Renaker Build Ltd

CROWN STREET PHASE 2

Geo-Environmental Assessment Report



70059549-11515(4)
SEPTEMBER 2020

CONFIDENTIAL

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PROJECT NO. 70059549

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1 INTRODUCTION

1.1 AUTHORISATION

This report is prepared by WSP in support of a hybrid planning application for the development of a residential-led, mixed use development at Crown Street Phase 2, which forms part of the Great Jackson Street Regeneration Area. It should be noted that Phase 2 has been formerly referred to as 'Zone 2'.

WSP has undertaken geotechnical and geo-environmental consultancy works for the proposed development located off Crown Street, Manchester (Figure 1 in **Appendix A**). The geo-environmental aspects (i.e. soil and groundwater contamination) are contained herein and the geotechnical aspect are reported separately.

1.2 OBJECTIVES & SCOPE OF WORKS

The objective of the report is to identify potential development constraints with respect to soil and groundwater contamination and hazardous ground gases.

The scope of works comprised:

- Design of site investigation
- Targeted intrusive investigation
- Laboratory chemical testing of soil and groundwater
- Groundwater level / ground gas monitoring
- Revision of the preliminary conceptual ground model presented in WSP Preliminary Risk Assessment (see Section 1.4).
- Contamination risk assessment considering human health and the wider environment
- Ground gas risk assessment
- Waste classification assessment for excess soils
- Outline remedial requirements

The site works were completed by Geotechnics Limited and the findings of the investigation presented in their factual report (final report reference PN194002, December 2019), provided in **Appendix D**. The Geotechnics factual report has been reviewed and interpreted herein.

1.3 DEVELOPMENT PROPOSALS

In summary, the proposals include the following elements for which full planning permission is sought:

- Erection of two 51-storey residential buildings (Use Class C3) incorporating a shared podium accommodating residential amenity facilities and ground floor commercial units (Use Class A1, A2, A3, & D1)
- Each building has separate private car and cycle parking within a three-storey basement.
- A three-storey basement public car park with access on to Silvercroft Street.
- A new public park.
- Landscaping and public realm works.
- A highways and servicing route.

In addition, the proposals also include the following elements for which outline planning permission (with all matters reserved) is sought:

- A single-form entry primary school (Use Class D1)

The three levels of basement car parking will cover the vast majority of the site area, necessitating the removal of existing soils to approximately 10-12m bgl.

The proposed site layout (ground level) is presented in **Appendix B**.

1.4 PREVIOUS REPORTS

The following report has been prepared previously by WSP for the site:

- WSP (2019). *Crown Street Phase 2 - Preliminary Risk Assessment*. Report Ref 70059549-11451(1) (referred to 'WSP PRA').

The following report has previously been produced for Crown Street Phase 1, immediately adjacent to the northwest of the site:

- GeoAssist Limited (2018) *Ground Investigation Report – Crown Street*, Ref: Z1-GEO-A180-Rp-XX-001 rev 1. Dated: March 2018 (referred to as 'GeoAssist, 2018'). This report included a review of environmental data contained within a Groundsure report.

Geotechnical reports comprising the Ground Investigation Report (WSP report reference 70059549-GIR-001) and Geotechnical Design Report (GDR) have been prepared separately and address the geotechnical aspects.

1.5 CONFIDENTIALITY

This report is addressed to and may be relied upon by the following:

Renaker Build Limited
First Floor NQ Building
47 Bengal Street
Manchester
M4 6BB

This assessment has been prepared for the sole use of the above-named party. This report shall not be relied upon or transferred to any other parties without the express written authorisation of WSP. No responsibility will be accepted where this report is used in its entirety, or in part, by any other party.

1.6 LIMITATIONS

Information provided by others is taken in good faith as being accurate. WSP cannot and will not accept liability for any deficiencies in third party information. General limitations are presented in **Appendix C**.

2 THE SITE AND EXISTING INFORMATION

2.1 SITE DESCRIPTION & TOPOGRAPHY

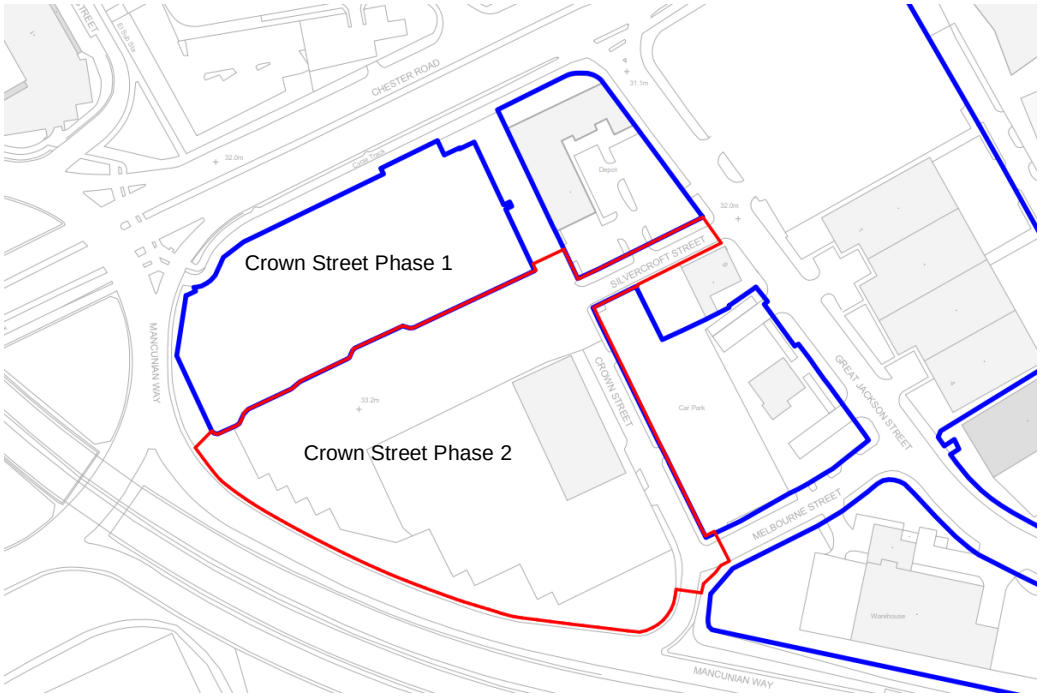
The 1.1ha site comprises a largely triangular area of land located between Silvercroft Street, Crown Street, and the Mancunian Way, located approximately 350m to the southwest of Manchester Deansgate Station in the Castlefield area of Manchester. The approximate centre of the site is located a National Grid Reference 383176E, 397245N.

The site is currently used as a site compound for construction works on an adjacent development. However, previous to this, its established use was as a surface level car park.

Recorded ground levels are between 32.5m and 33.3m AOD (above Ordnance Datum). Surfacing across the site comprised a mixture of tarmac, concrete and cobble setts and vegetation is limited to the southern boundary.

A site location plan is presented as Figure 1 in **Appendix A** and the site boundary is shown in red on Insert 2-1 below.

Insert 2-1 – Site Boundary Plan



The adjacent land uses are predominantly residential to the north of Chester Road and west of the Chester Road Roundabout. To the south beyond the Ring Road (Mancunian Way) is Hulme Park. The remainder of the Great Jackson Street area to the east is characterised by light industrial units and car parking, the exception being Gaddum House which is a 3 storey office building at the corner of Silvercroft Street and Great Jackson Street.

2.2 SITE HISTORY

The following information is summarised from the WSP PRA and includes a review of the historical plans provided within the Groundsure Report (GR) and Ordnance Survey (OS) maps available on the National Library of Scotland website.

2.2.1 THE SITE

Earliest available GR mapping (1848) indicates unnamed buildings (most likely terraced housing) occupy much of the site area. By 1905 additional buildings have been added in the south-eastern and central areas and the layout remains largely the same to 1938 mapping. More detailed OS mapping from 1922 indicates the large building in the centre of the site is a gym and public baths; surrounding buildings are likely to be residential. The OS map from 1922 and a recent online aerial image are presented below in Insert 2-2.

Insert 2-2 - Layout in 1922 compared with recent aerial imagery (approximate site boundary)



Reproduced with the permission of the National Library of Scotland

GR mapping from 1956 shows clearance of buildings in the northern and western areas and the map dated 1972 indicates two rectangular buildings in the northern part of the site, with the remainder of the site unoccupied. The western-most building corresponds with the footprint of the former gym and has been extended to the south and southeast on 1985 mapping, indicated as a 'factory' on maps from 2001 to 2010. Demolition of the buildings occurred after 2010 and the site was used as a car park.

2.2.2 SURROUNDING AREA

Maps suggest that prior to the 1970s the surrounding area was occupied predominantly by residential properties, with occasional commercial/industrial properties located sporadically amongst the housing. The land use becomes more commercial/industrial towards the north (quays/wharves) and northeast (e.g. Knott Mill). The 1922 OS map indicates Pryme Street Mills (Cattle Food) adjacent to the site on the other side of Silver Street to the north. After the 1970s the surrounding land tended towards more commercial uses, more recently becoming redeveloped for predominantly residential use.

2.2.3 POTENTIAL FOR CONTAMINATION

Historical maps suggest the site does not have a history of potentially contaminative former uses. However, given the long history of development on the site, the site location (i.e. on the outskirts of the city centre) and the possible presence of infilled basements/structures, it is considered that the site has a low to moderate potential for contamination, most likely to be associated with infill materials, if present.

2.3 UNEXPLODED ORDNANCE HAZARDS

The Envirocheck UXO Assessment referenced in the WSP PRA for Crown Street Phase 1 indicates a medium possibility of a UXO encounter on the Phase 1 site (no information given for Phase 2). It was concluded, that based on historical data, the risk the risk was low to very low.

Mapping of the 1940-1941 Manchester Blitz (Insert 2-3) does not show any bomb strikes within the Phase 2 boundary. However, there are several strikes in the surrounding area.

Given the developed nature of the site, it is considered unlikely that any unexploded ordnance would have fallen on the site and not been recorded. The site was also completely redeveloped post-war although, whilst this does reduce the risk, it is anticipated these works would have involved relatively shallow excavations for foundations and services.

Insert 2-3 - Manchester Bomb Map (Blue circle = high explosive, Red circle = fire bomb, Pink shading = damaged building & Red shading = demolished building



The information viewed suggests that there is a low probability of UXO being present on the site.

3 ENVIRONMENTAL SETTING

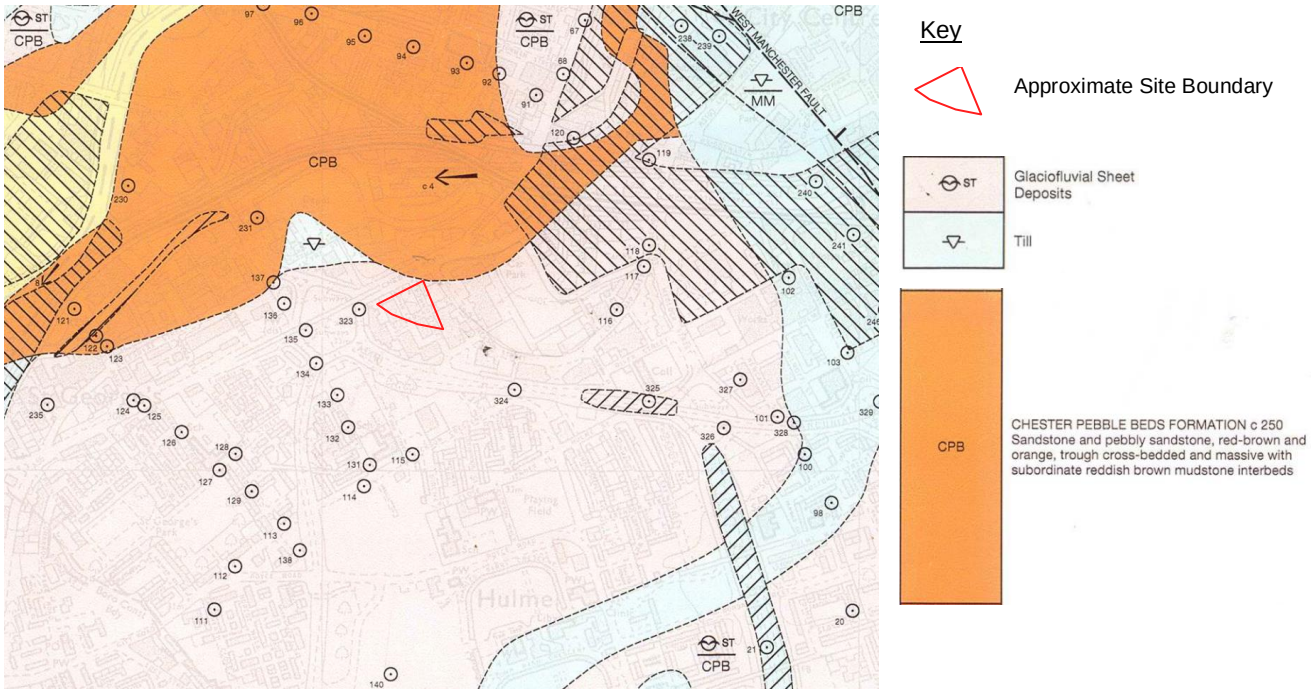
The following section presents a summary of the environmental setting and site history. For a more detailed assessment, reference should be made to the Phase I Preliminary Risk Assessment (WSP, 2019).

3.1 GEOLOGY

Published geological mapping (BGS, 2004) indicates the site to be underlain by superficial Glaciofluvial Sheet Deposits and bedrock comprising sandstone of the Chester Formation (formerly the Chester Pebble Beds Formation).

An extract of the geological map is presented below.

Insert 3-1 - Extract of Solid and Superficial Map (BGS, 2004)



The GeoAssist (2019) Ground Investigation report for the adjacent Crown Street Phase 1 site reports the following ground conditions:

- Made Ground to depths of between 0.50m bgl and 4.80m bgl: Generally comprising sandy gravel, brick rubble and concrete fragments with cinders and building debris, varying from loose to medium dense in state of compaction.
- Glaciofluvial deposits generally comprising loose to medium dense sandy gravel at relatively shallow depths becoming denser with a higher cobble content to depths of between 8.10m bgl to 10.10m bgl.
- Glacial Till to depths of between 7.10m bgl and 9.60m bgl. The description is variable but is typically stiff gravelly sandy silty clay, becoming very silty at depth with silt partings.
- Sandstone: An upper weathered to silty sand / sandstone zone, becoming weak to medium in strength (below 21.5m bgl) with random rounded gravel bands and rare marl gravel / pellets and lenses. Proved to a depth of >48.50m bgl.

3.2 HYDROGEOLOGY

Information on Defra's "Magic Map" website (Defra, 2019) indicates that Chester Formation is classified as a Principal Aquifer; the overlying Glaciofluvial Sheet Deposits are classified as a Secondary A Aquifer and the Glacial Till as a Secondary Undifferentiated aquifer.

According to the WSP PRA there are no recorded groundwater abstraction points within 500m of the site and the site is not located within 500m of a groundwater source protection zone. The closest recorded groundwater abstraction is located at Manchester Metropolitan University for a ground source heat pump, 672m southeast.

The site is in an area with potential for 'clearwater flooding' or Superficial Deposits Flooding; due to water table rises caused by extreme rainfall, although the confidence in this rating is stated as 'low'.

Groundwater monitoring undertaken by GeoAssist, 2018 on the adjacent Phase 1 indicates groundwater elevations ranged between 23.3m AOD to 24.5m AOD (approximately 9m bgl).

3.3 HYDROLOGY

There is a large surface water network in the vicinity, formed of canals and rivers including the Bridgewater Canal (150m north) and the River Irwell (652m northwest).

3.4 LANDFILLS, INFILLED LAND AND WASTE MANAGEMENT SITES

The Groundsure report (included in the WSP Phase I) contains the following information on landfills and waste treatment sites:

- The closest recorded landfill is located more than 700m northwest of the site.
- 34 records of potentially infilled land are recorded within 500m, the closest is 98m northwest of the site, associated with canal construction.
- A historic refuse destructor site is present 138m north with no further details provided.
- A scrap yard is recorded 268m east.

3.5 RADON

According to the Groundsure Report, the site is not within a Radon Affected Area, as less than 1% of properties are above the Action Level. Radon protection measures are not required.

4 PRELIMINARY CONCEPTUAL SITE MODEL

4.1 INTRODUCTION

The potential risks from contamination within soil and groundwater are assessed according to the environmental setting/ground model, potential sources of contamination and the proposed use of the site.

The source-pathway-receptor model forms the basis of the risk assessment; potential risks are only considered to exist if there is a credible source (e.g. a chemical substance capable of causing harm); a pathway for migration of the source to a receptor; and a sensitive receptor that could be affected (e.g. nearby river or future resident). A source-pathway-receptor contaminant linkage assessment is termed a conceptual site model (CSM). A preliminary CSM is produced in consideration of available desk-based information and prior to intrusive investigation and this is refined following collection of site-specific data.

4.2 PRELIMINARY GROUND MODEL

The ground conditions are anticipated to comprise an unknown depth of relatively permeable Made Ground potentially containing perched groundwater and obstructions associated with former site use as a gym / public baths / 'factory'.

The ground conditions are anticipated to be such that mobile contamination would likely migrate through the upper superficial deposits (Glaciofluvial, where present) with limited migration through the lower permeability superficial deposits (Glacial Till, where present) which would provide protection to the underlying bedrock.

There is also the potential for contamination within the ground/groundwater to be mobilised during excavation / foundation / basement construction into the underlying Principal Aquifer.

The proposed development is likely to involve removal of much of the Made Ground from the footprints of the building. It is assumed that Made Ground materials out of the footprint of the building will remain in place.

4.3 SOURCES, PATHWAYS AND RECEPTORS

The potential sources of contamination, receptors relevant to the proposed residential development with basements and potential exposure pathways have been identified and are presented below. The assessment assumes that no remedial measures are implemented to mitigate risks during or within the development.

4.3.1 POTENTIAL CONTAMINATION SOURCES

Based on the historical and current site use, the potential sources of contamination are considered to include:

- Contaminants associated with Made Ground / infill materials (e.g. within infilled basements) (including asbestos containing materials and free asbestos fibres)
- Contaminants associated with the potentially contaminative historical on-site (e.g. factory) and off-site uses (e.g. garages)
- Ground gases, should significant depths and extents of potentially biodegradable material be present.

It is noted that much of the Made Ground will be removed during basement construction.

4.3.2 POTENTIAL RECEPTORS

Relevant potential receptors are considered to comprise:

- Construction workers during redevelopment
- Neighbouring site users during redevelopment
- Future site users (residents/school pupils/maintenance workers)
- Groundwater within the principal aquifer (unlikely given clay layer)
- Surface waters
- Future below ground structures and building services (such as potable water pipes).

4.3.3 POTENTIAL EXPOSURE PATHWAYS

Relevant exposure pathways are considered to include:

- Direct contact, ingestion and inhalation of soil bound contaminants / dust
- In-ground migration, accumulation and inhalation of vapours associated with volatile soil/groundwater contamination or ground gases
- In-ground migration of ground gases and accumulation of potentially explosive atmosphere
- Migration of leachable / mobile contamination through soil and groundwater to wider environment
- Direct contact between contaminants and buried services or infrastructure.

4.4 CONTAMINANT LINKAGE ASSESSMENT

If chemical or asbestos-related contamination is present within Made Ground or natural soils beneath the site, the following contaminant linkages could be present:

- Construction workers and neighbouring site users could be at risk of exposure during construction, largely via direction contact, ingestion and inhalation of soil dust.
- If contaminated soil remained on site within the redevelopment future site users and maintenance workers could also be at risk of exposure via direct contact, ingestion and inhalation.
- If mobile contamination is present, or groundwater is contaminated, surface water and groundwater resources could be impacted if migration pathways are viable.
- If ground gas is being generated (considered unlikely), it has the potential to accumulate and impact construction workers and future site users.

If complete contaminant linkages are present, they would likely be broken by completing some relatively basic remediation / mitigation works, e.g. removal of hot spots of contamination prior to the construction phase, application of a clean soil cover layer.

5 GROUND INVESTIGATION

5.1 FIELDWORK

A ground investigation was scoped by WSP to provided geotechnical information to support the cost-effective design of the substructures and data to assess the contamination status of the site.

Fieldworks were undertaken between 12 and 30 August 2019 by Geotechnics and observed by WSP. The works undertaken are summarised in Table 5-1.

Table 5-1 - Summary of Fieldwork

Investigation Method	No. of Positions (reference)	Depth (m BGL*)
Cable percussion borehole with rotary follow on	9 (BH101 to BH109)	25.4 – 51.0

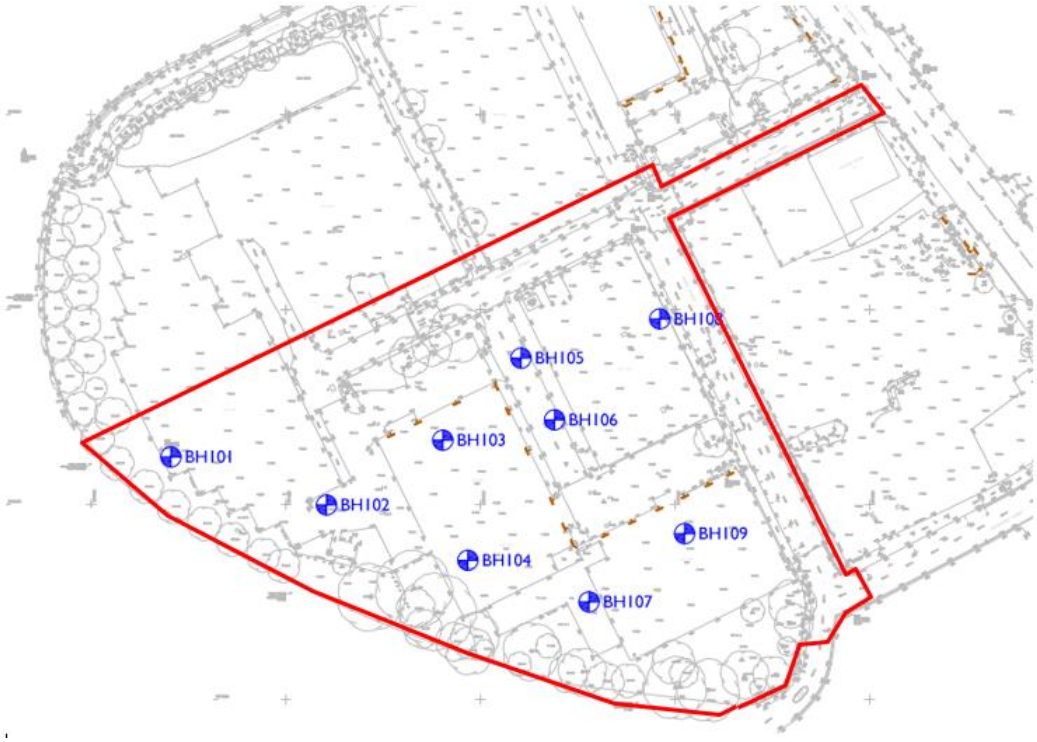
* metres below ground level

The procedures followed in the investigation were in general accordance with guidance presented in BS 5930:2015 and BS 10175:2011 (BSI, 2013, 2015).

The results of the ground investigation are presented in the Factual Report (Geotechnics, December 2019), which is included as **Appendix D**. The Factual Report contains exploratory hole records, core photographs, in-situ testing data, monitoring results and laboratory testing results.

An exploratory hole location plan is presented in **Appendix A**. An extract from the drawing showing the site boundary is provided as Insert 5-1 below:

Insert 5-1 – Exploratory Hole Location Plan Extract (approximate site boundary)



5.2 MONITORING INSTALLATIONS

Six of the nine boreholes were installed with groundwater / ground gas monitoring wells. Details of the installations are included in the exploratory hole records and summarised in Table 5-2.

Table 5-2 - Summary of Monitoring Installations

Exploratory Hole	Standpipe Diameter (mm)	Screen Top & Base (m bgl)	Strata within Response Zone
BH101	50	9.0 – 20.0	Cohesive Glacial Till / Granular Glacial Till / Sandstone
BH103	50	0.5 – 3.0	Made Ground / Glaciofluvial Deposits
BH104	50	0.5 – 3.0	Made Ground / Glaciofluvial Deposits
BH107	50	10.0 – 15.0	Sandstone
BH108	50	8.5 – 20.0	Sandstone
BH109	50	0.5 – 3.0	Made Ground / Glaciofluvial Deposits

5.3 SURVEYING

All exploratory holes were surveyed by Geotechnics; easting, northing and elevation are included within the exploratory hole records.

5.4 GAS MONITORING / GROUNDWATER MONITORING

Six ground gas monitoring and groundwater gauging visits were specified over a three-month period in accordance with guidance presented in BS 8485 (BSI, 2015) and CIRIA C665 (Wilson et al, 2007) for a moderate sensitivity end use and low ground gas potential site.

Six visits have been completed (27 September, 29 October, 12 and 25 November and 9 and 16 December 2019). Groundwater was sampled from all wells on 09 December 2019.

Groundwater and ground gas monitoring results are provided in the Final Geotechnics Factual Report (2019) in **Appendix D**.

5.5 IN-SITU TESTING

In situ geotechnical testing including Standard Penetration Tests, high pressure dilatometer tests and an acoustic televiewer survey were completed; these are interpreted separately within the geotechnical GIR and GDR reports.

5.6 CHEMICAL LABORATORY TESTING

A summary of the chemical testing completed on soil and groundwater samples is provided in Table 5-3 below.

Table 5-3 - Summary of Chemical Analysis Completed

Analyte	No. of soil samples analysed	No of groundwater samples analysed
Metals (including arsenic, boron (water soluble), cadmium, chromium, hexavalent chromium, copper, lead, mercury, nickel, selenium and zinc)	7	6*
Total Organic Carbon	7	0
Total Petroleum Hydrocarbons Criteria Working Group (TPH CWG)	7	6*
Polyaromatic Hydrocarbons (PAH 16 Speciated)	7	6*
Asbestos in soils	10	Not applicable
Waste Acceptance Criteria (WAC)	4	Not applicable

Table Note: * Insufficient sample size from BH109 to perform laboratory analysis

6 GROUND AND GROUNDWATER CONDITIONS

6.1 SUMMARY

The preliminary ground model presented in the WSP PRA suggested that Phase 2 would be underlain by Made Ground overlying Glaciofluvial deposits and Glacial Till over sandstone bedrock. The ground investigation has confirmed this general sequence.

Generally, ground conditions comprised granular Made Ground over firm grading to very stiff clay including localised bands of sand / sand and gravel at varying depths, over sandstone. A layer of medium dense sand and gravel or silt was encountered between the Made Ground and underlying clay in areas where Made Ground was shallower, interpreted as Glaciofluvial deposits. Further details are provided below.

6.2 GROUND CONDITIONS

6.2.1 MADE GROUND

Surface cover generally comprised either a concrete slab or stone setts, set in a material described as 'pitch' in the logs. Surface materials were underlain by Made Ground in all boreholes to depths of between 0.8m bgl (BH107 in the south) and 3.5m bgl (BH106 in the centre north). The Made Ground depth generally increased from the south to the north. A clayey sand in BH103 between 2.2m and 3.2m bgl was recorded as possible Made Ground.

The Made Ground generally comprised sand with a variable content of ash, clinker, gravel and cobbles of brick, masonry and concrete consistent with demolition rubble from the housing that formerly occupied the site. A cohesive (clay) Made Ground was also recorded in several locations (BH101, BH105, BH106 and BH107) comprising very soft to soft slightly gravelly sandy clay with cobbles of brick.

6.2.2 SUPERFICIAL SOILS

A medium dense slightly silty very gravelly fine to coarse sand (silt in one location) was encountered beneath the Made Ground in the central and southern parts of the site to depths of between 3.0m bgl and 4.2m bgl. This material is interpreted as Glaciofluvial Sheet Deposits and was absent where the Made Ground was deepest in the centre and north (this layer likely having been removed).

The Made Ground or Glaciofluvial Sheet Deposits was underlain by a firm, stiff and very stiff sandy gravelly clay with partings of sand and gravel; interpreted as Glacial Till.

6.2.3 SANDSTONE

Sandstone bedrock was encountered at depths of between 7.40m bgl (BH103 in the centre of the site) and 11.2m bgl (BH101 in the west) and comprised a weathered surface layer (approx. 0.5m thick) of extremely weak reddish-brown fine to medium grained sandstone (recovered as sand) overlying intact bedrock of extremely weak to medium strong fine and medium grained sandstone.

The bedrock was recorded in all boreholes to the maximum drilled depth of 51.0m bgl

6.3 GROUNDWATER

Groundwater strikes were not recorded within the superficial deposits during drilling and water flush used during the drilling of the rotary sections masked any inflows.

Groundwater levels recorded in the standpipes during the six groundwater level monitoring events completed to date are included in **Appendix D**. The groundwater depths recorded on 09 December 2019 are shown in the table below to give an indication of the variation between wells during one event.

The results suggest perched water is present within the Made Ground and shallow superficial soils at a depth of approximately 2.5m bgl and deeper water within the sandstone is resting at a depth of between 6m and 10m bgl. Given the presence of the Glacial Till deposits above the sandstone, hydraulic connectivity between these could be limited.

Table 6-1 - Depth to Groundwater

					Depth to water on 09/12/2019	
Monitoring Well	**Ground Level m AOD**	**Screen top depth (m bgl)**	**Well depth (m bgl)**	**Response zone installed in strata**	**m bgl**	**m AOD**
BH101	33.42	9.0	20.0	Clay over gravel over sandstone	9.82	23.60
BH103	33.23	0.5	30.0	Base of granular possible Made Ground over clay	2.62	29.61
BH104	33.22	0.5	3.0	Granular Made Ground over clay	2.52	30.70
BH107	33.20	10.0	15.0	Sandstone	6.60	26.60
BH108	32.77	8.5	20.0	Sandstone	5.88	26.89
BH109	33.20	0.5	3.0	Granular Made Ground over sand	2.71	30.49

6.4 VISUAL OR OLFACTORY EVIDENCE OF CONTAMINATION

Aside of the ash noted within Made Ground (a potential source of metal and PAH contamination) and bituminous sealant (possible 'pitch') surrounding the cobble setts (a possible source of PAH contamination) there was no visual or olfactory evidence of chemical contamination noted in soil or groundwater during the investigation or subsequent monitoring.

6.5 CHEMICAL ANALYSIS RESULTS

The soil chemical analysis results (presented in the Geotechnics report (**Appendix D**) have been qualitatively reviewed for evidence of chemical contamination. Comments are provided below:

- Metal concentrations are generally consistent across samples and are not considered indicative of a potential source of contamination, other than ash content. Concentrations of three metals (copper, lead and zinc) are notably elevated in one sample when compared to the others; higher by an order of magnitude in the sample from BH108 1.0m bgl. It is possible that these higher concentrations are associated with a higher ash content than the other samples, although there is no indication in the log that this was the case.
- TPH concentrations were either below the detection limit or at trace concentrations (one sample, BH101 0.5m bgl).
- PAH concentrations were below the detection limit or at trace concentrations in 4 of the 7 samples tested. Concentrations were notably elevated in the three remaining samples; highest in

BH101 0.5m bgl (total PAH 130mg/kg) and one order of magnitude lower in BH101 1.0m bgl and BH108 1.0m bgl.

- Soil chemical concentrations are generally consistent with those expected in ashy soils and are not considered to indicate the presence of other sources of chemical contamination within soils.
- Asbestos fibres were not detected in any of the ten samples of Made Ground tested.

The groundwater analysis results provided in **Appendix D** (for five monitoring wells; insufficient sample volume from BH109) have been reviewed for evidence of chemical contamination. Comments are provided below:

- Metal concentrations are generally consistent across all groundwater samples and are not considered indicative of a potential source of contamination.
- TPH and PAH concentrations were either below the detection limit or at trace concentrations in four of the five samples. Slightly higher concentrations of PAH and significantly higher concentrations of TPH were detected in BH104 than in the other samples. Of the five monitoring wells sampled, BH104 is the only one installed within the shallow Made Ground (the likely source of these concentrations).

7 GENERIC QUANTITATIVE RISK ASSESSMENT

7.1 INTRODUCTION

Legislation and guidance on the assessment of potentially contaminated sites acknowledges the need for a tiered risk-based approach. This assessment represents a generic quantitative risk assessment (GQRA). It incorporates a comparison of site contaminant levels against generic assessment criteria (GAC), including a qualitative assessment of risk using the source-pathway-receptor model. The purpose of this GQRA is to assess potential risks to human health (based on a proposed future residential end use) and controlled waters.

7.2 HUMAN HEALTH SOIL RISK ASSESSMENT

7.2.1 SCREENING CRITERIA

A series of soil and groundwater human health GAC screening values have been calculated by WSP for standard end-uses and various soil organic matter (SOM) content. Further details on the risk assessment approach and methodology for the derivation of human health GAC are provided in **Appendix E**.

Based on the proposed end-use, the human health GAC for 'residential use without home grown produce' have been used for screening purposes. The total organic carbon content of the samples varied between 0.8% and 6.6%, which equates to a SOM content of between 1.376% and 11.352% (average 6.2%); therefore GAC for soil with 6% SOM have been used.

The approach to assessing risks from asbestos in soils differs from the GQRA process for chemical contamination, since there is no accepted 'safe' screening value for asbestos fibres in soils. The potential risks from asbestos in soils are discussed in more detail in Section 7.4.

7.2.2 HUMAN HEALTH SOILS ASSESSMENT – RESULTS

A comparison of the soil concentrations to the selected GAC (screen results presented in **Appendix F**) has identified GAC exceedances for lead and benzo(a)pyrene, as detailed in the table below.

Table 7-1 - Human health soil GAC exceedances

Analyte	GAC (mg/kg)	Locations Exceeding	Depths Exceeding	Concentrations Exceeding (mg/kg)	Strata Exceeding
Lead	188	BH108	1.00	840	Made Ground
Benzo (a) pyrene	1.7	BH101 BH101 BH108	0.50 1.00 1.00	8.2 1.7 3.6	Made Ground Made Ground Made Ground

The GAC exceedances suggest that if Made Ground remained accessible near the surface of the redevelopment, there would be theoretical risks to residential site users associated with lead and benzo(a)pyrene concentrations within the Made Ground.

7.3 HUMAN HEALTH GROUNDWATER ASSESSMENT RESULTS

7.3.1 GENERIC ASSESSMENT CRITERIA

VOCs in shallow groundwater may represent a potential risk via vapour inhalation.

WSP has generated a set of GAC applicable to selected volatile compounds in groundwater designed to be protective of human health for selected land uses, as described in **Appendix E**.

The model used to generate the GAC assumes a groundwater depth of 1.0m bgl, which is considered conservative in relation to the suggested shallow groundwater conditions at this site.

7.3.2 HUMAN HEALTH GROUNDWATER RISK ASSESSMENT RESULTS

The concentrations of volatile compounds with the standard analysis suites (light end TPH and naphthalene) have been compared to the groundwater vapour GAC for the proposed end use. The comparison is provided in **Appendix G**.

