended in uniform soil

All depths are relative to ground level.

Initial ground water level	2.04	m	Top of test section	7.00	m
Height of casing above surface	0.80	m	Bottom of test section	10.00	m
Length of test section	3.00	m	Water level at end of test	9.75	m
Diameter of test section	50	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Water from borehole	Test start time	09:00
Weather	Fine	Test finish time	10:00

Time Minutes	Depth to water m	H	Log H/H0	Time Minutes	Depth to water m	H	Log H/H0
0	10.00	7.96	0.00				
0.5	9.82	7.78	0.02				
1	9.80	7.76	0.03				
1.5	9.79	7.75	0.03				
2	9.79	7.75	0.03				
2.5	9.79	7.75	0.03				
3	9.78	7.74	0.03				
3.5	9.78	7.74	0.03				
4	9.78	7.74	0.03				
4.5	9.78	7.74	0.03				
5	9.78	7.74	0.03				
6	9.78	7.74	0.03				
7	9.78	7.74	0.03				
8	9.78	7.74	0.03				
9	9.78	7.74	0.03				
10	9.78	7.74	0.03				
12	9.78	7.74	0.03				
14	9.78	7.74	0.03				
16	9.78	7.74	0.03				
18	9.78	7.74	0.03				
20	9.78	7.74	0.03				
25	9.78	7.74	0.03				
30	9.77	7.73	0.03				
40	9.75	7.71	0.03				
50	9.75	7.71	0.03				
60	9.75	7.71	0.03				

Remarks

Well dry after purging for <2 minutes.

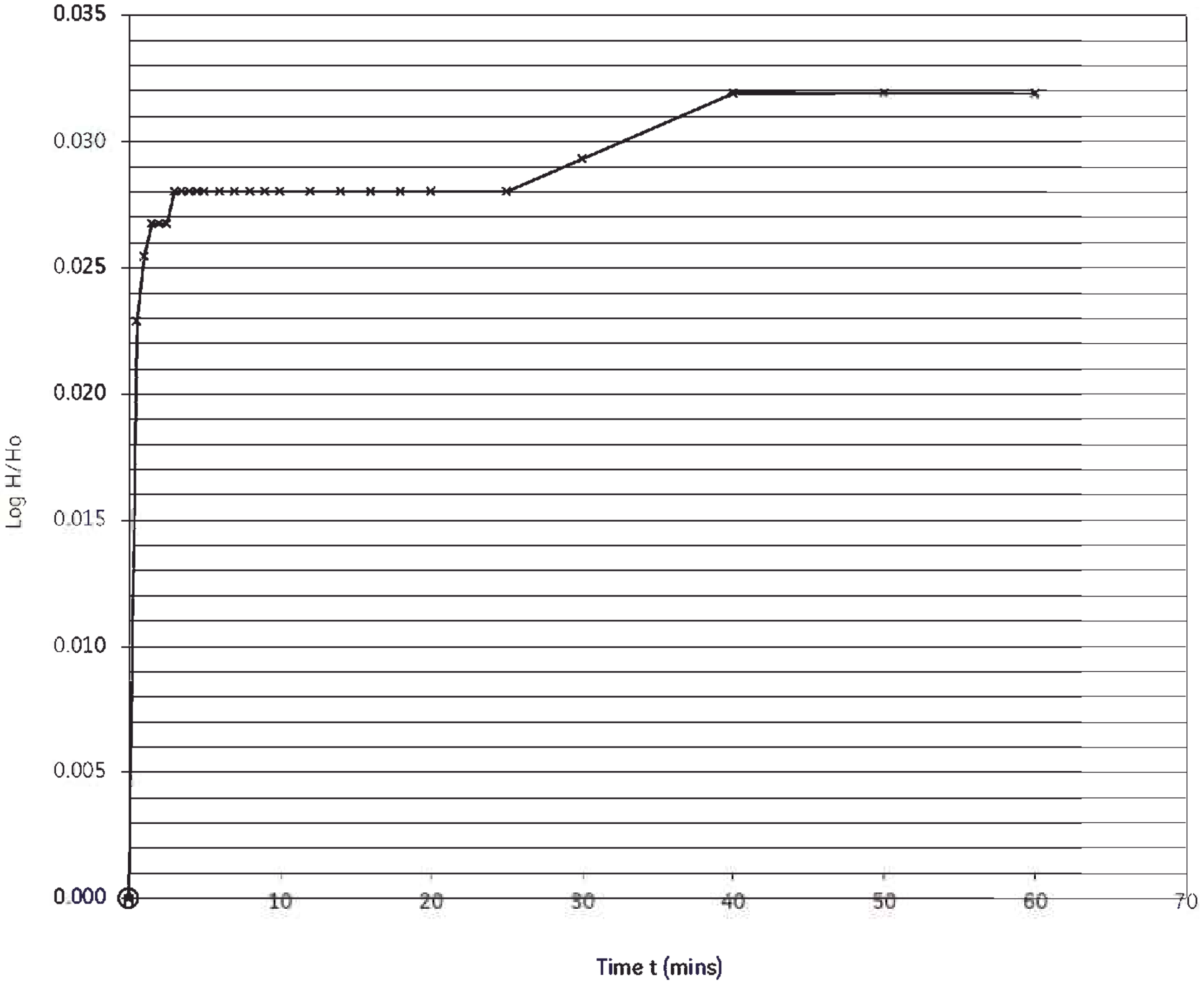
Recorded by: Andrew Yuen

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test**	Hole ID BH_TUN_005B
Project No.	TE8364		Ground Level 6.69m AOD
Engineer	Mott MacDonald Bentley		Date 29/10/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 2 of 2
Description	Firm thinly laminated fissured bluish grey CLAY. (GAULT CLAY FORMATION)		

Type of test	Standpipe	Installation type	Well point or hole extended in uniform soil			
Initial ground water level	2.04	m	Top of test section	7.00	m BGL	
Height of casing above surface	0.80	m	Bottom of test section	10.00	m BGL	
Length of test section	3.00	m	Water level at end of test	9.75	m	
Diameter of test section	50	mm	Diameter of casing/standpipe	50	mm	

Quality of water used	Water from borehole	Test start time	09:00
Weather	Fine	Test finish time	10:00



using Velocity graph method $k = \alpha . S/F$ = 5.05×10^{-10} m/s

where $\alpha = 1.425 \times 10^{-6}\ sec^{-1}$

$S = 0.001963 m^2$

$F = 5.539m$

Recorded by: Andrew Yuen			SOIL ENGINEERING
Form No. SE PGR F 003	Revision No. 3.04	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_TUN_016
Project No.	TE8364		Ground Level 10.19m AOD
Engineer	Mott MacDonald Bentley		Date 15/11/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2

Description: Extremely weak to very weak low to medium density yellowish brown CHALK composed of calcareous SILTSTONE.

Type of test	Standpipe	Installation type				
All depths are relative to ground level.						
Initial ground water level	4.89	m	Top of test section	1.50	m	
Height of casing above surface	0.49	m	Bottom of test section	10.80	m	
Length of test section	9.30	m	Water level at end of test	4.84	m	
Diameter of test section	150	mm	Diameter of casing/standpipe	50	mm	
Quality of water used	Clean and fresh		Test start time	10:30		
Weather	Fine		Test finish time	10:35		

Time Minutes	Depth to water m	H	Log H/H0	Time Minutes	Depth to water m	H	Log H/H0
0	4.30	0.59	0.00				
0.5	4.45	0.44	0.29				
1	4.53	0.36	0.49				
1.5	4.61	0.28	0.75				
2	4.66	0.23	0.94				
2.5	4.70	0.19	1.13				
3	4.76	0.13	1.51				
3.5	4.79	0.10	1.77				
4	4.82	0.07	2.13				
4.5	4.84	0.05	2.47				

Remarks

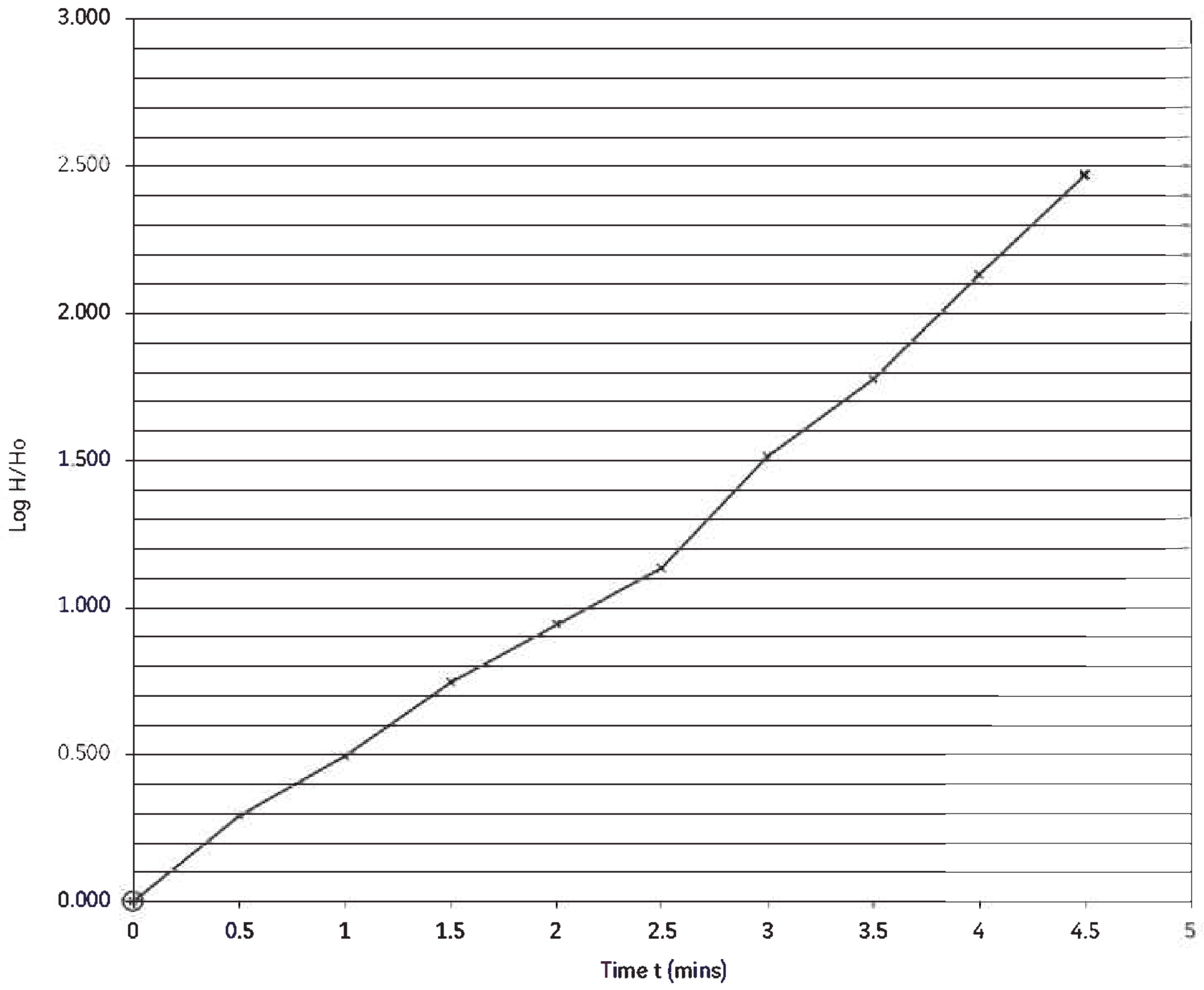
SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_TUN_016
Project No.	TE8364		Ground Level 10.19m AOD
Engineer	Mott MacDonald Bentley		Date 15/11/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 2 of 2

Description Extremely weak to very weak low to medium density yellowish brown CHALK composed of calcareous SILTSTONE.

Type of test Standpipe	Installation type				
Initial ground water level	4.89	m	Top of test section	1.50	m BGL
Height of casing above surface	0.49	m	Bottom of test section	10.80	m BGL
Length of test section	9.30	m	Water level at end of test	4.84	m
Diameter of test section	150	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Clean and fresh	Test start time	10:30
Weather	Fine	Test finish time	10:35



using Velocity graph method $k = \alpha . S/F$ = 1.48×10^{-6} m/s

where $\alpha = 0.009141\ sec^{-1}$

$S = 0.001963 m^2$

$F = 12.116m$

Form No. SE PGR F 003	Revision No. 3.04	Issue Date 24/01/2014	SOIL ENGINEERING Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test**	Hole ID BH_TUN_016
Project No.	TE8364		Ground Level 10.19m AOD
Engineer	Mott MacDonald Bentley		Date 11/11/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2

Description Extremely weak to very weak low to medium density yellowish brown CHALK composed of calcareous SILTSTONE.