None of the compounds exceed the GAC. Therefore, the potential risk to human health from vapour inhalation from a groundwater source is considered negligible.

7.4 ASBESTOS IN SOILS

The Control of Asbestos Regulations, 2012 (CAR) makes it clear that asbestos management procedures are required on sites where asbestos is present and this covers asbestos in the ground as well as buildings.

Asbestos was not identified in any of the ten samples analysed. However, there is potential for asbestos to be present within all Made Ground materials, especially those containing demolition materials, and therefore appropriate mitigation should be considered during redevelopment to prevent exposure of site workers and neighbours to asbestos fibres in soils. This could include, but not be limited to the following:

- Measures to prevent site operatives and neighbouring site users being exposed to airborne fibres during the redevelopment.
- Measures to prevent exposure of future site users within the future development to affected soils (e.g. use imported soils for potential landscaped areas).

7.5 CONTROLLED WATERS RISK ASSESSMENT

7.5.1 WATER QUALITY STANDARDS

Generic controlled waters assessments are usually conducted by comparing directly measured chemical concentrations in groundwater with published Water Quality Standards (WQS) that are protective of surface water or groundwater resources. This provides an initial conservative assessment of potential risks from groundwater to groundwater/surface waters and assumes there is a viable migration pathway.

Appropriate published WQS are selected for use in this assessment based on both a hierarchy of relevance to England and Wales/Scotland and the nature of the controlled waters receptor. In this case, the assessment has been completed using WQS protective of groundwater (shallow Secondary A Aquifer and Principal Aquifer at depth) and surface waters (river and canals) as follows:

Surface Waters

- Environmental Quality Standards (EQS) from The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015.

Groundwater

- UK Drinking Water Quality Standards (DWS) from the Water Supply (Water Quality) Regulation 2000 (amended 2004).
- World Health Organisation Guidelines for Drinking Water Quality, Fourth Edition, Volume 1, (2011).
- World Health Organisation Petroleum Products in Drinking Water (2008).

The output of the groundwater GQRA is presented in **Appendix G.**

7.5.2 CONTROLLED WATERS ASSESSMENT RESULTS

The screening exercise indicates:

- Several minor EQS exceedances for metals (copper, nickel and zinc) and PAH compounds (fluoranthene and benzo(a)pyrene) in some or all groundwater samples, suggesting a theoretical risk to surface waters.
- WHO 2008 exceedances for TPH fractions (aromatic C12-C16, C16-C21 and C21-C35) in one sample (BH104), suggesting a theoretical risk to the underlying Principal Aquifer.

The WQS exceedances discussed above are not considered to represent a potentially significant risk to controlled water receptors given the following:

- The minor metal EQS exceedances are noted in several samples, from both shallow wells installed in the Made Ground and deeper wells installed in the underlying sandstone, suggesting the concentrations are representative of background concentrations rather than a source of contamination within the site.
- The PAH EQS exceedances recorded in all samples are based on highly conservative WQS that are not considered applicable to this site setting. The results suggest no evidence of PAH contamination within the groundwater except to a minor extent in BH104, which is installed within Made Ground.
- The TPH WHO 2008 exceedances were recorded in water from shallow monitoring well BH104, installed within Made Ground soils, the likely source of the slightly elevated concentrations. Given that most of the Made Ground will be removed to enable basement construction it is considered that this potential source of minor shallow groundwater impact (PAH and TPH) will not be present in the final development. In addition, the presence of cohesive soils beneath the Made Ground will offer some protection to the underlying Principal Aquifer from vertical migration of shallow groundwater contamination.

Given the above and the proposed removal of nearly all the Made Ground as part of the development proposals, it is considered that remedial works in relation to groundwater contamination are not required.

8 GROUND GAS AND WASTE ASSESSMENT

8.1 GROUND GAS ASSESSMENT

Six ground gas monitoring visits have been completed, although due to access restrictions it was not possible to monitor all six wells on all occasions. The results are presented in the Factual Report in **Appendix D**.

Whilst ground gas assessment is usually conducted via the calculation of a gas screening value in line with CIRIA C665, an alternative qualitative assessment of the ground gas regime has been completed for this site, given the likely changes to the site conditions within the proposed redevelopment.

Given the ground conditions, the most plausible source of hazardous ground gas at the site is the Made Ground, present at significant depth in the central and northern parts of the site, although its gas generation potential will likely be relatively low due to limited organic material content. Two monitoring wells were installed with response zones largely located within the Made Ground (BH104 and BH109). The other monitoring wells were installed within deeper strata comprising natural soils with low organic content or sandstone bedrock; neither considered likely to generate significant quantities of hazardous ground gases.

The ground gas monitoring results indicate carbon dioxide concentrations of up to 8.4%v/v (BH104) and methane concentrations of up to 0.5%v/v (also in BH104); however, concentrations were generally significantly lower than this and flow rates are generally low; maximum steady flow rate 1.9l/h (BH109). The full set of ground gas monitoring results suggest that the Made Ground is not likely generating significant quantities of hazardous gases. Given that most of the Made Ground within the site boundary is likely to be excavated and removed from site during redevelopment, the gas monitoring results within the Made Ground are not considered likely to be representative of the ground conditions following basement excavation.

In addition, the following points are noted in relation to the proposed development:

- A ‘collar’ of Made Ground may remain around the site perimeter; however, significant quantities of organic/putrescible material were not recorded within the Made Ground and ground gas monitoring results do not indicate the site is affected by significant ground gas generation.
- The basement levels will be occupied by car parking and the ground floor by amenity space; these are lower sensitivity end uses in relation to risks from ground gases than residential apartments, which are located on the first floor and above.
- The basement will be ventilated and given that it will likely be located below the water table, will be provided with significant damp proofing measures. These structural and ventilation measures will offer significant protection against ground gas ingress, were significant ground gas generation be occurring.

Given the above information, it is proposed to classify the site as characteristic situation 1, whereby no specific ground gas protection measures are required.

8.2 WASTE SOIL CLASSIFICATION / RE-USE

Construction of the development will generate excess Made Ground and natural soils that will likely not be required on site; therefore, will need to be taken away for recycling or disposal at landfill.

Preliminary waste classification of the granular Made Ground materials based on chemical results indicates it would be classified as non – hazardous waste for landfilling purposes with a possibility that the material would be accepted at the lower inert rate (based on WAC results) or for recycling/re-use via a soil treatment centre. Asbestos has not been detected in any of the tested samples, confirming the non-hazardous waste classification on the basis of asbestos content (i.e. asbestos <0.1%w/w).

Chemical analysis has not been completed on natural soil and rock and therefore a waste characterisation assessment has not been completed for this material. Based on observations on site, it is considered likely that excavated natural materials would be classified as non-hazardous waste for landfilling purposes, with a possibility that the material would be accepted by an inert facility or for recycling. However, a waste characterisation exercise would need to be completed on excavated materials to confirm this if it is to be sent to landfill.

Small quantities of surface pitch (between stone setts) and tarmac will likely be classified as hazardous waste for landfilling purposes, although an assessment of this material has not been completed.

Final waste classification for landfilling purposes is the responsibility of the producer of the waste and it is recommended that the laboratory results are forwarded to the landfill to confirm acceptability prior to offsite disposal. Additionally, liaison with the intended landfill operator may be required to confirm receipt of the waste.

Excess natural uncontaminated materials generated during excavation could be re-used within the site or on other sites (subject to chemical and geotechnical suitability) under a Materials Management Plan (MMP). The CL:AIRE MMP regime will enable excess Made Ground materials to be re-used appropriately within the redevelopment; however, excess Made Ground materials may not be re-used on other sites under this regime.

8.3 OTHER ISSUES

It is recommended that potable water pipes are laid in clean imported granular material in line with best practice. A water pipeline risk assessment will likely be required to justify the choice of pipeline material.

The chemical suitability of any imported soils for use as cover in soft landscaped areas will need to be demonstrated.

9 REVISED CONCEPTUAL SITE MODEL

Following completion of the site investigation and generic quantitative risk assessment, the conceptual site model has been updated with the potential contaminants (sources), receptors that could be impacted and pathways, via which sources and receptors may be connected.

9.1 REVISED GROUND MODEL

The ground investigation has confirmed the presence of a relatively permeable Made Ground (proven to depths of up to 3.5m bgl in the central northern part of the site) containing perched groundwater. There was limited evidence of obstructions associated with former site use as a gym / public baths / 'factory'. The ground investigation has confirmed the presence of a layer of relatively permeable granular soils over lower permeability cohesive soils (with granular partings) to the top of the sandstone. A deeper groundwater body has been identified within the sandstone; groundwater within the monitoring wells installed in the sandstone recorded groundwater levels of between approximately 6m bgl and 10m bgl. There is likely to be limited connectivity between the shallow and deeper groundwater bodies due to the presence of low permeability cohesive soils above the sandstone.

Much of the Made Ground materials and some of the shallow natural soils will be removed from the site during basement/car park construction.

9.2 CONTAMINANT SOURCES

Chemical analysis and risk assessment has confirmed the following viable contaminant sources in soil:

- Concentrations of lead and benzo(a) pyrene within Made Ground soils present a potential risk to human health if left exposed at the surface in the redevelopment.

Concentrations of chemical contaminants within groundwater are not considered to represent a significant source of contamination or risk to controlled waters.

It is considered that, given the proposed removal of the Made Ground, hazardous ground gases do not represent a significant risk to the development.

9.3 VIABLE RECEPTORS

Viable receptors that may be impacted by the identified sources are confirmed to be:

- Future site users.
- Proposed water supply pipes.

The following receptors are not considered to be viable in relation to the identified sources:

- Construction workers and site neighbours during redevelopment (due to limited exposure time)
- Future maintenance workers (due to limited exposure time).
- Surface waters / underlying aquifers.

9.4 POTENTIAL MIGRATION PATHWAYS AND ACTIVE CONTAMINANT LINKAGES

Given the above sources and receptors, the following contaminant linkages are considered to be viable:

- If Made Ground materials remain within the top 600mm of soft landscaped areas within the redevelopment, future site users could be at risk of exposure via direct contact, ingestion and inhalation.

10

OUTLINE REMEDIATION STRATEGY

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10 OUTLINE REMEDIATION STRATEGY

10.1 INTRODUCTION & OBJECTIVES

The human health risk assessment concluded that Made Ground represents a potential risk to human health (from ingestion, inhalation and direct contact pathways) if it remains with the upper 600mm of proposed landscaped areas. Remedial works are therefore recommended to address these potential risks.

As existing soils covering most of the site area are to be excavated to approximately 10-12m bgl to accommodate the basement car parks, the majority of Made Ground will be removed; a narrow 'collar' of existing shallow soils will remain around the edge of the site. The removal of soils for construction purposes is not considered as remedial work within this strategy, although the disposal off-site of surplus materials will need to be undertaken as described previously (Waste Soil Classification / Re-use Section 8.2).

The principal objective of any remedial strategy is to take reasonably practicable measures to reduce or remove the potential risks associated with the identified potential contaminant linkages. To achieve this, one or more elements of the contaminant linkages (source, pathway or receptor(s)) will need to be eliminated or reduced to an acceptable level. As the identified (future) receptors cannot be removed in this scenario, the objectives of the remediation scheme are to complete one or both of the following:

- Removal of source material (i.e. Made Ground with concentrations of lead and benzo(a)pyrene which may present a risk to human health)
- Block / remove the pathway from source to receptors (i.e. prevent or mitigate the potential active pathways – inhalation, direct contact, ingestion).

In line with statutory guidance, this will be achieved by the most effective and sustainable remediation option, or combination of options, considering any site constraint, without disproportionate costly measures.

This outline Remediation Strategy has been prepared in general accordance with the following guidance:

- Planning Guidance in Relation to Ground Contamination: Guidance Note for Applicants, Developers, Land Owners and Consultants, Version 6.0 Dated September 2016.Environmental Protection Group, Contaminated Land Section, Manchester City Council (referred to as 'Local Authority Planning Guidance').
- Contaminated Land Strategy, Updated March 2011, Contaminated Land Section, Environmental Services, Manchester City Council.

10.2 OUTLINE PROPOSED REMEDIAL WORKS

To mitigate potential risks, it is proposed that for landscaped areas, a cover system is placed to provide a barrier between Made Ground that will remain in-situ in the narrow 'collar 'around the edge of the site and future site users. The cover system shall comprise a minimum 600mm combined thickness of topsoil / sub-soil. The design thicknesses of the topsoil / sub-soil shall be determined by the landscape architect and be based upon the requirements of the proposed landscaping.

Local Authority Planning Guidance states that the minimum acceptable total depth for fill materials within areas of softstanding / public open spaces is 450mm. The cover system proposed here comprises a minimum thickness of 600mm over retained Made Ground. The increased thickness in cover has been recommended due to the higher sensitivity of future receptors associated with the proposed school in the northwest of the site.

10.2.1 IMPORTED SOIL REQUIREMENTS

Imported soil shall not contain concentrations of chemicals that would cause a significant risk to human health and the environment. It shall be demonstrated that imported material is free from contamination by provision of the following information:

- A desk study with details of the source of the cover material; and
- Soil analytical test results, which shall present justification for the selected analytical suite.

As such, soil samples shall be tested, as a minimum, for a standard suite of contaminants, to include:

- Toxic metals
- Polyaromatic hydrocarbons (PAHs)
- Total Petroleum Hydrocarbons (speciated)
- Asbestos
- pH

Additional testing may be required depending on the provenance of source material and findings of the desk study. Where topsoil is required confirmation will also be needed that the soil meets the nutritional requirements of the proposed planting scheme.

Concentrations should not exceed the imported soil criteria, which are presented in Appendix H. The criteria are based on minimal risk generic assessment criteria (GACs), primarily for chronic exposure, which have been derived in-house by WSP. The criteria assume a soil organic matter of 2.5% as a conservative approach. As the site end use is mixed (residential, school and park use) a 'residential without home grown produce' land use has been selected. Details of the derivation of the imported soil criteria are also presented in Appendix E.

Though no specific guidance exists for imported material frequency testing, Local Authority Guidance stipulates that it shall also take into consideration desk study findings, and meet a minimum of:

- Three samples per source material used; and / or
- For areas of soft landscaping, one sample per 200m^3 of 'greenfield' sourced material or one sample per 150m^3 from unknown / remediated / brownfield sourced material.

10.3 OUTLINE VERIFICATION PLAN

This Verification Plan sets out the data gathering requirements in order to demonstrate that the remediation criteria and objectives are met, and how the works are to be documented and reported. Any changes to the Verification Plan, particularly where they lead to a change to the objectives, will be documented and, where necessary, agreed with relevant parties.

10.3.1 VALIDATION TESTING

Testing and placement of topsoil shall be done in accordance with BS 3882 (2015): *Specification for topsoil* and local authority guidance.

In the Local Authority Planning Guidance, it is stated that Manchester City Council '*would expect to see on site sampling, and not just sampling at the source*' for validation testing. Therefore, testing of imported soils should also be carried out in situ, after materials have been imported to site. Testing requirements (both frequency and testing suite) shall be undertaken as detailed in 10.2.1 and screened using imported soil screening criteria presented in Appendix H.

10.3.2 COVER SYSTEM VALIDATION

Upon placement of the cover system in the areas of softstanding, a cover system inspection shall be undertaken. The inspection shall comprise a physical inspection i.e. machine or hand dug inspection pits, along with a photographic log, of the composition of the materials, to validate that the required minimum thickness (600mm combined topsoil / sub-soil) has been achieved.

Whilst no specific guidance exists for inspection pit frequency, WSP consider that BS10175:2011+A2:2017*: Investigation of potentially contaminated sites – Code of practice*, may be used as guidance, and an inspection pit frequency of one per 20m^2 or one per discrete section of landscaped areas shall be undertaken.

10.3.3 VERIFICATION REPORT

Following remedial work and validation, a verification report shall be submitted to the Local Authority for review. The purpose of the verification report is to present evidence to confirm that all remedial measures presented in the remediation plan have been successfully undertaken.

The verification shall include:

BACKGROUND INFORMATION AND REMEDIAL WORKS

- Relevant site location / identifying information;
- Summary of the reasons and objectives of the remediation and any items out of scope;
- Full description of the works undertaken, including methodology and any approved changes to the remediation strategy;
- Summary of the programme - start / completion dates;
- Quantities of material imported;
- A copy of the desk study with details of the cover material provenance.
- Summary tables of screened analytical data demonstrating contaminants are below assessment criteria in imported soils.

RECORDS

- All relevant analytical / laboratory certificates;
- Photographic log;
- Details of any third-party consultation, licencing, permits, consents, site visits or communications.
- Plans / drawings, to include stockpile locations, areas of soft landscaping with a cover system and locations of inspection pits.

In addition, the verification report shall also include records relating to waste soils disposal from the basement area. Whilst this information is not a requirement of remedial verification process (as it is not classed as remedial works), the records should be submitted to the local authority for review to demonstrate that correct waste disposal procedures have been followed.

- Waste Classification testing data
- Consignment notes / tickets.
- Quantities of materials disposed.
- Details of waste disposal facilities.
- As-built drawings including:
  - Original ground level surveys
  - Excavation extents.
  - Finished ground levels.

The Verification Report will be incorporated into the health & safety file for the site, and relevant details included in the future maintenance plan.

11 SUMMARY AND RECOMMENDATIONS

The results of the human health GQRA and chemical testing reported herein suggest a theoretical risk to future site users associated with concentrations of lead and benzo(a)pyrene in Made Ground if these materials were accessible at the surface of the redevelopment. Most of these materials are likely to be removed from the site during basement construction; however, if to be re-used on site, they should not be placed within the top 600mm of any areas of soft landscaping and re-use should be appropriate and governed by a CL:AIRE code of practice-compliant MMP.

If existing Made Ground materials are to be retained beneath areas of soft landscaping they should be covered with a 600m thick layer of chemically-suitable topsoil and subsoil to prevent exposure to future site users. Chemical testing of the topsoil/subsoil and depth validation will be required to confirm suitable cover soil has been placed appropriately and a verification report should be submitted to the local authority for review once remedial works are complete. If existing Made Ground materials will not be retained beneath areas of soft landscaping, then the depth of cover soil may be specified by the landscape architect with no requirement for validation works.

Several water quality standards are exceeded in groundwater samples; however, given that the ashy Made Ground materials that are likely contributing to the highest concentrations recorded on site (in BH104) are going to be removed from site, it is considered that risks to controlled waters will remain low and further remedial action is not required.

It is recommended that new water pipes should be laid in clean granular imported fill material in line with best practice. A water pipeline risk assessment will likely be needed if potable water pipes are to be laid within existing Made Ground materials, to determine the most appropriate pipeline material.

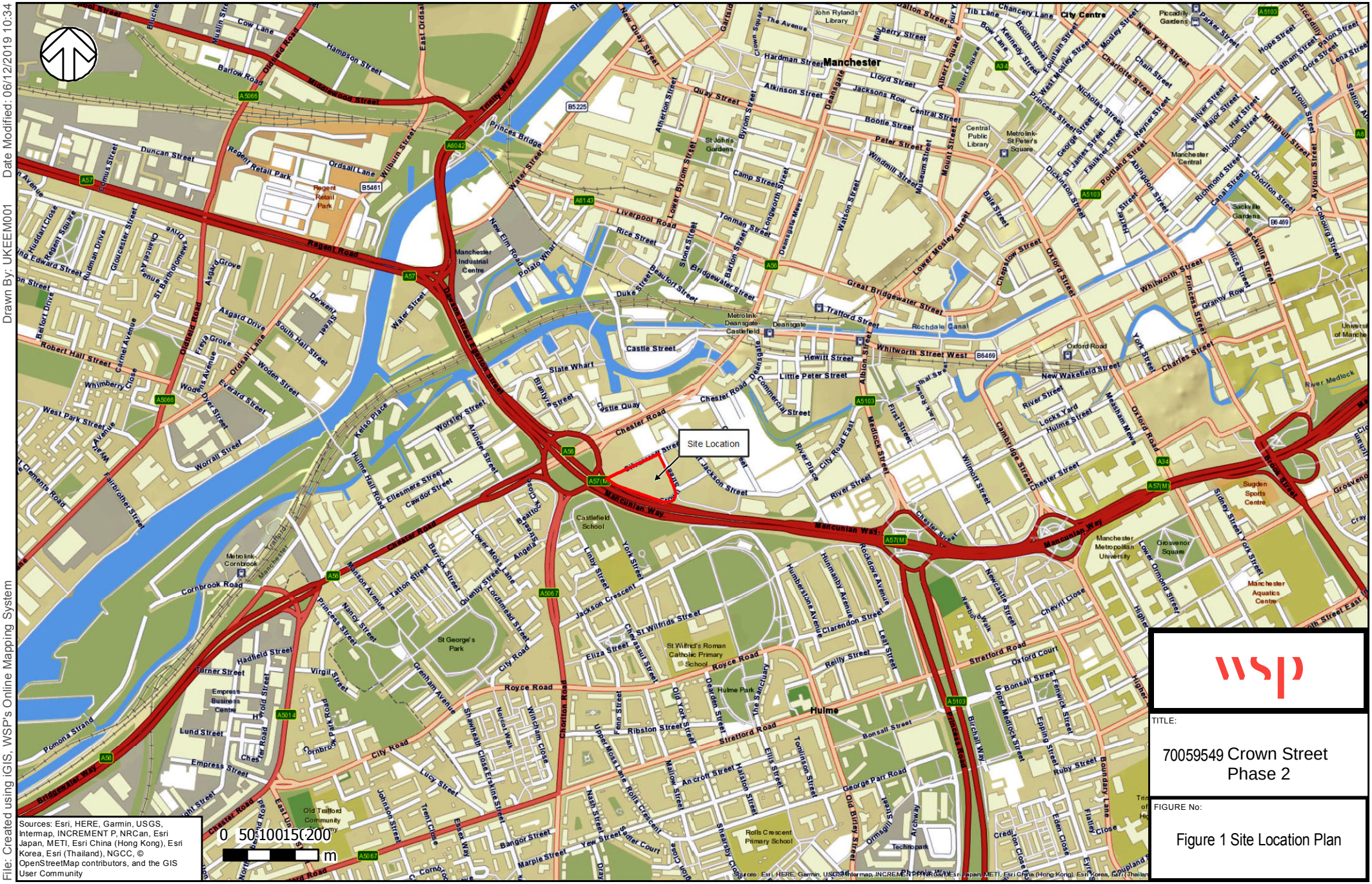
The waste assessment indicates that Made Ground materials would generally be classified as non-hazardous waste for landfilling purposes. Natural materials have not been assessed. Any pitch or bituminous material will likely require disposal as hazardous waste (not assessed in this report).

Ground operatives should be vigilant to the potential for asbestos fibres within Made Ground, possible larger pieces of asbestos containing materials (ACM) and chemical contamination during excavations through Made Ground and seek specialist advice if encountered.

Appendix A

FIGURES

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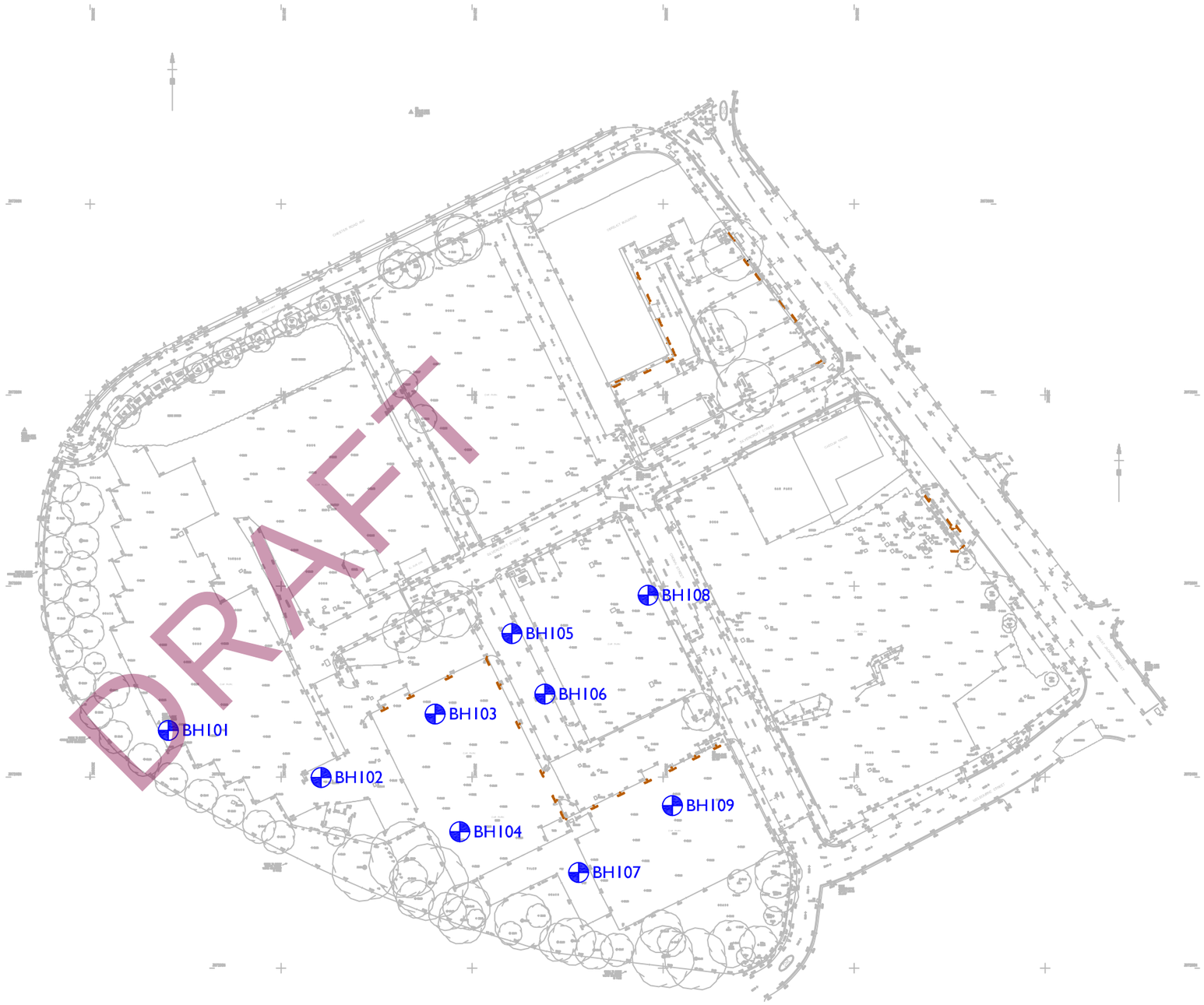
File: Created using iGIS, WSP's Online Mapping System Drawn By: UKEEM001 Date Modified: 06/12/2019 10:34

TITLE:

70059549 Crown Street Phase 2

FIGURE No:

Figure 1 Site Location Plan



Key

Cable Percussion with Rotary Follow-On Borehole

Hole ID	Easting (mE)	Northing (mN)	Level (mOD)
BH101	383096.4	397249.8	33.42
BH102	383128.4	397239.9	33.28
BH103	383152.3	397253.2	33.23
BH104	383157.4	397228.6	33.22
BH105	383168.3	397270.1	32.84
BH106	383175.2	397257.4	32.96
BH107	383182.3	397220.0	33.20
BH108	383196.9	397278.1	32.77
BH109	383202.0	397234.0	33.20

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Engineer:
WSP UK Limited

Client:
WSP UK Limited

Project:
Crown Street Phase 2

Drawing Title:

Exploratory Hole Location Plan

Scale: 1:1000@A3

Date:
September 2019

Project No:
PN194002

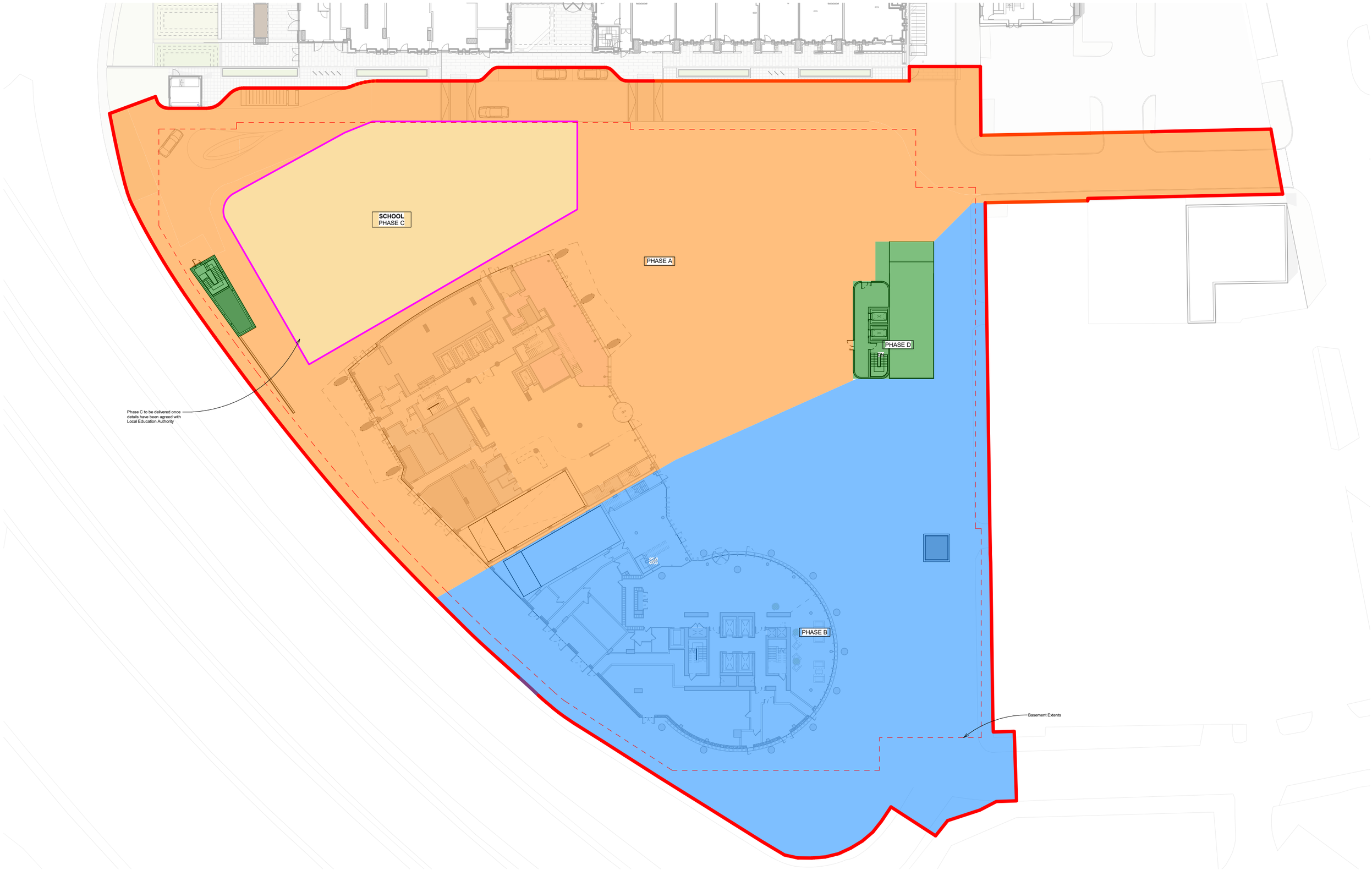
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Geo-PN194002-001(1)

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Appendix B

DEVELOPMENT PROPOSALS

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This drawing is copyright
Do not scale off dimensions.

All dimensions to be checked on site by contractor.

Contractor to report any dimensional discrepancies, errors or omissions prior to commencing on site.

Phases A, B, C and D are standalone and delivery sequence is yet to be finalised

C3
C4
C5

NORTH

Rev	Date	Description
P01	31-01-2020	Planning Issue

Project Title
Crown Street - Phase 2
Crown Street
Manchester

Drawing Title
Phasing Plan
Ground Level

Job No
10292

Scale
1:500 @ A3
1 : 250 @ A1

Status
Planning Issue

SHP Drawing Code
10292-Z1-SHP-G000-PL-00-B5D802

Revision
P01

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Appendix C

LIMITATIONS

REPORT LIMITATIONS - GROUND RISK AND REMEDIATION

GENERAL

1. WSP UK Limited has prepared this report solely for the use of the Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed and outlined in the body of the report.

2. Unless explicitly agreed otherwise, in writing, this report has been prepared under WSP UK Limited standard Terms and Conditions as included within our proposal to the Client.

3. Project specific appointment documents may be agreed at our discretion and a charge may be levied for both the time to review and finalise appointments documents and also for associated changes to the appointment terms. WSP UK Limited reserves the right to amend the fee should any changes to the appointment terms create an increase risk to WSP UK Limited.

4. The report needs to be considered in the light of the WSP UK Limited proposal and associated limitations of scope. The report needs to be read in full and isolated sections cannot be used without full reference to other elements of the report and any previous works referenced within the report.

PHASE 1 GEO ENVIRONMENTAL AND PRELIMINARY RISK ASSESSMENTS

Coverage: *This section covers reports with the following titles or combination of titles: phase 1; desk top study; geo environmental assessment; development appraisal; preliminary environmental risk assessment; constraints report; due diligence report; geotechnical development review; environmental statement; environmental chapter; project scope summary report (PSSR), program environmental impact report (PEIR), geotechnical development risk register; and, baseline environmental assessment.*

5. The works undertaken to prepare this report comprised a study of available and easily documented information from a variety of sources (including the Client), together with (where appropriate) a brief walk over inspection of the Site and correspondence with relevant authorities and other interested parties. Due to the short timescales associated with these projects responses may not have been received from all parties. WSP UK Limited cannot be held responsible for any disclosures that are provided post production of our report and will not automatically update our report.

6. The opinions given in this report have been dictated by the finite data on which they are based and are relevant only for the purpose for which the report was commissioned. The information reviewed should not be considered exhaustive and has been accepted in good faith as providing true and representative data pertaining to site conditions. Should additional information become available which may affect the opinions expressed in this report, WSP UK Limited reserves the right to review such information and, if warranted, to modify the opinions accordingly.

7. It should be noted that any risks identified in this report are perceived risks based on the information reviewed. Actual risks can only be assessed following intrusive investigations of the site.

8. WSP UK Limited does not warrant work / data undertaken / provided by others.

REPORT LIMITATIONS - GROUND RISK AND REMEDIATION

INTRUSIVE INVESTIGATION REPORTS

Coverage: *The following report titles (or combination) may cover this category of work: geo environmental site investigation; geotechnical assessment; GIR (Ground Investigation reports); preliminary environmental and geotechnical risk assessment; and, geotechnical risk register.*

9. The investigation has been undertaken to provide information concerning either:

- **i.** The type and degree of contamination present at the site in order to allow a generic quantitative risk assessment to be undertaken; or
- **ii.** Information on the soil properties present at the site to allow for geotechnical development constraints to be considered.

10. The scope of the investigation was selected on the basis of the specific development and land use scenario proposed by the Client and may be inappropriate to another form of development or scheme. If the development layout was not known at the time of the investigation the report findings may need revisiting once the development layout is confirmed.