Type of test	Standpipe		Installation type	Well point or hole extended in uniform soil		
All depths are relative to ground level.						
Initial ground water level	5.00	m		Top of test section	1.50	m
Height of casing above surface	0.49	m		Bottom of test section	10.80	m
Length of test section	9.30	m		Water level at end of test	5.01	m
Diameter of test section	50	mm		Diameter of casing/standpipe	50	mm

Quality of water used	Water from borehole	Test start time	10:00
Weather	Raining	Test finish time	10:08

Time Minutes	Depth to water m	H	Log H/H0		Time Minutes	Depth to water m	H	Log H/H0
0	6.92	1.92	0.00					
0.5	6.51	1.51	0.24					
1	5.95	0.95	0.70					
1.5	5.74	0.74	0.95					
2	5.46	0.46	1.43					
2.5	5.24	0.24	2.08					
3	5.20	0.20	2.26					
3.5	5.17	0.17	2.42					
4	5.12	0.12	2.77					
4.5	5.09	0.09	3.06					
5	5.05	0.05	3.65					
6	5.03	0.03	4.16					
7	5.02	0.02	4.56					
8	5.01	0.01	5.26					

Remarks

Purged 87 litres in 18 minutes

Recorded by: Andrew Yuen

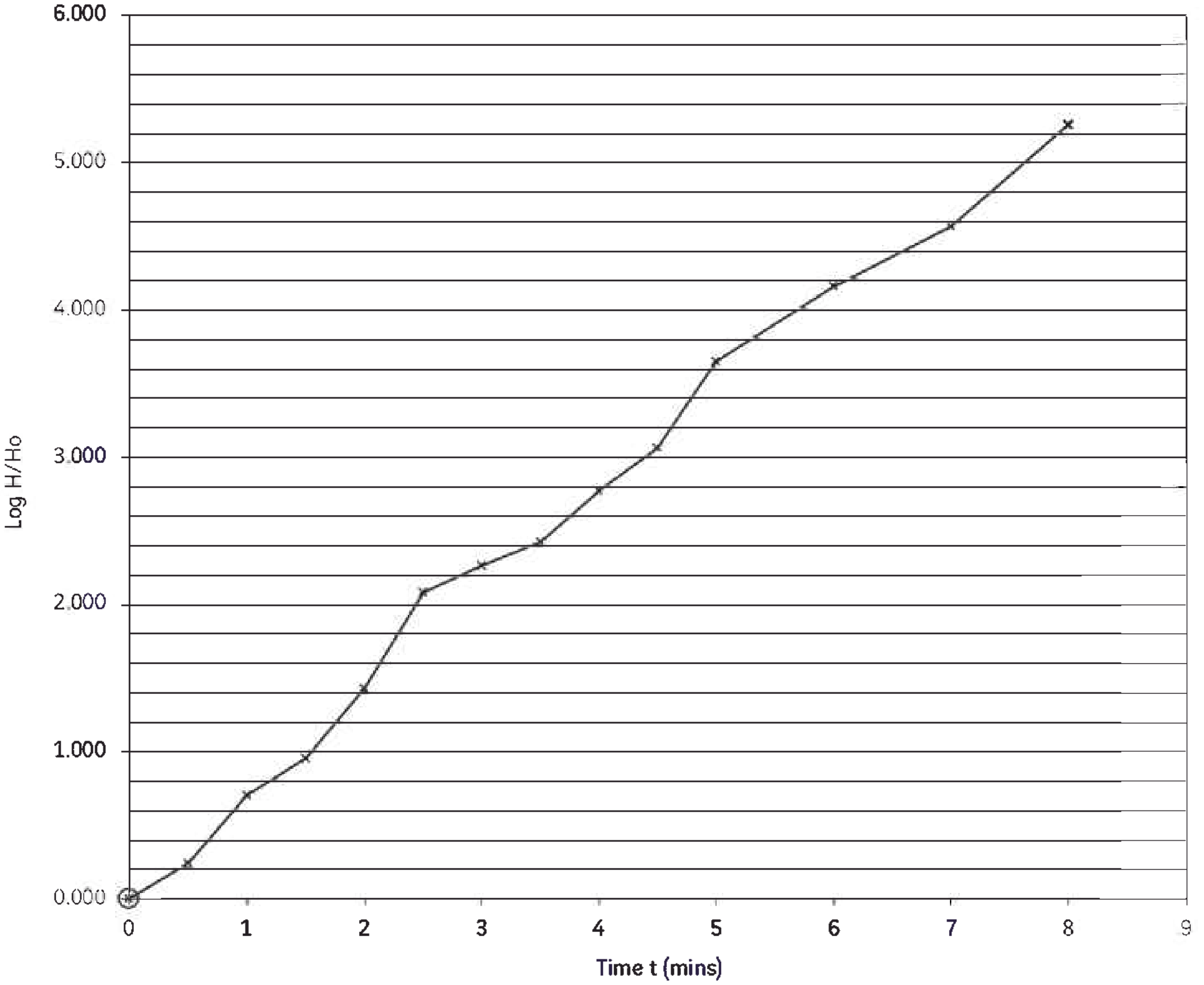
SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test** BS EN ISO 22282-2: 2012	Hole ID BH_TUN_016
Project No.	TE8364		Ground Level 10.19m AOD
Engineer	Mott MacDonald Bentley		Date 11/11/2021
Client	Barhale Limited		Page 2 of 2

Description Extremely weak to very weak low to medium density yellowish brown CHALK composed of calcareous SILTSTONE.

Type of test	Standpipe	Installation type	Well point or hole extended in uniform soil			
Initial ground water level	5.00	m	Top of test section	1.50	m BGL	
Height of casing above surface	0.49	m	Bottom of test section	10.80	m BGL	
Length of test section	9.30	m	Water level at end of test	5.01	m	
Diameter of test section	50	mm	Diameter of casing/standpipe	50	mm	

Quality of water used	Water from borehole	Test start time	10:00
Weather	Raining	Test finish time	10:08



using Velocity graph method $k = \alpha . S/F$ = 1.77×10^{-6} m/s

where $\alpha = 0.01095\ sec^{-1}$

$S = 0.001963 m^2$

$F = 12.116m$

Recorded by: Andrew Yuen			SOIL ENGINEERING Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test**	Hole ID BH_TUN_016
Project No.	TE8364		Ground Level 10.19m AOD
Engineer	Mott MacDonald Bentley		Date 11/11/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2

Description Extremely weak to very weak low to medium density yellowish brown CHALK composed of calcareous SILTSTONE.

Type of test	Standpipe	Installation type				
All depths are relative to ground level.						
Initial ground water level	5.00	m	Top of test section		1.50	m
Height of casing above surface	0.49	m	Bottom of test section		10.80	m
Length of test section	9.30	m	Water level at end of test		5.02	m
Diameter of test section	50	mm	Diameter of casing/standpipe		50	mm
Quality of water used	Water from borehole		Test start time		15:30	
Weather	Raining		Test finish time		15:38	

Time Minutes	Depth to water m	H	Log H/H0	Time Minutes	Depth to water m	H	Log H/H0
0	6.68	1.68	0.00				
0.5	6.30	1.30	0.26				
1	6.12	1.12	0.41				
1.5	5.94	0.94	0.58				
2	5.84	0.84	0.69				
2.5	5.72	0.72	0.85				
3	5.60	0.60	1.03				
3.5	5.44	0.44	1.34				
4	5.26	0.26	1.87				
4.5	5.18	0.18	2.23				
5	5.11	0.11	2.73				
6	5.06	0.06	3.33				
7	5.02	0.02	4.43				
8	5.01	0.01	5.12				

Remarks

Purged 87 litres in 18 minutes

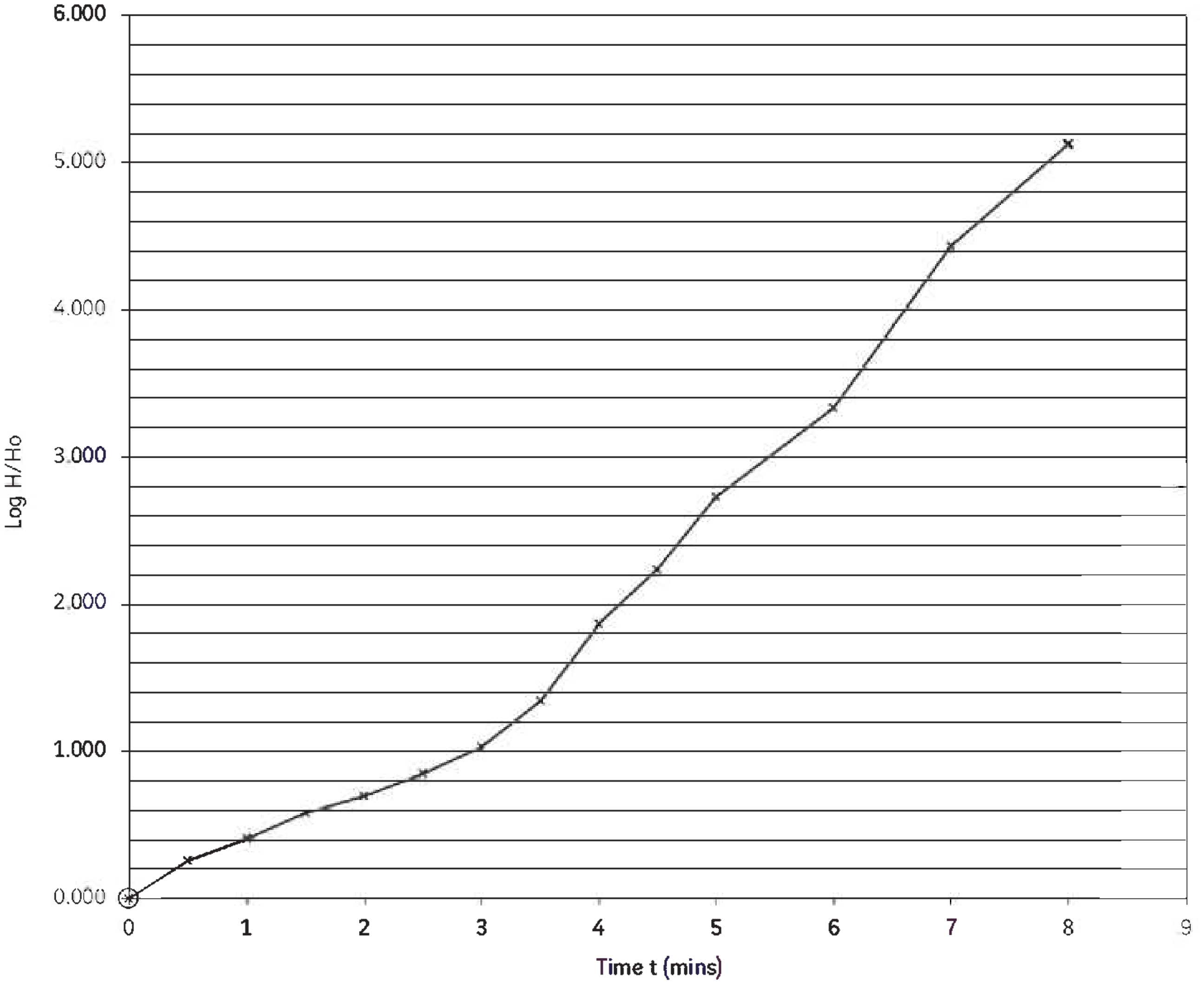
Recorded by: Andrew Yuen

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test** BS EN ISO 22282-2: 2012	Hole ID BH_TUN_016
Project No.	TE8364		Ground Level 10.19m AOD
Engineer	Mott MacDonald Bentley		Date 11/11/2021
Client	Barhale Limited		Page 2 of 2
Description	Extremely weak to very weak low to medium density yellowish brown CHALK composed of calcareous SILTSTONE.		

Type of test Standpipe	Installation type				
Initial ground water level	5.00	m	Top of test section	1.50	m BGL
Height of casing above surface	0.49	m	Bottom of test section	10.80	m BGL
Length of test section	9.30	m	Water level at end of test	5.02	m
Diameter of test section	50	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Water from borehole	Test start time	15:30
Weather	Raining	Test finish time	15:38



using Velocity graph method $k = \alpha . S/F$ = 1.73×10^{-6} m/s

where α= $0.01068\ sec^{-1}$

$S = 0.001963 m^2$

F= 12.116m

Recorded by: Andrew Yuen			SOIL ENGINEERING
Form No. SE PGR F 003	Revision No. 3.04	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Falling Head Permeability Test**	Hole ID BH_TUN_018
Project No.	TE8364		Ground Level 10.28m AOD
Engineer	Mott MacDonald Bentley		Date 11/11/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 1

Description Structureless CHALK overlying extremely weak to very weak low to medium density CHALK at 3.44m, overlying very weak to weak medium to high density CHALK at 7.70m.

Type of test Standpipe Installation type

All depths are relative to ground level.

Initial ground water level	4.19	m	Top of test section	1.50	m
Height of casing above surface	0.30	m	Bottom of test section	10.20	m
Length of test section	8.70	m	Water level at end of test	4.19	m
Diameter of test section	200	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Clean and fresh	Test start time	07:50
Weather	Raining	Test finish time	07:50

Time Minutes	Depth to water m	H	ln H_0/H		Time Minutes	Depth to water m	H	Log H/H0

Remarks

Test failed. Water level did not change after putting 60 litres of water into standpipe.

Recorded by: Andrew Yuen

SOIL ENGINEERING

Form No.	SE PGR F 002	Revision No.	3.03	Issue Date	01/09/2010

Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test**	Hole ID BH_TUN_018
Project No.	TE8364		Ground Level 10.28m AOD
Engineer	Mott MacDonald Bentley		Date 11/11/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2

Description	Structureless CHALK overlying extremely weak to very weak low to medium density CHALK at 3.44m, overlying very weak to weak medium to high density CHALK at 7.70m.
Type of test	Standpipe Installation type

All depths are relative to ground level.					
Initial ground water level	4.25	m	Top of test section	1.50	m
Height of casing above surface	0.30	m	Bottom of test section	10.20	m
Length of test section	8.70	m	Water level at end of test	4.26	m
Diameter of test section	200	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Water from borehole	Test start time	09:00
Weather	Raining	Test finish time	09:10

Time Minutes	Depth to water m	H	ln H_0/H		Time Minutes	Depth to water m	H	Log H/H0
0	4.50	0.25	0.00					
0.5	4.45	0.20	0.22					
1	4.41	0.16	0.45					
1.5	4.34	0.09	1.02					
2	4.33	0.08	1.14					
2.5	4.32	0.07	1.27					
3	4.30	0.05	1.61					
3.5	4.29	0.04	1.83					
4	4.29	0.04	1.83					
4.5	4.28	0.03	2.12					
5	4.28	0.03	2.12					
6	4.27	0.02	2.53					
7	4.27	0.02	2.53					
8	4.26	0.01	3.22					
9	4.26	0.01	3.22					

Remarks

Purged 90 litres in 20 minutes.