11. For contamination purposes, the objectives of the investigation are limited to establishing the risks associated with potential contamination sources with the potential to cause harm to human health, building materials, the environment (including adjacent land), or controlled waters.

12. For geotechnical investigations the purpose is to broadly consider potential development constraints associated with the physical property of the soils underlying the site within the context of the proposed future or continued use of the site, as stated within the report.

13. The amount of exploratory work, soil property testing and chemical testing undertaken has necessarily been restricted by various factors which may include accessibility, the presence of services; existing buildings; current site usage or short timescales. The exploratory holes completed assess only a small percentage of the area in relation to the overall size of the Site, and as such can only provide a general indication of conditions.

14. The number of sampling points and the methods of sampling and testing do not preclude the possible existence of contamination where concentrations may be significantly higher than those actually encountered or ground conditions that vary from those identified. In addition, there may be exceptional ground conditions elsewhere on the site which have not been disclosed by this investigation and which have therefore not been taken into account in this report.

15. The inspection, testing and monitoring records relate specifically to the investigation points and the timeframe that the works were undertaken. They will also be limited by the techniques employed. As part of this assessment, WSP UK Limited has used reasonable skill and care to extrapolate conditions between these points based upon assumptions to develop our interpretation and conclusions. The assumption made in forming our conclusions is that the ground and groundwater conditions (both chemically and physically) are the same as have been encountered during the works undertaken at the specific points of investigation. Conditions can change between investigation points and these interpretations should be considered indicative.

16. The risk assessment and opinions provided are based on currently available guidance relating to acceptable contamination concentrations; no liability can be accepted for the retrospective effects of any future changes or amendments to these values. Specific assumptions associated

with the WSP UK Limited risk assessment process have been outlined within the body or associated appendix of the report.

17. Additional investigations may be required in order to satisfy relevant planning conditions or to resolve any engineering and environmental issues.

18. Where soil contamination concentrations recorded as part of this investigation are used for commentary on potential waste classification of soils for disposal purposes, these should be classed as indicative only. Due consideration should be given to the variability of contaminant concentrations taken from targeted samples versus bulk excavated soils and the potential variability of contaminant concentrations between sampling locations. Where major waste disposal operations are considered, targeted waste classification investigations should be designed.

19. The results of the asbestos testing are factually reported and interpretation given as to how this relates to the previous use of the site, the types of ground encountered and site conceptualisation. This does not however constitute a formal asbestos assessment. These results should be treated cautiously and should not be relied upon to provide detailed and representative information on the delineation, type and extent of bulk ACMs and / or trace loose asbestos fibres within the soil matrix at the site.

20. If costs have been included in relation to additional site works, and / or site remediation works these must be considered as indicative only and must be confirmed by a qualified quantity surveyor.

EUROCODE 7: GEOTECHNICAL DESIGN

21. On 1st April 2010, BS EN 1997-1:2004 (Eurocode 7: Geotechnical Design – Part 1) became the mandatory baseline standard for geotechnical ground investigations.

22. In terms of geotechnical design for foundations, slopes, retaining walls and earthworks, EC7 sets guidance on design procedures including specific guidance on the numbers and spacings of boreholes for geotechnical design, there are limits to methods of ground investigation and the quality of data obtained and there are also prescriptive methods of assessing soil strengths and methods of design. Unless otherwise explicitly stated, the work has not been undertaken in accordance with EC7. A standard geotechnical interpretative report will not meet the requirements of the Geotechnical Design Report (GDR) under Eurocode 7. The GDR can only be prepared following confirmation of all structural loads and serviceability requirements. The report is likely to represent a Ground Investigation Report (GIR) under the Eurocode 7 guidance.

DETAILED QUANTITATIVE RISK ASSESSMENTS AND REMEDIAL STRATEGY REPORTS

23. These reports build upon previous report versions and associated notes. The scope of the investigation, further testing and monitoring and associated risk assessments were selected on the basis of the specific development and land use scenario proposed by the Client and may not be appropriate to another form of development or scheme layout. The risk assessment and opinions provided are based on currently available approaches in the generation of Site Specific Assessment Criteria relating to contamination concentrations and are not considered to represent a risk in a specific land use scenario to a specific receptor. No liability can be accepted for the retrospective effects of any future changes or amendments to these values, associated models or associated guidance.

REPORT LIMITATIONS - GROUND RISK AND REMEDIATION

24. The outputs of the Detailed Quantitative Risk Assessments are based upon WSP UK Limited manipulation of standard risk assessment models. These are our interpretation of the risk assessment criteria.

25. Prior to adoption on site they will need discussing and agreeing with the Regulatory Authorities prior to adoption on site. The regulatory discussion and engagement process may result in an alternative interpretation being determined and agreed. The process and timescales associated with the Regulatory Authority engagement are not within the control of WSP UK Limited. All costs and programmes presented as a result of this process should be validated by a quantity surveyor and should be presumed to be indicative.

GEOTECHNICAL DESIGN REPORT (GDR)

26. The GDR can only be prepared following confirmation of all structural loads and serviceability requirements. All the relevant information needs to be provided to allow for a GDR to be produced.

MONITORING (INCLUDING REMEDIATION MONITORING REPORTS)

27. These reports are factual in nature and comprise monitoring, normally groundwater and ground gas and data provided by contractors as part of an earthworks or remedial works.

28. The data is presented and will be compared with assessment criteria.

Appendix D

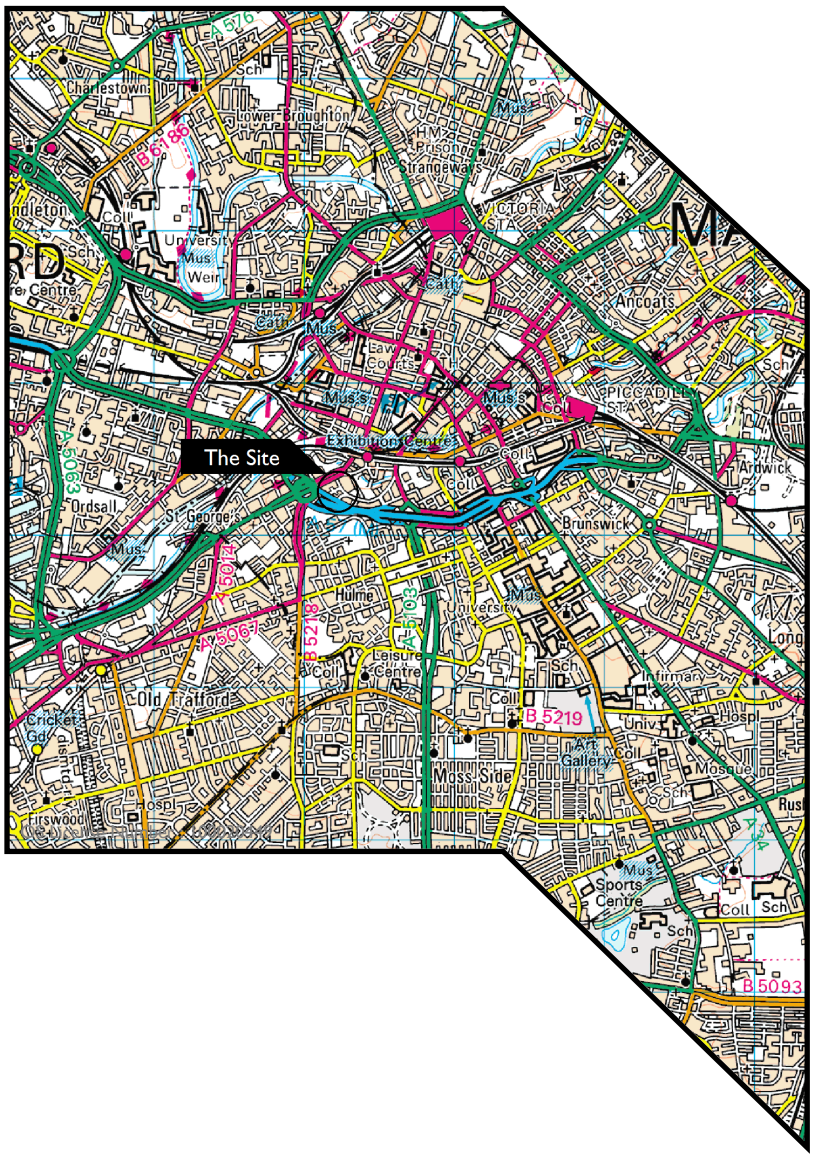
FACTUAL REPORT

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geotechnical and geoenvironmental specialists

Ground Investigation



www.geotechnics.co.uk

CROWN STREET ZONE 2

Factual Report

for

WSP UK Limited

Engineer : WSP UK Limited

Project Number PN194002

December 2019

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Ground Investigation
for

Factual Report

CROWN STREET ZONE 2

for
WSP UK Limited

Engineer :
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1.0 INTRODUCTION

A geotechnical and geo-environmental investigation was undertaken by Geotechnics Limited at the site of a proposed high-rise residential development at Crown Street, Manchester, M15 4AX. The project involves the construction of three towers of twenty-nine, thirty-seven and forty-four storeys in height, with adjoining amenities buildings. The scheme also includes between two and four levels of basement car parking. The investigation was carried out to the instructions of the Client and Engineer, WSP UK Limited, acting on behalf of their Client, Renaker Build Limited. This report describes the work undertaken and presents the data obtained.

2.0 OBJECT AND SCOPE OF THE INVESTIGATION

The object of the investigation was to obtain information on the ground and groundwater conditions relating to the design of the proposed works within the limitations posed by trial hole numbers, locations, depths, methods adopted and the scope of approved in situ and laboratory testing. The investigation comprised cable percussion with rotary cored follow-on boreholes, in situ and laboratory testing and reporting. A Factual Report was also commissioned.

3.0 PRESENTATION

A description of the site and a summary of the procedures followed during the investigation process are presented in Sections 4 to 6. The factual data so obtained are presented in Appendices 2 to 12 of this report. Attention is drawn to the General Notes and Investigation Procedures presented in Appendix 13 to aid an understanding of the procedures followed and the context in which the report should be read.

In addition, data in electronic format in accordance with "The Electronic Transfer of Geotechnical Data from Ground Investigations" published by the AGS (the AGS Format) are presented separately on disk together with a copy of the report in electronic PDF format.

4.0 THE SITE

4.1 Location

The site is located approximately 350 metres south-west of Deansgate Railway Station at a site off Crown Street in the Castlefields area of Manchester. The approximate Ordnance Survey National Grid Reference for the site is SJ 831 972 and an extract from the relevant 1:50,000 Scale O.S. Map (Sheet No. 109) is included as Appendix 1.

4.2 Description

The Crown Street Zone 2 development forms part of a larger development of an area of land bounded by the A56 Chester Road to the northwest, Great Jackson Street to the north-east, Melbourne Street to the south-east and the Mancunian Way Ring Road to the south-west.

The area covered by Zone 2 is triangular in shape with sides roughly as follows:

- Silvercroft Street to the north, about 110m in length,
- Crown Street to the east about 90m long, and
- and the Mancunian Way Ring Road to the south-west, extending over about 130m in length.

The site varies in elevation between about 32.5m AOD and 33.3m AOD. It is currently surfaced in a mixture of tarmacadam, concrete and cobble setts, and is currently used for car parking. Significant vegetation (trees and bushes) are limited to the southern boundary along the Mancunian Way Ring Road.

4.3 Site Geology

The 1:50,000 scale Bedrock and Superficial Edition map published by the British Geological Survey, Sheet 85 (Manchester) dated 2011, shows the site to be underlain by Glacio-fluvial Sheet Deposits, resting upon Glacial Till. These superficial deposits are shown to be underlain by strata of the Chester Pebble Beds Formation (now known as the Chester Formation), which forms part of the Sherwood Sandstone Group which is Triassic in age. A short distance to the north-east of the site, at the junction of the A56 Chester Road and Great Jackson Street, superficial deposits are shown to be absent, with sandstone bedrock being shown near to ground level.

Whilst Made Ground is not indicated on the site in question, it is shown about 250m to the north-east of the site around Deansgate Railway Station. Nevertheless, given the site's urban setting a thickness of Made Ground is anticipated at the site.

The 1:50,000 scale Bedrock Edition map published by the British Geological Survey, Sheet 85 (Manchester) dated 2010, shows the site as lying between two major faults, namely,

- the "West Manchester Fault", a north-west top south-east trending fault located about 800m to the north-east of the site, and
- the "Pendleton Fault, a north-north-west to south-south-east trending fault, located about 1 kilometre to the south-west of the site.

For both faults, the strata to the north-west is shown to be downthrown.

Locally the sandstone strata is shown to be dipping at 8 degrees to the south-west.

The British Geological Survey website, http://mapapps.bgs.ac.uk/geologyofbritain/home.html, accessed on 6th September 2019 confirms the mapping.

The Chester Formation is generally described as follows:
"The formation comprises conglomerates and reddish brown, cross-bedded, pebbly sandstones with subordinate beds of red-brown mudstone. The conglomerates have a reddish brown sandy matrix and consist mainly of pebbles of brown or purple quartzite, with quartz conglomerate and vein quartz. In these areas the formation generally fines upwards, from dominantly conglomerates at the base, to interbedded conglomerates and sandstones, with sandstone and pebbly sandstone predominant in the upper part, and rare mudstones".

4.4 Hydrogeology

The 1:625,000 scale Hydrogeological Map of England and Wales, published by the British Geological Survey, dated 1977 shows the underlying Triassic Sandstone to be an extensive and highly productive aquifer in which flow is dominantly intergranular.

The DEFRA Magic Map website, https://magic.defra.gov.uk/MagicMap.aspx, accessed on 6th September 2019, shows that the superficial deposits are classified as a Secondary A Aquifer. The bedrock underlying the site is classified as a Principal Aquifer

5.0 PROCEDURE

5.1 Commissioning

The work was awarded following submission of a tender for work designed by the Client for ground investigation of the site in accordance with their Client's requirements.

5.2 General

The procedures followed in this site investigation are based on *BS 5930: 2015 – Code of Practice for Site Investigations* and *BS 10175:2011+A2:2017 - Investigation of Potentially Contaminated Sites*. The soils and rocks encountered have been described in accordance with BS5930:2015 and BS EN ISO 14688-1:2018 and BS EN ISO 14689:2018.

The Exploratory Hole locations were specified by WSP UK Limited and their positions are shown on the Exploratory Hole Location Plan in Appendix 12. The co-ordinates and levels shown on the Exploratory Hole Records were measured using a Leica GPS survey device. The depths quoted on the exploratory hole records are in metres below ground level.

5.3 Buried Service Clearance

Prior to the investigation, available records and plans of buried services were consulted and a survey was carried out by CMS Surveys Limited utilising Ground Penetrating Radar (GPR) techniques and a Cable Avoidance Tool (CAT) and genny to check for the presence of buried services at the proposed exploratory hole locations.

As a further precaution, at each exploratory hole location, an inspection pit was excavated using hand tools to a depth of 1.20m below ground level to check for the presence of underground services. Prior to and on completion of the excavation, the location was scanned using a cable avoidance tool (CAT).

5.4 Boreholes

Nine (9 No.), cable percussion boreholes (numbered BH101 to BH109) were sunk using either 150mm or 200mm diameter tools and casings to depths ranging between 8.12m (BH103) and 11.60m (BH101) below ground level. This boring work was carried out between 12th and 28th August 2019.

Samples were taken from the service inspection pits, where appropriate, for laboratory examination and analysis. Representative disturbed (D and B) and driven open-tube thick-walled (U) samples of the soils encountered were obtained at regular intervals. In addition, Environmental samples (ES) were recovered at the depths indicated on the Borehole Records, presented in Appendix 2. Soil samples taken specifically for chemical analyses were contained within appropriate receptacles (glass jars) and stored alongside ice packs in a cool box to preclude any sample deterioration prior to delivery to the testing laboratory.

Standard Penetration Tests (SPTs) were undertaken at the depths indicated on the Cable Percussion Borehole Records in accordance with BS EN ISO 22476-3:2005+A1:2011 to obtain a measure of the engineering properties of the proved strata. The full details of the SPT results are presented on the SPT Results Summary Sheets, included in Appendix 2, along with the Borehole Records and the SPT Hammer Energy Test Report.

The cable percussion boreholes were extended using 102mm and 92mm rotary coring techniques to depths ranging between 25.40m (BH101) and 51.00m (BH103 amd BH109). This rotary coring work was carried out between 15th and 30th August 2019.

The drilling equipment on this particular contract mainly utilised air-mist as the flushing medium however mud was also used in Boreholes BH103 and BH109, and water was used in Borehole BH108.

The rock core diameter was reduced to 76mm diameter in places within Boreholes BH103 and BH109 to facilitate high pressure dilatometer testing (See Section 5.5).

Rock cores were extruded horizontally in transparent liners and placed into suitable core boxes. Photographs of the individual core boxes are included in Appendix 2.

Groundwater observations are included on the Borehole Records where appropriate and any rise in water level was recorded over 20 minutes whilst the drilling operations were suspended. It should be noted that the addition of water to the borehole as part of the drilling process may have masked the presence of groundwater in the borehole. Where water was added it has been noted on the Borehole Records.

On completion, 50mm diameter gas-monitoring standpipes were installed in Boreholes BH101, BH103, BH104, BH107, BH108 and BH109 (see Section 5.8). The other boreholes were backfilled with bentonite pellets and the inspection pits backfilled with arisings.

5.5 High Pressure Dilatometer Tests

Twelve (12 No.) high pressure dilatometer tests were carried out by Socotec Limited in Boreholes BH103 and BH109 in 1.50m long 76mm diameter rock pockets at the following depths:

High Pressure Dilatometer Tests – BH103	
Test No.	**Depth Range (m bgl)**
1	10.50-12.00
2	15.00-16.50
3	21.00-22.50
4	25.50-27.00
5	30.00-31.50
6	39.00-40.50

High Pressure Dilatometer Tests – BH109	
Test No.	**Depth Range (m bgl)**
1	13.50-15.00
2	18.00-19.50
3	24.00-25.50
4	28.50-30.00
5	33.00-34.50
6	37.50-39.00

The high pressure dilatometer test results are presented in Appendix 4.

5..6 Elastometer Tests

Experimental elastometer tests were carried out by Robertsons Geo Services Limited in Borehole BH102.

The elastometer test results are presented separately.

5.7 Downhole Geophysical Logging

Following completion of the drilling in Boreholes BH101, BH102 and BH108, downhole geophysical logging was undertaken. This work comprising high resolution acoustic televiewer, 3-arm caliper and natural gamma probe surveying was carried out by Robertson Geo Services Limited and their report is presented in Appendix 5.

5.8 Installations and Monitoring

Long-term monitoring of the gas and groundwater levels was made possible by the installation of 50mm diameter gas-monitoring standpipes as follows:

Exploratory Hole	Standpipe Slotted Pipe & Filter Zone (m)
BH101	9.00 to 20.00
BH103	0.50 to 3.00
BH104	0.50 to 3.00
BH107	10.00 to 15.00
BH108	8.50 to 20.00
BH109	0.50 to 3.00

Monitoring of the gas and groundwater levels at the site commenced on 27th September 2019, with further visits on 16th and 29th October, 12th and 25th November and 9th and 16th December 2019.

On each of the monitoring visits a record of the groundwater level in the standpipes was obtained.

In addition to the groundwater levels, the following parameters were measured and recorded in each standpipe using a GasData LMSxi Gas Analyser, GA5000 Gas Analyser and GFM436 Gas Analyser:-

- Concentrations (% Vol) of CH_4, O_2, CO_2, along with (% LEL) CH_4 and (ppm) H_2S, CO
- Flow Rate
- Differential Pressure
- Barometric Pressure

The results of the monitoring are presented in Appendix 6.

5.9 Groundwater Purging and Sampling

On 9th December 2019 where water was recorded, groundwater samples were obtained (where possible) following purging of water in the standpipes The following parameters were recorded using a multi-parameter flow cell during purging which continued until such time as the parameters reached a steady level.

- Temperature (°C)
- Electrical Conductivity (mS/cm)
- Dissolved Oxygen Concentration (%)
- pH
- Redox Potential (mV)

Groundwater samples taken specifically for chemical analyses were contained within appropriate receptacles (glass bottles) and stored alongside ice packs in a cool box to preclude any sample deterioration prior to delivery to the testing laboratory.

6.0 LABORATORY TESTING

6.1 Geotechnical

The laboratory testing schedule was specified by WSP UK Limited. Unless otherwise stated, the tests were carried out in Geotechnics Limited's UKAS accredited Laboratory (Testing No. 1365) and were undertaken in accordance with the appropriate Standards as indicated below and on the Laboratory Test Certificate in Appendix 7. Any descriptions, opinions and interpretations are outside the scope of UKAS accreditation.

Soil

The tests undertaken can be summarised as follows:-

BS EN ISO 17892-1:2014

23 No. Water Content Determination

BS EN ISO 17892-2:2014

2 No. Bulk Density Determination

BS EN ISO 17892-4:2016

3 No. Particle Size Distribution Determination – Sieving Method

BS EN ISO 17892-8:2018

18 No. Unconsolidated Undrained Triaxial Test

BS EN ISO 17892-12:2018

15 No. Determination of Liquid and Plastic Limits

The results of these geotechnical soil tests are presented in Appendix 7.

Rock
In addition the following tests were also carried out on suitable specimens of rock core:

ISRM Testing Methods

149 No. Point Load Determination

The following testing was carried out at the laboratories of MATtest Limited (UKAS Accredited Laboratory, Number 2643):

ISRM Testing Methods

45 No. Unconfined Compressive Strength Determination

1 No. Point Load Determination

The results of these geotechnical rock tests are presented in Appendix 8.

6.2 BRE SD1 Test Suites

The following testing was carried out at the laboratories of Derwentside Environmental Testing Services Limited (UKAS Accredited Laboratory, Number 2139):

BRE Special Digest 1 Suite A

20 No. Suites comprising:-
Soluble Sulphate
pH

The results of these BRE SD1 test suites are presented in Appendix 9.

6.3 Contamination

Selected samples of soil were tested at the laboratories of Derwentside Environmental Testing Services Limited (UKAS Accredited Laboratory, Number 2139) for a number of determinands in order to check on potential site contamination.

The determinands were specified by WSP UK Limited and are detailed on the results sheets in Appendices 10 (soil) and 11 (groundwater) together with the test result as well as the test method, accreditation and detection limit.

Signed for and on behalf of Geotechnics Limited.

Written by: ……..

John Knowles,
BSc (Hons), PGCE, MSc, CGeol, FGS
Principal Engineer

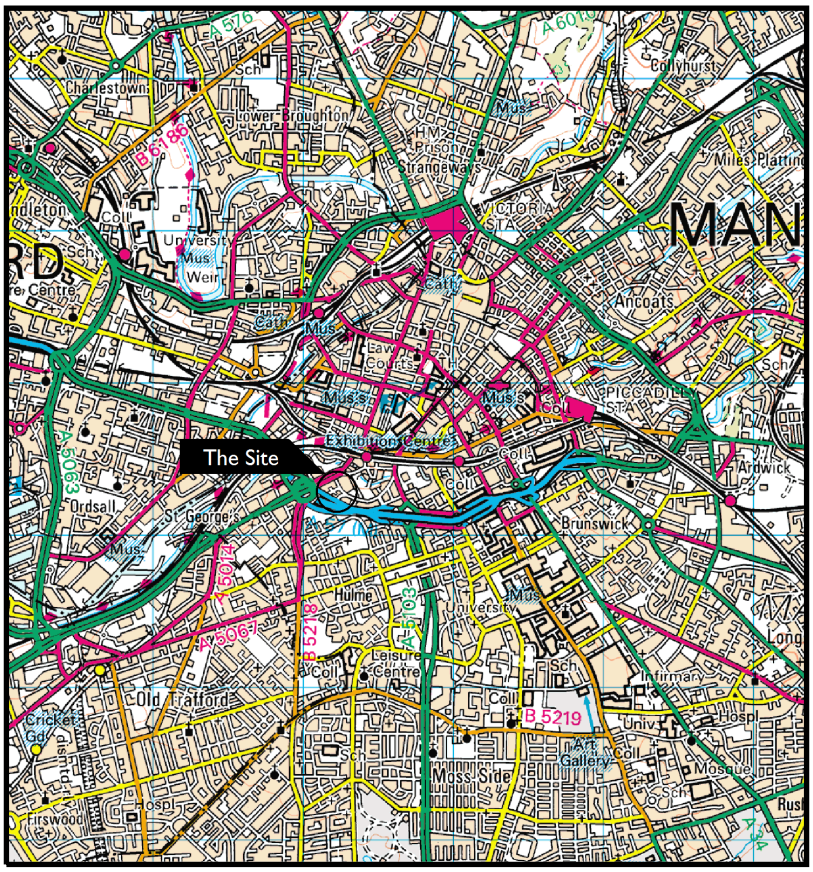
Reviewed by: ……..

Colin Dodd
BSc (Hons), MSc, CEng, MICE
Principal Engineer
for GEOTECHNICS LIMITED - North West Office

APPENDIX I

Site Location Plan

SITE LOCATION PLAN



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Ground Investigation
for
CROWN STREET ZONE 2
for
WSP UK Limited

GEOTECHNICS
geotechnical and geoenvironmental specialists

APPENDIX 2

Borehole Records,
SPT Results Summary Sheet and
SPT Hammer Energy Test Report

DATA SHEET - Symbols and Abbreviations used on Records

Sample Types

B	Bulk disturbed sample
BLK	Block sample
C	Core sample
D	Small disturbed sample (tub/jar)
E	Environmental test sample
ES	Environmental soil sample
EW	Environmental water sample
G	Gas sample
L	Liner sample
LB	Large bulk disturbed sample
P	Piston sample (PF - failed P sample)
TW	Thin walled push in sample
U	Open Tube - 102mm diameter with blows to take sample. (UF - failed U sample)
UT	Thin wall open drive tube sampler - 102mm diameter with blows to take sample. (UTF - failed UT sample)
V	Vial sample
W	Water sample
#	Sample Not Recovered

Insitu Testing / Properties

CBRP	CBR using TRL probe
CHP	Constant Head Permeability Test
COND	Electrical conductivity
TC	Thermal Conductivity
TR	Thermal Resistivity
HV	Strength from Hand Vane
ICBR	CBR Test
IDEN	Density Test
IRES	Resistivity Test
MEX	CBR using Mexecone Probe Test
PKR	Packer Permeability Test
PLT	Plate Load Test
PP	Strength from Pocket Penetrometer
Temp	Temperature
VHP	Variable Head Permeability Test
VN	Strength from Insitu Vane
w%	Water content

(All other strengths from undrained triaxial testing)

S	Standard Penetration Test (SPT)
C	SPT with cone
N	SPT Result
-/-	Blows/penetration (mm) after seating drive
-*/- (mm)	Total blows/penetration
( )	Extrapolated value

Groundwater

Water Strike

Depth Water Rose To

Instrumentation



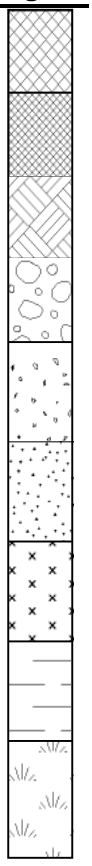
Seal

Filter

Seal

Strata

Legend



Made Ground Granular

Made Ground Cohesive

Topsoil

Cobbles and Boulders

Gravel

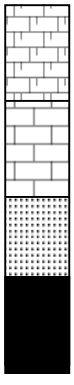
Sand

Silt

Clay

Peat

Note: Composite soil types shown by combined symbols



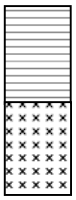
Chalk

Limestone

Sandstone

Coal

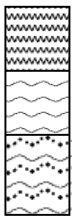
Strata, Continued



Mudstone

Siltstone

Metamorphic Rock

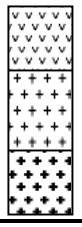


Fine Grained

Medium Grained

Coarse Grained

Igneous Rock



Fine Grained

Medium Grained

Coarse Grained

Backfill Materials



Arisings

Bentonite Seal

Concrete

Fine Gravel Filter

General Fill

Gravel Filter

Grout

Sand Filter

Tarmacadam

Rotary Core

RQD	Rock Quality Designation (% of intact core >100mm)
FRACTURE INDEX	Fractures/metre
FRACTURE SPACING (m)	Maximum Minimum
NI	Non-intact core
NR	No core recovery
AZCL	Assumed zone of core loss

(where core recovery is unknown it is assumed to be at the base of the run)

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH101** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **33.42** m OD

Scale 1:50

Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT N (FI)	Description	Depth	Level m OD
						MADE GROUND: Grey reinforced concrete slab. At 0.10m, 6mm diameter steel reinforcement mesh.	G.L.	33.42
0.40- 0.70	B					**MADE GROUND: Dark greyish brown gravelly fine to coarse sand with a high angular cobble content of bricks. Gravel is angular to subrounded fine to coarse including ash, masonry and brick fragments.**	0.40	33.02
0.50	ES							
0.70- 1.20	D						0.70	32.72
1.00	ES							
1.20- 1.65	B					**MADE GROUND: Firm dark greyish brown slightly gravelly sandy clay with a low angular cobble content of bricks. Gravel is angular to subrounded fine to coarse including ash and brick fragments.**	1.20	32.22
1.20- 1.65	D	(DRY)			S21			
						MADE GROUND: Medium dense dark greyish brown gravelly fine to coarse sand with a high angular cobble content of bricks. Gravel is angular to subrounded fine to coarse including ash, cinders, masonry and brick fragments.	1.65	31.77
2.00	ES							
2.20- 2.65	B							
2.20- 2.65	D	2.20 (DRY)			S27	**Medium dense brown silty fine to coarse SAND and subrounded fine to coarse GRAVEL of various lithologies.**		
3.20- 3.65	B							
3.20- 3.65	D	3.20 (DRY)			S21			
4.20- 4.65	U31	4.20 (DRY)	124	15		**Stiff locally laminated greyish brown mottled reddish brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of various lithologies.**	4.20	29.22
4.65- 4.75	D							
5.20- 5.65	B							
5.20- 5.65	D	5.20 (DRY)			S15			
6.20- 6.65	U37	6.20 (DRY)	92	20				
6.65- 6.75	D							
7.20- 7.65	B							
7.20- 7.65	D	7.20 (DRY)			S21			
						Below 8.20m, very stiff.		
8.20- 8.65	U80	8.20 (DRY)	692	8.5				
8.65- 8.75	D							
9.20- 9.65	B							
9.20- 9.65	D	9.20 (DRY)			S50			

Boring

Depth	Hole Dia	Technique	Crew
1.20	0.40	Inspection Pit	JP/SP
11.50	0.15	Cable Percussion	JP/SP
25.40	0.09	Rotary Core	DP/MR

Progress

Depth of Hole	Depth Cased	Depth to Water	Date	Time
G.L.			21/08/19	08:00
9.95	9.50	DRY	21/08/19	18:00
9.95	9.50	DRY	22/08/19	08:00
11.60	11.50	DRY	22/08/19	18:00
11.60	11.50	9.40	27/08/19	08:00
25.40	11.50	ADDED	27/08/19	18:00

Groundwater

Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater
					Minor inflows possibly masked by drilling flush.

Remarks

AGS

Inspection pit hand excavated to 1.20m depth and no services were found.
ES sample = 2 x 258ml amber glass jars and 1 x 60ml VOC vial.
Below 10.20m, slow boring progress.
Water was added to assist boring below 11.20m.
At 25.40m, Borehole flushed clean to facilitate downhole geophysical logging by Robertson Geo Services Limited.
A 50mm gas monitoring pipe was installed to 20.00m with a geowrapped slotted section from 9.00m to 20.00m with flush lockable protective cover. Backfill details from base of hole:

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by JG/TL
Checked by JK
Figure 1 of 3
31/10/2019

geotechnics

BOREHOLE RECORD - Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** **Borehole** **BH101** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **33.42** m OD

Scale 1:50

Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT N (FI)	Description	Depth	Legend	Level m OD
10.20-10.32 10.20-10.33	B D	10.20 (DRY)			S50/50	Very dense orangish brown very sandy silty subangular to rounded fine to coarse GRAVEL of various lithologies. Low cobble content.	10.20		23.22
11.20-11.32 11.20-11.33 11.50-11.60	# B #	11.20 (DRY) 11.50 (DRY)			S50/40 S50/25	Extremely weak reddish brown slightly silty fine to medium grained SANDSTONE (Recovered as slightly gravelly sand).	11.20 11.60		22.22 21.82

Core Run/Depth (Core Dia/Time)	Depth Cased	TCR/SCR / Type	Length Max/Min	RQD %	SPT (FI)	Continued by Rotary techniques General	Detail
11.60-13.40 (96mm) 12.07-12.18	11.50 (9.40)	73 67 C	0.24 0.01	46	(AZCL) (15)	Very weak to weak reddish brown fine to medium grained SANDSTONE with occasional subrounded to rounded clasts (up to 60mm) of quartzite and mudstone. Discontinuities are subhorizontal, very closely to closely spaced, planar and rough with sand on surfaces.	Between 11.60-12.00m, assumed zone of core loss. Between 12.20-12.30m, non-intact, recovered as coarse gravel.
12.80-13.00 13.00-13.24		C C			(8)		Below 13.00m, Weak.
13.40-16.40 (96mm)	11.50 (ADDED)	62 55	0.30 0.01	26	(AZCL)		Between 13.40-14.55m, assumed zone of core loss.
14.69-14.72		C			(10) (NI)		Between 14.96-15.03m, non-intact, recovered as coarse gravel.
15.40-15.50 15.50-15.80		C C			(10)		Between 15.77-15.86m, Inclined (50deg.), black stained discontinuity with sand on surface.
16.40-19.40 (92mm)	11.50 (ADDED)	94 93	0.30 0.03	65			
17.01-17.23		C			(8)		
18.73-19.03		C					
19.03-19.29		C			(4)		
19.40-22.40 (92mm)	11.50 (ADDED)	98 98	0.33 0.03	88			

Boring

Depth	Dia	Technique	Crew

Progress

Depth of Hole	Depth Cased	Depth to Water	Date	Time
25.40	11.50	9.70	30/08/19	08:00
25.40		9.90	30/08/19	18:00

Groundwater

Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks

bentonite seal up to 20.00m, gravel filter up to 9.00m, bentonite seal up to 0.30m, concrete up to ground level.
Flush: 11.60-25.40m, Air/Mist, 100% return.