Recorded by: Andrew Yuen

SOIL ENGINEERING

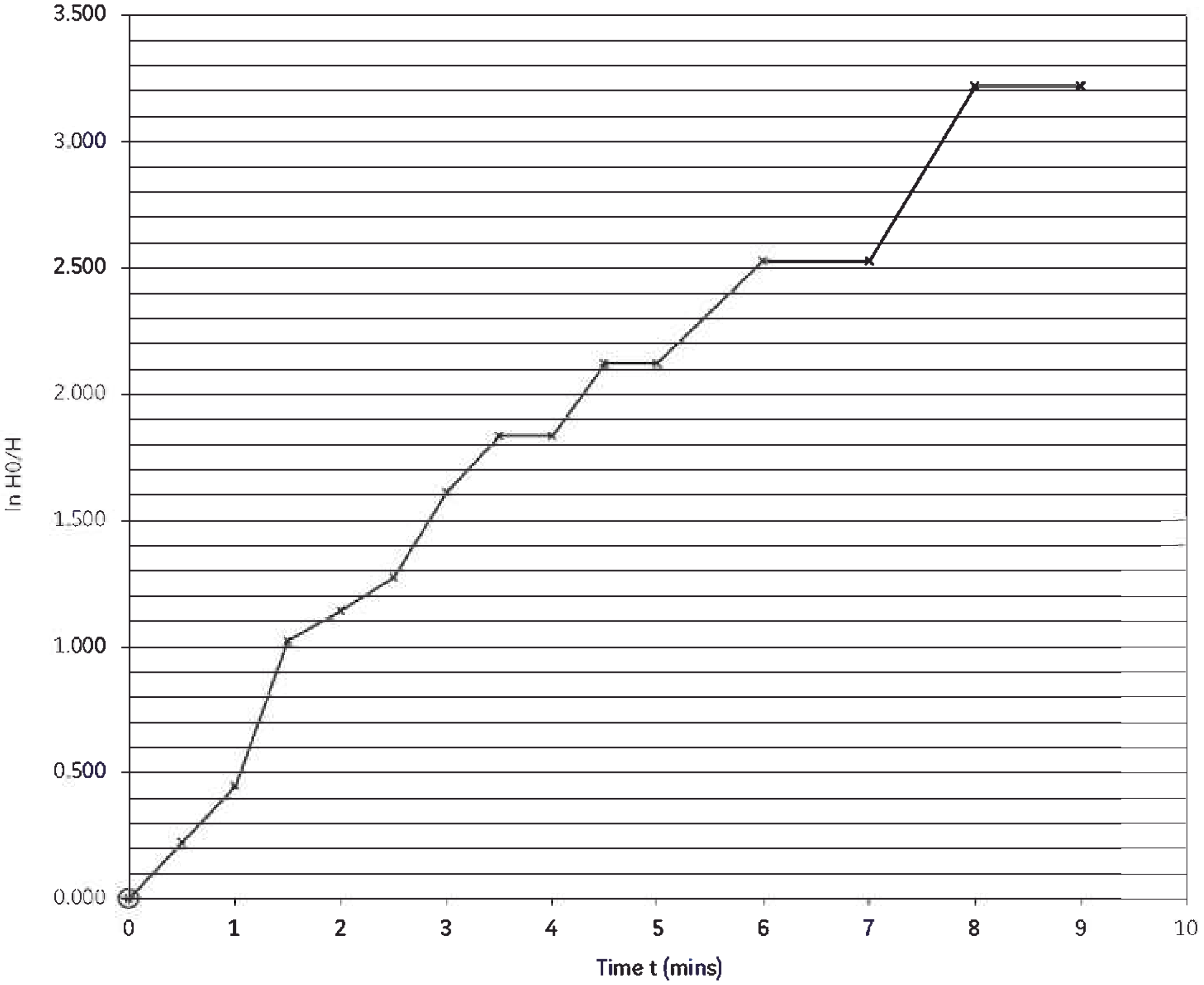
Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test** BS EN ISO 22282-2: 2012	Hole ID BH_TUN_018
Project No.	TE8364		Ground Level 10.28m AOD
Engineer	Mott MacDonald Bentley		Date 11/11/2021
Client	Barhale Limited		Page 2 of 2

Description: Structureless CHALK overlying extremely weak to very weak low to medium density CHALK at 3.44m, overlying very weak to weak medium to high density CHALK at 7.70m.

Type of test: Standpipe — Installation type

Initial ground water level	4.25	m	Top of test section	1.50	m BGL
Height of casing above surface	0.30	m	Bottom of test section	10.20	m BGL
Length of test section	8.70	m	Water level at end of test	4.26	m
Diameter of test section	200	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Water from borehole	Test start time	09:00
Weather	Raining	Test finish time	09:10



using Velocity graph method $k = \alpha . S/F$ = 9.57×10^{-7} m/s

where $\alpha = 0.005963\ sec^{-1}$

$S = 0.001963 m^2$

F= 12.234m

Recorded by: Andrew Yuen			SOIL ENGINEERING Part of the Bachy Soletanche Group
Form No. SE PGR F 003	Revision No. 3.04	Issue Date 24/01/2014	

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test**	Hole ID BH_TUN_018
Project No.	TE8364		Ground Level 10.28m AOD
Engineer	Mott MacDonald Bentley		Date 11/11/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 1 of 2

Description: Structureless CHALK overlying extremely weak to very weak low to medium density CHALK at 3.44m, overlying very weak to weak medium to high density CHALK at 7.70m.

Type of test: Standpipe   Installation type

All depths are relative to ground level.					
Initial ground water level	4.25	m	Top of test section	1.50	m
Height of casing above surface	0.30	m	Bottom of test section	10.20	m
Length of test section	8.70	m	Water level at end of test	4.26	m
Diameter of test section	200	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Water from borehole	Test start time	12:50
Weather	Raining	Test finish time	13:00

Time Minutes	Depth to water m	H	ln H_0/H	Time Minutes	Depth to water m	H	Log H/H0
0	4.52	0.27	0.00				
0.5	4.47	0.22	0.20				
1	4.42	0.17	0.46				
1.5	4.35	0.10	0.99				
2	4.34	0.09	1.10				
2.5	4.32	0.07	1.35				
3	4.31	0.06	1.50				
3.5	4.31	0.06	1.50				
4	4.30	0.05	1.69				
4.5	4.29	0.04	1.91				
5	4.29	0.04	1.91				
6	4.28	0.03	2.20				
7	4.28	0.03	2.20				
8	4.27	0.02	2.60				
9	4.27	0.02	2.60				
10	4.26	0.01	3.30				

Remarks

Purged 90 litres in 20 minutes.

Recorded by: Andrew Yuen

SOIL ENGINEERING

Form No.	SE PGR F 002	Revision No.	3.03	Issue Date	01/09/2010

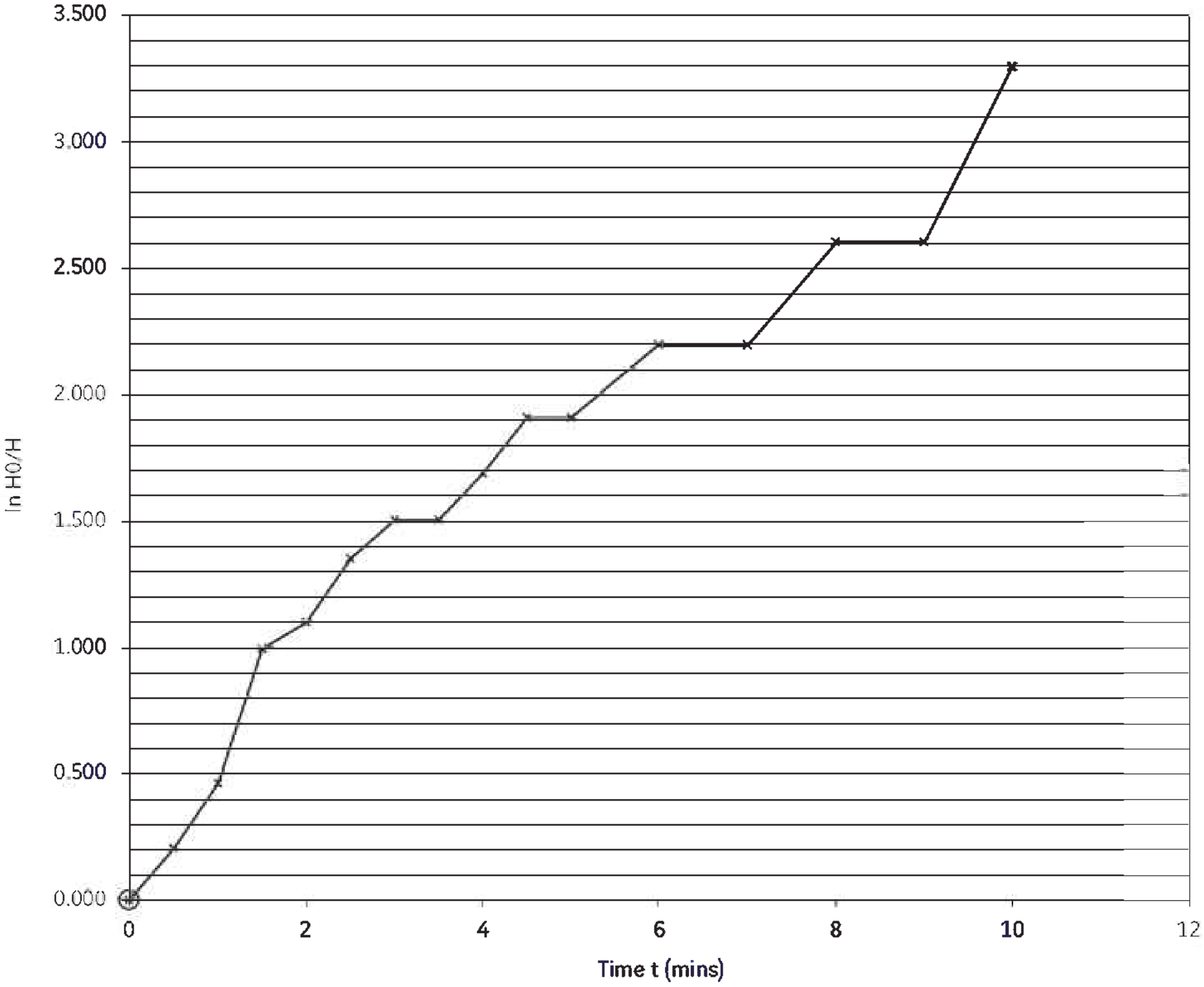
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Borehole Rising Head Permeability Test**	Hole ID BH_TUN_018
Project No.	TE8364		Ground Level 10.28m AOD
Engineer	Mott MacDonald Bentley		Date 11/11/2021
Client	Barhale Limited	BS EN ISO 22282-2: 2012	Page 2 of 2

Description	Structureless CHALK overlying extremely weak to very weak low to medium density CHALK at 3.44m, overlying very weak to weak medium to high density CHALK at 7.70m.
Type of test	Standpipe Installation type

Initial ground water level	4.25	m	Top of test section	1.50	m BGL
Height of casing above surface	0.30	m	Bottom of test section	10.20	m BGL
Length of test section	8.70	m	Water level at end of test	4.26	m
Diameter of test section	200	mm	Diameter of casing/standpipe	50	mm

Quality of water used	Water from borehole	Test start time	12:50
Weather	Raining	Test finish time	13:00



using Velocity graph method $k = \alpha . S/F$ = 8.82×10^{-7} m/s

where $\alpha = 0.0055\ sec^{-1}$

$S = 0.001963 m^2$

F= 12.234m

Recorded by: Andrew Yuen			SOIL ENGINEERING Part of the Bachy Soletanche Group
Form No. SE PGR F 003	Revision No. 3.04	Issue Date 24/01/2014	

SOIL ENGINEERING

SUPPORTING FACTUAL DATA

SECTION A
Exploratory Hole Records and Field Data

GROUNDWATER / GAS MONITORING RESULTS

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Groundwater Readings For Installations**	
Project No.	TE8364		**Sheet No.**
Engineer	Mott MacDonald Bentley		
Client	Barhale Limited		

NOTES: SPIE=Piezometer, SP=Standpipe
For multiple installations at the same depth, use different Installation IDs. Otherwise, the field is optional.
Monitoring point depth for piezometers = tip depth, for standpipes = base of response zone

COMMENTS

	Installation Details				Recorded Water Level								
Exploratory Hole ID	Type	Depth to base of pipe m	Monitoring point depth m	ID	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m
BH_TUN_011	SP	5.00	5.00	S1	15/10/2021	09:47	1.76						

Recorded by:	**Checked by:**	**Approved by:**
Date:	**Date:**	**Date:**

Form No. SE-PGR-F-008 Issue.Revision No. 2.05 Issue Date 24/01/2014

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Groundwater Readings For Installations**	
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		**Sheet No.**
Client	Barhale Limited		

NOTES: SPIE=Piezometer, SP=Standpipe
For multiple installations at the same depth, use different Installation IDs. Otherwise, the field is optional.
Monitoring point depth for piezometers = tip depth, for standpipes = base of response zone

COMMENTS

Exploratory Hole ID	Installation Details				Recorded Water Level								
	Type	Depth to base of pipe m	Monitoring point depth m	ID	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m
BH_STW_013C	SP	1.50	1.50	G1	24/09/2021	10:35	DRY	01/10/2021	12:10	DRY	08/10/2021	09:55	DRY
					15/10/2021	10:23	DRY						

Recorded by:	**Checked by:**	**Approved by:**	soil engineering
Date:	**Date:**	**Date:**	
Form No. SE-PGR-F-008	Issue.Revision No. 2.05	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation
Project No.	TE8364
Engineer	Mott MacDonald Bentley
Client	Barhale Limited

Groundwater Readings For Installations

Sheet No.

NOTES: SPIE=Piezometer, SP=Standpipe
For multiple installations at the same depth, use different Installation IDs. Otherwise, the field is optional.
Monitoring point depth for piezometers = tip depth, for standpipes = base of response zone

COMMENTS

Exploratory Hole ID	Installation Details				Recorded Water Level								
	Type	Depth to base of pipe m	Monitoring point depth m	ID	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m
BH_TUN_018	SP	9.70	10.20	S1	01/10/2021	09:35	3.95	08/10/2021	09:44	3.98	15/10/2021	13:18	4.04

Recorded by:	**Checked by:**	**Approved by:**
Date:	**Date:**	**Date:**
Form No. SE-PGR-F-008	Issue.Revision No. 2.05	Issue Date 24/01/2014

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Groundwater Readings For Installations**	
Project No.	TE8364		**Sheet No.**
Engineer	Mott MacDonald Bentley		
Client	Barhale Limited		

NOTES: SPIE=Piezometer, SP=Standpipe
For multiple installations at the same depth, use different Installation IDs. Otherwise, the field is optional.
Monitoring point depth for piezometers = tip depth, for standpipes = base of response zone

COMMENTS

Exploratory Hole ID	**Installation Details**				Recorded Water Level								
	Type	**Depth to base of pipe** m	Monitoring point depth m	**ID**	**Date** dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	**Reading** m	**Date** dd/mm/yyyy	**Time** hh:mm	Reading m
BH_TUN_016	SP	9.70	10.20	S1	24/09/2021	09:39	4.73	01/10/2021	10:10	4.80	08/10/2021	11:07	4.83
					15/10/2021	11:16	4.86						

Recorded by:	**Checked by:**	**Approved by:**	SOIL ENGINEERING
Date:	**Date:**		
Form No. SE-PGR-F-008	Issue.Revision No. 2.05	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Groundwater Readings For Installations**	
Project No.	TE8364		**Sheet No.**
Engineer	Mott MacDonald Bentley		
Client	Barhale Limited		

NOTES: SPIE=Piezometer, SP=Standpipe
For multiple installations at the same depth, use different Installation IDs. Otherwise, the field is optional.
Monitoring point depth for piezometers = tip depth, for standpipes = base of response zone

COMMENTS

Exploratory Hole ID	**Installation Details**				Recorded Water Level								
	Type	**Depth to base of pipe**	Monitoring point depth	**ID**	**Date**	Time	Reading	Date	Time	Reading	Date	**Time**	Reading
		m	m		**dd/mm/yyyy**	**hh:mm**	m	dd/mm/yyyy	hh:mm	m	dd/mm/yyyy	hh:mm	m
BH_TUN_006	**SP**	**3.50**	3.50	**G1**	**08/10/2021**	**12:17**	**3.71**	08/10/2021	12:17	3.71	15/10/2021	08:39	3.68

Recorded by:	**Checked by:**	**Approved by:**
Date:	**Date:**	**Date:**

Form No. SE-PGR-F-008 Issue.Revision No. 2.05 Issue Date 24/01/2014

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Groundwater Readings For Installations**	
Project No.	TE8364		**Sheet No.**
Engineer	Mott MacDonald Bentley		
Client	Barhale Limited		

NOTES: SPIE=Piezometer, SP=Standpipe
For multiple installations at the same depth, use different Installation IDs. Otherwise, the field is optional.
Monitoring point depth for piezometers = tip depth, for standpipes = base of response zone

COMMENTS

Exploratory Hole ID	Installation Details				Recorded Water Level								
	Type	Depth to base of pipe	Monitoring point depth	ID	Date	Time	Reading	Date	Time	Reading	Date	Time	Reading
		m	m		dd/mm/yyyy	hh:mm	m	dd/mm/yyyy	hh:mm	m	dd/mm/yyyy	hh:mm	m
BH_TUN_006	SP	6.00	6.00	S1	08/10/2021	12:16	4.47	08/10/2021	12:16	4.47	15/10/2021	08:38	4.41

Recorded by:	Checked by:	Approved by:
Date:	Date:	Date:

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Form No. SE-PGR-F-008 Issue.Revision No. 2.05 Issue Date 24/01/2014

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Groundwater Readings For Installations**	
Project No.	TE8364		**Sheet No.**
Engineer	Mott MacDonald Bentley		
Client	Barhale Limited		

NOTES: SPIE=Piezometer, SP=Standpipe
For multiple installations at the same depth, use different Installation IDs. Otherwise, the field is optional.
Monitoring point depth for piezometers = tip depth, for standpipes = base of response zone

COMMENTS

Exploratory Hole ID	Installation Details				Recorded Water Level								
	Type	Depth to base of pipe m	Monitoring point depth m	ID	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m
BH_TUN_005B	SP	10.00	10.00	S1	28/09/2021	11:56	4.39	01/10/2021	10:30	4.45	08/10/2021	12:08	1.97
					15/10/2021	08:24	1.91						

Recorded by:	**Checked by:**	**Approved by:**
Date:	**Date:**	**Date:**
Form No. SE-PGR-F-008	Issue.Revision No. 2.05	Issue Date 24/01/2014

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Groundwater Readings For Installations**	
Project No.	TE8364		**Sheet No.**
Engineer	Mott MacDonald Bentley		
Client	Barhale Limited		

NOTES: SPIE=Piezometer, SP=Standpipe
For multiple installations at the same depth, use different Installation IDs. Otherwise, the field is optional.
Monitoring point depth for piezometers = tip depth, for standpipes = base of response zone

COMMENTS

	Installation Details				Recorded Water Level								
Exploratory Hole ID	Type	**Depth to base of pipe**	Monitoring point depth	ID	**Date**	Time	Reading	Date	Time	Reading	Date	**Time**	Reading
		m	m		**dd/mm/yyyy**	**hh:mm**	m	dd/mm/yyyy	hh:mm	m	dd/mm/yyyy	hh:mm	m
BH_TUN_001PM	SP	1.50	1.50	G1	24/09/2021	10:21	1.23	01/10/2021	10:25	1.28	08/10/2021	12:01	1.29
					15/10/2021	08:17	1.27						

Recorded by:	**Checked by:**	**Approved by:**
Date:	**Date:**	**Date:**
Form No. SE-PGR-F-008	Issue Revision No. 2.05	Issue Date 24/01/2014

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name Cambridge Waste Water Treatment Plant Relocation
Project No. TE8364
Engineer Mott MacDonald Bentley
Client Barhale Limited

Groundwater Readings For Installations

Sheet No.

NOTES: SPIE=Piezometer, SP=Standpipe
For multiple installations at the same depth, use different Installation IDs. Otherwise, the field is optional.
Monitoring point depth for piezometers = tip depth, for standpipes = base of response zone

COMMENTS

Exploratory Hole ID	Installation Details				Recorded Water Level								
	Type	Depth to base of pipe m	Monitoring point depth m	ID	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m
BH_TUN_001A	SP	4.25	4.75	S1	24/09/2021	10:16	1.28	01/10/2021	10:20	1.35	08/10/2021	11:59	1.30
					15/10/2021	08:19	1.28						

Recorded by:	**Checked by:**	**Approved by:**
Date:	**Date:**	**Date:**

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Form No. SE-PGR-F-008 Issue.Revision No. 2.05 Issue Date 24/01/2014

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Groundwater Readings For Installations**	
Project No.	TE8364		**Sheet No.**
Engineer	Mott MacDonald Bentley		
Client	Barhale Limited		

NOTES: SPIE=Piezometer, SP=Standpipe
For multiple installations at the same depth, use different Installation IDs. Otherwise, the field is optional.
Monitoring point depth for piezometers = tip depth, for standpipes = base of response zone

COMMENTS

	Installation Details				Recorded Water Level								
Exploratory Hole ID	**Type**	**Depth to base of pipe** m	Monitoring point depth m	**ID**	**Date** dd/mm/yyyy	Time **hh:mm**	Reading **m**	Date **dd/mm/yyyy**	Time hh:mm	Reading m	Date **dd/mm/yyyy**	**Time hh:mm**	Reading m
BH_STW_031B	**SP**	**13.60**	**13.60**	**S1**	15/10/2021	**11:01**	**7.39**						

Recorded by:	**Checked by:**	**Approved by:**
Date:	**Date:**	**Date:**
Form No. SE-PGR-F-008	Issue Revision No. 2.05	Issue Date 24/01/2014

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Groundwater Readings For Installations**
Project No.	TE8364	**Sheet No.**
Engineer	Mott MacDonald Bentley	
Client	Barhale Limited	

NOTES:
SPIE=Piezometer, SP=Standpipe
For multiple installations at the same depth, use different Installation IDs. Otherwise, the field is optional.
Monitoring point depth for piezometers = tip depth, for standpipes = base of response zone

COMMENTS

	Installation Details				Recorded Water Level								
Exploratory Hole ID	**Type**	**Depth to base of pipe** m	Monitoring point depth m	**ID**	**Date** dd/mm/yyyy	Time **hh:mm**	Reading **m**	Date **dd/mm/yyyy**	Time hh:mm	Reading m	Date **dd/mm/yyyy**	**Time** **hh:mm**	Reading **m**
BH_STW_010B	**SP**	**12.00**	**12.00**	**S1**	**15/10/2021**	**10:53**	**3.98**						

Recorded by:	**Checked by:**	**Approved by:**	SOIL ENGINEERING
Date:	**Date:**	**Date:**	
Form No. SE-PGR-F-008	Issue Revision No. 2.05	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Groundwater Readings For Installations**	
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		**Sheet No.**
Client	Barhale Limited		

NOTES: SPIE=Piezometer, SP=Standpipe
For multiple installations at the same depth, use different Installation IDs. Otherwise, the field is optional.
Monitoring point depth for piezometers = tip depth, for standpipes = base of response zone

COMMENTS

Exploratory Hole ID	**Installation Details**				Recorded Water Level								
	Type	**Depth to base of pipe**	**Monitoring point depth**	**ID**	**Date**	Time	Reading	Date	Time	Reading	Date	**Time**	Reading
		m	m		dd/mm/yyyy	hh:mm	m	dd/mm/yyyy	hh:mm	m	dd/mm/yyyy	hh:mm	m
BH_FE_001	SP	3.50	3.90	S1	20/08/2021	12:41	1.01	03/09/2021	10:06	1.11	10/09/2021	08:31	1.12
					17/09/2021	08:59	0.93	08/10/2021	11:47	0.88	15/10/2021	09:26	0.91

Recorded by:	**Checked by:**	**Approved by:**	SOIL ENGINEERING
Date:	**Date:**	**Date:**	
Form No. SE-PGR-F-008	Issue.Revision No. 2.05	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Project Name Cambridge Waste Water Treatment Plant Relocation
Project No. TE8364
Engineer Mott MacDonald Bentley
Client Barhale Limited

Groundwater Readings For Installations

Sheet No.

NOTES: SPIE=Piezometer, SP=Standpipe
For multiple installations at the same depth, use different Installation IDs. Otherwise, the field is optional.
Monitoring point depth for piezometers = tip depth, for standpipes = base of response zone

COMMENTS

Exploratory Hole ID	Installation Details				Recorded Water Level								
	Type	Depth to base of pipe m	Monitoring point depth m	ID	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m
BH_FE_002	SP	4.00	5.00	S1	03/09/2021	09:49	2.33	10/09/2021	08:58	2.36	17/09/2021	09:12	2.38
					08/10/2021	11:30	2.39	15/10/2021	09:15	2.32			

Recorded by:	**Checked by:**	**Approved by:**
Date:	**Date:**	**Date:**

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Groundwater Readings For Installations**	
Project No.	TE8364		**Sheet No.**
Engineer	Mott MacDonald Bentley		
Client	Barhale Limited		

NOTES: SPIE=Piezometer, SP=Standpipe
For multiple installations at the same depth, use different Installation IDs. Otherwise, the field is optional.
Monitoring point depth for piezometers = tip depth, for standpipes = base of response zone

COMMENTS

Exploratory Hole ID	**Installation Details**				Recorded Water Level								
	Type	**Depth to base of pipe** m	Monitoring point depth m	**ID**	**Date** **dd/mm/yyyy**	Time **hh:mm**	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	**Time** **hh:mm**	Reading m
BH_STW_001	**SP**	**9.00**	9.50	**S1**	**06/08/2021**	**12:59**	4.54	13/08/2021	10:02	4.42	20/08/2021	**12:27**	4.53
					08/10/2021	**11:13**	**4.81**	**15/10/2021**	**11:21**	**4.83**			

Recorded by:	**Checked by:**	**Approved by:**	SOIL ENGINEERING
Date:	**Date:**	**Date:**	
Form No. SE-PGR-F-008	Issue.Revision No. 2.05	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Project Name Cambridge Waste Water Treatment Plant Relocation
Project No. TE8364
Engineer Mott MacDonald Bentley
Client Barhale Limited

Groundwater Readings For Installations

Sheet No.

NOTES: SPIE=Piezometer, SP=Standpipe
For multiple installations at the same depth, use different Installation IDs. Otherwise, the field is optional.
Monitoring point depth for piezometers = tip depth, for standpipes = base of response zone

COMMENTS

	Installation Details				Recorded Water Level								
Exploratory Hole ID	Type	Depth to base of pipe	Monitoring point depth	ID	Date	Time	Reading	Date	Time	Reading	Date	Time	Reading
		m	m		dd/mm/yyyy	hh:mm	m	dd/mm/yyyy	hh:mm	m	dd/mm/yyyy	hh:mm	m
BH_STW_005A	SP	9.50	10.00	S1	24/09/2021	09:32	3.23	01/10/2021	09:40	3.55	08/10/2021	09:37	3.41
					15/10/2021	10:47	3.43						

Recorded by:
Date:

Checked by:
Date:

Approved by:
Date:

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Form No. SE-PGR-F-008 Issue.Revision No. 2.05 Issue Date 24/01/2014

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Groundwater Readings For Installations**
Project No.	TE8364	
Engineer	Mott MacDonald Bentley	**Sheet No.**
Client	Barhale Limited	

NOTES: SPIE=Piezometer, SP=Standpipe
For multiple installations at the same depth, use different Installation IDs. Otherwise, the field is optional.
Monitoring point depth for piezometers = tip depth, for standpipes = base of response zone

COMMENTS

	Installation Details				Recorded Water Level								
Exploratory Hole ID	**Type**	**Depth to base of pipe** m	**Monitoring point depth** m	**ID**	**Date** dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	**Time** hh:mm	Reading m
BH_STW_009	SP	3.00	12.00	G1	06/08/2021	13:40	DRY	13/08/2021	09:50	DRY	20/08/2021	08:04	DRY
					03/09/2021	09:27	DRY	06/09/2021	08:26	DRY	07/09/2021	08:04	DRY
					08/09/2021	08:20	DRY	09/09/2021	08:14	DRY	10/09/2021	09:34	DRY
					13/09/2021	10:15	DRY	14/09/2021	15:29	DRY	15/09/2021	14:15	DRY
					16/09/2021	08:23	DRY	17/09/2021	13:05	DRY	20/09/2021	10:32	DRY
					21/09/2021	09:13	DRY	22/09/2021	08:03	DRY	23/09/2021	09:17	DRY
					24/09/2021	08:27	DRY	27/09/2021	08:25	DRY	01/10/2021	09:30	DRY
					08/10/2021	09:45	DRY	15/10/2021	11:11	DRY			

Recorded by:	**Checked by:**	**Approved by:**	SOIL ENGINEERING
Date:	**Date:**	**Date:**	
Form No. SE-PGR-F-008	Issue.Revision No. 2.05	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Groundwater Readings For Installations**
Project No.	TE8364	
Engineer	Mott MacDonald Bentley	**Sheet No.**
Client	Barhale Limited	

NOTES: SPIE=Piezometer, SP=Standpipe
For multiple installations at the same depth, use different Installation IDs. Otherwise, the field is optional.
Monitoring point depth for piezometers = tip depth, for standpipes = base of response zone

COMMENTS

Exploratory Hole ID	**Installation Details**				Recorded Water Level								
	Type	**Depth to base of pipe** m	Monitoring point depth m	**ID**	**Date** dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	**Time** hh:mm	Reading m
BH_STW_009	SP	12.00	12.00	S1	06/08/2021	12:34	3.80	13/08/2021	09:50	3.91	20/08/2021	12:57	4.02
					03/09/2021	09:25	4.23	06/09/2021	08:23	4.84	07/09/2021	08:03	4.94
					08/09/2021	08:22	4.96	09/09/2021	08:13	4.96	10/09/2021	09:33	4.36
					13/09/2021	10:14	5.07	14/09/2021	15:28	5.07	15/09/2021	14:16	5.09
					16/09/2021	08:24	5.11	17/09/2021	13:04	4.48	20/09/2021	10:31	5.18
					21/09/2021	09:12	5.20	22/09/2021	08:02	5.21	23/09/2021	09:16	5.21
					24/09/2021	08:26	5.19	27/09/2021	08:24	5.23	01/10/2021	09:30	5.15
					08/10/2021	09:44	4.76	15/10/2021	11:10	4.82			

Recorded by:	**Checked by:**	**Approved by:**
Date:	**Date:**	**Date:**

Form No. SE-PGR-F-008 Issue.Revision No. 2.05 Issue Date 24/01/2014

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Groundwater Readings For Installations**	
Project No.	TE8364		
Engineer	Mott MacDonald Bentley		**Sheet No.**
Client	Barhale Limited		

NOTES: SPIE=Piezometer, SP=Standpipe
For multiple installations at the same depth, use different Installation IDs. Otherwise, the field is optional.
Monitoring point depth for piezometers = tip depth, for standpipes = base of response zone

COMMENTS

Exploratory Hole ID	Installation Details				Recorded Water Level								
	Type	Depth to base of pipe	Monitoring point depth	ID	Date	Time	Reading	Date	Time	Reading	Date	Time	Reading
		m	m		dd/mm/yyyy	hh:mm	m	dd/mm/yyyy	hh:mm	m	dd/mm/yyyy	hh:mm	m
BH_STW_011B	SP	9.20	9.70	S1	24/09/2021	09:13	3.12	01/10/2021	09:45	3.20	08/10/2021	09:13	3.27
					15/10/2021	10:28	3.25						

Recorded by:	**Checked by:**	**Approved by:**	SOIL ENGINEERING
Date:	**Date:**	**Date:**	
Form No. SE-PGR-F-008	Issue.Revision No. 2.05	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Groundwater Readings For Installations

Project Name	Cambridge Waste Water Treatment Plant Relocation
Project No.	TE8364
Engineer	Mott MacDonald Bentley
Client	Barhale Limited

Sheet No.