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **JG/TL**
Checked by **JK**
Figure **2 of 3**
31/10/2019

geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH101** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **33.42** m OD

Drilling | Properties/Sampling | Strata | Scale 1:50

Core Run/Depth (Core Dia/Time)	Depth Cased & (to Water)	Type TCR/SCR%	Length Max/Min	RQD %	SPT N (FI)	Description General	Description Detail	Depth	Legend	Level m OD
20.07-20.40		C								
20.40-20.50		C								
21.16-21.40		C			(6)					
22.40-25.40 (92mm)	11.50 (ADDED)	99 94	0.25 0.03	77						
22.57-22.74		C			(7)					
24.84-24.95		C								
						End of Borehole		25.40		8.02

Drilling				Progress					Groundwater					
Depth	Hole Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **JG/TL**
Checked by **JK**
Figure **3 of 3**
31/10/2019

geotechnics

BOREHOLE RECORD - Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** **Borehole** **BH102** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **33.28** m OD

Scale 1:50

Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT N (FI)	Description	Depth	Legend	Level m OD
							G.L.		33.28
						MADE GROUND: Grey reinforced concrete slab.	0.20		33.08
0.30	B					MADE GROUND: Black and brown gravelly fine to coarse sand. gravel is angular to subrounded fine to medium including clinker and brick fragments.			
0.30	D								
0.30	ES								
0.50	B								
0.50	D						0.80		32.48
0.50	ES					MADE GROUND: Orangish brown slightly gravelly silty fine to coarse sand. Gravel is angular to rounded fine to medium including brick fragments.			
1.00	B						1.20		32.08
1.00	D								
1.00	ES								
1.20- 1.65	B					Medium dense orangish brown gravelly clayey fine to coarse SAND. Gravel is subangular to rounded fine to coarse of various lithologies.			
1.20- 1.65	D	(DRY)			S18				
2.20- 2.65	B								
2.20- 2.65	D	2.20 (DRY)			S17				
3.20- 3.65	U28	3.20 (DRY)					3.20		30.08
						Firm locally laminated brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of various lithologies.			
3.65- 3.75	D								
						Below 4.20m, stiff.			
4.20- 4.65	B								
4.20- 4.65	D	4.20 (DRY)			S19				
5.20- 5.65	U30	5.20 (DRY)	98	18					
5.65- 5.75	D								
6.20- 6.65	B								
6.20- 6.65	D	6.20 (DRY)			S19				
						Below 7.20m, very stiff.			
7.20- 7.65	U100	7.20 (DRY)	305	7.7					
							7.65		25.63
7.65- 7.75	D					Extremely weak reddish brown slightly silty fine to medium grained SANDSTONE (Recovered as slightly gravelly sand).			
8.00- 8.13	D	8.00 (ADDED)			S50/50		8.13		25.15

Core Run/Depth (Core Dia/Time)	Depth Cased	TCR/SCR / Type	Length Max/Min	RQD %	SPT (FI)	Continued by Rotary techniques General	Detail
8.13- 9.50 (92mm)	8.00 (DRY)	47 38	0.09 0.01	0	(AZCL) (16)	Very weak to weak reddish brown fine to medium grained SANDSTONE with occasional subrounded to rounded clasts (up to 60mm) of quartzite. Discontinuities are subhorizontal, very closely to closely spaced, planar and rough with sand on surfaces. Occasional vertical and	Between 8.13-8.80m, assumed zone of core loss. Between 8.80-8.85m, non-intact, recovered as sand and gravel.
9.38- 9.47		C					
9.50-11.00 (92mm)	8.00 (ADDED)	60 43	0.10 0.02	0	(AZCL)		Between 9.50-10.10m, assumed zone of core loss.

Boring

Depth	Dia	Technique	Crew
1.20	0.40	Inspection Pit	JP/SP
8.00	0.15	Cable Percussion	JP/SP
14.00	0.09	Rotary Core	DP/MR

Progress

Depth of Hole	Depth Cased	Depth to Water	Date	Time
G.L.			22/08/18	08:00
3.65	3.20	DRY	22/08/18	18:00
3.65	3.20	DRY	23/08/18	08:00
8.13	8.00	ADDED	23/08/18	18:00
8.13	8.00	DRY	27/08/18	08:00
14.00	8.00	ADDED	27/08/18	18:00

Groundwater

Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater
					Minor inflows possibly masked by drilling flush.

Remarks

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Inspection pit hand excavated to 1.20m depth and no services were found.
ES sample = 2 x 258ml amber glass jars and 1 x 60ml VOC vial.
Water was added to assist boring below 8.00m.
Experimental elastometer testing carried out by Robertson Geo Services Limited.
At 35.00, Borehole flushed clean to facilitate downhole geophysical logging by Robertson Geo Services Limited.
30.08.2019 - Borehole backfilled with bentonite.
Backfill details from base of hole: bentonite seal up to 1.20m, arisings up to ground level.

Logged in accordance with BS5930:2015

Logged by **JG/TL**
Checked by **JK**
Figure **1 of 4**
31/10/2019

geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH102** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **33.28** m OD

Drilling | Properties/Sampling | Strata | Scale 1:50

Core Run/Depth (Core Dia/Time)	Depth Cased & (to Water)	Type TCR/SCR%	Length Max/Min	RQD %	SPT N (FI)	Description General	Description Detail	Depth	Legend	Level m OD
					(17)	subvertical discontinuities noted in places.	Between 10.34-10.41m, thin bed of extremely weak mudstone.			
10.92-11.00		C			(AZCL)		Below 11.00m, weak. Between 11.00-11.40m, assumed zone of core loss.			
11.00-12.50 (92mm)	8.00 (ADDED)	73 57	0.13 0.02	9						
11.64-11.71		C			(16)					
12.50-14.00 (92mm)	8.00 (ADDED)	75 69	0.14 0.01	40	(AZCL)		Between 12.50-12.88m, assumed zone of core loss. Between 12.96-13.05m, non-intact, recovered as slightly sandy gravel.			
13.66-13.79		C			(10)					
14.00-15.50 (92mm)	8.00 (8.90)	69 63	0.16 0.02	38	(AZCL)		Between 14.00-14.46m, assumed zone of core loss.			
14.46-14.63		C								
15.50-17.00 (92mm)	8.00 (ADDED)	93 91	0.17 0.02	44						
15.81-15.92		C			(10)					
17.00-18.50 (92mm)	8.00 (ADDED)	81 74	0.20 0.01	38			Between 17.24-17.28m, non-intact, recovered as slightly sandy gravel.			
17.47-17.67		C								
17.67-17.78		C								
18.50-20.00 (92mm)	8.00 (ADDED)	91 83	0.15 0.01	46			Between 18.74-18.77m, very thin bed of extremely weak mudstone.			
19.27-19.42		C					Between 19.71-19.75m, non-intact, recovered as slightly sandy gravel.			

Drilling

Depth	Hole Dia	Technique	Crew

Progress

Depth of Hole	Depth Cased	Depth to Water	Date	Time
14.00	8.00	8.90	28/08/18	08:00
35.00	8.00	ADDED	28/08/18	18:00

Groundwater

Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks **Flush: 8.13-35.00m, Air/Mist, 100% return.**

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **JG/TL**
Checked by **JK**
Figure **2 of 4**
31/10/2019

geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH102** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **33.28** m OD

Drilling | Properties/Sampling | Strata | Scale 1:50

Core Run/Depth (Core Dia/Time)	Depth Cased & (to Water)	Type TCR/SCR%	Length Max/Min	RQD %	SPT N (FI)	Description General	Description Detail	Depth	Legend	Level m OD
20.00-21.50 (92mm)	8.00 (ADDED)	92 85	0.20 0.01	47	(8)		Between 20.11-20.16m, non-intact, recovered as slightly sandy gravel.			
20.64-20.77		C								
20.77-20.98		C								
21.50-23.00 (92mm)	8.00 (ADDED)	91 79	0.12 0.01	15	(14)					
22.40-22.53		C								
23.00-24.50 (92mm)	8.00 (ADDED)	89 78	0.13 0.01	37	(AZCL) (15) (NI) (12)		Between 23.00-23.11m, assumed zone of core loss. Between 23.22-23.29m, non-intact. Between 23.22-23.29m, very thin bed of extremely weak mudstone, non-intact.			
23.59-23.72		C								
24.50-26.00 (92mm)	8.00 (ADDED)	84 65	0.13 0.01	15	(AZCL) (NI) (15)		Between 24.76-25.00m, assumed zone of core loss. Between 25.00-25.06m, very thin bed of extremely weak mudstone, non-intact.			
24.50-24.63		C								
26.00-27.50 (92mm)	8.00 (ADDED)	85 72	0.11 0.01	21	(AZCL) (NI) (14)		Between 26.00-26.23m, assumed zone of core loss. Between 23.23-23.48m, non-intact, recovered as slightly sandy gravel.			
27.07-27.17		C								
27.50-29.00 (92mm)	8.00 (ADDED)	92 88	0.14 0.01	39	(14)					
27.76-27.86		C					Between 28.20-28.25m, non-intact, recovered as slightly sandy gravel. Between 28.20-28.25m, non-intact, recovered as slightly sandy gravel.			
29.00-30.50 (92mm)	8.00 (ADDED)	96 96	0.14 0.03	66	(12) (9)					

Drilling

Depth	Hole Dia	Technique	Crew

Progress

Depth of Hole	Depth Cased	Depth to Water	Date	Time

Groundwater

Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **JG/TL**
Checked by **JK**
Figure **3 of 4**
31/10/2019

geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH102** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **33.28** m OD

Scale 1:50

Core Run/Depth (Core Dia/Time)	Depth Cased & (to Water)	Type TCR/SCR%	Length Max/Min	RQD %	SPT N (FI)	Description General	Description Detail	Depth	Legend	Level m OD
30.18-30.30		**C**								
30.50-32.00 (92mm)	**8.00 (ADDED)**	**88 64**	**0.22 0.01**	**22**	**(15)**		**Between 31.08-31.26m, assumed zone of core loss. Between 31.26-31.33m, non-intact, recovered as slightly gravelly sand.**			
					(AZCL) (NI) (10)					
32.00-33.50 (92mm)	**8.00 (ADDED)**	**90 83**	**0.15 0.02**	**47**						
32.40-32.53		**C**					**At 32.70m, some rounded clasts (up to 60mm) of quartzite.**			
33.50-35.00 (92mm)	**8.00 (ADDED)**	**90 76**	**0.13 0.02**	**31**	**(8)**					
						End of Borehole		**35.00**		**-1.72**

Drilling				Progress					Groundwater					
Depth	Hole Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **JG/TL**
Checked by **JK**
Figure **4 of 4**
31/10/2019

geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** **Borehole** **BH103** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **33.23** m OD

Scale 1:50

Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT N (FI)	Description	Depth	Legend	Level m OD
							G.L.		33.23
0.20- 0.45	B					MADE GROUND: Very loose grey gravelly fine to coarse sand with much ash. Gravel is subangular to rounded fine to coarse of various lithologies and brick fragments.	0.20		33.03
0.20- 0.45	D								
0.25	ES						0.45		32.78
0.45- 1.20	B					MADE GROUND: Light yellowish grey sandy slightly silty angular to subangular fine to coarse gravel of limestone (Sub base). At 0.20m, Visqueen membrane.			
0.45- 1.20	D								
0.50	ES								
1.00	ES								
1.20- 1.65	B						1.20		32.03
1.20- 1.65	D	(DRY)			S1	MADE GROUND: Dark brownish grey gravelly silty fine to coarse sand with a high cobble content of bricks. Gravel is angular to subrounded fine to coarse including ash, limestone, concrete and brick fragments.			
2.20- 2.65	B					MADE GROUND: Very loose grey gravelly fine to coarse sand with much ash. Gravel is subangular to rounded fine to coarse of various lithologies and brick fragments.	2.20		31.03
2.20- 2.65	D	2.20 (DRY)			S18				
						Medium dense dark orangish brown mottled dark grey gravelly slightly clayey fine to coarse SAND. Gravel is subrounded to rounded fine to coarse of various lithologies (Possible Made Ground).			
3.20- 3.65	U27	3.20 (DRY)	219	15		Stiff to very stiff locally laminated greyish brown slightly sandy slightly gravelly CLAY. Gravel is subangular to rounded fine to coarse of various lithologies.	3.20		30.03
3.65- 3.75	D								
4.20- 4.65	B								
4.20- 4.65	D	4.20 (DRY)			S15				
5.20- 5.65	U37	5.20 (DRY)	222	12					
5.65- 5.75	D								
6.20- 6.65	B								
6.20- 6.65	D	6.20 (DRY)			S20				
						Below 7.20m, reddish brown, sandy.			
7.20- 7.65	U100	7.65 (DRY)	40	11			7.40		25.83
						Extremely weak reddish brown silty fine to medium grained SANDSTONE (Recovered s silty sand).			
7.65- 7.75	D								
8.00- 8.12	#	8.00 (DRY)			S50/40		8.12		25.11

Core Run/Depth (Core Dia/Time)	Depth Cased	TCR/SCR / Type	Length Max/Min	RQD %	SPT (FI)	Continued by Rotary techniques General	Detail
					(NI)	Very weak to weak reddish brown fine to medium grained SANDSTONE with occasional subrounded to rounded clasts (up to 60mm) of quartzite. Discontinuities are subhorizontal, closely spaced, planar and rough with some sand and rare clay smear on surfaces.	Between 8.12-8.20m, non-intact, recovered as slightly gravelly slightly clayey sand.
8.12- 8.20 (102mm) (12mins)	7.70 (DRY)	80 0	0.01 0.01	0	(11)		
8.20- 9.00 (102mm) (14mins)	7.70 (ADDED)	100 100	0.14 0.02	44			
8.55- 8.69		C					
8.77- 8.90		C			(8)		
9.75- 9.86		C					

Boring

Depth	Dia	Technique	Crew
1.20	0.40	Inspection Pit	AJ/JG
8.00	0.20	Cable Percussion	JP/SP
39.00	0.10	Rotary Core	PH

Progress

Depth of Hole	Depth Cased	Depth to Water	Date	Time
G.L.			15/08/19	08:00
1.20		DRY	15/08/19	18:00
1.20		DRY	16/08/19	08:00
8.09	8.00	DRY	16/08/19	18:00
7.70	7.70	DRY	21/08/19	08:00
12.00	9.30	2.30	21/08/19	18:00

Groundwater

Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater
					Minor inflows possibly masked by drilling flush.

Remarks

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Inspection pit hand excavated to 1.20m depth and no services were found.
ES sample = 2 x 258ml amber glass jars and 1 x 60ml VOC vial.
Between 22.50-24.00m, dropped core due to gravel obstruction in catcher spring. Core recovered on short run between 24.00-24.50m.
High Pressure Dilatometer (HPD) Tests carried out by Socotec Limited between 10.50-12.00m, 15.00-16.50m, 21.00-22.50m, 25.50-27.00m, 30.00-31.50m and 39.00-40.50m.
A 50mm gas monitoring pipe was installed to 3.00m with a geowrapped slotted section from 0.50m to 3.00m with flush lockable protective cover. Backfill details from base of hole:

Logged in accordance with BS5930:2015

Logged by **JG/TL**
Checked by **JK**
Figure **1 of 6**
31/10/2019

geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH103** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **33.23** m OD

Drilling | Properties/Sampling | Strata — Scale 1:50

Core Run/Depth (Core Dia/Time)	Depth Cased & (to Water)	Type TCR/SCR%	Length Max/Min	RQD %	SPT N (FI)	Description General	Description Detail	Depth	Legend	Level m OD
9.00-10.50 (102mm) (19mins)	7.70 (ADDED)	100 96	0.21 0.01	55						
10.50-12.00 (76mm) (14mins)	9.30 (ADDED)	100 100	0.19 0.02	72	(10)					
11.46-11.69		C					Between 11.46-17.87m, Very weak.			
11.69-11.86		C								
12.00-13.50 (102mm) (21mins)	9.30 (6.00)	100 100	0.26 0.03	62						
12.59-12.84		C			(12)					
13.50-15.00 (102mm) (23mins)	9.30 (ADDED)	99 99	0.25 0.02	61	(10)					
14.39-14.57		C								
15.00-16.50 (76mm) (17mins)	15.00 (ADDED)	100 100	1.10 0.03	87	(4)					
15.76-15.90		C								
16.50-17.25 (102mm) (9mins)	9.30 (ADDED)	89 85	0.50 0.01	79			Between 16.64-16.70m, non-intact, recovered as gravelly sand.			
16.61-16.76		C								
17.25-18.00 (102mm) (10mins)	9.30 (ADDED)	100 93	0.35 0.01	76	(7)		Between 17.25-17.32m, non-intact, recovered as sandy gravel including quartzite clasts.			
17.44-17.78		C								
17.87-18.00		C								
18.00-19.50 (102mm) (17mins)	9.30 (ADDED)	97 78	0.23 0.01	34	(12)		Between 18.00-18.12m, non-intact, recovered as sandy gravel including quartzite clasts. Between 18.40-18.47m, thin bed of extremely weak mudstone. Between 19.10-19.16m, non-intact, recovered as slightly gravelly clay including rounded clasts (up to 60mm) of quartzite.			
19.50-20.25 (102mm) (9mins)	9.30 (ADDED)	100 100	0.19 0.02	79				19.50		13.73
19.72-19.87		C								
19.87-20.05		C								

Drilling

Depth	Hole Dia	Technique	Crew

Progress

Depth of Hole	Depth Cased	Depth to Water	Date	Time
12.00	9.30	6.00	22/08/19	08:00
22.50	21.40	8.70	22/08/19	18:00
22.50	9.30	9.10	23/08/19	08:00
27.00	26.80	ADDED	23/08/19	18:00
27.00	9.30	9.30	24/08/19	08:00
39.00	9.30	ADDED	24/08/19	18:00

Groundwater

Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks AGS **bentonite seal up to 3.00m, gravel filter up to 0.50m, bentonite seal up to 0.30m, concrete up to ground level.**
Flush: 8.09-10.50m, Mud, 100% returns; 10.50-12.00m, Mud, 50% returns; 12.00-13.50m, Mud, 80% returns; 13.50-16.50m, Mud, 90% returns; 16.50-37.00m, Mud, 100% return.

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **JG/TL** Checked by **JK** Figure **2 of 6** 31/10/2019

geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH103** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **33.23** m OD

Drilling		Properties/Sampling				Strata				Scale 1:50
Core Run/Depth (Core Dia/Time)	Depth Cased & (to Water)	Type TCR/SCR%	Length Max/Min	RQD %	SPT N (FI)	Description General	Description Detail	Depth	Legend	Level m OD
					(10)	**Weak to medium strong reddish brown fine to medium grained SANDSTONE with occasional subrounded to rounded clasts (up to 60mm) of quartzite. Discontinuities are subhorizontal, closely spaced, planar and rough with some sand on surfaces and rare clasts of quartzite.**				
20.25-21.00 (102mm) (11mins) 20.74-20.98	**9.30 (ADDED)**	**100 100 C**	**0.21 0.02**	**77**						
21.00-22.50 (76mm) (16mins) 21.30-21.65 21.65-22.00	**21.40 (ADDED)**	**100 100 C C**	**0.33 0.02**	**85**	**(8)**					
22.50-24.00 (102mm) (24mins) 23.00-23.18	**9.30 (9.10)**	**91 87 C**	**0.18 0.03**	**18**	**(11)**					
24.00-24.50 (102mm) (7mins)	**9.30 (ADDED)**	**100 100**	**0.25 0.03**	**96**						
24.50-25.50 (102mm) (13mins) 24.75-25.05	**9.30 (ADDED)**	**100 100 C**	**0.39 0.03**	**80**						
25.50-27.00 (76mm) (12mins) 26.30-26.57	**26.80 (ADDED)**	**95 89 C**	**0.29 0.02**	**67**						
27.00-28.50 (102mm) (27mins) 27.16-27.46	**9.30 (9.30)**	**100 100 C**	**0.29 0.06**	**61**	**(6)**					
28.50-30.00 (102mm) (35mins) 29.19-29.44 29.44-29.72	**9.30 (ADDED)**	**100 100 C C**	**0.28 0.05**	**95**						

Drilling				Progress					Groundwater					
Depth	Hole Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater
				39.00	**9.30**	**ADDED**	**27/08/19**	**08:00**						
				51.00	**9.30**	**ADDED**	**27/08/19**	**18:00**						

Remarks

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **JG/TL**
Checked by **JK**
Figure **3 of 6**
31/10/2019

geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH103** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **33.23** m OD

Scale 1:50

Drilling: Core Run/Depth (Core Dia/Time)	Depth Cased & (to Water)	Properties/Sampling: Type TCR/SCR%	Length Max/Min	RQD %	SPT N (FI)	Strata: Description General	Description Detail	Depth	Legend	Level m OD
30.00-31.50 (76mm) (9mins)	30.00 (ADDED)	100 100	0.36 0.04	76						
30.22-30.39		C								
31.15-31.50		C								
31.50-33.00 (102mm) (36mins)	9.30 (ADDED)	93 93	0.40 0.06	89	(3)					
32.15-32.54		C								
32.54-32.94		C								
33.00-34.50 (102mm) (37mins)	9.30 (ADDED)	100 100	0.31 0.03	73			Between 33.33-33.48m, inclined (65deg.), planar, rough discontinuity with sand on surfaces.			
33.55-33.81		C								
34.00-34.26		C			(7)					
34.50-36.00 (102mm) (41mins)	9.30 (ADDED)	100 100	0.35 0.01	91						
35.00-35.23		C								
36.00-37.35 (102mm) (39mins)	9.30 (ADDED)	100 100	0.29 0.01	87						
36.27-36.53		C			(5)					
36.53-36.82		C								
37.50-39.00 (102mm) (40mins)	9.30 (ADDED)	100 100	0.38 0.02	93						
38.29-38.45		C								
39.00-40.50 (76mm)	9.30 (ADDED)	100 100	0.24 0.03	77	(8)					
40.00-40.21		C								

Drilling: Depth	Hole Dia	Technique	Crew	Progress: Depth of Hole	Depth Cased	Depth to Water	Date	Time	Groundwater: Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks AGS

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **JG/TL**
Checked by **JK**
Figure **4 of 6**
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geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH103** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **33.23** m OD

Scale 1:50

Drilling: Core Run/Depth (Core Dia/Time)	Depth Cased & (to Water)	Properties/Sampling: Type TCR/SCR%	Length Max/Min	RQD %	SPT N (FI)	Strata: Description General	Description Detail	Depth	Legend	Level m OD
40.50-42.00 (102mm)	**9.30 (ADDED)**	**100 100**	**0.14 0.04**	**42**						
					(10)		**Between 41.15-41.60m, some subrounded to rounded clasts (up to 60mm) of quartzite.**			
42.00-43.50 (102mm)	**9.30 (ADDED)**	**100 100**	**0.25 0.01**	**83**						
42.67-42.82		**C**			**(8)**		**Between 43.44-43.50m, inclined (45deg.), undulating and rough with sand on surfaces and occasional black staining.**			
43.50-45.00 (102mm)	**9.30 (ADDED)**	**100 100**	**0.32 0.05**	**87**						
44.50-44.68		**C**								
45.00-46.50 (102mm)	**9.30 (ADDED)**	**100 100**	**0.55 0.06**	**73**			**Between 45.00-45.10m, inclined (80deg.), undulating and rough with sand on surfaces.**			
46.50-48.00 (102mm)	**9.30 (ADDED)**	**100 100**	**0.34 0.02**	**81**						
47.51-47.70		**C**			**(5)**					
48.00-49.50 (102mm)	**9.30 (ADDED)**	**100 100**	**0.44 0.03**	**69**			**Between 48.86-49.75m, occasional clasts (up to 60mm) of mudstone.**			
49.50-51.00 (102mm)	**9.30 (ADDED)**	**100 100**	**0.26 0.05**	**73**						

Drilling: Depth	Hole Dia	Technique	Crew	Progress: Depth of Hole	Depth Cased	Depth to Water	Date	Time	Groundwater: Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks AGS

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **JG/TL**
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Figure **5 of 6**
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geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2**

Engineer **WSP UK LIMITED**

Borehole **BH103**
Project No **PN194002**

Client **WSP UK LIMITED**

Ground Level **33.23** m OD

Scale 1:50

Drilling		Properties/Sampling				Strata				
Core Run/Depth (Core Dia/Time)	Depth Cased & (to Water)	Type TCR/SCR%	Length Max/Min	RQD %	SPT N (FI)	Description General	Description Detail	Depth	Legend	Level m OD
						End of Borehole		51.00		-17.77

Drilling				Progress					Groundwater					
Depth	Hole Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **JG/TL**
Checked by **JK**
Figure **6 of 6**
31/10/2019

geotechnics

BOREHOLE RECORD - Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH104** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **33.22** m OD

Scale 1:50

Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT N (FI)	Description	Depth	Legend	Level m OD
							G.L.		33.22
						MADE GROUND: Grey reinforced concrete.	0.20		33.02
0.30	ES					MADE GROUND: Light grey sandy slightly silty angular fine to coarse gravel of limestone. Medium cobble content of limestone (Sub base).	0.40		32.82
0.40- 0.90	D								
0.50	ES					At 0.20m, Visqueen membrane.			
							0.90		32.32
0.90- 1.10	D					MADE GROUND: Dark greyish brown gravelly slightly silty fine to coarse sand with a low cobble content of concrete and bricks. Gravel is angular fine to coarse of various lithologies, ash, concrete and brick fragments.	1.10		32.12
1.00	ES								
1.20- 1.65	B								
1.20- 1.65	D	(1.00)			S29				
						MADE GROUND: Yellowish brown slightly gravelly slightly silty fine to coarse sand. Gravel is angular fine to medium of various lithologies and occasional brick fragments.			
2.20- 2.65	B								
2.20- 2.65	D	2.20 (ADDED)			S21	Medium dense orangish brown mottled dark brown very gravelly slightly silty fine to coarse SAND. Gravel is subangular to rounded fine to coarse of various lithologies. Below 2.20m, grading to very sandy silty fine to coarse gravel.			
3.20- 3.65	UT37	3.20 (DRY)	139	18		Stiff indistinctly laminated greyish brown slightly sandy slightly gravelly CLAY with occasional thin laminae of fine sand. Gravel is angular to subrounded fine to coarse of various lithologies including coal.	3.20		30.02
3.65- 3.75	D								
						Between 4.20-5.65m, firm.			
4.20- 4.65	B								
4.20- 4.65	D	4.20 (DRY)			S12				
5.20- 5.65	UT36	5.20 (DRY)							
5.65- 5.75	D								
6.20- 6.65	B								
6.20- 6.65	D	6.20 (DRY)			S18				
7.20- 7.65	UT100	7.20 (DRY)		8.6		Between 7.20-7.65m, grading to slightly sandy slightly gravelly silt with occasional thin laminae of sand.			
7.65- 7.75	D								
8.20- 8.65	B								
8.20- 8.65	D	8.20 (DRY)			S19				
							8.60		24.62
						Extremely weak slightly silty reddish brown fine to medium grained SANDSTONE. (Recovered as gravelly sand).			
9.00	B								
9.00- 9.25	D	9.00 (DRY)			S50/95				
9.50- 9.61	#	9.50			S50/40				
9.50- 9.64	C	(ADDED)					9.61		23.61

Core Run/Depth (Core Dia/Time)	Depth Cased	TCR/SCR / Type	Length Max/Min	RQD %	SPT (FI)

Continued by Rotary techniques

General

Detail

Boring

Depth	Dia	Technique	Crew
1.20	0.40	Inspection Pit	RP/SP
9.50	0.15	Cable Percussion	RP/SP
35.00	0.09	Rotary Core	DP/MR

Progress

Depth of Hole	Depth Cased	Depth to Water	Date	Time
G.L.			15/08/19	08:00
9.20	9.00	DRY	15/08/19	18:00
9.20	9.00	ADDED	16/08/19	08:00
9.61	9.50	ADDED	16/08/19	18:00
9.50	9.50	9.20	19/08/19	08:00
20.00	9.50	ADDED	19/08/19	18:00

Groundwater

Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater
					Minor inflows possibly masked by drilling flush.

Remarks

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Inspection pit hand excavated to 1.20m depth and no services were found.
ES sample = 2 x 258ml amber glass jars and 1 x 60ml VOC vial.
Water was added to assist boring between 1.20m and 2.20m and below 9.00m depth.
A 50mm gas monitoring pipe was installed to 3.00m with a geowrapped slotted section from 0.50m to 3.00m with flush lockable protective cover. Backfill details from base of hole: bentonite seal up to 3.00m, gravel filter up to 0.50m, bentonite seal up to 0.30m, bentonite grout up to ground level concrete up to ground level.
Flush: 9.61-35.00m, Air/Mist, 100% return.

Logged in accordance with BS5930:2015

Logged by **JG**
Checked by **JK**
Figure **1 of 4**
31/10/2019

geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH104** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **33.22** m OD

Drilling		Properties/Sampling				Strata				
									Scale 1:50	
Core Run/Depth (Core Dia/Time)	Depth Cased & (to Water)	Type TCR/SCR%	Length Max/Min	RQD %	SPT N (FI)	Description General	Description Detail	Depth	Legend	Level m OD
9.61-11.00 (92mm)	9.50 (9.20)	93 83	0.18 0.01	36	(12)	Very weak to weak locally laminated reddish brown slightly silty fine to medium grained SANDSTONE. Discontinuities are subhorizontal to inclined (20deg.), extremely closely to closely spaced, undulating to planar and rough.	Between 10.30-10.40m, Inclined (45deg.), planar discontinuity.			
10.60-10.72		C								
11.00-14.00 (92mm)	9.50 (ADDED)	97 85	0.35 0.01	67			Below 11.10m, discontinuities are very closely to medium spaced, locally extremely closely spaced.			
11.09-11.46		C								
11.65-11.78		C					At 11.65m, non-intact zone (15mm thick).			
13.25-13.50		C								
14.00-17.00 (92mm)	9.50 (ADDED)	100 97	0.27 0.01	72						
15.52-15.82		C								
15.82-16.02		C								
16.45-16.59		C								
17.00-20.00 (92mm)	9.50 (ADDED)	98 93	0.34 0.02	72						
18.35-18.70		C								
18.70-18.94		C								
19.44-19.67		C								

Drilling				Progress					Groundwater					
Depth	Hole Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater
				20.00	9.50	9.50	20/08/19	08:00						
				35.00	9.50	10.10	20/08/19	18:00						

Remarks

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **JG**
Checked by **JK**
Figure **2 of 4**
31/10/2019

geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH104** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **33.22** m OD

Scale 1:50

Core Run/Depth (Core Dia/Time)	Depth Cased & (to Water)	Type TCR/SCR%	Length Max/Min	RQD %	SPT N (FI)	Description General	Description Detail	Depth	Legend	Level m OD
20.00-23.00 (92mm)	**9.50 (9.50)**	**97 83**	**0.30 0.01**	**54**			**Between 20.75-20.85m, Inclined (45deg.), planar discontinuity. At 21.10m, thick lamination of mudstone (10mm thick).**			
22.43-22.61		**C**					**Below 22.00m, occasional subrounded to rounded clasts (up to 60mm) of quartzite .**			
22.69-23.00		**C**								
23.00-26.00 (92mm)	**9.50 (ADDED)**	**100 97**	**0.35 0.08**	**73**	**(7)**					
24.36-24.50		**C**					**Between 24.55-24.75m, subvertical, planar discontinuity.**			
26.00-29.00 (92mm)	**9.50 (ADDED)**	**100 95**	**0.53 0.03**	**86**						
27.13-27.33		**C**								
29.00-32.00 (92mm)	**9.50 (ADDED)**	**98 89**	**0.37 0.01**	**71**						
29.62-29.87		**C**					**Between 29.60-29.70m, Inclined (60deg.), undulating discontinuity.**			

Drilling

Depth	Hole Dia	Technique	Crew

Progress

Depth of Hole	Depth Cased	Depth to Water	Date	Time

Groundwater

Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **JG**
Checked by **JK**
Figure **3 of 4**
31/10/2019

geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH104** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **33.22** m OD

Scale 1:50

Drilling: Core Run/Depth (Core Dia/Time)	Drilling: Depth Cased & (to Water)	Properties/Sampling: Type TCR/SCR%	Properties/Sampling: Length Max/Min	Properties/Sampling: RQD %	Properties/Sampling: SPT N (FI)	Strata: Description General	Strata: Description Detail	Depth	Legend	Level m OD
32.00-35.00 (92mm) 32.00-32.25	**9.50 (ADDED)**	**100 92 C**	**0.33 0.01**	**70**			**Below 32.30m, discontinuities are inclined (30deg.).**			
							At 33.60m, very thin bed (30mm thick) of mudstone.			
						End of Borehole		**35.00**		**-1.78**

Drilling: Depth	Hole Dia	Technique	Crew	Progress: Depth of Hole	Depth Cased	Depth to Water	Date	Time	Groundwater: Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **JG**
Checked by **JK**
Figure **4 of 4**
31/10/2019

geotechnics

BOREHOLE RECORD - Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH105** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **32.84** m OD

Scale 1:50

Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT N (FI)	Description	Depth	Legend	Level m OD
							G.L.		32.84
						MADE GROUND: Cobble setts.			
0.20- 0.40	B						0.20		32.64
0.20- 0.40	ES					MADE GROUND: Firm brownish grey slightly sandy slightly gravelly clay with a medium angular cobble content of bricks. Gravel is angular to subangular fine to coarse of various lithologies, ash, clinker and brick fragments.			
0.50- 0.70	B								
0.50- 0.70	ES								
1.00- 1.20	B								
1.00- 1.20	ES								
1.20- 1.65	B						1.20		31.64
1.20- 1.65	D	(DRY)			S8	MADE GROUND: Loose to medium dense brown gravelly slightly clayey fine to coarse sand with a low angular cobble content of bricks. Gravel is angular to subangular fine to coarse of various lithologies and brick fragments.			
2.00- 2.20	ES								
2.20- 2.65	B								
2.20- 2.65	D	2.20 (DRY)			S11				
3.20- 3.65	U30	3.20 (DRY)	99	17		Stiff greyish brown slightly sandy slightly gravelly CLAY. Gravel is angular to subangular fine to coarse of various lithologies.	3.20		29.64
3.65- 3.75	D								
4.20- 4.65	B								
4.20- 4.65	D	4.20 (DRY)			S17				
5.20- 5.65	U56	5.20 (DRY)				Below 5.20m, some bands of sand and gravel.			
5.65- 5.75	D			11					
6.20- 6.65	B								
6.20- 6.65	D	6.20 (DRY)			S50				
7.20- 7.65	B						7.20		25.64
7.20- 7.65	D	7.20 (ADDED)			S40	Dense brown fine to coarse SAND and angular to subangular fine to coarse GRAVEL of various lithologies.	7.50		25.34
7.65- 8.00	B								
8.00- 8.09	D	8.00 (ADDED)			S50/10	Extremely weak to weak reddish brown fine to coarse grained SANDSTONE (Recovered as gravelly sand).	8.09		24.75

Core Run/Depth (Core Dia/Time)	Depth Cased	TCR/SCR / Type	Length Max/Min	RQD %	SPT (FI)	Continued by Rotary techniques General	Detail
8.09-11.00 (92mm)	8.00 (DRY)	85 75	0.21 0.01	50	(AZCL) (8)	Very weak to weak reddish brown fine to medium grained SANDSTONE with occasional subrounded to rounded clasts (up to 60mm) of quartzite and mudstone. Discontinuities are subhorizontal, closely spaced, planar and rough with some sand and silt smear on surfaces.	Between 8.09-8.45m, assumed zone of core loss. Between 8.63-8.69m, non-intact, recovered as slightly sandy gravel.
8.73- 8.95		C			(NI) (6)		
9.79-10.00		C					

Boring

Depth	Dia	Technique	Crew
1.20	0.50	Inspection Pit	RP
8.00	0.15	Cable Percussion	RP
26.00	0.09	Rotary Core	DP/MR

Progress

Depth of Hole	Depth Cased	Depth to Water	Date	Time
G.L.			29/08/19	08:00
8.09	8.00	ADDED	29/08/19	18:00
8.09	8.00	DRY	30/08/19	08:00
26.00	8.00	ADDED	30/08/19	18:00

Groundwater

Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater
					Minor inflows possibly masked by drilling flush.

Remarks

Inspection pit hand excavated to 1.20m depth and no services were found.
ES sample = 2 x 258ml amber glass jars and 1 x 60ml VOC vial.
Water was added to assist boring below 7.20m depth.
Backfill details from base of hole: bentonite seal up to 1.20m, arisings up to ground level.
Flush: 8.09-26.00m, Air/Mist, 100% return.

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **TL**
Checked by **JK**
Figure **1 of 3**
31/10/2019

geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH105** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **32.84** m OD

Drilling		Properties/Sampling				Strata				Scale 1:50
Core Run/Depth (Core Dia/Time)	Depth Cased & (to Water)	Type TCR/SCR%	Length Max/Min	RQD %	SPT N (FI)	Description General	Description Detail	Depth	Legend	Level m OD
					(NI) (6)	Occasional black staining. Occasional subvertical, planar and rough discontinuities with some black staining.	Between 10.33-10.39m, non-intact, recovered as sandy slightly clayey gravel.			
11.00-14.00 (92mm)	8.00 (ADDED)	88 88	0.20 0.02	37	(AZCL)		Between 11.00-11.35m, assumed zone of core loss.			
12.18-12.27		C								
12.33-12.52		C			(8)					
13.00-13.15		C								
14.00-17.00 (92mm)	8.00 (ADDED)	93 90	0.36 0.01	60	(NI) (8)		Between 14.00-14.08m, non-intact, recovered as gravel of quartzite.			
15.31-15.42		C								
15.42-15.77		C			(6)					
16.33-16.53		C								
17.00-20.00 (92mm)	8.00 (ADDED)	88 78	0.34 0.03	63	(AZCL)		Between 16.70-17.00m, subvertical to inclined (70-80deg.), planar and rough discontinuities with sand and silt smear on surfaces. Occasional black staining. Between 17.00-17.35m, assumed zone of core loss.			
18.41-18.62		C								
18.62-18.97		C			(5)					
19.31-19.45		C								

Drilling				Progress					Groundwater					
Depth	Hole Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **TL**
Checked by **JK**
Figure **2 of 3**
31/10/2019

geotechnics

BOREHOLE RECORD - Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH105** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **32.84** m OD

Scale 1:50

Core Run/Depth (Core Dia/Time)	Depth Cased & (to Water)	Type TCR/SCR%	Length Max/Min	RQD %	SPT N (FI)	Description General	Description Detail	Depth	Legend	Level m OD
20.00-23.00 (92mm)	**8.00 (ADDED)**	**100 93**	**0.24 0.02**	**51**						
20.62-20.80		**C**			**(9)**					
22.37-22.54		**C**			**(6)**					
23.00-26.00 (92mm)	**8.00 (ADDED)**	**89 87**	**0.28 0.01**	**51**	**(AZCL)**		**Between 23.00-23.34m, assumed zone of core loss.**			
24.03-24.11		**C**								
24.11-24.39		**C**			**(6)**					
25.31-25.52		**C**			**(NI)** **(6)**		**Between 25.16-25.22m, non-intact, recovered as rounded gravel of quartzite. Between 25.16-25.77m, some rounded clasts (up to 60mm) of quartzite.**			
						End of Borehole		**26.00**		**6.84**

Drilling / Progress / Groundwater

Drilling Depth	Hole Dia	Technique	Crew	Progress Depth of Hole	Depth Cased	Depth to Water	Date	Time	Groundwater Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks AGS

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **TL**
Checked by **JK**
Figure **3 of 3**
31/10/2019

geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH106** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **32.96** m OD

Sampling			Properties			Strata			Scale 1:50
Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT N (FI)	Description	Depth	Legend	Level m OD
							G.L.		32.96
0.20- 1.20	B					MADE GROUND: Sandstone cobble setts set in pitch.	0.15		32.81
0.20- 1.20	D					MADE GROUND: Black to dark greyish brown gravelly slightly silty fine to coarse sand including ash. Gravel is angular to rounded fine to coarse of various lithologies, clinker, pottery and brick fragments.			
0.20	ES								
0.50	ES								
1.00	ES								
1.20- 1.65	B						1.20		31.76
1.20- 1.65	D	(DRY)			S2	MADE GROUND: Very soft black and dark brown sandy to very sandy slightly gravelly clay with a low angular cobble content of bricks. Gravel is angular to subangular fine to coarse of various lithologies, ash, clinker and brick fragments.			
2.20- 2.65	B								
2.20- 2.65	D	2.20 (DRY)			S3				
							3.00		29.96
3.20- 3.65	U30	3.20 (DRY)				MADE GROUND: Firm greyish brown slightly sandy slightly gravelly clay. Gravel is subangular to rounded fine to coarse of various lithologies. Between 3.20-3.50m, redundant clayware sewer pipe encountered.	3.50	▽	29.46
3.65- 3.75	D					Firm to stiff, locally laminated greyish brown slightly sandy slightly gravelly CLAY. Gravel is subangular to rounded fine to coarse of various lithologies.			
4.20- 4.65	B								
4.20- 4.65	D	4.20 (DRY)		15	S9				
5.20- 5.65	U43	5.20 (DRY)	54	16		Below 5.00m, stiff to very stiff. Between 5.20-5.65m, grading to firm slightly sandy slightly gravelly silt.			
5.65- 5.75	D								
6.20- 6.65	B								
6.20- 6.58	D	6.20 (DRY)			S50/ 225				
7.20- 7.65	B						7.20		25.76
7.20- 7.27	D	7.20 (DRY)			S50/50	Very dense brown fine to coarse SAND and angular to subangular fine to coarse GRAVEL of various lithologies.			
8.00- 8.14	#	8.00			S50/60		8.00		24.96
8.00- 8.13	B	(ADDED)				Extremely weak to weak reddish brown fine to coarse grained SANDSTONE (Recovered as gravelly sand).			
8.50- 8.62	D	8.50 (ADDED)			S50/40		8.62	▽	24.34

Core Run/Depth (Core Dia/Time)	Depth Cased	TCR/SCR / Type	Length Max/Min	RQD %	SPT (FI)	Continued by Rotary techniques General	Detail
8.62-11.00 (92mm) 8.73- 8.83	8.50 (8.30)	83 81 C	0.10 0.01	29	(AZCL) (10) (NI) (9)	Very weak to weak reddish brown fine to medium grained SANDSTONE with occasional subrounded to rounded clasts (up to 60mm) of quartzite. Discontinuities are subhorizontal, closely	Between 8.62-8.93m, assumed zone of core loss. Between 9.08-9.17m, non-intact, recovered as gravel.

Boring

Depth	Dia	Technique	Crew
1.20	0.40	Inspection Pit	JP/SP
8.62	0.15	Cable Percussion	JP/SP
26.00	0.09	Rotary Core	DP/MR

Progress

Depth of Hole	Depth Cased	Depth to Water	Date	Time
G.L.			27/08/19	08:00
7.80	7.20	ADDED	27/08/19	18:00
7.80	7.20	ADDED	28/08/19	08:00
8.62	8.50	ADDED	28/08/19	18:00
8.62	8.50	8.30	30/08/19	08:00
26.00	8.50	ADDED	30/08/19	18:00

Groundwater

Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater
3.45					Stagnant water in redundant clayware sewer pipe.

Remarks

Inspection pit hand excavated to 1.20m depth and no services were found.
ES sample = 2 x 258ml amber glass jars and 1 x 60ml VOC vial.
Water was added to assist boring between 7.20m and 8.62m.
Backfill details from base of hole: bentonite seal up to 1.20m, arisings up to ground level.
Flush: 8.62-26.00m, Air/Mist, 100% return.

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **JG/TL** Checked by **JK** Figure **1 of 3** 31/10/2019

geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH106** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **32.96** m OD

Drilling | Properties/Sampling | Strata — Scale 1:50

Core Run/Depth (Core Dia/Time)	Depth Cased & (to Water)	Type TCR/SCR%	Length Max/Min	RQD %	SPT N (FI)	Description General	Description Detail	Depth	Legend	Level m OD
10.36-10.50		C				spaced, planar and rough with some sand and silt smear on surfaces. Occasional black staining. Occasional subvertical, planar and rough discontinuities with some black staining.				
11.00-14.00 (92mm)	8.50 (ADDED)	73 66	0.25 0.01	49	(AZCL)		Between 11.00-11.80m, assumed zone of core loss.			
					(NI)		Between 11.80-11.91m, non-intact, recovered as gravel.			
12.24-12.38		C			(8)					
13.19-13.44		C								
13.44-13.57		C								
14.00-17.00 (92mm)	8.50 (ADDED)	78 75	0.26 0.01	45	(AZCL)		Between 14.00-14.65m, assumed zone of core loss.			
					(10)					
					(NI)		Between 15.14-15.24m, non-intact, recovered as gravel with quartzite clasts.			
					(14)					
15.62-15.78		C								
16.00-16.13		C								
16.13-16.39		C								
17.00-20.00 (92mm)	8.50 (ADDED)	99 96	0.40 0.01	75						
					(6)					
18.29-18.69		C								
							Between 19.00-19.08m, non-intact, recovered as gravel.			
19.49-19.67		C								

Drilling | Progress | Groundwater

Depth	Hole Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater
									8.62					Minor inflows possibly masked by drilling flush.

Remarks

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **JG/TL**
Checked by **JK**
Figure **2 of 3**
31/10/2019

geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH106** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **32.96** m OD

Drilling | Properties/Sampling | Strata | Scale 1:50

Core Run/Depth (Core Dia/Time)	Depth Cased & (to Water)	Type TCR/SCR%	Length Max/Min	RQD %	SPT N (FI)	Description General	Description Detail	Depth	Legend	Level m OD
20.00-23.00 (92mm)	**8.50 (ADDED)**	**95 94**	**0.25 0.04**	**61**						
21.55-21.80		**C**								
21.84-22.00		**C**			**(7)**					
22.34-22.52		**C**								
23.00-26.00 (92mm)	**8.50 (ADDED)**	**87 81**	**0.29 0.01**	**50**	**(AZCL)**		**Between 23.00-23.38m, assumed zone of core loss.**			
23.07-23.36		**C**								
23.42-23.59		**C**			**(7)**					
25.30-25.55		**C**			**(NI) (8)**		**Between 25.30-25.36m, non-intact, recovered as gravel with quartzite clasts.**			
								26.00		**6.96**
						End of Borehole				

Drilling				Progress					Groundwater					
Depth	Hole Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **JG/TL**
Checked by **JK**
Figure **3 of 3**
31/10/2019

geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH107** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **33.20** m OD

Sampling			Properties			Strata	Scale 1:50		
Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT N (FI)	Description	Depth	Legend	Level m OD
							G.L.		33.20
						MADE GROUND: Tiles and screed.	0.03		33.17
0.20	ES					MADE GROUND: Grey reinforced concrete.	0.15		33.05
0.40- 0.80	B						0.40		32.80
0.50	ES					MADE GROUND: Grey sandy angular to subangular fine to coarse gravel of limestone (Sub base).			
0.80- 1.20	B						0.80		32.40
						MADE GROUND: Dark brown to black gravelly silty fine to coarse sand of ash. Gravel is angular to subangular fine to coarse of clinker and brick fragments.			
1.20- 1.65	B								
1.20- 1.65	D	(DRY)			S7		1.30		31.90
						Firm orangish brown slightly sandy to sandy SILT. Grading locally to silty fine sand.			
						Loose brown gravelly slightly clayey fine to coarse SAND. Gravel is subangular to subrounded fine to coarse of sandstone and quartzite.			
2.20- 2.65	B								
2.20- 2.65	D	2.20 (DRY)			S19	Below 2.20m, medium dense.			
3.20- 3.65	UT37	3.20 (DRY)							
							3.65		29.55
3.65- 3.75	D					Firm brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of mudstone, siltstone and sandstone. Below 4.20m, stiff.			
4.20- 4.65	B								
4.20- 4.65	D	4.20 (DRY)			S18				
5.20- 5.65	UT30	5.20 (DRY)	106	12					
							5.65		27.55
5.65- 5.75	D					Stiff locally laminated brown slightly gravelly CLAY with occasional laminae and lenses of silt. Gravel is subangular to subrounded fine to coarse of mudstone and sandstone.			
6.20- 6.65	B								
6.20- 6.65	D	6.20 (DRY)			S19				
7.20- 7.65	UT47	7.20 (DRY)	402	13		Between 7.20-7.65m, grading to slightly sandy slightly gravelly silt.			
7.65- 7.75	D								
8.20- 8.65	B								
8.20- 8.65	D	8.20 (DRY)			S31				
9.00- 9.15	B						9.00		24.20
9.00- 9.15	D	9.00 (DRY)			S50/75	Very dense brown very gravelly fine to coarse SAND. Gravel is subangular to subrounded fine to coarse of sandstone and quartzite.			
9.60- 9.73	B						9.60		23.60
9.60- 9.74	D	9.60 (ADDED)			S50/60	Extremely weak reddish brown fine to coarse grained SANDSTONE.			
10.00-10.14	C								

Boring

Depth	Hole Dia	Technique	Crew
1.20	0.40	Inspection Pit	AJ/JG
10.12	0.15	Cable Percussion	JP/DH
35.50	0.09	Rotary Core	DP/MR

Progress

Depth of Hole	Depth Cased	Depth to Water	Date	Time
G.L.			12/08/19	10:00
1.20		DRY	12/08/19	11:00
1.20		DRY	14/08/19	08:00
10.12	10.00	ADDED	14/08/19	18:00
10.12	10.00	DRY	15/08/19	08:00
16.00	10.00	14.90	15/08/19	18:00

Groundwater

Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater
					Minor inflows possibly masked by drilling flush.

Remarks

AGS

Inspection pit hand excavated to 1.20m depth and no services were found.
ES sample = 2 x 258ml amber glass jars and 1 x 60ml VOC vial.
** Driller's description.
Water was added to assist boring between 9.60m and 10.00m.
A 50mm gas monitoring pipe was installed to 15.00m with a geowrapped slotted section from 10.00m to 15.00m with flush lockable protective cover. Backfill details from base of hole: bentonite seal up to 15.00m, gravel filter up to 10.00m, bentonite seal up to 0.20m, concrete up to ground level.

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **LP/JG**
Checked by **JK**
Figure **1 of 4**
31/10/2019

geotechnics

BOREHOLE RECORD - Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** **Borehole** **BH107** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **33.20** m OD

Scale 1:50

Sampling			Properties			Strata			
Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT N (FI)	Description	Depth	Legend	Level m OD
10.00-10.12	**D**	**10.00 (ADDED)**			**S50/40**		**10.12**		**23.08**
Core Run/Depth (Core Dia/Time)	Depth Cased	TCR/SCR / Type	Length Max/Min	RQD %	SPT (FI)	Continued by Rotary techniques General	Detail		
10.12-11.50 (92mm)	**10.00 (ADDED)**	**99 96**	**0.15 0.01**	**43**	**(13)**	**Very weak to weak thinly laminated reddish brown slightly silty fine to medium grained SANDSTONE with occasional subrounded to rounded clasts (up to 60mm) of quartzite. Discontinuities are horizontal to inclined (30 deg.), extremely closely to closely spaced, planar to undulating, rough with occasional clay infill (up to 1mm thick). Locally intersected by subvertical to inclined (60 deg.), undulating discontinuities.**			
11.50-13.00 (92mm)	**10.00 (ADDED)**	**100 84**	**0.15 0.01**	**41**	**(25)** (NI)		**Between 11.50-11.55m, non-intact. Between 11.55-11.75m, discontinuities are predominantly extremely closely spaced, locally very closely spaced. Between 11.75-11.85m, non-intact.**		
12.00-12.18		**C**							
13.00-14.50 (92mm)	**10.00 (ADDED)**	**98 85**	**0.27 0.01**	**59**					
13.24-13.46		**C**					**Below 13.30m, discontinuities are very closely to medium spaced, locally extremely closely spaced.**		
13.50-13.78		**C**			**(7)**				
14.50-16.00 (92mm)	**10.00 (ADDED)**	**95 92**	**0.24 0.02**	**51**					
15.54-15.69		**C**							
16.00-17.50 (92mm)	**10.00 (14.50)**	**100 79**	**0.29 0.01**	**53**	**(28)**		**Between 16.00-16.40m, discontinuities are predominantly extremely closely spaced, locally very closely spaced. Between 16.40-16.45m, very thin bed of extremely weak reddish brown mudstone. Between 16.45-16.50m, non-intact.**		
17.09-17.38		**C**							
17.38-17.50		**C**			**(6)**		**Between 17.55-17.60m, non-intact.**		
17.50-19.00 (92mm)	**10.00 (ADDED)**	**100 85**	**0.30 0.02**	**59**					
18.36-18.70		**C**							
					(27)				
					(10)		**At 18.90m, discontinuities are randomly-orientated and extremely closely spaced. Between 19.00-19.13m, assumed zone of core loss.**		
19.00-20.50 (92mm)	**10.00 (ADDED)**	**91 91**	**0.42 0.01**	**72**	**(AZCL)**				
19.00-19.30		**C**							
20.00-20.37		**C**							

Boring				Progress					Groundwater					
Depth	Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater
				16.00	**10.00**	**14.50**	**16/08/19**	**08:00**						
				31.00	**10.00**	**11.80**	**16/08/19**	**18:00**						
				31.00	**10.00**	**10.40**	**19/08/19**	**08:00**						
				35.50	**10.00**	**ADDED**	**19/08/19**	**18:00**						

Flush: 10.12-35.50m, Air/Mist, 100% return.

Remarks

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **LP/JG**
Checked by **JK**
Figure **2 of 4**
31/10/2019

geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH107** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **33.20** m OD

Scale 1:50

Core Run/Depth (Core Dia/Time)	Depth Cased & (to Water)	Type TCR/SCR%	Length Max/Min	RQD %	SPT N (FI)	Description General	Description Detail	Depth	Legend	Level m OD
20.49-20.74		**C**								
20.50-22.00 (92mm)	**10.00 (ADDED)**	**100 99**	**0.29 0.01**	**94**	**(5)**					
22.00-23.50 (92mm)	**10.00 (ADDED)**	**97 59**	**0.29 0.01**	**29**						
22.00-22.30		**C**								
22.30-22.48		**C**					**Between 22.60-23.20m, Subvertical, very closely spaced discontinuities with sand infill.**			
					(18)					
					(10)					
23.50-25.00 (92mm)	**10.00 (ADDED)**	**93 75**	**0.24 0.03**	**55**	**(AZCL)**		**Between 23.50-23.60m, assumed zone of core loss.**			
24.73-25.00		**C**								
					(8)					
25.00-26.50 (92mm)	**10.00 (ADDED)**	**99 97**	**0.27 0.02**	**59.**						
25.08-25.17		**C**								
25.17-25.45		**C**					**Between 26.00-29.50m, extremely weak to very weak.**			
26.35-26.50		**C**								
26.50-28.00 (92mm)	**10.00 (ADDED)**	**73 63**	**0.20 0.01**	**13**	**(AZCL)**		**Between 26.50-26.90m, assumed zone of core loss.**			
					(8)					
					(25)		**Between 27.60-28.00m, discontinuities are predominantly extremely closely spaced, locally very closely spaced.**			
28.00-29.50 (92mm)	**10.00 (ADDED)**	**45 23**	**0.09 0.01**	**0**	**(AZCL)**		**Between 28.00-28.80m, assumed zone of core loss.**			
					(NI)		**Between 28.80-28.90m, non-intact.**			
					(10)					
29.50-31.00 (92mm)	**10.00 (ADDED)**	**99 93**	**0.36 0.01**	**84**						
29.79-30.00		**C**								

Drilling

Depth	Hole Dia	Technique	Crew

Progress

Depth of Hole	Depth Cased	Depth to Water	Date	Time

Groundwater

Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **LP/JG**
Checked by **JK**
Figure **3 of 4**
31/10/2019

geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH107** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **33.20** m OD

Scale 1:50

Drilling: Core Run/Depth (Core Dia/Time)	Drilling: Depth Cased & (to Water)	Properties/Sampling: Type TCR/SCR%	Properties/Sampling: Length Max/Min	Properties/Sampling: RQD %	Properties/Sampling: SPT N (FI)	Strata: Description General	Strata: Description Detail	Depth	Legend	Level m OD
30.38-30.58		**C**			**(7)**		**Between 30.65-30.67m, non-intact. Below 30.65m, discontinuities are predominantly closely to medium spaced. Between 31.10-31.20m, subvertical to inclined (60 deg.), extremely yo very closely spaced discontinuities.**			
31.00-32.50 (92mm)	**10.00 (ADDED)**	**97 93**	**0.39 0.05**	**69**						
31.53-31.69		**C**								
31.69-32.00		**C**								
32.50-34.00 (92mm)	**10.00 (ADDED)**	**100 99**	**0.29 0.10**	**82**						
33.00-33.17		**C**			**(4)**					
34.00-35.50 (92mm)	**10.00 (ADDED)**	**97 97**	**0.49 0.17**	**93**						
34.72-35.00		**C**								
						End of Borehole		**35.50**		**-2.30**

Drilling: Depth	Hole Dia	Technique	Crew	Progress: Depth of Hole	Depth Cased	Depth to Water	Date	Time	Groundwater: Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **LP/JG**
Checked by **JK**
Figure **4 of 4**
31/10/2019

geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** **Borehole** **BH108** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **32.77** m OD

Scale 1:50

Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT N (FI)	Description	Depth	Legend	Level m OD
						MADE GROUND: Reinforced concrete slab.	G.L.		32.77
0.30	ES						0.40		32.37
0.50	ES					**MADE GROUND: Dark greyish brown very gravelly fine to coarse sand with a high cobble content. Gravel is angular fine to coarse including ash, clinker, sandstone masonry and brick fragments.**			
1.00	ES								
1.20- 1.65	B								
1.20- 1.65	D	(DRY)			S16				
							1.70		31.07
2.00	ES					**MADE GROUND: Orangish brown very gravelly fine to coarse sand. Gravel is angular to subrounded fine to coarse including various lithologies and brick fragments.**			
2.20- 2.65	B								
2.20- 2.65	D	2.20 (DRY)			S13				
3.00- 3.20	ES						3.00		29.77
3.20- 3.65	U37	3.20 (DRY)	152	14		**Stiff to very stiff indistinctly laminated greyish brown slightly sandy slightly gravelly CLAY. Gravel is subangular to rounded fine to coarse of various lithologies.**			
3.65- 3.75	D					**Between 3.20-3.65m, grading to slightly sandy slightly gravelly silt.**			
4.20- 4.65	B								
4.20- 4.65	D	4.20 (DRY)			S14				
5.20- 5.65	U50	5.20 (DRY)	196	12		**Between 5.20-7.00m, sandy.**			
5.65- 5.75	D								
6.20- 6.65	B								
6.20- 6.65	D	6.20 (DRY)			S50				
7.20- 7.65	U40	7.20 (DRY)	88	20		**Below 7.00m, laminae are more distinct.**			
7.65- 7.75	D								
						Extremely weak reddish brown slightly silty fine to medium grained SANDSTONE (Recovered as slightly gravelly sand).	8.00		24.77
8.20- 8.37	B								
8.20- 8.37	D	8.20 (DRY)			S50/95				
8.50- 8.62	D	8.50 (DRY)			S50/45		8.62		24.15

Core Run/Depth (Core Dia/Time)	Depth Cased	TCR/SCR / Type	Length Max/Min	RQD %	SPT (FI)	Continued by Rotary techniques General	Detail
8.62-10.00 (92mm)	(9.50)	47 13	0.10 0.01	13	(AZCL) (NI) (10)	**Extremely weak reddish brown slightly silty fine to medium grained SANDSTONE (Recovered as slightly gravelly clayey sand).**	**Between 8.62-9.30m, assumed zone of core loss.**
							10.00 22.77

Boring

Depth	Dia	Technique	Crew
1.20	0.40	Inspection Pit	JP/SP
8.50	0.15	Cable Percussion	JP/SP
35.50	0.09	Rotary Core	DP/MR

Progress

Depth of Hole	Depth Cased	Depth to Water	Date	Time
G.L.			19/08/19	08:00
6.65	6.20	DRY	19/08/19	18:00
6.65	6.20	DRY	20/08/19	08:00
8.62	8.50	DRY	20/08/19	18:00
8.50	8.50	DRY	21/08/19	08:00
10.00	8.50	8.10	21/08/19	18:00

Groundwater

Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater
					Minor inflows possibly masked by drilling flush.

Remarks

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Inspection pit hand excavated to 1.20m depth and no services were found.
ES sample = 2 x 258ml amber glass jars and 1 x 60ml VOC vial.
Water flush used below 10.00m depth.
At 35.50, Borehole flushed clean to facilitate downhole geophysical logging by Robertson Geo Services Limited.
A 50mm gas monitoring pipe was installed to 20.00m with a geowrapped slotted section from 8.50m to 20.00m with flush lockable protective cover. Backfill details from base of hole: bentonite seal up to 20.00m, gravel filter up to 8.50m, bentonite seal up to 0.20m, concrete

Logged in accordance with BS5930:2015

Logged by **JG/TL**
Checked by **JK**
Figure **1 of 4**
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geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH108** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **32.77** m OD

Drilling | Properties/Sampling | Strata | Scale 1:50

Core Run/Depth (Core Dia/Time)	Depth Cased & (to Water)	Type TCR/SCR%	Length Max/Min	RQD %	SPT N (FI)	Description General	Description Detail	Depth	Legend	Level m OD
10.00-11.50 (92mm)	(ADDED)	85 81	0.23 0.01	33	(AZCL) (12)	Very weak to weak reddish brown fine to medium grained SANDSTONE with occasional subrounded to rounded clasts (up to 60mm) of quartzite. Discontinuities are subhorizontal, very closely to closely spaced, planar, rough with sand on surfaces.	Between 10.00-10.23m, assumed zone of core loss.	10.00		22.77
10.56-10.63		C								
10.77-10.91		C			(7)					
10.91-11.14		C								
11.50-14.50 (92mm)	(ADDED)	98 97	0.34 0.03	81	(12)					
12.78-13.01		C								
13.01-13.18		C			(6)					
					(12)	Weak reddish brown MUDSTONE with occasional laminae of sandstone.		13.62		19.15
13.96-14.21		C						14.02		18.75
14.50-17.50 (92mm)	(ADDED)	98 97	0.37 0.02	69		Very weak to weak reddish brown fine to medium grained SANDSTONE with occasional subrounded to rounded clasts (up to 60mm) of quartzite and occasional laminae of mudstone. Discontinuities are subhorizontal, very closely to medium spaced, planar to undulating, rough with sand on surfaces.				
14.92-15.01		C								
15.01-15.32		C			(7)					
16.50-16.75		C								
					(4)					
17.50-20.50 (92mm)	(ADDED)	98 94	0.23 0.01	76	(10)					
17.75-17.98		C								
					(5)					
19.91-20.23		C								

Drilling

Depth	Hole Dia	Technique	Crew

Progress

Depth of Hole	Depth Cased	Depth to Water	Date	Time
10.00	8.50	9.50	22/08/19	08:00
29.50	9.50	ADDED	22/08/19	18:00
29.50	9.50	9.50	23/08/19	08:00
35.50	9.50	ADDED	23/08/19	18:00

Groundwater

Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks **up to ground level. Flush: 8.62-10.00m, Air/Mist, 100% returns; 10.00-11.50m, Water, 20% returns; 11.50-35.50m, Water, 80% return.**

Logged by **JG/TL** Checked by **JK** Figure **2 of 4** 31/10/2019

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** **Borehole** **BH108**
Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **32.77** m OD

Scale 1:50

Drilling: Core Run/Depth (Core Dia/Time)	Depth Cased & (to Water)	Properties/Sampling: Type TCR/SCR%	Length Max/Min	RQD %	SPT N (FI)	Strata: Description General	Description Detail	Depth	Legend	Level m OD
20.50-23.50 (92mm)	**(ADDED)**	**98 95**	**0.23 0.01**	**69**	**(15)**					
21.15-21.35		**C**								
					(8)					
22.50-22.66		**C**								
22.66-22.89		**C**								
							Between 23.35-23.40m, non-intact, recovered as slightly sandy gravel.			
23.50-26.50 (92mm)	**(ADDED)**	**83 72**	**0.28 0.01**	**49**	**(10)**					
					(15)		**Between 24.30-24.80m, assumed zone of core loss (possible pebble bed).**			
					(AZCL)		**Between 24.80-24.96m, non-intact, recovered as slightly sandy gravel.**			
					(NI)					
25.10-25.22		**C**								
25.22-25.50		**C**								
					(8)					
26.50-29.50 (92mm)	**(ADDED)**	**95 94**	**0.27 0.04**	**73**						
26.60-26.72		**C**								
27.95-28.23		**C**			**(6)**					
29.50-32.50 (92mm)	**(ADDED)**	**94 91**	**0.23 0.01**	**61**						

Drilling: Depth	Hole Dia	Technique	Crew	Progress: Depth of Hole	Depth Cased	Depth to Water	Date	Time	Groundwater: Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks AGS

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **JG/TL**
Checked by **JK**
Figure **3 of 4**
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geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** **Borehole** **BH108** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **32.77** m OD

Drilling | Properties/Sampling | Strata | Scale 1:50

Core Run/Depth (Core Dia/Time)	Depth Cased & (to Water)	Type TCR/SCR%	Length Max/Min	RQD %	SPT N (FI)	Description General	Description Detail	Depth	Legend	Level m OD
					(9)					
31.30-31.50		C								
31.59-31.82		C			(5)					
32.50-35.50 (92mm)	(ADDED)	70 65	0.25 0.01	45	(AZCL)		Between 32.50-33.10m, assumed zone of core loss.			
34.00-34.24		C								
					(8)					
34.65-34.86		C								
						End of Borehole		35.50		-2.73

Drilling | Progress | Groundwater

Depth	Hole Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **JG/TL**
Checked by **JK**
Figure **4 of 4**
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geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** | Engineer **WSP UK LIMITED** | Borehole / Project No **BH109** / **PN194002**

Client **WSP UK LIMITED** | Ground Level **33.20** m OD

Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT N (FI)	Description	Depth	Legend	Level m OD
							G.L.		33.20
0.20	ES					MADE GROUND: Reinforced concrete.	0.14		33.06
0.35- 1.10	B					MADE GROUND: Dark grey slightly sandy angular to subangular fine to coarse gravel of limestone. Low cobble content of limestone (Sub base). At 0.14m, Visqueen membrane.	0.35		32.85
0.50	ES								
1.00	ES					MADE GROUND: Dark grey and brown gravelly slightly clayey fine to coarse sand with a high cobble content of concrete and bricks. Gravel is angular to subangular fine to coarse of ash, clinker, concrete and brick fragments.	1.10		32.10
1.20- 1.65	B								
1.20- 1.65	D	(1.00)			S2				
						MADE GROUND: Very loose yellowish brown slightly gravelly silty fine to coarse sand. Gravel is subangular to subrounded fine to coarse of various lithologies and brick fragments.			
2.20- 2.65	B						2.20		31.00
2.20- 2.65	D	2.20 (DRY)			S16	Medium dense yellowish brown very gravelly silty fine to coarse SAND. Gravel is subangular to rounded fine to coarse of various lithologies.			
							3.00		30.20
3.20- 3.65	UT30	3.20 (ADDED)	26	17		Soft greyish brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to medium of various lithologies.			
3.65- 3.75	D					Below 3.65m, firm.			
4.20- 4.65	B								
4.20- 4.65	D	4.20 (DRY)			S13				
5.20- 5.65	UT35	5.20 (DRY)							
5.65- 5.75	D			16					
6.20- 6.65	B					Below 6.20m, stiff.			
6.20- 6.65	D	6.20 (DRY)			S21				
7.20- 7.65	UT100	7.20 (DRY)		8.6		Between 7.20-7.65m, grading to stiff slightly sandy slightly gravelly silt.			
7.65- 7.75	D								
8.20- 8.65	B					Below 8.20m, very stiff.			
8.20- 8.65	D	8.20 (DRY)			S33				
9.20- 9.65	UT100	9.20 (DRY)	60	19		Below 9.20m, firm, reddish brown.			
							9.50		23.70
9.65- 9.75	D					Very weak to weak reddish brown fine to medium grained SANDSTONE.			
10.00-10.42	B								

Scale 1:50

Boring

Depth	Hole Dia	Technique	Crew
1.20	0.40	Inspection Pit	AJ/JG
10.42	0.20	Cable Percussion	JP/DH
37.50	0.10	Rotary Core	PH/TH
39.00	0.08	Rotary Core	PH/TH

Progress

Depth of Hole	Depth Cased	Depth to Water	Date	Time
G.L.			12/08/19	08:00
1.20		DRY	12/08/19	18:00
1.20		1.00	13/08/19	08:00
10.32	10.20	ADDED	13/08/19	18:00
10.42	10.20	ADDED	14/08/19	08:00
13.50	10.20	ADDED	14/08/19	18:00

Groundwater

Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater
					Minor inflows possibly masked by drilling flush.