NOTES: SPIE=Piezometer, SP=Standpipe
For multiple installations at the same depth, use different Installation IDs. Otherwise, the field is optional.
Monitoring point depth for piezometers = tip depth, for standpipes = base of response zone

COMMENTS

Exploratory Hole ID	**Installation Details**				Recorded Water Level								
	Type	**Depth to base of pipe** m	**Monitoring point depth** m	**ID**	**Date** dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	**Time** hh:mm	Reading m
BH_STW_015	SP	3.00	12.00	G1	06/08/2021	13:28	2.97	13/08/2021	09:40	2.98	23/08/2021	08:08	DRY
					03/09/2021	09:01	DRY	06/09/2021	08:36	DRY	07/09/2021	07:47	DRY
					08/09/2021	08:07	DRY	09/09/2021	07:56	DRY	10/09/2021	09:52	DRY
					13/09/2021	09:56	DRY	14/09/2021	15:13	DRY	15/09/2021	13:16	DRY
					16/09/2021	08:15	DRY	17/09/2021	12:53	DRY	20/09/2021	09:38	DRY
					21/09/2021	08:34	DRY	22/09/2021	08:08	DRY	23/09/2021	09:34	DRY
					24/09/2021	08:38	DRY	27/09/2021	08:34	DRY	01/10/2021	09:45	DRY
					08/10/2021	09:19	DRY	15/10/2021	10:31	DRY			

Recorded by:	**Checked by:**	**Approved by:**
Date:	**Date:**	**Date:**

Form No. SE-PGR-F-008 Issue.Revision No. 2.05 Issue Date 24/01/2014

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Groundwater Readings For Installations**	
Project No.	TE8364		**Sheet No.**
Engineer	Mott MacDonald Bentley		
Client	Barhale Limited		

NOTES: SPIE=Piezometer, SP=Standpipe
For multiple installations at the same depth, use different Installation IDs. Otherwise, the field is optional.
Monitoring point depth for piezometers = tip depth, for standpipes = base of response zone

COMMENTS

	Installation Details				Recorded Water Level								
Exploratory Hole ID	**Type**	**Depth to base of pipe** m	**Monitoring point depth** m	**ID**	**Date** dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	**Time** hh:mm	Reading m
BH_STW_015	SP	12.00	12.00	S1	06/08/2021	12:52	2.93	13/08/2021	09:37	3.02	20/08/2021	11:59	3.15
					03/09/2021	09:12	3.37	06/09/2021	08:34	3.81	07/09/2021	07:46	3.82
					08/09/2021	08:06	3.82	09/09/2021	07:57	3.83	10/09/2021	09:51	3.52
					13/09/2021	09:55	3.91	14/09/2021	15:12	3.91	15/09/2021	13:15	3.92
					16/09/2021	08:16	3.95	17/09/2021	12:52	3.62	20/09/2021	09:37	3.96
					21/09/2021	08:33	4.01	22/09/2021	08:07	4.02	23/09/2021	09:33	4.01
					24/09/2021	08:37	4.03	27/09/2021	08:33	4.02	01/10/2021	09:45	4.03
					08/10/2021	09:18	3.83	15/10/2021	10:32	3.83			

Recorded by:	Checked by:	Approved by:	SOIL ENGINEERING
Date:	Date:	Date:	
Form No. SE-PGR-F-008	Issue.Revision No. 2.05	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Groundwater Readings For Installations**	
Project No.	TE8364		**Sheet No.**
Engineer	Mott MacDonald Bentley		
Client	Barhale Limited		

NOTES: SPIE=Piezometer, SP=Standpipe
For multiple installations at the same depth, use different Installation IDs. Otherwise, the field is optional.
Monitoring point depth for piezometers = tip depth, for standpipes = base of response zone

COMMENTS

Exploratory Hole ID	**Installation Details**				Recorded Water Level								
	Type	**Depth to base of pipe** m	Monitoring point depth m	**ID**	**Date** **dd/mm/yyyy**	Time **hh:mm**	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	**Time** hh:mm	Reading m
BH_STW_018	SP	11.70	12.20	S1	24/09/2021	09:25	3.37	01/10/2021	09:50	3.65	08/10/2021	09:22	3.61
					15/10/2021	10:36	3.62						

Recorded by:	**Checked by:**	**Approved by:**
Date:	**Date:**	**Date:**

Form No. SE-PGR-F-008 Issue.Revision No. 2.05 Issue Date 24/01/2014

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Groundwater Readings For Installations**	
Project No.	TE8364		**Sheet No.**
Engineer	Mott MacDonald Bentley		
Client	Barhale Limited		

NOTES: SPIE=Piezometer, SP=Standpipe
For multiple installations at the same depth, use different Installation IDs. Otherwise, the field is optional.
Monitoring point depth for piezometers = tip depth, for standpipes = base of response zone

COMMENTS

Exploratory Hole ID	Installation Details				Recorded Water Level								
	Type	Depth to base of pipe	Monitoring point depth	ID	Date	Time	Reading	Date	Time	Reading	Date	Time	Reading
		m	m		dd/mm/yyyy	hh:mm	m	dd/mm/yyyy	hh:mm	m	dd/mm/yyyy	hh:mm	m
BH_STW_022A	SP	2.00	2.00	S1	24/09/2021	09:02	1.71	01/10/2021	10:00	1.87	08/10/2021	08:53	1.84
					15/10/2021	10:13	1.94						

Recorded by:	**Checked by:**	**Approved by:**	SOIL ENGINEERING
Date:	**Date:**	**Date:**	
Form No. SE-PGR-F-008	Issue Revision No. 2.05	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Groundwater Readings For Installations**	
Project No.	TE8364		**Sheet No.**
Engineer	Mott MacDonald Bentley		
Client	Barhale Limited		

NOTES: SPIE=Piezometer, SP=Standpipe
For multiple installations at the same depth, use different Installation IDs. Otherwise, the field is optional.
Monitoring point depth for piezometers = tip depth, for standpipes = base of response zone

COMMENTS

	Installation Details				Recorded Water Level								
Exploratory Hole ID	**Type**	**Depth to base of pipe** m	**Monitoring point depth** m	**ID**	**Date** dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	**Time** hh:mm	Reading m
BH_STW_023	SP	14.00	14.50	S1	06/08/2021	12:44	2.51	13/08/2021	09:25	2.49	20/08/2021	12:08	2.67
					03/09/2021	09:16	2.85	10/09/2021	09:59	3.00	17/09/2021	13:13	3.09
					08/10/2021	09:27	3.41	15/10/2021	10:41	3.44			

Recorded by:	**Checked by:**	**Approved by:**
Date:	Date:	Date:

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Form No. SE-PGR-F-008 Issue.Revision No. 2.05 Issue Date 24/01/2014

Project Name Cambridge Waste Water Treatment Plant Relocation
Project No. TE8364
Engineer Mott MacDonald Bentley
Client Barhale Limited

Groundwater Readings For Installations

Sheet No.

NOTES: SPIE=Piezometer, SP=Standpipe
For multiple installations at the same depth, use different Installation IDs. Otherwise, the field is optional.
Monitoring point depth for piezometers = tip depth, for standpipes = base of response zone

COMMENTS

	Installation Details				Recorded Water Level								
Exploratory Hole ID	Type	Depth to base of pipe m	Monitoring point depth m	ID	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m
BH_STW_024	SP	11.00	11.50	S1	06/08/2021	11:59	1.90	13/08/2021	10:16	1.92	20/08/2021	11:35	1.94
					03/09/2021	08:41	2.07	10/09/2021	11:21	2.10	17/09/2021	12:23	2.12
					08/10/2021	08:58	2.17	15/10/2021	10:09	2.14			

Recorded by:	Checked by:	Approved by:
Date:	Date:	Date:

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Form No. SE-PGR-F-008 Issue.Revision No. 2.05 Issue Date 24/01/2014

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Groundwater Readings For Installations**	
Project No.	TE8364		**Sheet No.**
Engineer	Mott MacDonald Bentley		
Client	Barhale Limited		

NOTES: SPIE=Piezometer, SP=Standpipe
For multiple installations at the same depth, use different Installation IDs. Otherwise, the field is optional.
Monitoring point depth for piezometers = tip depth, for standpipes = base of response zone

COMMENTS

Exploratory Hole ID	Installation Details				Recorded Water Level								
	Type	Depth to base of pipe m	Monitoring point depth m	ID	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m
BH_STW_025	SP	8.50	9.00	S1	06/08/2021	12:17	2.02	13/08/2021	10:25	2.05	20/08/2021	11:53	2.04
					03/09/2021	08:59	2.05	10/09/2021	11:47	2.11	17/09/2021	12:41	2.11
					08/10/2021	08:43	2.24	15/10/2021	09:59	2.20			

Recorded by:	Checked by:	Approved by:	SOIL ENGINEERING
Date:	Date:	Date:	
Form No. SE-PGR-F-008	Issue.Revision No. 2.05	Issue Date 24/01/2014	Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Groundwater Readings For Installations**	
Project No.	TE8364		**Sheet No.**
Engineer	Mott MacDonald Bentley		
Client	Barhale Limited		

NOTES: SPIE=Piezometer, SP=Standpipe
For multiple installations at the same depth, use different Installation IDs. Otherwise, the field is optional.
Monitoring point depth for piezometers = tip depth, for standpipes = base of response zone

COMMENTS

Exploratory Hole ID	Installation Details				Recorded Water Level								
	Type	Depth to base of pipe m	Monitoring point depth m	ID	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m	Date dd/mm/yyyy	Time hh:mm	Reading m
BH_STW_026	SP	9.50	10.00	S1	06/08/2021	12:09	2.40	13/08/2021	10:30	2.37	20/08/2021	11:48	2.38
					03/09/2021	08:52	2.39	10/09/2021	11:35	2.40	17/09/2021	12:32	2.45
					08/10/2021	09:04	2.54	15/10/2021	10:05	1.50			

Recorded by:	Checked by:	Approved by:
Date:	Date:	Date:

Form No. SE-PGR-F-008 Issue.Revision No. 2.05 Issue Date 24/01/2014

SOIL ENGINEERING
Part of the Bachy Soletanche Group

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Record Of Gas Monitoring**	**Location ID** **BH_STW_009**
Project No.	TE8364		**Monitoring point ID** G1
Engineer	Mott MacDonald Bentley		Monitoring round number 01
Client	Barhale Limited		Date 19/10/2021

Monitoring point information

Distance to monitoring point	m	12.00	Initial base depth	m	3.00
Top of response zone	m	1.50	Base of response zone	m	12.00
Installation type		SP			
Condition of monitoring point		Good			

Preceding atmospheric conditions for three days (nominally at noon)

		Day 1	Day 2	Day 3
Date/time of reading				
Atmospheric pressure	mbar			
Description of previous days weather				

Equipment details

Equipment type	GA5000	Equipment serial number	GA501940
Date equipment last calibrated	20/07/2021		
Has equipment been zeroed	Yes	Time equipment zeroed	

Incidental information

Description of weather conditions during monitoring	Overcast
Ground conditions at the time of monitoring	Dry

Barometric / air readings

Barometric pressure trend		Stable		
		Barometric	Relative	
Time of reading	hh:mm:ss	15:25:00	15:25:00	
Pressure	mbar	1009	1009	
		Ambient air temperature		
Time of reading	hh:mm:ss	15:25:00		
Temperature	°C	17.0		

Gas readings

			Peak		Steady	
Determinand	LoD	Unit	Reading	Time	Reading	Time
Methane	0.1	%v/v	0.1	15:27:00	0.1	15:30:00
Methane (LEL)	1	%	2	15:27:00	2	15:30:00
Carbon Dioxide	0.1	%v/v	1.9	15:27:00	1.8	15:30:00
Oxygen	0.1	%v/v	20.5	15:27:00	20.4	15:30:00
Carbon Monoxide	1	ppm	1	15:27:00	<1	15:30:00
Hydrogen Sulfide	1	ppm	1	15:27:00	<1	15:30:00
Gas Flow	0.1	l/hr	0.1	15:25:00	0.1	15:26:00

Further information

		Groundwater level	Installation base		
Time of reading	hh:mm:ss	15:35:00	15:35:00		
Reading	m	DRY	3.06		

Remarks

Monitored by:	Checked by:	Approved by:
Form No. SE-EMS-F-002	Revision No. 3.00	Issue Date 01/02/2021

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Record Of Gas Monitoring**	**Location ID** BH_STW_009
Project No.	TE8364		Monitoring point ID G1
Engineer	Mott MacDonald Bentley		Monitoring round number 02
Client	Barhale Limited		Date 02/11/2021

Monitoring point information					
Distance to monitoring point	m	12.00	Initial base depth	m	3.00
Top of response zone	m	1.50	Base of response zone	m	12.00
Installation type		SP			
Condition of monitoring point		Good			

Preceding atmospheric conditions for three days (nominally at noon)			
	Day 1	Day 2	Day 3
Date/time of reading			
Atmospheric pressure mbar			
Description of previous days weather			

Equipment details			
Equipment type	GA5000	Equipment serial number	GA501940
Date equipment last calibrated	20/07/2021		
Has equipment been zeroed	Yes	Time equipment zeroed	

Incidental information	
Description of weather conditions during monitoring	Clear
Ground conditions at the time of monitoring	Dry

Barometric / air readings				
Barometric pressure trend		Stable		
		Barometric	Relative	
Time of reading	hh:mm:ss	11:49:00	11:49:00	
Pressure	mbar	997	997	
		Ambient air temperature		
Time of reading	hh:mm:ss	11:49:00		
Temperature	°C	9.0		

Gas readings						
			Peak		Steady	
Determinand	LoD	Unit	Reading	Time	Reading	Time
Methane	0.1	%v/v	<0.1	11:52:00	<0.1	11:55:00
Methane (LEL)	1	%	<1	11:52:00	<1	11:55:00
Carbon Dioxide	0.1	%v/v	1.9	11:52:00	1.9	11:55:00
Oxygen	0.1	%v/v	21.1	11:52:00	18.6	11:55:00
Carbon Monoxide	1	ppm	<1	11:52:00	<1	11:55:00
Hydrogen Sulfide	1	ppm	<1	11:52:00	<1	11:55:00
Gas Flow	0.1	l/hr	<0.1	11:50:00	<0.1	11:51:00