Remarks

Inspection pit hand excavated to 1.20m depth and no services were found.
ES sample = 2 x 258ml amber glass jars and 1 x 60ml VOC vial.
Water was added to assist boring between 2.20m and 3.20m and at 10.00m.
Between 30.00-31.50m, gravel obstruction in catcher spring.
High Pressure Dilatometer (HPD) Tests carried out by Socotec Limited between 13.50-15.00m, 18.00m-19.50m, 24.00-25.50m, 28.50-30.00m, 33.00-34.50m and 37.50-39.00m.
A 50mm gas monitoring pipe was installed to 3.00m with a geowrapped slotted section from 0.50m to 3.00m with flush lockable protective cover. Backfill details from base of hole:

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **JG/TL**
Checked by **JK**
Figure **1 of 6**
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geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** **Borehole** **BH109** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **33.20** m OD

Scale 1:50

Sampling			Properties			Strata			
Depth	Sample Type	Depth Cased & (to Water)	Strength kPa	w %	SPT N (FI)	Description	Depth	Legend	Level m OD
10.00-10.32	**D**	**10.00 (ADDED)**			**S50/ 170**	**Between 10.20-10.51m, extremely weak.**			
Core Run/Depth (Core Dia/Time)	Depth Cased	TCR/SCR / Type	Length Max/Min	RQD %	SPT (FI)	Continued by Rotary techniques General	Detail	**10.32**		**22.88**
10.32-11.50 (102mm)	**10.20 (ADDED)**	**88 85**	**0.44 0.01**	**78**		**Very weak to weak reddish brown fine to medium grained SANDSTONE with occasional subrounded to rounded clasts (up to 60mm) of quartzite and occasional laminae of mudstone. Discontinuities are subhorizontal, closely to medium spaced, planar, rough with sand on surfaces.**	**Between 10.50-11.70m, very weak, becoming weak to medium strong.**			
10.56-10.68		**C**								
10.77-10.89		**C**								
11.50-12.60 (102mm)	**10.20 (ADDED)**	**100 100**	**0.35 0.06**	**86**	**(7)**					
12.25-12.35		**C**								
12.60-13.00 (102mm)	**10.20 (ADDED)**	**100 100**	**0.32 0.12**	**100**						
13.00-13.50 (102mm)	**10.20 (ADDED)**	**100 100**	**0.23 0.12**	**100**						
13.50-15.00 (76mm) (20mins)	**13.30 (0.50)**	**100 100**	**1.27 0.05**	**97**						
14.57-14.73		**C**								
14.73-14.86		**C**								
14.86-15.00		**C**			**(3)**					
15.00-16.50 (102mm) (44mins)	**13.30 (ADDED)**	**97 97**	**0.45 0.08**	**91**						
15.00-15.22		**C**								
16.50-18.00 (102mm) (38mins)	**13.30 (ADDED)**	**98 98**	**0.50 0.07**	**93**						
17.03-17.28		**C**								
17.35-17.47		**C**			**(5)**					
18.00-19.50 (76mm) (24mins)	**17.90 (ADDED)**	**100 100**	**1.30 0.20**	**100**						
18.65-18.75		**C**			**(2)**					
18.75-18.94		**C**								
18.94-19.14		**C**								
19.50-21.00 (102mm) (17mins)	**17.90 (ADDED)**	**91 85**	**0.32 0.03**	**77**						

Boring				Progress					Groundwater					
Depth	Dia	Technique	Crew	Depth of Hole	Depth Cased	Depth to Water	Date	Time	Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater
				13.50	**13.30**	**0.50**	**15/08/19**	**08:00**						
				21.00	**17.90**	**2.10**	**15/08/19**	**18:00**						
				21.00	**11.00**	**2.10**	**16/08/19**	**08:00**						
				30.00	**28.20**	**2.20**	**16/08/19**	**18:00**						
				30.00	**11.00**	**9.40**	**19/08/19**	**08:00**						
				39.00	**37.30**	**4.50**	**19/08/19**	**18:00**						

Remarks

bentonite seal up to 3.00m, gravel filter up to 0.50m, bentonite seal up to 0.30m, concrete up to ground level.
Flush: 10.32-51.00m, Mud, 100% return.

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **JG/TL**
Checked by **JK**
Figure **2 of 6**
31/10/2019

geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH109** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **33.20** m OD

Scale 1:50

Drilling: Core Run/Depth (Core Dia/Time)	Drilling: Depth Cased & (to Water)	Properties/Sampling: Type TCR/SCR%	Length Max/Min	RQD %	SPT N (FI)	Strata: Description General	Description Detail	Depth	Legend	Level m OD
21.00-21.75 (102mm) (19mins)	**11.00 (2.10)**	**99 99**	**0.26 0.04**	**93**						
21.38-21.60		**C**			**(5)**					
21.75-22.50 (102mm) (22mins)	**11.00 (ADDED)**	**97 93**	**0.31 0.03**	**85**						
22.50-23.60 (102mm) (10mins)	**11.00 (ADDED)**	**100 97**	**0.47 0.02**	**93**						
23.22-23.42		**C**					**Between 23.35-24.00m, some subrounded to rounded clasts (up to 60mm) of quartzite and mudstone.**			
23.60-24.00 (102mm) (20mins)	**11.00 (ADDED)**	**100 100**	**0.18 0.05**	**78**						
24.00-25.50 (76mm) (28mins)	**23.80 (ADDED)**	**100 100**	**0.47 0.04**	**90**						
24.14-24.30		**C**								
24.79-25.04		**C**								
25.04-25.42		**C**			**(4)**					
25.50-27.00 (102mm) (31mins)	**11.00 (ADDED)**	**100 100**	**0.39 0.06**	**91**						
27.00-28.50 (102mm) (31mins)	**11.00 (ADDED)**	**100 100**	**0.44 0.15**	**100**						
27.85-28.01		**C**			**(3)**					
28.50-30.00 (76mm) (26mins)	**28.20 (ADDED)**	**100 100**	**0.37 0.05**	**88**						
29.22-29.47		**C**								

Drilling

Depth	Hole Dia	Technique	Crew

Progress

Depth of Hole	Depth Cased	Depth to Water	Date	Time
39.00	**11.00**	**9.40**	**20/08/19**	**08:00**
51.00	**11.00**	**ADDED**	**20/08/19**	**18:00**

Groundwater

Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **JG/TL**
Checked by **JK**
Figure **3 of 6**
31/10/2019

geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH109** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **33.20** m OD

Drilling | Properties/Sampling | Strata | Scale 1:50

Core Run/Depth (Core Dia/Time)	Depth Cased & (to Water)	Type TCR/SCR%	Length Max/Min	RQD %	SPT N (FI)	Description General	Description Detail	Depth	Legend	Level m OD
30.00-31.50 (102mm) (29mins) 30.12-30.40	11.00 (9.40)	98 91 C	0.44 0.03	76	(5)		Between 30.00-31.50m, locally very weak, with some subrounded to rounded clasts (up to 60mm) of quartzite and mudstone.			
31.50-32.60 (102mm) (21mins) 31.50-31.97 31.97-32.11	11.00 (ADDED)	100 100 C C	0.47 0.09	92						
32.60-33.00 (102mm) (9mins)	11.00 (ADDED)	100 100	0.24 0.16	100						
33.00-34.50 (76mm) (21mins) 33.14-33.46 33.77-33.90	32.70 (ADDED)	100 100 C C	0.43 0.12	100						
34.50-36.00 (102mm) (19mins)	11.00 (ADDED)	100 100	0.31 0.04	97	(4)					
36.00-37.50 (102mm) (18mins) 36.75-36.93	11.00 (ADDED)	100 100 C	0.45 0.06	96						
37.50-39.00 (76mm) (21mins) 38.15-38.31 38.41-38.75	37.30 (ADDED)	100 100 C C	0.72 0.13	100			Between 38.41-47.02, Very weak.			
39.00-40.50 (102mm) (14mins) 39.11-39.40	11.00 (9.40)	100 89 C	0.29 0.04	71						

Drilling

Depth	Hole Dia	Technique	Crew

Progress

Depth of Hole	Depth Cased	Depth to Water	Date	Time

Groundwater

Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **JG/TL**
Checked by **JK**
Figure **4 of 6**
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geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH109** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **33.20** m OD

Scale 1:50

Drilling: Core Run/Depth (Core Dia/Time)	Drilling: Depth Cased & (to Water)	Properties/Sampling: Type TCR/SCR%	Properties/Sampling: Length Max/Min	Properties/Sampling: RQD %	Properties/Sampling: SPT N (FI)	Strata: Description General	Strata: Description Detail	Depth	Legend	Level m OD
							Between 40.15-40.35m, two (2No.) inclined (50-70deg.), planar to undulating, rough discontinuities with orangish brown staining and sand on surfaces.			
40.50-42.00 (102mm) (16mins)	**11.00 (ADDED)**	**100 100**	**0.44 0.13**	**100**						
42.00-43.50 (102mm) (29mins)	**11.00 (ADDED)**	**100 100**	**0.41 0.03**	**89**			**Between 42.00-42.44m, some laminae and very thin beds of very weak to weak mudstone,**			
42.52-42.81		**C**								
43.50-45.00 (102mm) (26mins)	**11.00 (ADDED)**	**100 100**	**0.66 0.04**	**97**	**(4)**					
45.00-46.50 (102mm) (14mins)	**11.00 (ADDED)**	**100 100**	**0.26 0.03**	**97**						
46.50-48.00 (102mm) (12mins)	**11.00 (ADDED)**	**100 100**	**0.41 0.06**	**96**						
46.50-46.64		**C**								
46.64-47.02		**C**								
48.00-49.50 (102mm) (12mins)	**11.00 (ADDED)**	**100 100**	**0.68 0.15**	**100**						
48.68-49.07		**C**								
49.50-51.00 (102mm) (10mins)	**11.00 (ADDED)**	**99 99**	**0.57 0.04**	**96**	**(2)**					

Drilling

Depth	Hole Dia	Technique	Crew

Progress

Depth of Hole	Depth Cased	Depth to Water	Date	Time

Groundwater

Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **JG/TL**
Checked by **JK**
Figure **5 of 6**
31/10/2019

geotechnics

BOREHOLE RECORD – Cable Percussion and Rotary

Project **CROWN STREET ZONE 2** Engineer **WSP UK LIMITED** Borehole **BH109** Project No **PN194002**

Client **WSP UK LIMITED** Ground Level **33.20** m OD

Scale 1:50

Drilling: Core Run/Depth (Core Dia/Time)	Drilling: Depth Cased & (to Water)	Properties/Sampling: Type TCR/SCR%	Properties/Sampling: Length Max/Min	Properties/Sampling: RQD %	Properties/Sampling: SPT N (FI)	Strata: Description General	Strata: Description Detail	Depth	Legend	Level m OD
						End of Borehole		**51.00**		**-17.80**

Drilling: Depth	Hole Dia	Technique	Crew	Progress: Depth of Hole	Depth Cased	Depth to Water	Date	Time	Groundwater: Depth Struck	Depth Cased	Rose to	in Mins	Depth Sealed	Remarks on Groundwater

Remarks

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

Logged in accordance with BS5930:2015

Logged by **JG/TL**
Checked by **JK**
Figure **6 of 6**
31/10/2019

geotechnics

Fieldwork Results - SPT Results Summary

Project CROWN STREET ZONE 2 **Project No** PN194002

Client WSP UK LIMITED

Hole	Depth m bgl	Level m OD	Type	SWP (mm)	Seating Drive		Test Drive				SPT 'N' Value	Uncorrected SPT 'N' 10 20 30 40 50
					0-75 (mm)	75-150 (mm)	0-75 (mm)	75-150 (mm)	150-225 (mm)	225-300 (mm)		
BH101	1.20	32.22	S	-	2	2	4	5	6	6	21	
BH101	2.20	31.22	S	-	7	8	8	7	6	6	27	
BH101	3.20	30.22	S	-	4	5	5	6	4	6	21	
BH101	5.20	28.22	S	-	2	2	3	3	4	5	15	
BH101	7.20	26.22	S	-	3	3	4	5	6	6	21	
BH101	9.20	24.22	S	-	3	3	8	10	14	18	50	
BH101	10.20	23.22	S	-	25		50/50				50/50	
BH101	11.20	22.22	S	-	25		50/40				50/40	
BH101	11.50	21.92	S	-	25		50/25				50/25	

Driller	John Price
Hammer No.	SRL4
Energy Ratio, Er (%)	65.00
Calibration Date	16/08/2018

Remarks
Equipment checked and calibration carried out in accordance with BS EN ISO 22476-3: 2005

-/- Blows/penetration (mm) after seating
-*/- Total blows/penetration (mm)
SWP Penetration under own weight (mm)

S - Standard Penetration Test (SPT)
C - SPT with cone
L - Split Spoon with liner used

GEOTECHNICS

Fieldwork Results - *SPT Results Summary*

Project CROWN STREET ZONE 2 **Project No** PN194002

Client WSP UK LIMITED

Hole	Depth m bgl	Level m OD	Type	SWP (mm)	Seating Drive		Test Drive				SPT 'N' Value	Uncorrected SPT 'N' 10 20 30 40 50
					0-75 (mm)	75-150 (mm)	0-75 (mm)	75-150 (mm)	150-225 (mm)	225-300 (mm)		
BH102	1.20	32.08	S	-	2	3	3	4	5	6	18	*
BH102	2.20	31.08	S	-	3	3	3	4	4	6	17	*
BH102	4.20	29.08	S	-	3	3	4	5	4	6	19	*
BH102	6.20	27.08	S	-	3	3	3	4	6	6	19	*
BH102	8.00	25.28	S	-	25		50/50				50/50	>

Driller	John Price
Hammer No.	SRL4
Energy Ratio, Er (%)	65.00
Calibration Date	16/08/2018

Remarks
Equipment checked and calibration carried out in accordance with BS EN ISO 22476-3: 2005

-/- Blows/penetration (mm) after seating
-*/- Total blows/penetration (mm)
SWP Penetration under own weight (mm)

S - Standard Penetration Test (SPT)
C - SPT with cone
L - Split Spoon with liner used

GEOTECHNICS

Fieldwork Results - SPT Results Summary

Project CROWN STREET ZONE 2 **Project No** PN194002

Client WSP UK LIMITED

Hole	Depth m bgl	Level m OD	Type	SWP (mm)	Seating Drive 0-75 (mm)	Seating Drive 75-150 (mm)	Test Drive 0-75 (mm)	Test Drive 75-150 (mm)	Test Drive 150-225 (mm)	Test Drive 225-300 (mm)	SPT 'N' Value	Uncorrected SPT 'N' 10 20 30 40 50
BH103	1.20	32.03	S	-	1	1	-	-	-	1	1	*
BH103	2.20	31.03	S	-	3	3	3	5	4	6	18	*
BH103	4.20	29.03	S	-	2	3	3	4	4	4	15	*
BH103	6.20	27.03	S	-	3	3	4	4	6	6	20	*
BH103	8.00	25.23	S	-	25		50/40				50/40	>

Driller	John Price
Hammer No.	SRL4
Energy Ratio, Er (%)	65.00
Calibration Date	16/08/2018

Remarks
Equipment checked and calibration carried out in accordance with BS EN ISO 22476-3: 2005

-/- Blows/penetration (mm) after seating
-*/- Total blows/penetration (mm)
SWP Penetration under own weight (mm)

S - Standard Penetration Test (SPT)
C - SPT with cone
L - Split Spoon with liner used

GEOTECHNICS

Fieldwork Results - *SPT Results Summary*

Project CROWN STREET ZONE 2 **Project No** PN194002

Client WSP UK LIMITED

Hole	Depth m bgl	Level m OD	Type	SWP (mm)	Seating Drive		Test Drive				SPT 'N' Value	Uncorrected SPT 'N' 10 20 30 40 50
					0-75 (mm)	75-150 (mm)	0-75 (mm)	75-150 (mm)	150-225 (mm)	225-300 (mm)		
BH104	1.20	32.02	S	-	4	5	7	7	7	8	29	
BH104	2.20	31.02	S	-	3	4	4	5	6	6	21	
BH104	4.20	29.02	S	-	2	2	3	3	3	3	12	
BH104	6.20	27.02	S	-	3	3	3	4	5	6	18	
BH104	8.20	25.02	S	-	3	4	4	4	5	6	19	
BH104	9.00	24.22	S	-	10	15	30	20/20			50/95	
BH104	9.50	23.72	S	-	25/70		50/40				50/40	

Driller	John Price
Hammer No.	SRL4
Energy Ratio, Er (%)	65.00
Calibration Date	16/08/2018

Remarks
Equipment checked and calibration carried out in accordance with BS EN ISO 22476-3: 2005

-/- Blows/penetration (mm) after seating
-*/- Total blows/penetration (mm)
SWP Penetration under own weight (mm)

S - Standard Penetration Test (SPT)
C - SPT with cone
L - Split Spoon with liner used

GEOTECHNICS

Fieldwork Results - *SPT Results Summary*

Project CROWN STREET ZONE 2 **Project No** PN194002

Client WSP UK LIMITED

Hole	Depth m bgl	Level m OD	Type	SWP (mm)	Seating Drive		Test Drive				SPT 'N' Value	Uncorrected SPT 'N'
					0-75 (mm)	75-150 (mm)	0-75 (mm)	75-150 (mm)	150-225 (mm)	225-300 (mm)		10 20 30 40 50
BH105	1.20	31.64	S	-	1	1	1	2	2	3	8	*
BH105	2.20	30.64	S	-	2	2	2	3	3	3	11	*
BH105	4.20	28.64	S	-	2	2	3	4	5	5	17	*
BH105	6.20	26.64	S	-	3	7	8	12	15	15	50	*
BH105	7.20	25.64	S	-	7	8	8	10	10	12	40	*
BH105	8.00	24.84	S	-	25		50/10				50/10	>

Driller	John Price
Hammer No.	SRL4
Energy Ratio, Er (%)	65.00
Calibration Date	16/08/2018

Remarks
Equipment checked and calibration carried out in accordance with BS EN ISO 22476-3: 2005

-/- Blows/penetration (mm) after seating
-*/- Total blows/penetration (mm)
SWP Penetration under own weight (mm)

S - Standard Penetration Test (SPT)
C - SPT with cone
L - Split Spoon with liner used

GEOTECHNICS

Fieldwork Results - *SPT Results Summary*

Project CROWN STREET ZONE 2 **Project No** PN194002

Client WSP UK LIMITED

Hole	Depth m bgl	Level m OD	Type	SWP (mm)	Seating Drive 0-75 (mm)	Seating Drive 75-150 (mm)	Test Drive 0-75 (mm)	Test Drive 75-150 (mm)	Test Drive 150-225 (mm)	Test Drive 225-300 (mm)	SPT 'N' Value	Uncorrected SPT 'N' 10 20 30 40 50
BH106	1.20	31.76	S	-	1	-	1	-+	1	-	2	*
BH106	2.20	30.76	S	-	1	1	1	-	1	1	3	*
BH106	4.20	28.76	S	-	1	1	1	2	3	3	9	*
BH106	6.20	26.76	S	-	17	7	10	15	25		50/225	>
BH106	7.20	25.76	S	-	25/15		50/50				50/50	>
BH106	8.00	24.96	S	-	25		50/60				50/60	>
BH106	8.50	24.46	S	-	25		50/40				50/40	>

Driller	John Price
Hammer No.	SRL4
Energy Ratio, Er (%)	65.00
Calibration Date	16/08/2018

Remarks
Equipment checked and calibration carried out in accordance with BS EN ISO 22476-3: 2005

-/- Blows/penetration (mm) after seating
-*/- Total blows/penetration (mm)
SWP Penetration under own weight (mm)

S - Standard Penetration Test (SPT)
C - SPT with cone
L - Split Spoon with liner used

GEOTECHNICS

Fieldwork Results - SPT Results Summary

Project CROWN STREET ZONE 2 **Project No** PN194002

Client WSP UK LIMITED

Hole	Depth m bgl	Level m OD	Type	SWP (mm)	Seating Drive		Test Drive				SPT 'N' Value	Uncorrected SPT 'N'
					0-75 (mm)	75-150 (mm)	0-75 (mm)	75-150 (mm)	150-225 (mm)	225-300 (mm)		10 20 30 40 50
BH107	1.20	32.00	S	-	3	4	3	1	1	2	7	*
BH107	2.20	31.00	S	-	4	4	6	4	4	5	19	*
BH107	4.20	29.00	S	-	2	3	3	4	5	6	18	*
BH107	6.20	27.00	S	-	3	3	4	4	5	6	19	*
BH107	8.20	25.00	S	-	2	3	5	7	7	12	31	*
BH107	9.00	24.20	S	-	25		50				50/75	>
BH107	9.60	23.60	S	-	25		50/60				50/60	>
BH107	10.00	23.20	S	-	25		50/40				50/40	>

Driller	John Price
Hammer No.	SRL4
Energy Ratio, Er (%)	65.00
Calibration Date	16/08/2018

Remarks
Equipment checked and calibration carried out in accordance with BS EN ISO 22476-3: 2005

-/- Blows/penetration (mm) after seating
-*/- Total blows/penetration (mm)
SWP Penetration under own weight (mm)

S - Standard Penetration Test (SPT)
C - SPT with cone
L - Split Spoon with liner used

GEOTECHNICS

Fieldwork Results - *SPT Results Summary*

Project CROWN STREET ZONE 2 **Project No** PN194002

Client WSP UK LIMITED

Hole	Depth m bgl	Level m OD	Type	SWP (mm)	Seating Drive		Test Drive				SPT 'N' Value	Uncorrected SPT 'N' 10 20 30 40 50
					0-75 (mm)	75-150 (mm)	0-75 (mm)	75-150 (mm)	150-225 (mm)	225-300 (mm)		
BH108	1.20	31.57	S	-	1	5	7	3	3	3	16	*
BH108	2.20	30.57	S	-	3	3	4	4	2	3	13	*
BH108	4.20	28.57	S	-	2	2	3	3	4	4	14	*
BH108	6.20	26.57	S	-	8	12	20	10	10	10	50	*
BH108	8.20	24.57	S	-	25		32	18/20			50/95	>
BH108	8.50	24.27	S	-	25		50/45				50/45	>

Driller	John Price
Hammer No.	SRL4
Energy Ratio, Er (%)	65.00
Calibration Date	16/08/2018

Remarks
Equipment checked and calibration carried out in accordance with BS EN ISO 22476-3: 2005

-/- Blows/penetration (mm) after seating
-*/- Total blows/penetration (mm)
SWP Penetration under own weight (mm)

S - Standard Penetration Test (SPT)
C - SPT with cone
L - Split Spoon with liner used

GEOTECHNICS

Fieldwork Results - SPT Results Summary

Project CROWN STREET ZONE 2 **Project No** PN194002

Client WSP UK LIMITED

Hole	Depth m bgl	Level m OD	Type	SWP (mm)	Seating Drive		Test Drive				SPT 'N' Value	Uncorrected SPT 'N' 10 20 30 40 50
					0-75 (mm)	75-150 (mm)	0-75 (mm)	75-150 (mm)	150-225 (mm)	225-300 (mm)		
BH109	1.20	32.00	S	-	1	1	-	-	1	1	2	*
BH109	2.20	31.00	S	-	2	3	3	4	4	5	16	*
BH109	4.20	29.00	S	-	1	1	3	3	3	4	13	*
BH109	6.20	27.00	S	-	2	2	3	5	6	7	21	*
BH109	8.20	25.00	S	-	3	5	6	7	8	12	33	*
BH109	10.00	23.20	S	-	10	10	12	26	12/20		50/170	>

Driller	John Price
Hammer No.	SRL4
Energy Ratio, Er (%)	65.00
Calibration Date	16/08/2018

Remarks
Equipment checked and calibration carried out in accordance with BS EN ISO 22476-3: 2005

-/- Blows/penetration (mm) after seating
-*/- Total blows/penetration (mm)
SWP Penetration under own weight (mm)

S - Standard Penetration Test (SPT)
C - SPT with cone
L - Split Spoon with liner used

GEOTECHNICS

SPT Hammer Energy Test Report

in accordance with BSEN ISO 22476-3:2005

James Fisher Testing Services
Ruby House
40A Hardwick Grange
Woolston
Warrington

SPT Hammer Ref:	SRL4
Test Date:	16/08/2018
Report Date:	16/08/2018
File Name:	SRL4.spt
Test Operator:	DA

Instrumented Rod Data

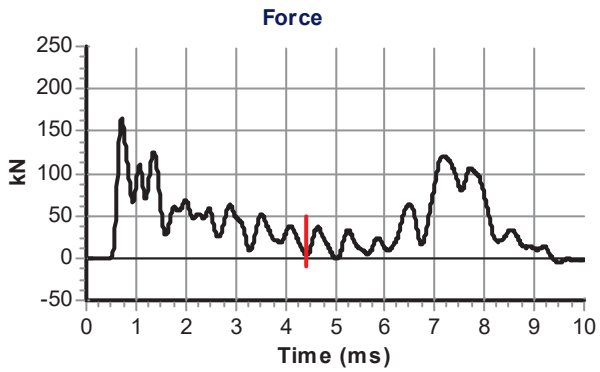
Diameter d_r (mm):	54
Wall Thickness t_r (mm):	7.0
Assumed Modulus E_a (GPa):	208
Accelerometer No.1:	11936
Accelerometer No.2:	1137

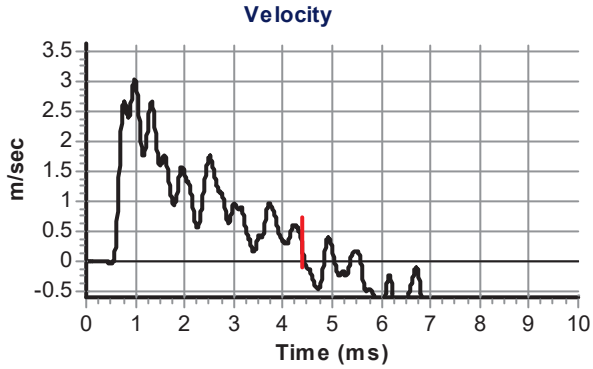
SPT Hammer Information

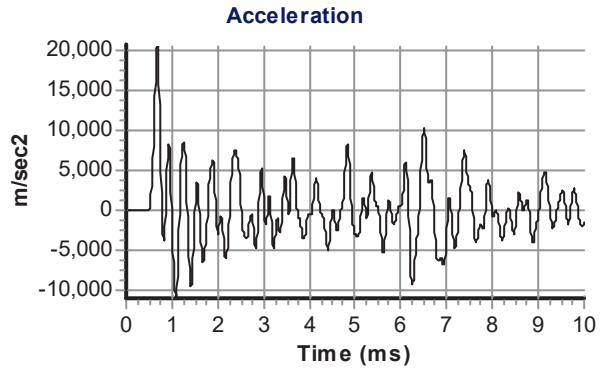
Hammer Mass m (kg):	63.5
Falling Height h (mm):	760
SPT String Length L (m):	14.5

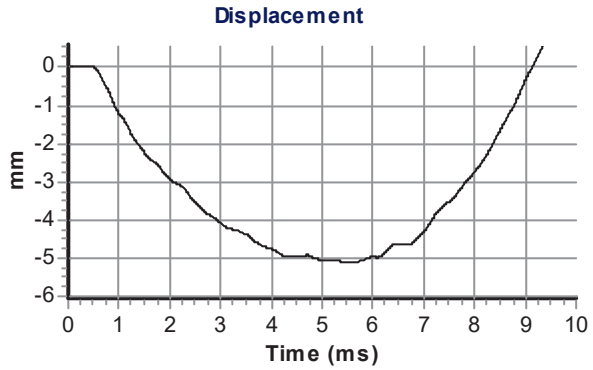
Comments / Location

Client: Strata Renewables Limited
Location: JFTS Laboratory
Hammer Type: Trip Hammer









Calculations

Area of Rod A (mm2):	1034
Theoretical Energy E_{theor} (J):	473
Measured Energy E_{meas} (J):	309

Energy Ratio E_r (%): **65**

Signed: Dylan Akpan
Title: Technician

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APPENDIX 3

Rock Core Photographs

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH101 Box 1 11.50m-13.40m



BH101 Box 1 13.40m-16.40m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH101 Box 3 16.40m-19.40m



BH101 Box 4 19.40m-22.40m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH101 Box 5 22.40m-25.40m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH102 Box 1 8.00m-11.00m



BH102 Box 2 11.00m-14.00m

PHOTOGRAPHS

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH102 Box 3 14.00m-17.00m



BH102 Box 4 17.00m-20.00m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH102 Box 5 20.00m-23.00m



BH102 Box 6 23.00m-26.00m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH102 Box 7 26.00m-29.00m



BH102 Box 8 29.00m-32.00m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH102 Box 9 32.00m-35.00m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH103 Box 1 7.70m-10.50m



BH103 Box 2 10.50m-13.50m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH103 Box 3 13.50m-16.50m



BH103 Box 4 16.50m-19.50m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH103 Box 5 19.50m-21.00m



BH103 Box 6 21.00m-24.00m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH103 Box 7 24.00m-27.00m



BH103 Box 8 27.00m-30.00m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH103 Box 9 30.00m-32.00m



BH103 Box 10 32.00m-34.00m

PHOTOGRAPHS

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH103 Box 11 34.00m-36.00m



BH103 Box 12 36.00m-38.00m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH103 Box 13 38.00m-40.00m



BH103 Box 14 40.00m-42.00m

Project Number : PN194002

Project : CROWN STREET ZONE 2



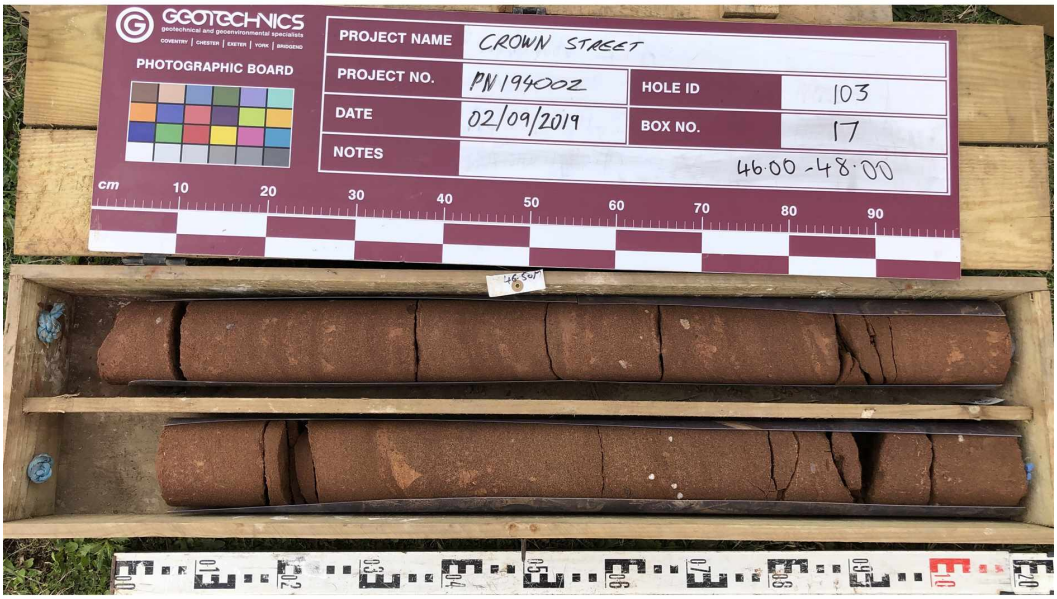
BH103 Box 15 42.00m-44.00m



BH103 Box 16 44.00m-46.00m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH103 Box 17 46.00m-48.00m



BH103 Box 18 48.00m-50.00m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH103 Box 19 50.00m-51.00m

PHOTOGRAPHS

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH104 Box 1 9.50m-11.00m



BH104 Box 2 11.00m-14.00m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH104 Box 3 14.00m-17.00m



BH104 Box 4 17.00m-20.00m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH104 Box 5 20.00m-23.00m



BH104 Box 6 23.00m-26.00m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH104 Box 7 26.00m-29.00m



BH104 Box 8 29.00m-32.00m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH104 Box 9 32.00m-35.00m

PHOTOGRAPHS

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH105 Box 1 8.00m-11.00m



BH105 Box 2 11.00m-14.00m

PHOTOGRAPHS

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH105 Box 3 14.00m-17.00m



BH105 Box 4 17.00m-20.00m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH105 Box 5 20.00m-23.00m



BH105 Box 6 23.00m-26.00m

PHOTOGRAPHS

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH106 Box 1 8.50m-11.00m



BH106 Box 2 11.00m-14.00m

PHOTOGRAPHS

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH106 Box 3 14.00m-17.00m



BH106 Box 4 17.00m-20.00m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH106 Box 5 20.00m-23.00m



BH106 Box 6 23.00m-26.00m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH107 Box 1 10.00m-13.00m



BH107 Box 2 13.00m-16.00m

PHOTOGRAPHS

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH107 Box 3 16.00m-19.00m



BH107 Box 4 19.00m-22.00m

PHOTOGRAPHS

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH107 Box 5 22.00m-25.00m



BH107 Box 6 25.00m-28.00m

PHOTOGRAPHS

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH107 Box 7 28.00m-31.00m



BH107 Box 8 31.00m-34.00m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH107 Box 9 34.00m-35.50m

PHOTOGRAPHS

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH108 Box 1 8.50m-11.50m



BH108 Box 2 11.50m-14.50m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH108 Box 3 14.50m-17.50m



BH108 Box 4 17.50m-20.50m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH108 Box 5 20.50m-23.50m



BH108 Box 6 23.50m-26.50m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH108 Box 7 26.50m-29.50m



BH108 Box 8 29.50m-32.50m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH108 Box 9 32.50m-35.20m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH109 Box 1 10.20m-13.00m



BH109 Box 2 13.00m-15.00m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH109 Box 3 15.00m-18.00m



BH109 Box 4 18.00m-21.00m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH109 Box 5 21.00m-24.00m



BH109 Box 6 24.00m-27.00m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH109 Box 7 27.00m-30.00m



BH109 Box 8 30.00m-33.00m

Project Number : PN194002

Project : CROWN STREET ZONE 2



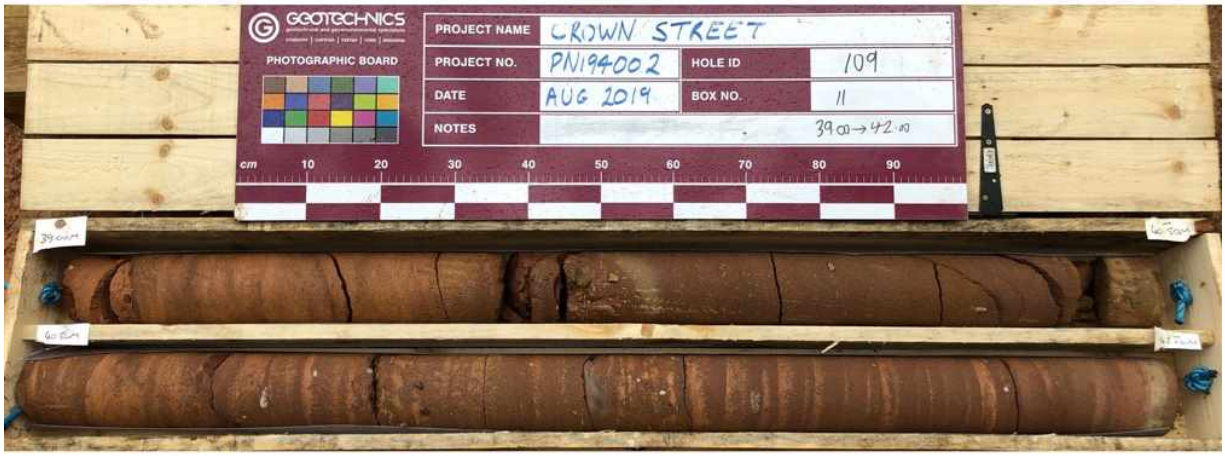
BH109 Box 9 33.00m-36.00m



BH109 Box 10 36.00m-39.00m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH109 Box 11 39.00m-42.00m



BH109 Box 12 42.00m-45.00m

Project Number : PN194002

Project : CROWN STREET ZONE 2



BH109 Box 13 45.00m-48.00m



BH109 Box 14 48.00m-51.00m

APPENDIX 4

High Pressure Dilatometer Test Results

CROWN STREET, MANCHASTER

FACTUAL REPORT ON PRESSUREMETER TESTING

DRAFT

Report No M9019-19

September 2019

Issue No 1

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Report No M9019-19

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1 Sept 2019	Final report	NAME and QUALIFICATIONS IR Campbell BSc, BEng, ACSM, FGS	NAME and QUALIFICATIONS P Hepton BSc PD	NAME and QUALIFICATIONS
		SIGNATURE	SIGNATURE	SIGNATURE

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1 INTRODUCTION

SOCOTEC UK Limited was commissioned in July 2019 by Geotechnics Limited to carry out high pressure dilatometer testing at Crown Street in Manchester. The scope of the investigation was specified by Geotechnics Limited and included pressuremeter testing.