Further information					
		Groundwater level	Installation base		
Time of reading	hh:mm:ss	11:56:00	11:56:00		
Reading	m	DRY	3.06		

Remarks

Monitored by:	Checked by:	Approved by:	SOIL ENGINEERING
Form No. SE-EMS-F-002	Revision No. 3.00	Issue Date 01/02/2021	

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Record Of Gas Monitoring**	**Location ID** BH_STW_009
Project No.	TE8364		Monitoring point ID G1
Engineer	Mott MacDonald Bentley		Monitoring round number 02
Client	Barhale Limited		Date 08/11/2021

Monitoring point information					
Distance to monitoring point	m	12.00	Initial base depth	m	3.00
Top of response zone	m	1.50	Base of response zone	m	12.00
Installation type		SP			
Condition of monitoring point		Good			

Preceding atmospheric conditions for three days (nominally at noon)				
		Day 1	Day 2	Day 3
Date/time of reading				
Atmospheric pressure	mbar			
Description of previous days weather				

Equipment details			
Equipment type	GA5000	Equipment serial number	GA501940
Date equipment last calibrated	20/07/2021		
Has equipment been zeroed	Yes	Time equipment zeroed	

Incidental information	
Description of weather conditions during monitoring	Clear
Ground conditions at the time of monitoring	Dry

Barometric / air readings				
Barometric pressure trend		Stable		
		Barometric	Relative	
Time of reading	hh:mm:ss	11:33:00	11:33:00	
Pressure	mbar	1022	1022	
		Ambient air temperature		
Time of reading	hh:mm:ss	11:33:00		
Temperature	°C	7.0		

Gas readings						
			Peak		Steady	
Determinand	LoD	Unit	Reading	Time	Reading	Time
Methane	0.1	%v/v	<0.1	11:36:00	<0.1	11:39:00
Methane (LEL)	1	%	<1	11:36:00	<1	11:39:00
Carbon Dioxide	0.1	%v/v	1.9	11:36:00	1.9	11:39:00
Oxygen	0.1	%v/v	20.9	11:36:00	18.6	11:39:00
Carbon Monoxide	1	ppm	<1	11:36:00	<1	11:39:00
Hydrogen Sulfide	1	ppm	<1	11:36:00	<1	11:39:00
Gas Flow	0.1	l/hr	<0.1	11:34:00	<0.1	11:35:00

Further information					
		Groundwater level	Installation base		
Time of reading	hh:mm:ss	11:40:00	11:40:00		
Reading	m	DRY	3.07		

Remarks

Monitored by:	Checked by:	Approved by:	SOIL ENGINEERING
Form No. SE-EMS-F-002	Revision No. 3.00	Issue Date 01/02/2021	

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Record Of Gas Monitoring**	**Location ID** BH_STW_013C
Project No.	TE8364		**Monitoring point ID** G1
Engineer	Mott MacDonald Bentley		Monitoring round number 01
Client	Barhale Limited		Date 19/10/2021

Monitoring point information					
Distance to monitoring point	m	1.50	**Initial base depth**	m	1.50
Top of response zone	m	0.50	**Base of response zone**	m	1.50
Installation type		SP			
Condition of monitoring point		Good			

Preceding atmospheric conditions for three days (nominally at noon)			
	Day 1	Day 2	Day 3
Date/time of reading			
Atmospheric pressure mbar			
Description of previous days weather			

Equipment details			
Equipment type	GA5000	Equipment serial number	GA501940
Date equipment last calibrated	20/07/2021		
Has equipment been zeroed	Yes	Time equipment zeroed	

Incidental information	
Description of weather conditions during monitoring	Overcast
Ground conditions at the time of monitoring	Dry

Barometric / air readings				
Barometric pressure trend		Stable		
		Barometric	Relative	
Time of reading	hh:mm:ss	15:10:00	15:10:00	
Pressure	mbar	1008	1008	
		Ambient air temperature		
Time of reading	hh:mm:ss	15:10:00		
Temperature	°C	20.0		

Gas readings						
			Peak		Steady	
Determinand	LoD	Unit	Reading	Time	Reading	Time
Methane	0.1	%v/v	0.1	15:10:00	0.1	15:13:00
Methane (LEL)	1	%	2	15:10:00	2	15:13:00
Carbon Dioxide	0.1	%v/v	0.2	15:10:00	0.2	15:13:00
Oxygen	0.1	%v/v	21.0	15:10:00	20.7	15:13:00
Carbon Monoxide	1	ppm	1	15:10:00	<1	15:13:00
Hydrogen Sulfide	1	ppm	1	15:10:00	<1	15:13:00
Gas Flow	0.1	l/hr	0.1	15:08:00	0.1	15:09:00

Further information					
		Groundwater level	Installation base		
Time of reading	hh:mm:ss	15:15:00	15:15:00		
Reading	m	DRY	1.45		

Remarks

Monitored by:	Checked by:	Approved by:	soil engineering
Form No. SE-EMS-F-002	Revision No. 3.00	Issue Date 01/02/2021	

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Record Of Gas Monitoring**	**Location ID** BH_STW_013C
Project No.	TE8364		Monitoring point ID G1
Engineer	Mott MacDonald Bentley		Monitoring round number 02
Client	Barhale Limited		Date 02/11/2021

Monitoring point information					
Distance to monitoring point	m	1.50	Initial base depth	m	1.50
Top of response zone	m	0.50	Base of response zone	m	1.50
Installation type		SP			
Condition of monitoring point		Good			

Preceding atmospheric conditions for three days (nominally at noon)				
		Day 1	Day 2	Day 3
Date/time of reading				
Atmospheric pressure	mbar			
Description of previous days weather				

Equipment details			
Equipment type	GA5000	Equipment serial number	GA501940
Date equipment last calibrated	20/07/2021		
Has equipment been zeroed	Yes	Time equipment zeroed	

Incidental information	
Description of weather conditions during monitoring	Clear
Ground conditions at the time of monitoring	Dry

Barometric / air readings				
Barometric pressure trend		Stable		
		Barometric	Relative	
Time of reading	hh:mm:ss	11:08:00	11:08:00	
Pressure	mbar	997	997	
		Ambient air temperature		
Time of reading	hh:mm:ss	11:08:00		
Temperature	°C	9.0		

Gas readings						
			Peak		Steady	
Determinand	LoD	Unit	Reading	Time	Reading	Time
Methane	0.1	%v/v	<0.1	11:11:00	<0.1	11:14:00
Methane (LEL)	1	%	<1	11:11:00	<1	11:14:00
Carbon Dioxide	0.1	%v/v	0.2	11:11:00	0.2	11:14:00
Oxygen	0.1	%v/v	20.6	11:11:00	20.5	11:14:00
Carbon Monoxide	1	ppm	<1	11:11:00	<1	11:14:00
Hydrogen Sulfide	1	ppm	<1	11:11:00	<1	11:14:00
Gas Flow	0.1	l/hr	<0.1	11:10:00	<0.1	11:11:00

Further information					
		Groundwater level	Installation base		
Time of reading	hh:mm:ss	11:15:00	11:15:00		
Reading	m	DRY	3.00		

Remarks

Monitored by:	Checked by:	Approved by:	soil engineering
Form No. SE-EMS-F-002	Revision No. 3.00	Issue Date 01/02/2021	

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Record Of Gas Monitoring**	**Location ID** BH_STW_013C
Project No.	TE8364		Monitoring point ID G1
Engineer	Mott MacDonald Bentley		Monitoring round number 03
Client	Barhale Limited		Date 08/11/2021

Monitoring point information					
Distance to monitoring point	m	1.50	Initial base depth	m	1.50
Top of response zone	m	0.50	Base of response zone	m	1.50
Installation type		SP			
Condition of monitoring point		Good			

Preceding atmospheric conditions for three days (nominally at noon)			
	Day 1	Day 2	Day 3
Date/time of reading			
Atmospheric pressure mbar			
Description of previous days weather			

Equipment details			
Equipment type	GA5000	Equipment serial number	GA501940
Date equipment last calibrated	20/07/2021		
Has equipment been zeroed	Yes	Time equipment zeroed	

Incidental information	
Description of weather conditions during monitoring	Clear
Ground conditions at the time of monitoring	Dry

Barometric / air readings				
Barometric pressure trend		Stable		
		Barometric	Relative	
Time of reading	hh:mm:ss	11:00:00	11:00:00	
Pressure	mbar	1022	1022	
		Ambient air temperature		
Time of reading	hh:mm:ss	11:00:00		
Temperature	°C	7.0		

Gas readings						
			Peak		Steady	
Determinand	LoD	Unit	Reading	Time	Reading	Time
Methane	0.1	%v/v	<0.1	11:03:00	<0.1	11:06:00
Methane (LEL)	1	%	<1	11:03:00	<1	11:06:00
Carbon Dioxide	0.1	%v/v	0.1	11:03:00	0.1	11:06:00
Oxygen	0.1	%v/v	20.9	11:03:00	20.8	11:06:00
Carbon Monoxide	1	ppm	<1	11:03:00	<1	11:06:00
Hydrogen Sulfide	1	ppm	<1	11:03:00	<1	11:06:00
Gas Flow	0.1	l/hr	<0.1	11:01:00	<0.1	11:02:00

Further information					
		Groundwater level	Installation base		
Time of reading	hh:mm:ss	11:07:00	11:07:00		
Reading	m	DRY	3.00		

Remarks

Monitored by:	Checked by:	Approved by:
Form No. SE-EMS-F-002	Revision No. 3.00	Issue Date 01/02/2021

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Record Of Gas Monitoring**	**Location ID** **BH_STW_015**
Project No.	TE8364		**Monitoring point ID** G1
Engineer	Mott MacDonald Bentley		Monitoring round number 01
Client	Barhale Limited		Date 19/10/2021

Monitoring point information					
Distance to monitoring point	m	12.00	**Initial base depth**	m	3.00
Top of response zone	m	1.50	**Base of response zone**	m	12.00
Installation type		SP			
Condition of monitoring point		Good			

Preceding atmospheric conditions for three days (nominally at noon)				
		Day 1	Day 2	Day 3
Date/time of reading				
Atmospheric pressure	mbar			
Description of previous days weather				

Equipment details			
Equipment type	GA5000	Equipment serial number	GA501940
Date equipment last calibrated	20/07/2021		
Has equipment been zeroed	Yes	Time equipment zeroed	
Incidental information			
Description of weather conditions during monitoring	Overcast		
Ground conditions at the time of monitoring	Dry		

Barometric / air readings				
Barometric pressure trend		Stable		
		Barometric	Relative	
Time of reading	hh:mm:ss	15:45:00	15:45:00	
Pressure	mbar	1009	1009	
		Ambient air temperature		
Time of reading	hh:mm:ss	15:45:00		
Temperature	°C	17.0		

Gas readings

			Peak		Steady	
Determinand	LoD	Unit	Reading	Time	Reading	Time
Methane	0.1	%v/v	0.1	15:47:00	0.1	15:50:00
Methane (LEL)	1	%	2	15:47:00	2	15:50:00
Carbon Dioxide	0.1	%v/v	1.6	15:47:00	1.6	15:50:00
Oxygen	0.1	%v/v	21.6	15:47:00	19.0	15:50:00
Carbon Monoxide	1	ppm	<1	15:47:00	<1	15:50:00
Hydrogen Sulfide	1	ppm	<1	15:47:00	<1	15:50:00
Gas Flow	0.1	l/hr	0.1	15:45:00	0.1	15:46:00

Further information

		Groundwater level	Installation base		
Time of reading	hh:mm:ss	15:52:00	15:52:00		
Reading	m	DRY	3.00		

Remarks

Monitored by:	Checked by:	Approved by:
Form No. SE-EMS-F-002	Revision No. 3.00	Issue Date 01/02/2021

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Record Of Gas Monitoring**	**Location ID** **BH_STW_015**
Project No.	TE8364		**Monitoring point ID** G1
Engineer	Mott MacDonald Bentley		Monitoring round number 02
Client	Barhale Limited		Date 02/11/2021

Monitoring point information					
Distance to monitoring point	m	12.00	Initial base depth	m	3.00
Top of response zone	m	1.50	Base of response zone	m	12.00
Installation type		SP			
Condition of monitoring point		Good			

Preceding atmospheric conditions for three days (nominally at noon)				
		Day 1	Day 2	Day 3
Date/time of reading				
Atmospheric pressure	mbar			
Description of previous days weather				

Equipment details			
Equipment type	GA5000	Equipment serial number	GA501940
Date equipment last calibrated	20/07/2021		
Has equipment been zeroed	Yes	Time equipment zeroed	

Incidental information	
Description of weather conditions during monitoring	Clear
Ground conditions at the time of monitoring	Dry

Barometric / air readings				
Barometric pressure trend		Stable		
		Barometric	Relative	
Time of reading	hh:mm:ss	11:30:00	11:30:00	
Pressure	mbar	997	997	
		Ambient air temperature		
Time of reading	hh:mm:ss	11:29:00		
Temperature	°C	9.0		

Gas readings						
			Peak		Steady	
Determinand	LoD	Unit	Reading	Time	Reading	Time
Methane	0.1	%v/v	<0.1	11:32:00	<0.1	11:35:00
Methane (LEL)	1	%	<1	11:32:00	<1	11:35:00
Carbon Dioxide	0.1	%v/v	1.6	11:32:00	1.6	11:35:00
Oxygen	0.1	%v/v	20.6	11:32:00	18.6	11:35:00
Carbon Monoxide	1	ppm	<1	11:32:00	<1	11:35:00
Hydrogen Sulfide	1	ppm	<1	11:32:00	<1	11:35:00
Gas Flow	0.1	l/hr	<0.1	11:30:00	<0.1	11:31:00

Further information					
		Groundwater level	Installation base		
Time of reading	hh:mm:ss	11:37:00	11:37:00		
Reading	m	DRY	3.00		

Remarks

Monitored by:	Checked by:	Approved by:	SOIL ENGINEERING
Form No. SE-EMS-F-002	Revision No. 3.00	Issue Date 01/02/2021	

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Record Of Gas Monitoring**	**Location ID** BH_STW_015
Project No.	TE8364		**Monitoring point ID** G1
Engineer	Mott MacDonald Bentley		Monitoring round number 03
Client	Barhale Limited		Date 08/11/2021

Monitoring point information

Distance to monitoring point	m	12.00	Initial base depth	m	3.00
Top of response zone	m	1.50	Base of response zone	m	12.00
Installation type		SP			
Condition of monitoring point		Good			

Preceding atmospheric conditions for three days (nominally at noon)

		Day 1	Day 2	Day 3
Date/time of reading				
Atmospheric pressure	mbar			
Description of previous days weather				