This report presents the factual fieldwork records of the pressuremeter testing carried out between 15 and 28 August 2019, together with an interpretation of the test results in terms of material parameters. The data are also presented separately in digital format following AGS (2017).

2 PRESSUREMETER TESTING

2.1 Pressuremeter Equipment

The testing was undertaken using a high pressure, direct strain measuring, borehole dilatometer (HPD) manufactured by Cambridge Insitu. The pressuremeter comprises a cylindrical instrument, inflated by gas pressure controlled from the surface. The HPD is inserted into a test pocket drilled in the ground using a rotary drilling rig (ie, a prebored type pressuremeter). During a test, strain is measured across three diameters in the same plane at the centre of the expanding section, and pressure measured by internal pressure transducers. Details of the instrument used are as follows in Table 1:

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TABLE 1 : SUMMARY OF PRESSUREMETER EQUIPMENT

INSTRUMENT	NOMINAL DIAMETER (mm)	STRAIN CAPACITY (mm)	PRESSURE CAPACITY (MPa)	INSTRUMENT DETAILS	REMARKS
HPD-95	95	25 (per arm)	20	Cambridge Insitu 6-arm multiplex pressuremeter.	Serial No 180126

The calibration register for the instrument is contained in Appendix A. This presents calibrations for the displacement and pressure measuring transducers, and corrections assessed for membrane stiffness (ie resistance to inflation in air) and system compliance.

2.2 Testing Programme

Twelve high pressure dilatometer tests were carried out in two borehole at depths scheduled by Geotechnics Limited, in general accordance with BS 5930 (2015). Details of the test depths, dates, remarks, etc are included in the Summary of Pressuremeter Tests, see Table 2.

TABLE 2 : SUMMARY OF PRESSUREMETER TESTS

BOREHOLE REF.	TEST REF.	TEST DEPTH (mBGL)	DATE	REMARKS
BH103	B103T1	11.30	22 August	
	B103T2	15.80	22 August	
	B103T3	21.80	23 August	
	B103T4	26.30	23 August	
	B103T5	30.80	27 August	
	B103T6	39.80	28 August	
BH109	B109T1	14.30	15 August	
	B109T2	18.80	15 August	
	B109T3	24.70	16 August	
	B109T4	29.10	19 August	
	B109T5	33.80	19 August	
	B109T6	38.30	20 August	

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The boreholes were drilled by Geotechnics Limited with a 2 to 3 m long test pocket drilled at the required test detpths. The HPD was inserted into the test pocket as soon as possible to minimise deterioration of the ground and the test carried out.

The testing was carried out in a stress controlled manner using a manually operated compressed gas control box to pressurise the pressuremeter at an appropriate loading rate for the ground conditions. During the test unload-reload loops were performed. Where considered necessary, in the operator's judgement, a holding period was maintained to allow creep of the ground to reduce before carrying out the unloading stage of the loop.

Loading was continued until either the strain or pressure capacity of the instrument was achieved or if in the operator's opinion continuation would result in risk of damage to the equipment. The pressuremeter was then unloaded and removed from the hole to allow continuation by rotary coring.

3 ANALYSIS

Analysis of the pressuremeter test data was carried out using proprietary software developed by Cambridge Insitu. Interpretation was performed on the average values obtained from all the displacement measuring positions (ie the average of the 6 arms).

The pressuremeter tests have been interpreted to provide, where appropriate, estimates of the following parameters:

- in situ cavity pressure after Marsland and Randolph (1977) modified by Hawkins et al (1990)
- lateral at-rest earth pressure coefficient, K_o, based on best estimate of horizontal pressure, assumed soil density of 2 Mg/m^3 and observed borehole groundwater level during test (Note that estimates of horizontal pressure other than by direct measurement of lift-off pressure in SBP test are unlikely to be reliable. (where no rational basis for estimate of horizontal pressure can be applied to the test data then K_o is not reported)
- undrained shear strength and limit pressure during loading after Gibson and Anderson (1961) modified by Windle and Wroth, 1977 (where insufficient yield has occurred during the test then strength interpretation is not reported)
- initial shear modulus from slope of early loading part of test
- shear modulus from linear fit to unload-reload loops after Windle and Wroth (1977)
- shear modulus – shear strain relationship (non-linear stiffness response) after Bolton and Whittle (1999), and derived shear modulus values at strain levels of 10^{-4}, 10^{-3} and 10^{-2}

Plots of total pressure against average arm displacement for each pressuremeter test, together with the results of interpretation of the data, are presented as Figures following the report text. It is advised that the interpretation should be examined against the individual Pressuremeter Test Analysis to see how well the test data conforms to model behaviour used for analysis, see Appendix B.

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4 REFERENCES

AGS: 2017 : Electronic transfer of geotechnical and geoenvironmental data (Edition 4.0.4). Association of Geotechnical and Geoenvironmental Specialists.

Bolton M D and Whittle R W : 1999 : A non-linear elastic/perfectly plastic analysis for plane strain undrained expansion tests. Géotechnique 49, No. 1, pp 133-141.

BS 5930 : 2015 : Code of practice for ground investigations. British Standards Institution.

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 6l5-6l8.

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

Marsland A and Randolph M F : 1977 : Comparison of the Results from Pressuremeter Tests and Large Insitu Plate Tests in London Clay. Géotechnique 27 No. 2 pp 2l7-243.

Whittle R W : 1999: Using non-linear elasticity to obtain the engineering properties clay - a new solution for the self-boring pressuremeter. Ground Engineering, Vol.32, No.5, pp 30-34.

Windle D and Wroth C P : 1977 : The Use of a Self-boring Pressuremeter to determine the Undrained Properties of Clays. Ground Engineering, September.

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Summary of Pressuremeter Tests

SOCOTEC

Borehole Reference	Test reference	Depth (m)	Date	Instrument Reference	Groundwater level (mbgl)	Arms Analysed	M+R horizontal pressure (kPa)	In situ horizontal stress, Po (kPa)	Coefficient of lateral earth pressure, K_o based on in situ horizontal stress	Undrained strength		Initial modulus, Gi (MPa)	Loop ref	Shear modulus, Gur (MPa)	Strain amplitude, ec (%)	Non linear stiffness analysis		Remarks
										Limit pressure, pL (kPa)	Shear strength (loading), cu (kPa)					Stiffness exponent, β	Shear stress constant, α (MPa)	
BH103	B103T1	11.30	22-Aug-19	180126	0.00	Arm ave	NA	2200	18.5	40168	7839	NA	1	689	0.134	0.835	196.780	
													2	787	0.150	0.836	232.685	
													3	897	0.141	0.826	235.986	
BH103	B103T2	15.80	22-Aug-19	180126	0.00	Arm ave	NA	1200	6.6	46297	10148	NA	1	669	0.149	0.884	283.632	
													2	876	0.126	0.834	243.712	
													3	908	0.116	0.785	166.236	
BH103	B103T3	21.80	23-Aug-19	180126	0.00	Arm ave	NA	2000	8.2	46360	8820	NA	1	991	0.106	0.860	332.669	
													2	1234	0.105	0.833	326.064	
													3	1468	0.080	0.867	483.451	
BH103	B103T4	26.30	23-Aug-19	180126	0.00	Arm ave	NA	2250	7.6	47956	8618	NA	1	987	0.121	0.865	357.657	
													2	1450	0.086	0.803	284.278	
													3	1509	0.091	0.822	359.558	
BH103	B103T5	30.80	27-Aug-19	180126	0.00	Arm ave	NA	2200	6.1	41508	7118	NA	1	970	0.094	0.878	371.798	
													2	1438	0.102	0.828	352.820	
													3	1540	0.078	0.797	282.655	
BH103	B103T6	39.80	28-Aug-19	180126	0.00	Arm ave	NA	2300	4.8	49261	9227	NA	1	986	0.115	0.828	262.617	
													2	1418	0.087	0.885	572.358	
													3	1451	0.090	0.839	398.628	
BH109	B109T1	14.30	15-Aug-19	180126	0.00	Arm ave	NA	4400	29.8	31514	5086	NA	1	701	0.159	0.819	180.603	
													2	937	0.157	0.851	303.273	
BH109	B109T2	18.80	15-Aug-19	180126	0.00	Arm ave	NA	4400	22.4	41483	7314	NA	1	889	0.106	0.786	163.950	
													2	1169	0.109	0.820	276.534	
BH109	B109T3	24.70	16-Aug-19	180126	0.00	Arm ave	NA	4500	17.2	41606	7311	NA	1	975	0.105	0.829	258.422	
													2	1153	0.111	0.798	240.720	
													3	1151	0.114	0.814	272.748	

Notes: Reference should be made to Section 3 of the report for explanation of the methods of test interpretation and assessment of material parameters.

Project Crown Street, Manchester

Project No. M9019-19

Carried out for Geotechnics

Table 1-1

Summary of Pressuremeter Tests

SOCOTEC

Borehole Reference	Test reference	Depth (m)	Date	Instrument Reference	Groundwater level (mbgl)	Arms Analysed	M+R horizontal pressure (kPa)	In situ horizontal stress, Po (kPa)	Coefficient of lateral earth pressure, K_o based on in situ horizontal stress	Undrained strength: Limit pressure, pL (kPa)	Undrained strength: Shear strength (loading), cu (kPa)	Initial modulus, Gi (MPa)	Loop ref	Shear modulus, Gur (MPa)	Strain amplitude, ec (%)	Non linear stiffness analysis: Stiffness exponent, β	Non linear stiffness analysis: Shear stress constant, α (MPa)	Remarks
BH109	B109T4	29.10	19-Aug-19	180126	0.00	Arm ave	NA	3000	9.3	38707	7338	NA	1	770	0.144	0.873	293.947	
													2	973	0.108	0.789	181.391	
													3	1131	0.120	0.809	249.989	
BH109	B109T5	33.80	19-Aug-19	180126	0.00	Arm ave	NA	2300	5.8	43475	7489	NA	1	882	0.114	0.869	330.241	
													2	1453	0.087	0.807	298.037	
													3	1617	0.067	0.866	526.414	
BH109	B109T6	38.30	20-Aug-19	180126	0.00	Arm ave	NA	3000	6.8	45326	7906	NA	1	985	0.109	0.846	303.953	
													2	1302	0.086	0.827	329.405	
													3	1496	0.081	0.877	563.576	

Notes: Reference should be made to Section 3 of the report for explanation of the methods of test interpretation and assessment of material parameters.

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Table 1-2

Notes on Pressuremeter Test Results

SOCOTEC

KEY TO RESULTS

P_o	Pressure corresponding to regeneration of in situ strain.
p_c	Pressure measured at the cavity wall
c_u	Undrained shear strength.
p_L	Limit pressure.
G_i	Initial shear modulus.
G_{ur}	Shear modulus derived from unload-reload loop.
$\Delta\varepsilon_c$	Cavity strain range over which loop has been performed.
G_s	Shear modulus = $\alpha \gamma^{\beta-1}$ for non-linear stiffness model
γ	Shear strain
α	Shear stress constant = $\eta \beta$
η	Radial stress constant
β	Elastic exponent

NOTES ON RESULTS

1. Summary results are presented for the pressuremeter tests carried out at this site as Table 1. Full details of the tests and analysis are presented in Appendix B. Where appropriate, the summary results presented here are based on a graphical average of all three strain axes of the pressuremeter. Use of average readings for strain arms reduces the influence of movement of the pressuremeter relative to the test pocket and may therefore be considered to be a more reliable result. Reference should be made to graphical data and test notes to assess the reliability of individual results.

2. The material type quoted is the presumed geological horizon. Reference should be made to borehole records for a full description.

3. Groundwater level was measured in the borehole at the start of shift by the lead driller before testing commenced. This is noted on the test plots and in Table 1.

4. The depth quoted for the test is the depth of the centre of the expanding section of the pressuremeter, corresponding to the location of the strain arms.

5. The test references used are the references assigned by the logging and analysis software. These take the form of BxxTyy, where xx is a two digit abbreviation of the borehole number and yy is a two digit test number, sequential for each borehole.

6. For prebored pressuremeter tests where there is insufficient yield to apply the modified Marsland and Randolph method, the strain origin (zero cavity strain) is assessed from projection of the initial linear elastic phase during loading back to zero pressure.

7. A pressuremeter test fails the ground in shear and all moduli quoted are shear moduli. Unload-reload loops are performed in tests to provide an estimate of unload-reload shear modulus (G_{ur}). The actual value of G_{ur} is dependant on the magnitude and range of stress and cavity strain.

8. It is normal practice to carry out two or more unload-reload loops during a test. Results from these individual loops are presented consecutively (ie G_{ur} for loop 1 is presented above G_{ur} for loop 2). The cavity strain range ($\Delta\varepsilon_c$) over which the loop has been performed is presented alongside the relevant G_{ur} value.

9. Linear stiffness/strain response

Linear elastic response can be used to derive the shear modulus. A best fit line is orientated by visual inspection of the data to bisect the extents of the loop. The slope of this line is approximately twice the shear modulus. The equation for this is as follows:

$$G = [1+\varepsilon_c][\Delta p_c/2\Delta \varepsilon_c]$$

When irregular shaped loops are observed the best fit line is applied to; either the most linear section of a curved loop; or the reloading points when a loop is open. The slope of this can then be used to assess shear modulus.

Due to the finite stiffness of the equipment and the potential inaccuracies associated with the methods used to assess the compression of the instrument membrane, the manufacturer advises that it is not possible to accurately measure shear moduli in excess of about 20,000 MPa and in such circumstances the apparent accuracy of the values reported should be regarded with caution.

Shear modulus (G) and Young's Modulus (E) are theoretically related by:

$$E = 2G(1+ \nu)$$

where ν is Poisson's Ratio

9. Non-linear stiffness/strain response

The Windle and Wroth (1977) interpretation is used to derive a value of shear modulus from the whole of an unload-reload loop; this values is quoted along with the corresponding change in strain during the loop. However, the elastic response of a soil is known to be non-linear and measurements of stiffness are therefore dependent on the magnitude of the corresponding strain. The Bolton and Whittle (1999) analysis extends the interpretation to give a comprehensive description of this non-linear relationship by looking at smaller increments of pressure and strain other than the points at the extreme ends of the loop. The shear modulus can be determined for the individual data points on the reloading part of the unload-reload loop from the increments of pressure and strain relative to an origin which is taken as the minimum values of stress and strain for the loop.

According to Bolton & Whittle (1999) the variation of stiffness (shear modulus, G_s) with strain (cavity strain, γ_c) seen during reloading in an unload-reload loop can be expressed as a power law, $G_s = \alpha \gamma_c^{\beta-1}$. The theory indicates a linear relationship between the log of radial stress and the log of shear strain, defined by a line with gradient β (the elastic exponent) and intercept η (radial stress constant). The shear stress constant α is equal to $\eta\beta$. These values are reported on the test summary sheets.

10. Tests terminated by membrane rupture before the full testing cycle could be completed have been identified as such on the individual test summary.

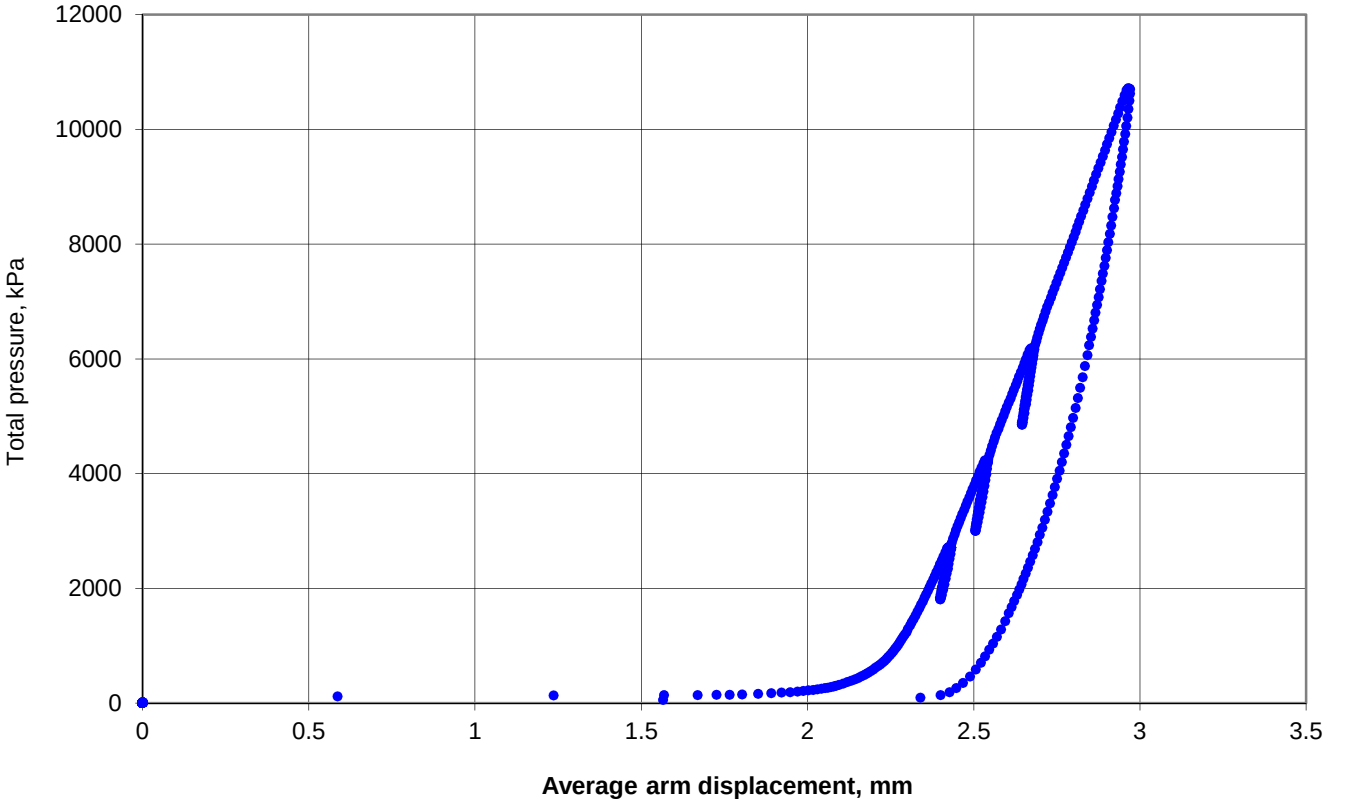
Pressuremeter Test

SOCOTEC

Date	22-Aug-19
Probe	HPD-95 180126
Material	Sandstone

Test reference	B103T1
GWL (mbgl)	0.00
Test pocket (mbgl)	10.50-12.00

BH	BH103
Test	1
Depth, m	11.30



In situ horizontal stress (Average arm)

$P_{o\ BE}$ (kPa)	2200	$P_{o\ LO}$ (kPa)	NA	$P_{o\ MR}$ (kPa)	NA
$P_{o\ curve\ modelling}$ (kPa)	NA			$P_{o\ drained}$ (kPa)	NA

Shear strength (Average arm)

$c_{u\ loading}$ (kPa)	7839	$c_{u\ unloading}$ (kPa)	2209	p_L (kPa)	40168
ϕ_{cv} (deg)	NA	ϕ (deg)	NA	ν (deg)	NA

Initial shear modulus (Average arm)

G_i (MPa)	360

Unload-reload loop shear modulus (Average arm)

Loop ref	G_{ur} (MPa)	ε_c (%)	Non linear stiffness interpretation				Remarks
			Undrained		Drained		
			β	α (MPa)	Gradient	Intercept, MPa	
1	689	0.134	0.835	196.8	NA	NA	(See below)
2	787	0.150	0.836	232.7	NA	NA	
3	897	0.141	0.826	236.0	NA	NA	

Remarks

Max test pressure = 10716 kPa. Max av displ = 2.97 mm. Max arm displ = 3.52 mm (Arm4). No of loops = 3 . Analysis type: Average arm.

Notes:

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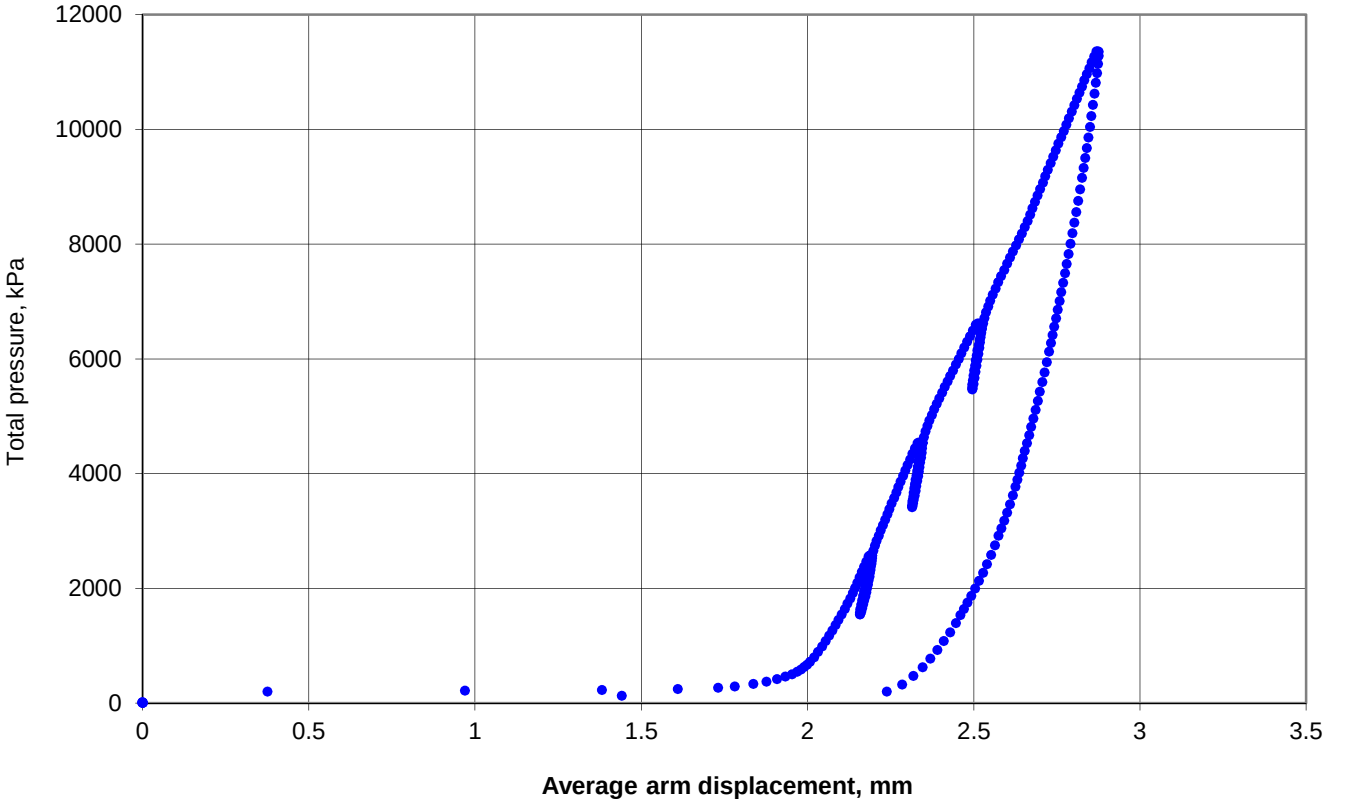
Figure
BH103 T1

Pressuremeter Test

Date	22-Aug-19
Probe	HPD-95 180126
Material	Sandstone

Test reference	B103T2
GWL (mbgl)	0.00
Test pocket (mbgl)	15.00-16.50

BH	BH103
Test	2
Depth, m	15.80



In situ horizontal stress (Average arm)

$P_{o\ BE}$ (kPa)	1200	$P_{o\ LO}$ (kPa)	NA	$P_{o\ MR}$ (kPa)	NA
$P_{o\ curve\ modelling}$ (kPa)	NA			$P_{o\ drained}$ (kPa)	NA

Shear strength (Average arm)

$c_{u\ loading}$ (kPa)	10148	$c_{u\ unloading}$ (kPa)	2243	p_L (kPa)	46297
ϕ_{cv} (deg)	NA	ϕ (deg)	NA	ν (deg)	NA

Initial shear modulus (Average arm)

G_i (MPa)	NA

Unload-reload loop shear modulus (Average arm)

Loop ref	G_{ur} (MPa)	ε_c (%)	Non linear stiffness interpretation				Remarks
			Undrained		Drained		
			β	α (MPa)	Gradient	Intercept, MPa	
1	669	0.149	0.884	283.6	NA	NA	(See below)
2	876	0.126	0.834	243.7	NA	NA	
3	908	0.116	0.785	166.2	NA	NA	

Remarks

Max test pressure = 11360 kPa. Max av displ = 2.88 mm. Max arm displ = 3.77 mm (Arm5). No of loops = 3 . Analysis type: Average arm.

Notes:

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Figure
BH103 T2

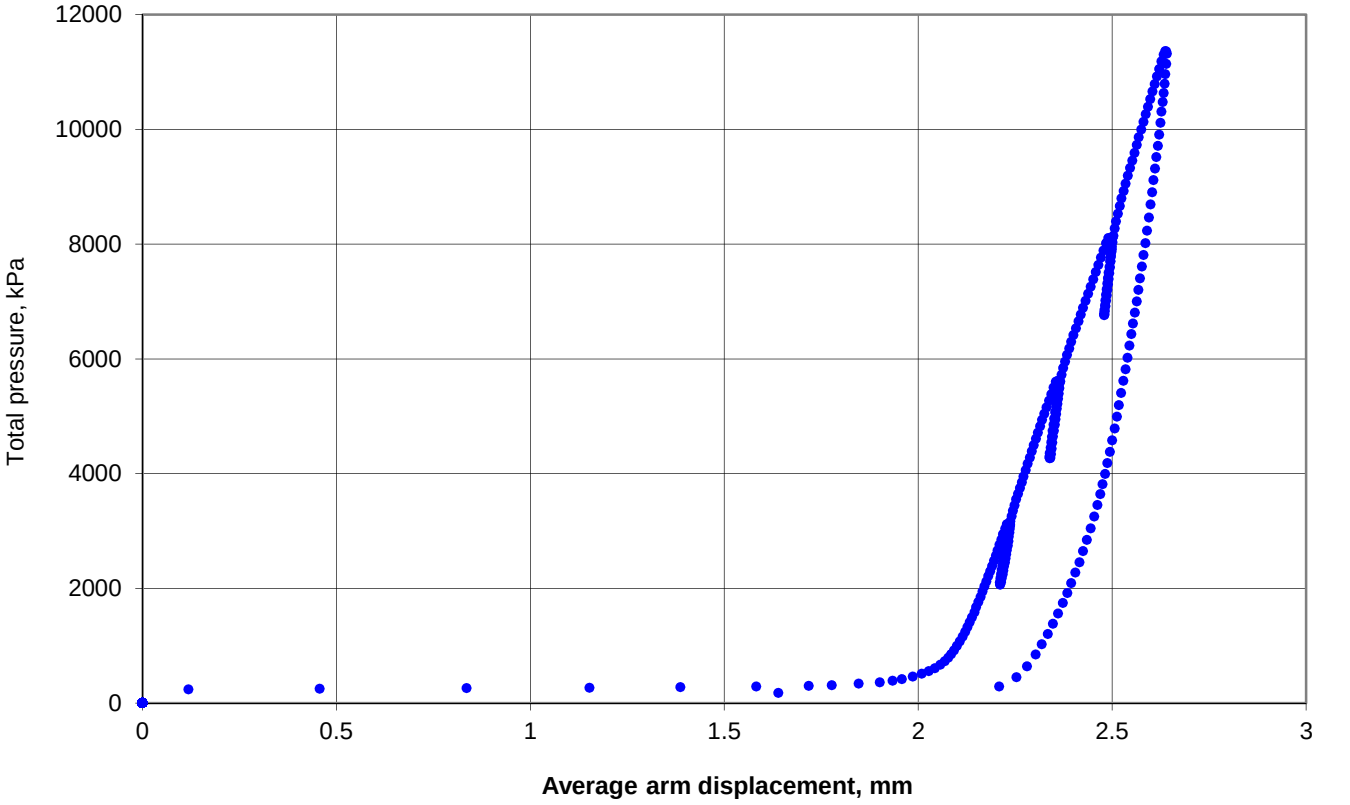
Pressuremeter Test

SOCOTEC

Date	23-Aug-19
Probe	HPD-95 180126
Material	Sandstone

Test reference	B103T3
GWL (mbgl)	0.00
Test pocket (mbgl)	21.00-22.50

BH	BH103
Test	3
Depth, m	21.80



In situ horizontal stress (Average arm)

$P_{o\ BE}$ (kPa)	2000	$P_{o\ LO}$ (kPa)	NA	$P_{o\ MR}$ (kPa)	NA
$P_{o\ curve\ modelling}$ (kPa)	NA			$P_{o\ drained}$ (kPa)	NA

Shear strength (Average arm)

$c_{u\ loading}$ (kPa)	8820	$c_{u\ unloading}$ (kPa)	2144	p_L (kPa)	46360
ϕ_{cv} (deg)	NA	ϕ (deg)	NA	ν (deg)	NA

Initial shear modulus (Average arm)

G_i (MPa)	NA

Unload-reload loop shear modulus (Average arm)

Loop ref	G_{ur} (MPa)	ε_c (%)	Non linear stiffness interpretation				Remarks
			Undrained		Drained		
			β	α (MPa)	Gradient	Intercept, MPa	
1	991	0.106	0.860	332.7	NA	NA	(See below)
2	1234	0.105	0.833	326.1	NA	NA	
3	1468	0.080	0.867	483.5	NA	NA	

Remarks

Max test pressure = 11364 kPa. Max av displ = 2.64 mm. Max arm displ = 3.4 mm (Arm5). No of loops = 3 . Analysis type: Average arm.

Notes:

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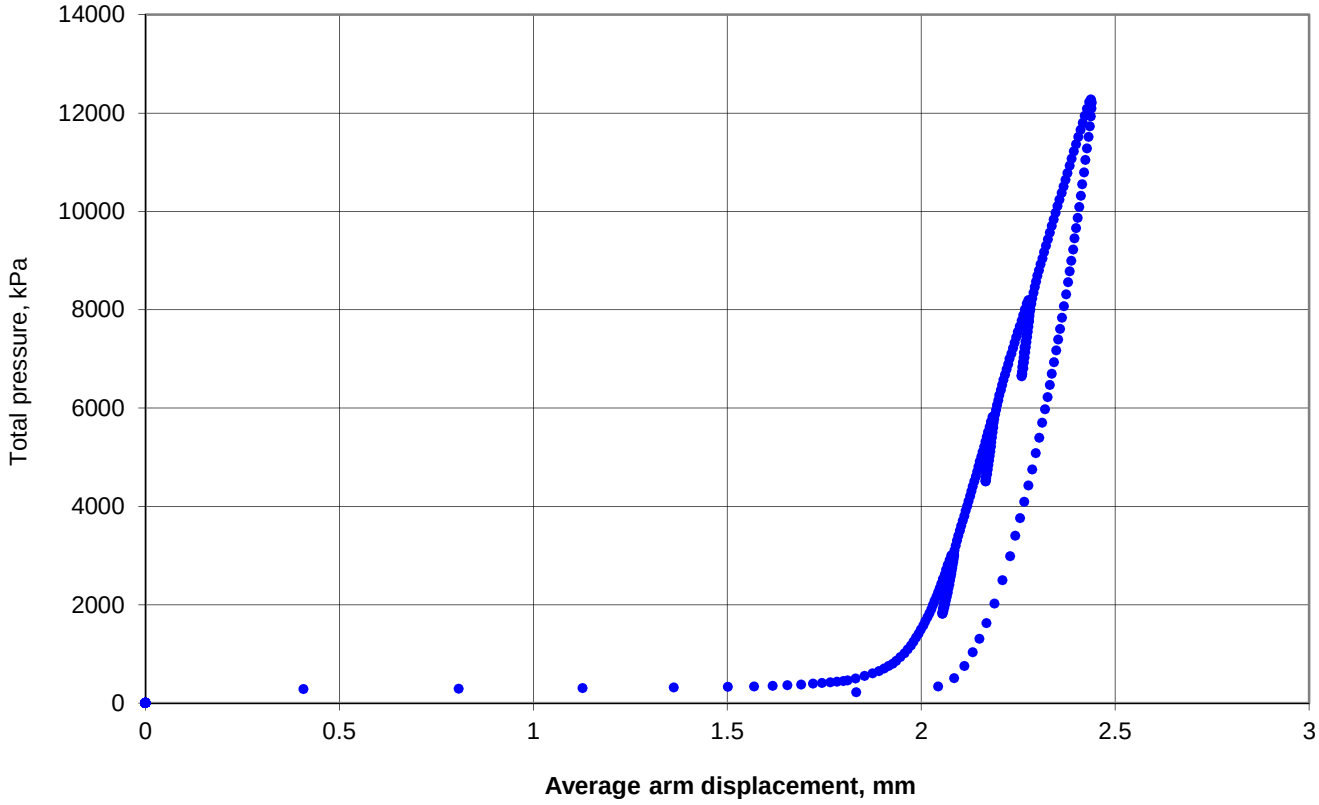
Figure
BH103 T3

Pressuremeter Test

Date	23-Aug-19
Probe	HPD-95 180126
Material	Sandstone

Test reference	B103T4
GWL (mbgl)	0.00
Test pocket (mbgl)	25.50-27.00

BH	BH103
Test	4
Depth, m	26.30



In situ horizontal stress (Average arm)

$P_{o\ BE}$ (kPa)	2250	$P_{o\ LO}$ (kPa)	NA	$P_{o\ MR}$ (kPa)	NA
$P_{o\ curve\ modelling}$ (kPa)	NA			$P_{o\ drained}$ (kPa)	NA

Shear strength (Average arm)

$c_{u\ loading}$ (kPa)	8618	$c_{u\ unloading}$ (kPa)	2626	p_L (kPa)	47956
ϕ_{cv} (deg)	NA	ϕ (deg)	NA	ν (deg)	NA

Initial shear modulus (Average arm)

G_i (MPa)	NA

Unload-reload loop shear modulus (Average arm)

Loop ref	G_{ur} (MPa)	ε_c (%)	Non linear stiffness interpretation				Remarks
			Undrained		Drained		
			β	α (MPa)	Gradient	Intercept, MPa	
1	987	0.121	0.865	357.7	NA	NA	(See below)
2	1450	0.086	0.803	284.3	NA	NA	
3	1509	0.091	0.822	359.6	NA	NA	

Remarks

Max test pressure = 12273 kPa. Max av displ = 2.44 mm. Max arm displ = 3.5 mm (Arm5). No of loops = 3 . Analysis type: Average arm.