Equipment details

Equipment type	GA5000	Equipment serial number	GA501940
Date equipment last calibrated	20/07/2021		
Has equipment been zeroed	Yes	Time equipment zeroed	

Incidental information

Description of weather conditions during monitoring	Clear
Ground conditions at the time of monitoring	Dry

Barometric / air readings

Barometric pressure trend		Stable		
		Barometric	Relative	
Time of reading	hh:mm:ss	11:14:00	11:14:00	
Pressure	mbar	1022	1022	
		Ambient air temperature		
Time of reading	hh:mm:ss	11:14:00		
Temperature	°C	7.0		

Gas readings

			Peak		Steady	
Determinand	LoD	Unit	Reading	Time	Reading	Time
Methane	0.1	%v/v	<0.1	11:18:00	<0.1	11:21:00
Methane (LEL)	1	%	<1	11:18:00	<1	11:21:00
Carbon Dioxide	0.1	%v/v	0.1	11:18:00	0.1	11:21:00
Oxygen	0.1	%v/v	21.1	11:18:00	21.1	11:21:00
Carbon Monoxide	1	ppm	<1	11:18:00	<1	11:21:00
Hydrogen Sulfide	1	ppm	<1	11:18:00	<1	11:21:00
Gas Flow	0.1	l/hr	<0.1	11:16:00	<0.1	11:17:00

Further information

		Groundwater level	Installation base		
Time of reading	hh:mm:ss	11:22:00	11:22:00		
Reading	m	DRY	2.70		

Remarks

Monitored by:	Checked by:	Approved by:
Form No. SE-EMS-F-002	Revision No. 3.00	Issue Date 01/02/2021

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Record Of Gas Monitoring**	**Location ID** **BH_STW_022A**
Project No.	TE8364		**Monitoring point ID** G1
Engineer	Mott MacDonald Bentley		Monitoring round number 01
Client	Barhale Limited		Date 19/10/2021

Monitoring point information					
Distance to monitoring point	**m**	**2.00**	**Initial base depth**	**m**	**2.00**
Top of response zone	**m**	**1.00**	**Base of response zone**	**m**	**2.00**
Installation type		**SP**			
Condition of monitoring point		**Good**			

Preceding atmospheric conditions for three days (nominally at noon)				
		Day 1	**Day 2**	**Day 3**
Date/time of reading				
Atmospheric pressure	**mbar**			
Description of previous days weather				

Equipment details			
Equipment type	**GA5000**	**Equipment serial number**	**GA501940**
Date equipment last calibrated	**20/07/2021**		
Has equipment been zeroed	**Yes**	**Time equipment zeroed**	

Incidental information	
Description of weather conditions during monitoring	**Overcast**
Ground conditions at the time of monitoring	**Dry**

Barometric / air readings				
Barometric pressure trend		**Stable**		
		Barometric	**Relative**	
Time of reading	**hh:mm:ss**	**16:14:00**	**16:14:00**	
Pressure	**mbar**	**1010**	**1010**	
		Ambient air temperature		
Time of reading	**hh:mm:ss**	**16:14:00**		
Temperature	**°C**	**16.0**		

Gas readings

			Peak		**Steady**	
Determinand	**LoD**	**Unit**	**Reading**	**Time**	**Reading**	**Time**
Methane	**0.1**	**%v/v**	**0.1**	**16:14:00**	**0.1**	**16:17:00**
Methane (LEL)	**1**	**%**	**2**	**16:14:00**	**2**	**16:17:00**
Carbon Dioxide	**0.1**	**%v/v**	**0.6**	**16:14:00**	**0.6**	**16:17:00**
Oxygen	**0.1**	**%v/v**	**21.1**	**16:14:00**	**15.0**	**16:17:00**
Carbon Monoxide	**1**	**ppm**	**1**	**16:14:00**	**<1**	**16:17:00**
Hydrogen Sulfide	**1**	**ppm**	**<1**	**16:14:00**	**<1**	**16:17:00**
Gas Flow	**0.1**	**l/hr**	**0.1**	**16:12:00**	**0.1**	**16:13:00**

Further information

		Groundwater level	**Installation base**		
Time of reading	**hh:mm:ss**	**16:23:00**	**16:23:00**		
Reading	**m**	**1.96**	**2.10**		

Remarks

Monitored by:	Checked by:	**Approved by:**	SOIL ENGINEERING
Form No. SE-EMS-F-002	Revision No. 3.00	Issue Date 01/02/2021	

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Record Of Gas Monitoring**	**Location ID** BH_STW_022A
Project No.	TE8364		Monitoring point ID G1
Engineer	Mott MacDonald Bentley		Monitoring round number 02
Client	Barhale Limited		Date 02/11/2021

Monitoring point information					
Distance to monitoring point	m	2.00	Initial base depth	m	2.00
Top of response zone	m	1.00	Base of response zone	m	2.00
Installation type		SP			
Condition of monitoring point		Good			

Preceding atmospheric conditions for three days (nominally at noon)				
		Day 1	Day 2	Day 3
Date/time of reading				
Atmospheric pressure	mbar			
Description of previous days weather				

Equipment details			
Equipment type	GA5000	Equipment serial number	GA501940
Date equipment last calibrated	20/07/2021		
Has equipment been zeroed	Yes	Time equipment zeroed	

Incidental information	
Description of weather conditions during monitoring	Clear
Ground conditions at the time of monitoring	Dry

Barometric / air readings				
Barometric pressure trend		Stable		
		Barometric	Relative	
Time of reading	hh:mm:ss	10:29:00	10:29:00	
Pressure	mbar	997	997	
		Ambient air temperature		
Time of reading	hh:mm:ss	10:29:00		
Temperature	°C	9.0		

Gas readings						
			Peak		Steady	
Determinand	LoD	Unit	Reading	Time	Reading	Time
Methane	0.1	%v/v	<0.1	10:32:00	<0.1	10:35:00
Methane (LEL)	1	%	<1	10:32:00	<1	10:35:00
Carbon Dioxide	0.1	%v/v	0.2	10:32:00	0.1	10:35:00
Oxygen	0.1	%v/v	20.9	10:32:00	18.9	10:35:00
Carbon Monoxide	1	ppm	1	10:32:00	<1	10:35:00
Hydrogen Sulfide	1	ppm	<1	10:32:00	<1	10:35:00
Gas Flow	0.1	l/hr	<0.1	10:30:00	<0.1	10:31:00

Further information					
		Groundwater level	Installation base		
Time of reading	hh:mm:ss	10:36:00	10:36:00		
Reading	m	DRY	2.00		

Remarks

Monitored by:	Checked by:	Approved by:	SOIL ENGINEERING
Form No. SE-EMS-F-002	Revision No. 3.00	Issue Date 01/02/2021	

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Record Of Gas Monitoring**	**Location ID** BH_STW_022A
Project No.	TE8364		Monitoring point ID G1
Engineer	Mott MacDonald Bentley		Monitoring round number 03
Client	Barhale Limited		Date 08/11/2021

Monitoring point information					
Distance to monitoring point	m	2.00	Initial base depth	m	2.00
Top of response zone	m	1.00	Base of response zone	m	2.00
Installation type		SP			
Condition of monitoring point		Good			

Preceding atmospheric conditions for three days (nominally at noon)				
		Day 1	Day 2	Day 3
Date/time of reading				
Atmospheric pressure	mbar			
Description of previous days weather				

Equipment details			
Equipment type	GA5000	Equipment serial number	GA501940
Date equipment last calibrated	20/07/2021		
Has equipment been zeroed	Yes	Time equipment zeroed	

Incidental information	
Description of weather conditions during monitoring	Clear
Ground conditions at the time of monitoring	Dry

Barometric / air readings				
Barometric pressure trend		Stable		
		Barometric	Relative	
Time of reading	hh:mm:ss	10:52:00	10:52:00	
Pressure	mbar	1022	1022	
		Ambient air temperature		
Time of reading	hh:mm:ss	10:52:00		
Temperature	°C	7.0		

Gas readings						
			Peak		Steady	
Determinand	LoD	Unit	Reading	Time	Reading	Time
Methane	0.1	%v/v	<0.1	10:55:00	<0.1	10:58:00
Methane (LEL)	1	%	<1	10:55:00	<1	10:58:00
Carbon Dioxide	0.1	%v/v	0.2	10:55:00	0.1	10:58:00
Oxygen	0.1	%v/v	20.9	10:55:00	18.9	10:58:00
Carbon Monoxide	1	ppm	1	10:55:00	<1	10:58:00
Hydrogen Sulfide	1	ppm	<1	10:55:00	<1	10:58:00
Gas Flow	0.1	l/hr	<0.1	10:53:00	<0.1	10:54:00

Further information					
		Groundwater level	Installation base		
Time of reading	hh:mm:ss	10:59:00	10:59:00		
Reading	m	DRY	2.00		

Remarks

Monitored by:	Checked by:	Approved by:	SOIL ENGINEERING
Form No. SE-EMS-F-002	Revision No. 3.00	Issue Date 01/02/2021	

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Record Of Gas Monitoring**	**Location ID** **BH_TUN_001PM**
Project No.	TE8364		**Monitoring point ID** G1
Engineer	Mott MacDonald Bentley		**Monitoring round number** 01
Client	Barhale Limited		Date 19/10/2021

Monitoring point information					
Distance to monitoring point	m	1.50	Initial base depth	m	1.50
Top of response zone	m	0.50	Base of response zone	m	1.50
Installation type		SP			
Condition of monitoring point		Good			

Preceding atmospheric conditions for three days (nominally at noon)				
		Day 1	Day 2	Day 3
Date/time of reading				
Atmospheric pressure	mbar			
Description of previous days weather				

Equipment details			
Equipment type	GA5000	Equipment serial number	GA501940
Date equipment last calibrated	20/07/2021		
Has equipment been zeroed	Yes	Time equipment zeroed	

Incidental information	
Description of weather conditions during monitoring	Overcast
Ground conditions at the time of monitoring	Dry

Barometric / air readings				
Barometric pressure trend		Stable		
		Barometric	Relative	
Time of reading	hh:mm:ss	13:15:00	13:15:00	
Pressure	mbar	1009	1009	
		Ambient air temperature		
Time of reading	hh:mm:ss	13:15:00		
Temperature	°C	18.0		

Gas readings

			Peak		Steady	
Determinand	LoD	Unit	Reading	Time	Reading	Time
Methane	0.1	%v/v	0.1	13:15:00	0.1	13:18:00
Methane (LEL)	1	%	2	13:15:00	2	13:18:00
Carbon Dioxide	0.1	%v/v	0.1	13:15:00	0.1	13:18:00
Oxygen	0.1	%v/v	21.8	13:15:00	21.8	13:18:00
Carbon Monoxide	1	ppm	<1	13:15:00	<1	13:18:00
Hydrogen Sulfide	1	ppm	<1	13:15:00	<1	13:18:00
Gas Flow	0.1	l/hr	0.2	13:13:00	0.1	13:14:00

Further information					
		Groundwater level	Installation base		
Time of reading	hh:mm:ss	13:23:00	13:23:00		
Reading	m	1.27	1.50		

Remarks

Monitored by:	Checked by:	Approved by:	SOIL ENGINEERING
Form No. SE-EMS-F-002	Revision No. 3.00	Issue Date 01/02/2021	

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Record Of Gas Monitoring**	**Location ID** BH_TUN_001PM
Project No.	TE8364		**Monitoring point ID** G1
Engineer	Mott MacDonald Bentley		**Monitoring round number** 02
Client	Barhale Limited		Date 02/11/2021

Monitoring point information

Distance to monitoring point	m	1.50	Initial base depth	m	1.50
Top of response zone	m	0.50	Base of response zone	m	1.50
Installation type		SP			
Condition of monitoring point		Good			

Preceding atmospheric conditions for three days (nominally at noon)

		Day 1	Day 2	Day 3
Date/time of reading				
Atmospheric pressure	mbar			
Description of previous days weather				

Equipment details

Equipment type	GA5000	Equipment serial number	GA501940
Date equipment last calibrated	20/07/2021		
Has equipment been zeroed	Yes	Time equipment zeroed	

Incidental information

Description of weather conditions during monitoring	Clear
Ground conditions at the time of monitoring	Dry

Barometric / air readings

Barometric pressure trend		Stable	
		Barometric	Relative
Time of reading	hh:mm:ss	14:33:00	14:33:00
Pressure	mbar	997	997
		Ambient air temperature	
Time of reading	hh:mm:ss	14:33:00	
Temperature	°C	9.0	

Gas readings

			Peak		Steady	
Determinand	LoD	Unit	Reading	Time	Reading	Time
Methane	0.1	%v/v	<0.1	14:36:00	<0.1	14:39:00
Methane (LEL)	1	%	<1	14:36:00	<1	14:39:00
Carbon Dioxide	0.1	%v/v	3.1	14:36:00	3.0	14:39:00
Oxygen	0.1	%v/v	20.5	14:36:00	13.4	14:39:00
Carbon Monoxide	1	ppm	<1	14:36:00	<1	14:39:00
Hydrogen Sulfide	1	ppm	<1	14:36:00	<1	14:39:00
Gas Flow	0.1	l/hr	<0.1	14:34:00	<0.1	14:35:00

Further information

		Groundwater level	Installation base		
Time of reading	hh:mm:ss	14:40:00	14:40:00		
Reading	m	1.24	1.50		

Remarks

Monitored by:	Checked by:	Approved by:

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Record Of Gas Monitoring**	**Location ID** BH_TUN_001PM
Project No.	TE8364		**Monitoring point ID** G1
Engineer	Mott MacDonald Bentley		**Monitoring round number** 03
Client	Barhale Limited		Date 08/11/2021

Monitoring point information					
Distance to monitoring point	**m**	1.50	**Initial base depth**	**m**	1.50
Top of response zone	**m**	0.50	**Base of response zone**	**m**	1.50
Installation type		SP			
Condition of monitoring point		Good			

Preceding atmospheric conditions for three days (nominally at noon)			
	Day 1	Day 2	Day 3
Date/time of reading			
Atmospheric pressure mbar			
Description of previous days weather			

Equipment details			
Equipment type	GA5000	Equipment serial number	GA501940
Date equipment last calibrated	20/07/2021		
Has equipment been zeroed	Yes	Time equipment zeroed	

Incidental information	
Description of weather conditions during monitoring	Clear
Ground conditions at the time of monitoring	Dry

Barometric / air readings				
Barometric pressure trend		Stable		
		Barometric	Relative	
Time of reading	hh:mm:ss	12:25:00	12:25:00	
Pressure	mbar	1022	1022	
		Ambient air temperature		
Time of reading	hh:mm:ss	12:26:00		
Temperature	°C	7.0		

Gas readings						
			Peak		Steady	
Determinand	LoD	Unit	Reading	Time	Reading	Time
Methane	0.1	%v/v	<0.1	12:28:00	<0.1	12:31:00
Methane (LEL)	1	%	<1	12:28:00	<1	12:31:00
Carbon Dioxide	0.1	%v/v	2.7	12:28:00	2.6	12:31:00
Oxygen	0.1	%v/v	19.0	12:28:00	15.4	12:31:00
Carbon Monoxide	1	ppm	<1	12:28:00	<1	12:31:00
Hydrogen Sulfide	1	ppm	<1	12:28:00	<1	12:31:00
Gas Flow	0.1	l/hr	<0.1	12:26:00	<0.1	12:27:00

Further information					
		Groundwater level	Installation base		
Time of reading	hh:mm:ss	12:32:00	12:32:00		
Reading	m	1.25	1.50		

Remarks

Monitored by:	Checked by:	Approved by:
Form No. SE-EMS-F-002	Revision No. 3.00	Issue Date 01/02/2021

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Record Of Gas Monitoring**	**Location ID** BH_TUN_006
Project No.	TE8364		Monitoring point ID G1
Engineer	Mott MacDonald Bentley		Monitoring round number 01
Client	Barhale Limited		Date 19/10/2021

Monitoring point information					
Distance to monitoring point	m	6.00	**Initial base depth**	m	3.50
Top of response zone	m	1.50	**Base of response zone**	m	6.00
Installation type		SP			
Condition of monitoring point		Good			

Preceding atmospheric conditions for three days (nominally at noon)			
	Day 1	**Day 2**	**Day 3**
Date/time of reading			
Atmospheric pressure mbar			
Description of previous days weather			

Equipment details			
Equipment type	GA5000	**Equipment serial number**	GA501940
Date equipment last calibrated	20/07/2021		
Has equipment been zeroed	Yes	**Time equipment zeroed**	

Incidental information	
Description of weather conditions during monitoring	Overcast
Ground conditions at the time of monitoring	Dry

Barometric / air readings				
Barometric pressure trend		Stable		
		Barometric	Relative	
Time of reading	hh:mm:ss	13:42:00	13:42:00	
Pressure	mbar	1009	1009	
		Ambient air temperature		
Time of reading	hh:mm:ss	13:42:00		
Temperature	°C	20.0		

Gas readings						
			Peak		**Steady**	
Determinand	**LoD**	**Unit**	**Reading**	**Time**	**Reading**	**Time**
Methane	0.1	%v/v	0.2	13:42:00	0.2	13:45:00
Methane (LEL)	1	%	4	13:42:00	4	13:45:00
Carbon Dioxide	0.1	%v/v	0.8	13:42:00	0.8	13:45:00
Oxygen	0.1	%v/v	21.5	13:42:00	20.5	13:45:00
Carbon Monoxide	1	ppm	<1	13:42:00	<1	13:45:00
Hydrogen Sulfide	1	ppm	<1	13:42:00	<1	13:45:00
Gas Flow	0.1	l/hr	0.1	13:40:00	0.1	13:41:00

Further information					
		Groundwater level	**Installation base**		
Time of reading	hh:mm:ss	13:47:00	13:47:00		
Reading	m	DRY	3.50		

Remarks

Monitored by:	**Checked by:**	**Approved by:**
Form No. SE-EMS-F-002	Revision No. 3.00	Issue Date 01/02/2021

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Record Of Gas Monitoring**	**Location ID** BH_TUN_006
Project No.	TE8364		Monitoring point ID G1
Engineer	Mott MacDonald Bentley		Monitoring round number 02
Client	Barhale Limited		Date 02/11/2021

Monitoring point information					
Distance to monitoring point	m	6.00	Initial base depth	m	3.50
Top of response zone	m	1.50	Base of response zone	m	6.00
Installation type		SP			
Condition of monitoring point		Good			

Preceding atmospheric conditions for three days (nominally at noon)				
		Day 1	Day 2	Day 3
Date/time of reading				
Atmospheric pressure	mbar			
Description of previous days weather				

Equipment details			
Equipment type	GA5000	Equipment serial number	GA501940
Date equipment last calibrated	20/07/2021		
Has equipment been zeroed	Yes	Time equipment zeroed	

Incidental information	
Description of weather conditions during monitoring	Clear
Ground conditions at the time of monitoring	Dry

Barometric / air readings				
Barometric pressure trend		Stable		
		Barometric	Relative	
Time of reading	hh:mm:ss	14:00:00	14:00:00	
Pressure	mbar	997	997	
		Ambient air temperature		
Time of reading	hh:mm:ss	14:00:00		
Temperature	°C	9.0		

Gas readings						
			Peak		Steady	
Determinand	LoD	Unit	Reading	Time	Reading	Time
Methane	0.1	%v/v	<0.1	14:04:00	<0.1	14:07:00
Methane (LEL)	1	%	<1	14:04:00	<1	14:07:00
Carbon Dioxide	0.1	%v/v	0.1	14:04:00	0.1	14:07:00
Oxygen	0.1	%v/v	21.2	14:04:00	21.2	14:07:00
Carbon Monoxide	1	ppm	<1	14:04:00	<1	14:07:00
Hydrogen Sulfide	1	ppm	<1	14:04:00	<1	14:07:00
Gas Flow	0.1	l/hr	<0.1	14:02:00	<0.1	14:03:00

Further information					
		Groundwater level	Installation base		
Time of reading	hh:mm:ss	14:04:00	14:04:00		
Reading	m	DRY	3.45		

Remarks

Monitored by:	Checked by:	Approved by:
Form No. SE-EMS-F-002	Revision No. 3.00	Issue Date 01/02/2021

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Record Of Gas Monitoring**	**Location ID** BH_TUN_006
Project No.	TE8364		Monitoring point ID G1
Engineer	Mott MacDonald Bentley		Monitoring round number 03
Client	Barhale Limited		Date 08/11/2021

Monitoring point information

Distance to monitoring point	m	6.00	Initial base depth	m	3.50
Top of response zone	m	1.50	Base of response zone	m	6.00
Installation type		SP			
Condition of monitoring point		Good			

Preceding atmospheric conditions for three days (nominally at noon)

		Day 1	Day 2	Day 3
Date/time of reading				
Atmospheric pressure	mbar			
Description of previous days weather				

Equipment details

Equipment type	GA5000	Equipment serial number	GA501940
Date equipment last calibrated	20/07/2021		
Has equipment been zeroed	Yes	Time equipment zeroed	

Incidental information

Description of weather conditions during monitoring	Clear
Ground conditions at the time of monitoring	Dry

Barometric / air readings

Barometric pressure trend		Stable		
		Barometric	Relative	
Time of reading	hh:mm:ss	12:11:00	12:11:00	
Pressure	mbar	1022	1022	
		Ambient air temperature		
Time of reading	hh:mm:ss	12:11:00		
Temperature	°C	7.0		

Gas readings

			Peak		Steady	
Determinand	LoD	Unit	Reading	Time	Reading	Time
Methane	0.1	%v/v	0.3	12:14:00	0.3	12:17:00
Methane (LEL)	1	%	6	12:14:00	6	12:17:00
Carbon Dioxide	0.1	%v/v	19.1	12:17:00	19.1	12:17:00
Oxygen	0.1	%v/v	19.1	12:14:00	2.0	14:07:00
Carbon Monoxide	1	ppm	1	12:14:00	1	14:07:00
Hydrogen Sulfide	1	ppm	<1	12:14:00	<1	14:07:00
Gas Flow	0.1	l/hr	<0.1	12:12:00	<0.1	12:13:00

Further information

		Groundwater level	Installation base		
Time of reading	hh:mm:ss	12:18:00	12:18:00		
Reading	m	DRY	3.45		

Remarks

Monitored by:	Checked by:	Approved by:

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Record Of Gas Monitoring**	**Location ID** BH_TUN_011
Project No.	TE8364		Monitoring point ID G1
Engineer	Mott MacDonald Bentley		Monitoring round number 01
Client	Barhale Limited		Date 19/10/2021

Monitoring point information					
Distance to monitoring point	m	5.00	**Initial base depth**	m	2.50
Top of response zone	m	1.50	**Base of response zone**	m	5.00
Installation type		SP			
Condition of monitoring point		Good			

Preceding atmospheric conditions for three days (nominally at noon)				
		Day 1	Day 2	Day 3
Date/time of reading				
Atmospheric pressure	mbar			
Description of previous days weather				

Equipment details			
Equipment type	GA5000	Equipment serial number	GA501940
Date equipment last calibrated	20/07/2021		
Has equipment been zeroed	Yes	Time equipment zeroed	

Incidental information	
Description of weather conditions during monitoring	Clear
Ground conditions at the time of monitoring	Dry

Barometric / air readings				
Barometric pressure trend		Stable		
		Barometric	Relative	
Time of reading	hh:mm:ss	14:33:00	14:33:00	
Pressure	mbar	1008	1008	
		Ambient air temperature		
Time of reading	hh:mm:ss	14:33:00		
Temperature	°C	20.0		

Gas readings

			Peak		Steady	
Determinand	LoD	Unit	Reading	Time	Reading	Time
Methane	0.1	%v/v	0.1	14:35:00	0.1	14:38:00
Methane (LEL)	1	%	2	14:35:00	2	14:38:00
Carbon Dioxide	0.1	%v/v	0.1	14:35:00	0.1	14:38:00
Oxygen	0.1	%v/v	22.0	14:35:00	11.6	14:38:00
Carbon Monoxide	1	ppm	5	14:35:00	5	14:38:00
Hydrogen Sulfide	1	ppm	1	14:35:00	1	14:38:00
Gas Flow	0.1	l/hr	0.1	14:33:00	0.1	14:34:00

Further information

		Groundwater level	Installation base		
Time of reading	hh:mm:ss	14:40:00	14:40:00		
Reading	m	1.77	2.50		

Remarks

Monitored by:	Checked by:	Approved by:	SOIL ENGINEERING
Form No. SE-EMS-F-002	Revision No. 3.00	Issue Date 01/02/2021	

Project Name	Cambridge Waste Water Treatment Plant Relocation
Project No.	TE8364
Engineer	Mott MacDonald Bentley
Client	Barhale Limited

Record Of Gas Monitoring

Location ID BH_TUN_011
Monitoring point ID G1
Monitoring round number 02
Date 02/11/2021

Monitoring point information					
Distance to monitoring point	m	5.00	**Initial base depth**	m	2.50
Top of response zone	m	1.50	**Base of response zone**	m	5.00
Installation type		SP			
Condition of monitoring point		Good			

Preceding atmospheric conditions for three days (nominally at noon)			
	Day 1	Day 2	Day 3
Date/time of reading			
Atmospheric pressure mbar			
Description of previous days weather			

Equipment details			
Equipment type	GA5000	Equipment serial number	GA501940
Date equipment last calibrated	20/07/2021		
Has equipment been zeroed	Yes	Time equipment zeroed	

Incidental information	
Description of weather conditions during monitoring	Clear
Ground conditions at the time of monitoring	Dry

Barometric / air readings				
Barometric pressure trend		Stable		
		Barometric	Relative	
Time of reading	hh:mm:ss	12:12:00	12:12:00	
Pressure	mbar	997	997	
		Ambient air temperature		
Time of reading	hh:mm:ss	12:12:00		
Temperature	°C	9.0		

Gas readings

			Peak		Steady	
Determinand	LoD	Unit	Reading	Time	Reading	Time
Methane	0.1	%v/v	<0.1	12:16:00	<0.1	12:19:00
Methane (LEL)	1	%	<1	12:16:00	<1	12:19:00
Carbon Dioxide	0.1	%v/v	0.1	12:16:00	0.1	12:19:00
Oxygen	0.1	%v/v	20.9	12:16:00	17.4	12:19:00
Carbon Monoxide	1	ppm	1	12:16:00	1	12:19:00
Hydrogen Sulfide	1	ppm	<1	12:16:00	<1	12:19:00
Gas Flow	0.1	l/hr	<0.1	12:14:00	<0.1	12:15:00

Further information

		Groundwater level	Installation base		
Time of reading	hh:mm:ss	12:20:00	12:20:00		
Reading	m	DRY	2.50		

Remarks

Monitored by:	Checked by:	Approved by:
Form No. SE-EMS-F-002	Revision No. 3.00	Issue Date 01/02/2021

SOIL ENGINEERING

Project Name	Cambridge Waste Water Treatment Plant Relocation	**Record Of Gas Monitoring**	**Location ID** BH_TUN_011
Project No.	TE8364		Monitoring point ID G1
Engineer	Mott MacDonald Bentley		Monitoring round number 03
Client	Barhale Limited		Date 08/11/2021

Monitoring point information					
Distance to monitoring point	m	5.00	**Initial base depth**	m	2.50
Top of response zone	m	1.50	**Base of response zone**	m	5.00
Installation type		SP			
Condition of monitoring point		Good			

Preceding atmospheric conditions for three days (nominally at noon)			
	Day 1	Day 2	Day 3
Date/time of reading			
Atmospheric pressure mbar			
Description of previous days weather			

Equipment details			
Equipment type	GA5000	Equipment serial number	GA501940
Date equipment last calibrated	20/07/2021		
Has equipment been zeroed	Yes	Time equipment zeroed	

Incidental information	
Description of weather conditions during monitoring	Clear
Ground conditions at the time of monitoring	Dry

Barometric / air readings				
Barometric pressure trend		Stable		
		Barometric	Relative	
Time of reading	hh:mm:ss	10:31:00	10:31:00	
Pressure	mbar	1022	1022	
		Ambient air temperature		
Time of reading	hh:mm:ss	10:31:00		
Temperature	°C	7.0		

Gas readings

			Peak		Steady	
Determinand	LoD	Unit	Reading	Time	Reading	Time
Methane	0.1	%v/v	<0.1	10:34:00	<0.1	10:37:00
Methane (LEL)	1	%	<1	10:34:00	<1	10:37:00
Carbon Dioxide	0.1	%v/v	0.1	10:34:00	0.1	10:37:00
Oxygen	0.1	%v/v	21.0	10:34:00	19.8	10:37:00
Carbon Monoxide	1	ppm	1	10:34:00	1	10:37:00
Hydrogen Sulfide	1	ppm	<1	10:34:00	<1	10:37:00
Gas Flow	0.1	l/hr	<0.1	10:32:00	<0.1	10:33:00

Further information

		Groundwater level	Installation base		
Time of reading	hh:mm:ss	10:38:00	10:38:00		
Reading	m	DRY	2.50		

Remarks

Monitored by:	Checked by:	Approved by:
Form No. SE-EMS-F-002	Revision No. 3.00	Issue Date 01/02/2021

SOIL ENGINEERING

Get in touch

You can contact us by:

Emailing at **info@cwwtpr.com**

Calling our Freephone information line on **0808 196 1661**

Writing to us at **Freepost: CWWTPR**

You can view all our DCO application documents and updates on the application on The Planning Inspectorate website:

https://infrastructure.planninginspectorate.gov.uk/projects/eastern/cambridge-waste-water-treatment-plant-relocation/