Notes:

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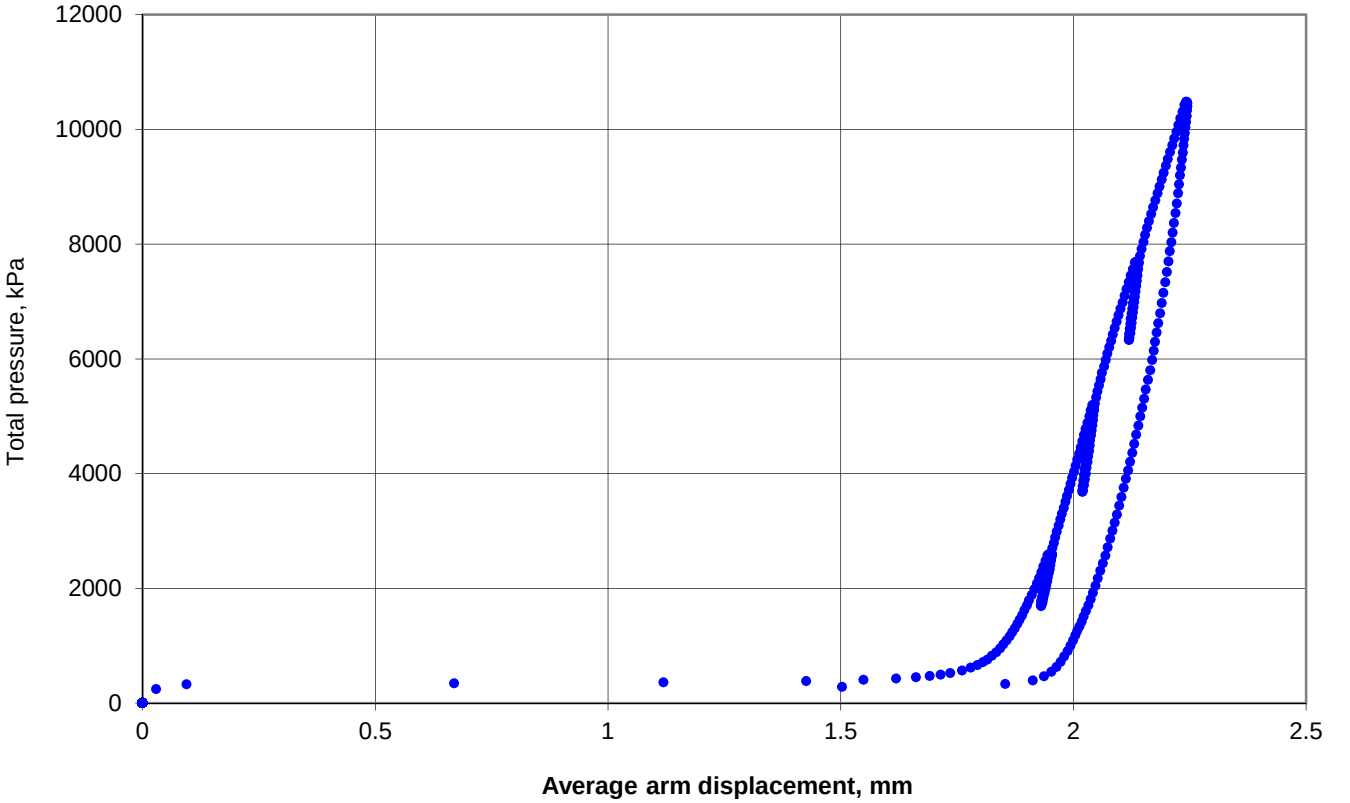
Figure
BH103 T4

Pressuremeter Test

Date	27-Aug-19
Probe	HPD-95 180126
Material	Sandstone

Test reference	B103T5
GWL (mbgl)	0.00
Test pocket (mbgl)	30.00-31.50

BH	BH103
Test	5
Depth, m	30.80



In situ horizontal stress (Average arm)

$P_{o\ BE}$ (kPa)	2200	$P_{o\ LO}$ (kPa)	NA	$P_{o\ MR}$ (kPa)	NA
$P_{o\ curve\ modelling}$ (kPa)	NA			$P_{o\ drained}$ (kPa)	NA

Shear strength (Average arm)

$c_{u\ loading}$ (kPa)	7118	$c_{u\ unloading}$ (kPa)	2170	p_L (kPa)	41508
ϕ_{cv} (deg)	NA	ϕ (deg)	NA	ν (deg)	NA

Initial shear modulus (Average arm)

G_i (MPa)	NA

Unload-reload loop shear modulus (Average arm)

Loop ref	G_{ur} (MPa)	ε_c (%)	Non linear stiffness interpretation				Remarks
			Undrained		Drained		
			β	α (MPa)	Gradient	Intercept, MPa	
1	970	0.094	0.878	371.8	NA	NA	(See below)
2	1438	0.102	0.828	352.8	NA	NA	
3	1540	0.078	0.797	282.7	NA	NA	

Remarks

Max test pressure = 10484 kPa. Max av displ = 2.24 mm. Max arm displ = 3.39 mm (Arm5). No of loops = 3 . Analysis type: Average arm.

Notes:

Project Crown Street, Manchester
Project No. M9019-19
Carried out for Geotechnics

Figure
BH103 T5

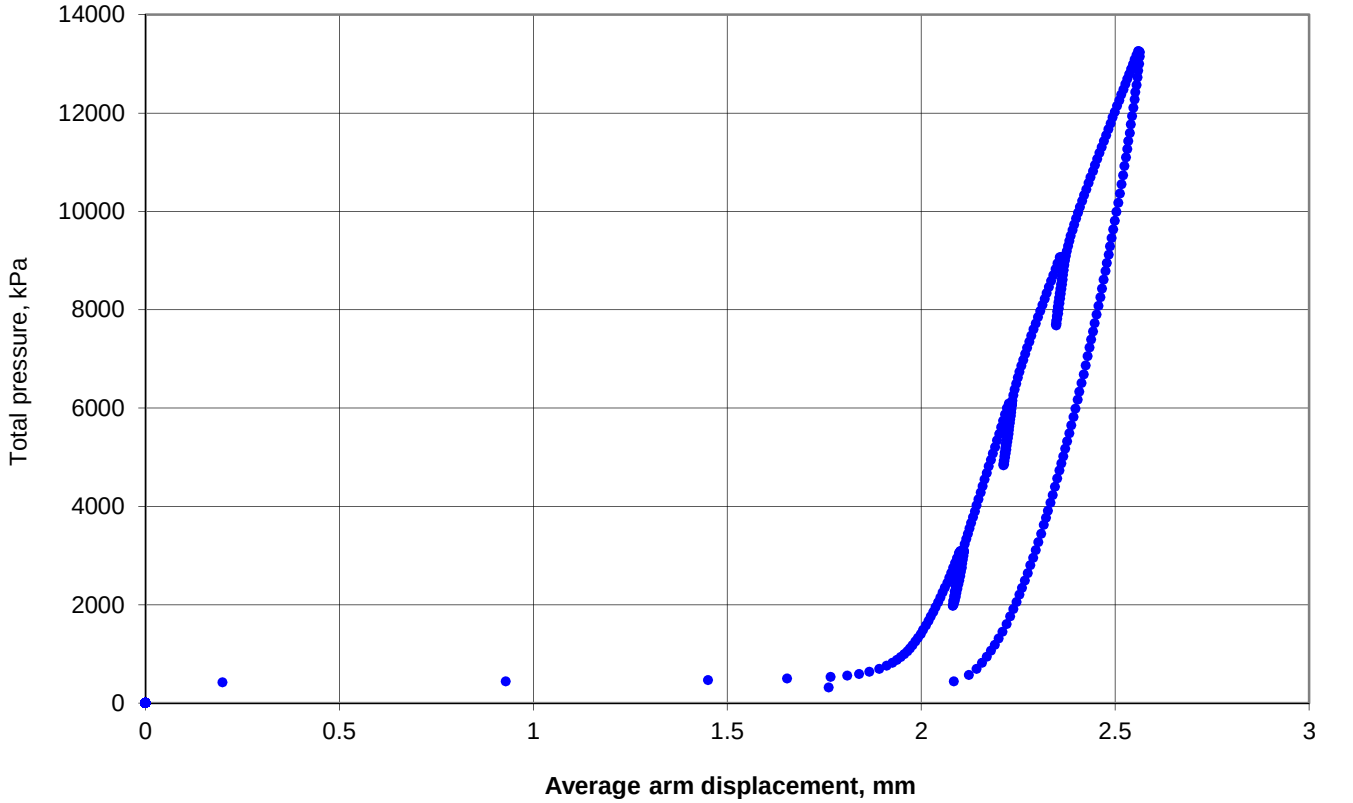
Pressuremeter Test

SOCOTEC

Date	28-Aug-19
Probe	HPD-95 180126
Material	Sandstone

Test reference	B103T6
GWL (mbgl)	0.00
Test pocket (mbgl)	39.00-40.50

BH	BH103
Test	6
Depth, m	39.80



In situ horizontal stress (Average arm)

$P_{o\ BE}$ (kPa)	2300	$P_{o\ LO}$ (kPa)	NA	$P_{o\ MR}$ (kPa)	NA
$P_{o\ curve\ modelling}$ (kPa)	NA			$P_{o\ drained}$ (kPa)	NA

Shear strength (Average arm)

$c_{u\ loading}$ (kPa)	9227	$c_{u\ unloading}$ (kPa)	2979	p_L (kPa)	49261
ϕ_{cv} (deg)	NA	ϕ (deg)	NA	ν (deg)	NA

Initial shear modulus (Average arm)

G_i (MPa)	NA

Unload-reload loop shear modulus (Average arm)

Loop ref	G_{ur} (MPa)	ε_c (%)	Non linear stiffness interpretation				Remarks
			Undrained		Drained		
			β	α (MPa)	Gradient	Intercept, MPa	
1	986	0.115	0.828	262.6	NA	NA	(See below)
2	1418	0.087	0.885	572.4	NA	NA	
3	1451	0.090	0.839	398.6	NA	NA	

Remarks

Max test pressure = 13256 kPa. Max av displ = 2.56 mm. Max arm displ = 3.51 mm (Arm5). No of loops = 3 . Analysis type: Average arm.

Notes:

Project	Crown Street, Manchester
Project No.	M9019-19
Carried out for	Geotechnics

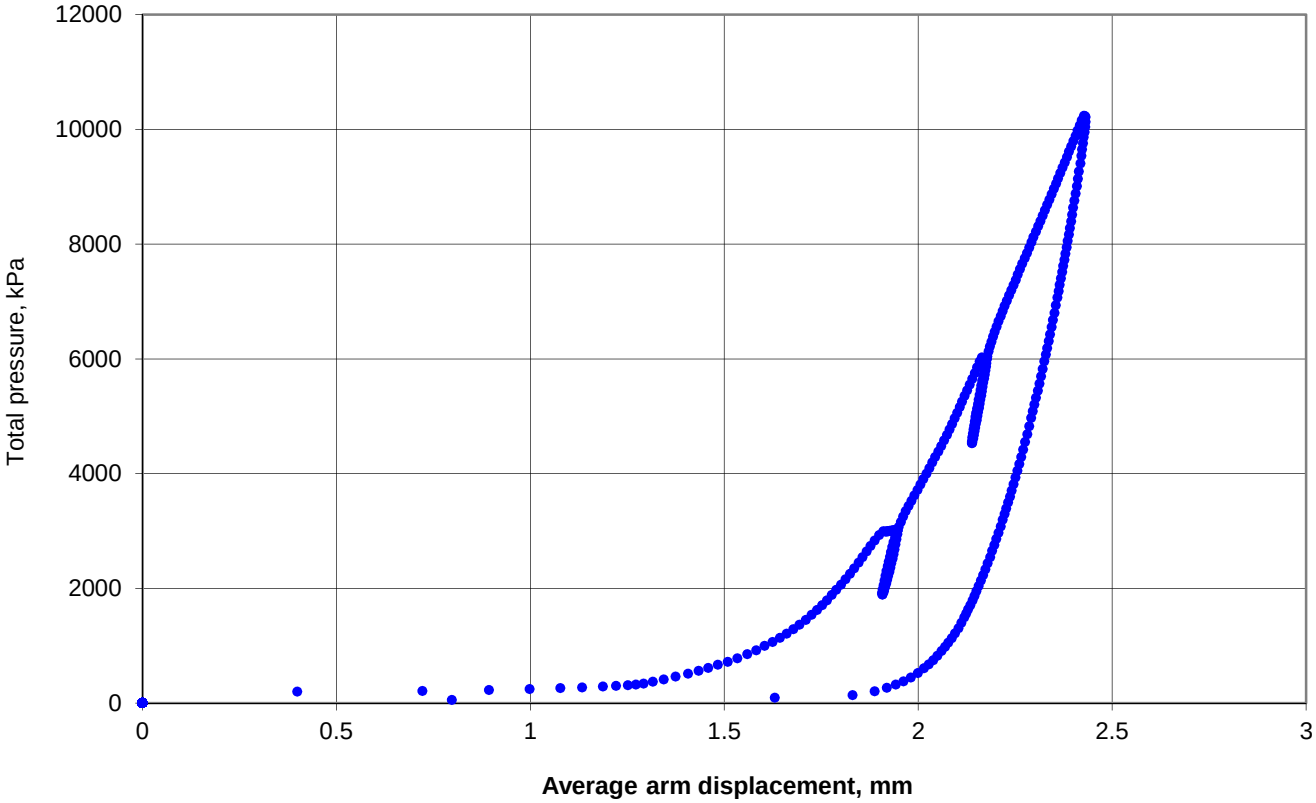
Figure
BH103 T6

Pressuremeter Test

Date	15-Aug-19
Probe	HPD-95 180126
Material	Sandstone

Test reference	B109T1
GWL (mbgl)	0.00
Test pocket (mbgl)	13.50-15.00

BH	BH109
Test	1
Depth, m	14.30



In situ horizontal stress (Average arm)

$P_{o\ BE}$ (kPa)	4400	$P_{o\ LO}$ (kPa)	NA	$P_{o\ MR}$ (kPa)	NA
$P_{o\ curve\ modelling}$ (kPa)	NA			$P_{o\ drained}$ (kPa)	NA

Shear strength (Average arm)

$c_{u\ loading}$ (kPa)	5086	$c_{u\ unloading}$ (kPa)	2140	p_L (kPa)	31514
ϕ_{cv} (deg)	NA	ϕ (deg)	NA	ν (deg)	NA

Initial shear modulus (Average arm)

G_i (MPa)	NA

Unload-reload loop shear modulus (Average arm)

Loop ref	G_{ur} (MPa)	ε_c (%)	Non linear stiffness interpretation				Remarks
			Undrained		Drained		
			β	α (MPa)	Gradient	Intercept, MPa	
1	701	0.159	0.819	180.6	NA	NA	(See below)
2	937	0.157	0.851	303.3	NA	NA	

Remarks

Max test pressure = 10234 kPa. Max av displ = 2.43 mm. Max arm displ = 2.88 mm (Arm4). No of loops = 2 . Analysis type: Average arm.

Notes:

Project Crown Street, Manchester
Project No. M9019-19
Carried out for Geotechnics

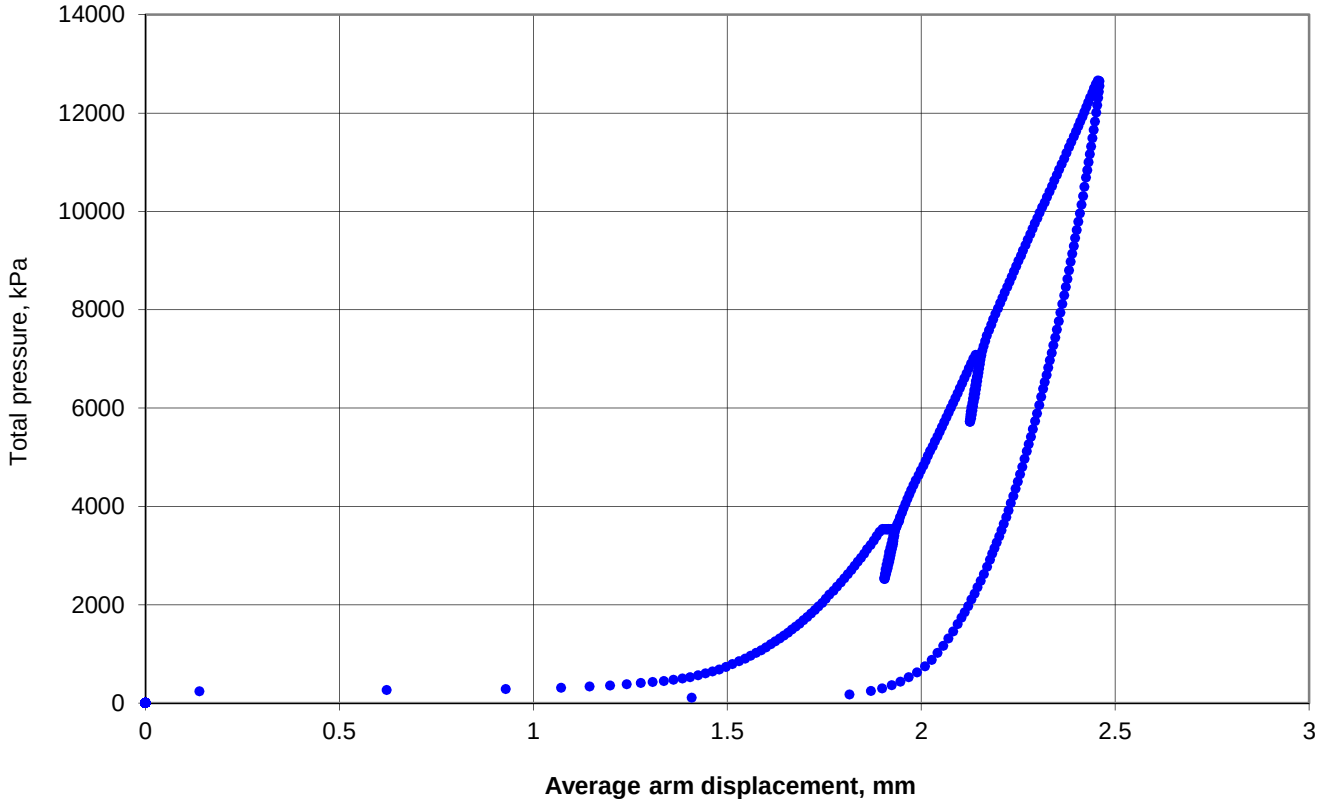
Figure
BH109 T1

Pressuremeter Test

Date	15-Aug-19
Probe	HPD-95 180126
Material	Sandstone

Test reference	B109T2
GWL (mbgl)	0.00
Test pocket (mbgl)	18.00-19.50

BH	BH109
Test	2
Depth, m	18.80



In situ horizontal stress (Average arm)

$P_{o\ BE}$ (kPa)	4400	$P_{o\ LO}$ (kPa)	NA	$P_{o\ MR}$ (kPa)	NA
$P_{o\ curve\ modelling}$ (kPa)	NA			$P_{o\ drained}$ (kPa)	NA

Shear strength (Average arm)

$c_{u\ loading}$ (kPa)	7314	$c_{u\ unloading}$ (kPa)	2527	p_L (kPa)	41483
ϕ_{cv} (deg)	NA	ϕ (deg)	NA	ν (deg)	NA

Initial shear modulus (Average arm)

G_i (MPa)	NA

Unload-reload loop shear modulus (Average arm)

Loop ref	G_{ur} (MPa)	ε_c (%)	Non linear stiffness interpretation				Remarks
			Undrained		Drained		
			β	α (MPa)	Gradient	Intercept, MPa	
1	889	0.106	0.786	164.0	NA	NA	(See below)
2	1169	0.109	0.820	276.5	NA	NA	

Remarks

Max test pressure = 12656 kPa. Max av displ = 2.46 mm. Max arm displ = 3.16 mm (Arm4). No of loops = 2 . Analysis type: Average arm.

Notes:

Project	Crown Street, Manchester
Project No.	M9019-19
Carried out for	Geotechnics

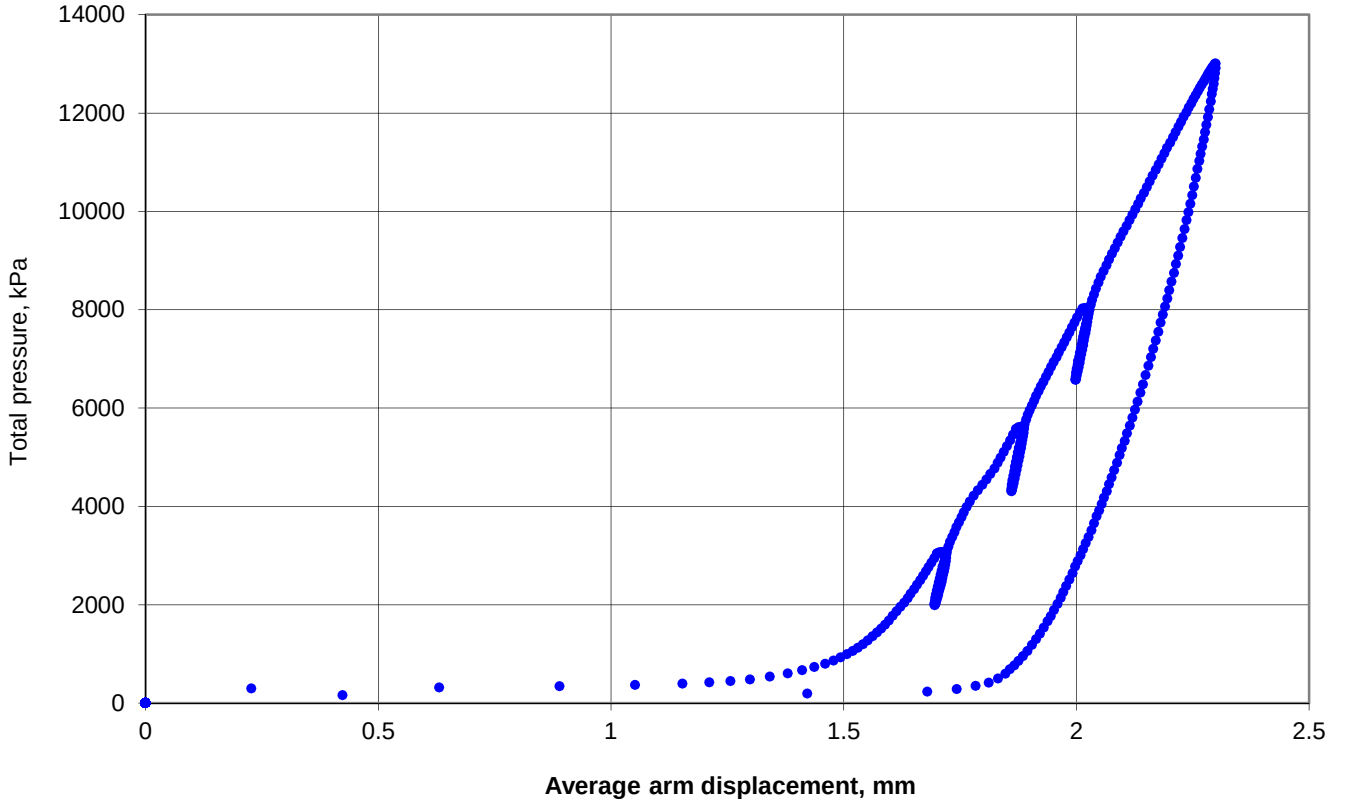
Figure
BH109 T2

Pressuremeter Test

Date	16-Aug-19
Probe	HPD-95 180126
Material	Sandstone

Test reference	B109T3
GWL (mbgl)	0.00
Test pocket (mbgl)	24.00-25.50

BH	BH109
Test	3
Depth, m	24.70



In situ horizontal stress (Average arm)

$P_{o\ BE}$ (kPa)	4500	$P_{o\ LO}$ (kPa)	NA	$P_{o\ MR}$ (kPa)	NA
$P_{o\ curve\ modelling}$ (kPa)	NA			$P_{o\ drained}$ (kPa)	NA

Shear strength (Average arm)

$c_{u\ loading}$ (kPa)	7311	$c_{u\ unloading}$ (kPa)	2978	p_L (kPa)	41606
ϕ_{cv} (deg)	NA	ϕ (deg)	NA	ν (deg)	NA

Initial shear modulus (Average arm)

G_i (MPa)	NA

Unload-reload loop shear modulus (Average arm)

Loop ref	G_{ur} (MPa)	ε_c (%)	Non linear stiffness interpretation				Remarks
			Undrained		Drained		
			β	α (MPa)	Gradient	Intercept, MPa	
1	975	0.105	0.829	258.4	NA	NA	(See below)
2	1153	0.111	0.798	240.7	NA	NA	
3	1151	0.114	0.814	272.7	NA	NA	

Remarks

Max test pressure = 13002 kPa. Max av displ = 2.3 mm. Max arm displ = 2.96 mm (Arm5). No of loops = 3 . Analysis type: Average arm.

Notes:

Project	Crown Street, Manchester
Project No.	M9019-19
Carried out for	Geotechnics

Figure
BH109 T3

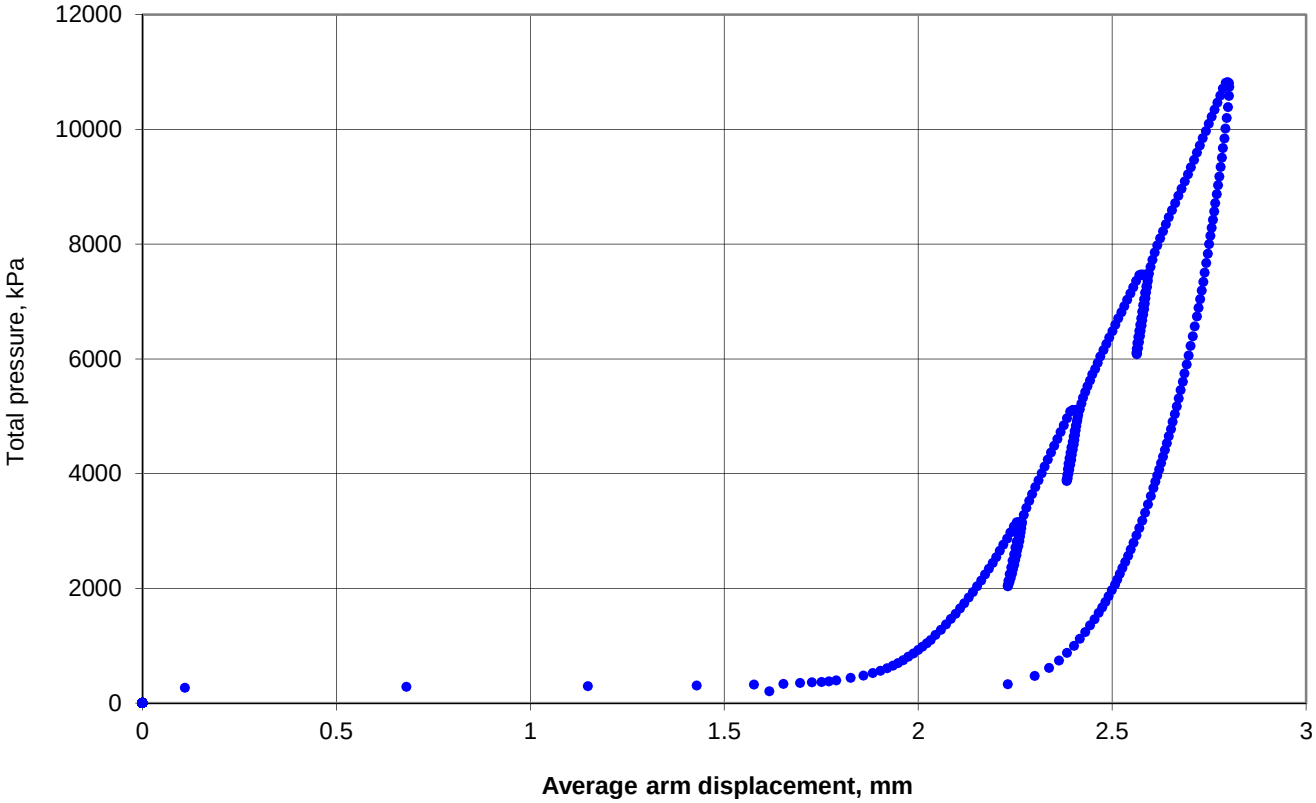
Pressuremeter Test

SOCOTEC

Date	19-Aug-19
Probe	HPD-95 180126
Material	Sandstone

Test reference	B109T4
GWL (mbgl)	0.00
Test pocket (mbgl)	28.50-30.00

BH	BH109
Test	4
Depth, m	29.10



In situ horizontal stress (Average arm)

$P_{o\ BE}$ (kPa)	3000	$P_{o\ LO}$ (kPa)	NA	$P_{o\ MR}$ (kPa)	NA
$P_{o\ curve\ modelling}$ (kPa)	NA			$P_{o\ drained}$ (kPa)	NA

Shear strength (Average arm)

$c_{u\ loading}$ (kPa)	7338	$c_{u\ unloading}$ (kPa)	1945	p_L (kPa)	38707
ϕ_{cv} (deg)	NA	ϕ (deg)	NA	ν (deg)	NA

Initial shear modulus (Average arm)

G_i (MPa)	NA

Unload-reload loop shear modulus (Average arm)

Loop ref	G_{ur} (MPa)	ε_c (%)	Non linear stiffness interpretation				Remarks
			Undrained		Drained		
			β	α (MPa)	Gradient	Intercept, MPa	
1	770	0.144	0.873	293.9	NA	NA	(See below)
2	973	0.108	0.789	181.4	NA	NA	
3	1131	0.120	0.809	250.0	NA	NA	

Remarks

Max test pressure = 10823 kPa. Max av displ = 2.8 mm. Max arm displ = 3.6 mm (Arm5). No of loops = 3 . Analysis type: Average arm.

Notes:

Project Crown Street, Manchester
Project No. M9019-19
Carried out for Geotechnics

Figure
BH109 T4

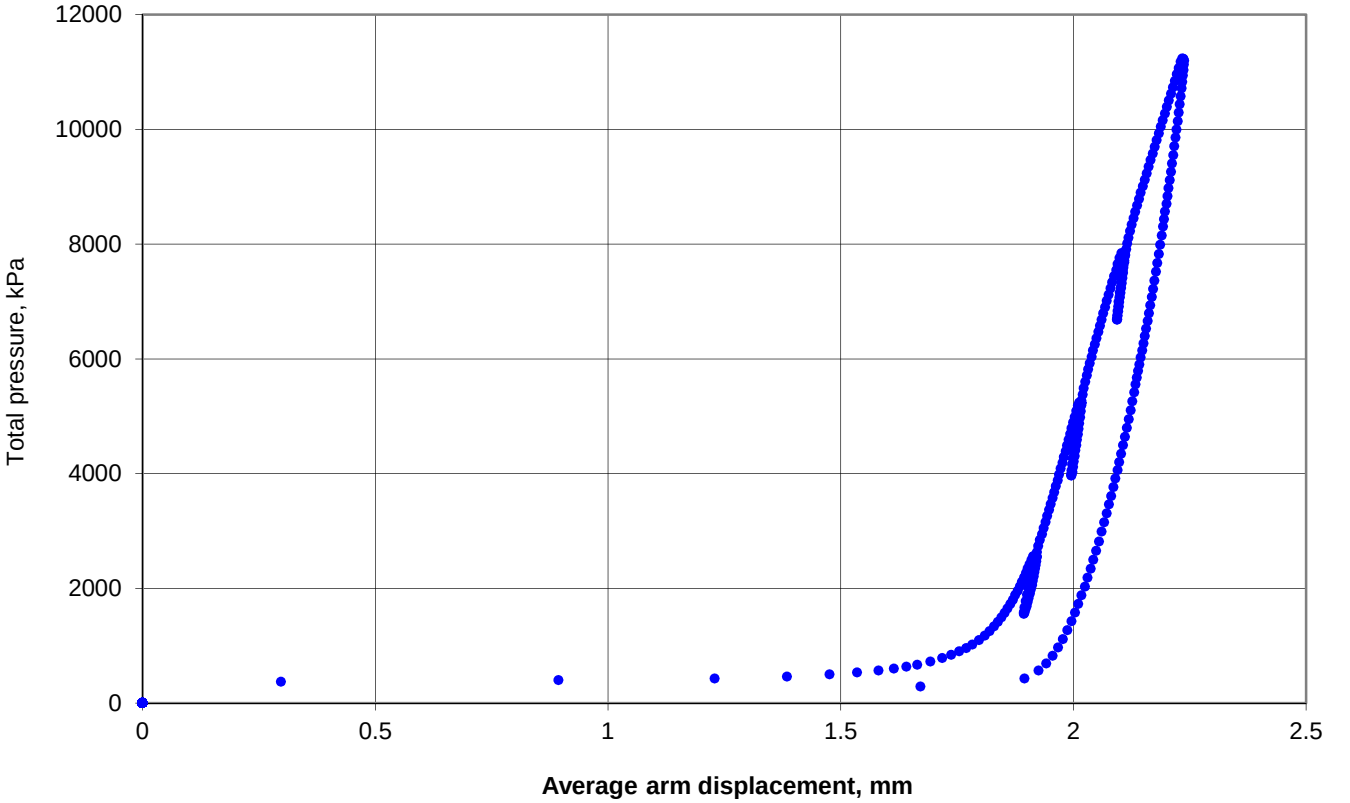
Pressuremeter Test

SOCOTEC

Date	19-Aug-19
Probe	HPD-95 180126
Material	Sandstone

Test reference	B109T5
GWL (mbgl)	0.00
Test pocket (mbgl)	33.00-34.50

BH	BH109
Test	5
Depth, m	33.80



In situ horizontal stress (Average arm)

$P_{o\ BE}$ (kPa)	2300	$P_{o\ LO}$ (kPa)	NA	$P_{o\ MR}$ (kPa)	NA
$P_{o\ curve\ modelling}$ (kPa)	NA			$P_{o\ drained}$ (kPa)	NA

Shear strength (Average arm)

$c_{u\ loading}$ (kPa)	7489	$c_{u\ unloading}$ (kPa)	2485	p_L (kPa)	43475
ϕ_{cv} (deg)	NA	ϕ (deg)	NA	ν (deg)	NA

Initial shear modulus (Average arm)

G_i (MPa)	NA

Unload-reload loop shear modulus (Average arm)

Loop ref	G_{ur} (MPa)	ε_c (%)	Non linear stiffness interpretation				Remarks
			Undrained		Drained		
			β	α (MPa)	Gradient	Intercept, MPa	
1	882	0.114	0.869	330.2	NA	NA	(See below)
2	1453	0.087	0.807	298.0	NA	NA	
3	1617	0.067	0.866	526.4	NA	NA	

Remarks

Max test pressure = 11235 kPa. Max av displ = 2.24 mm. Max arm displ = 3.11 mm (Arm5). No of loops = 3 . Analysis type: Average arm.

Notes:

Project Crown Street, Manchester
Project No. M9019-19
Carried out for Geotechnics

Figure
BH109 T5

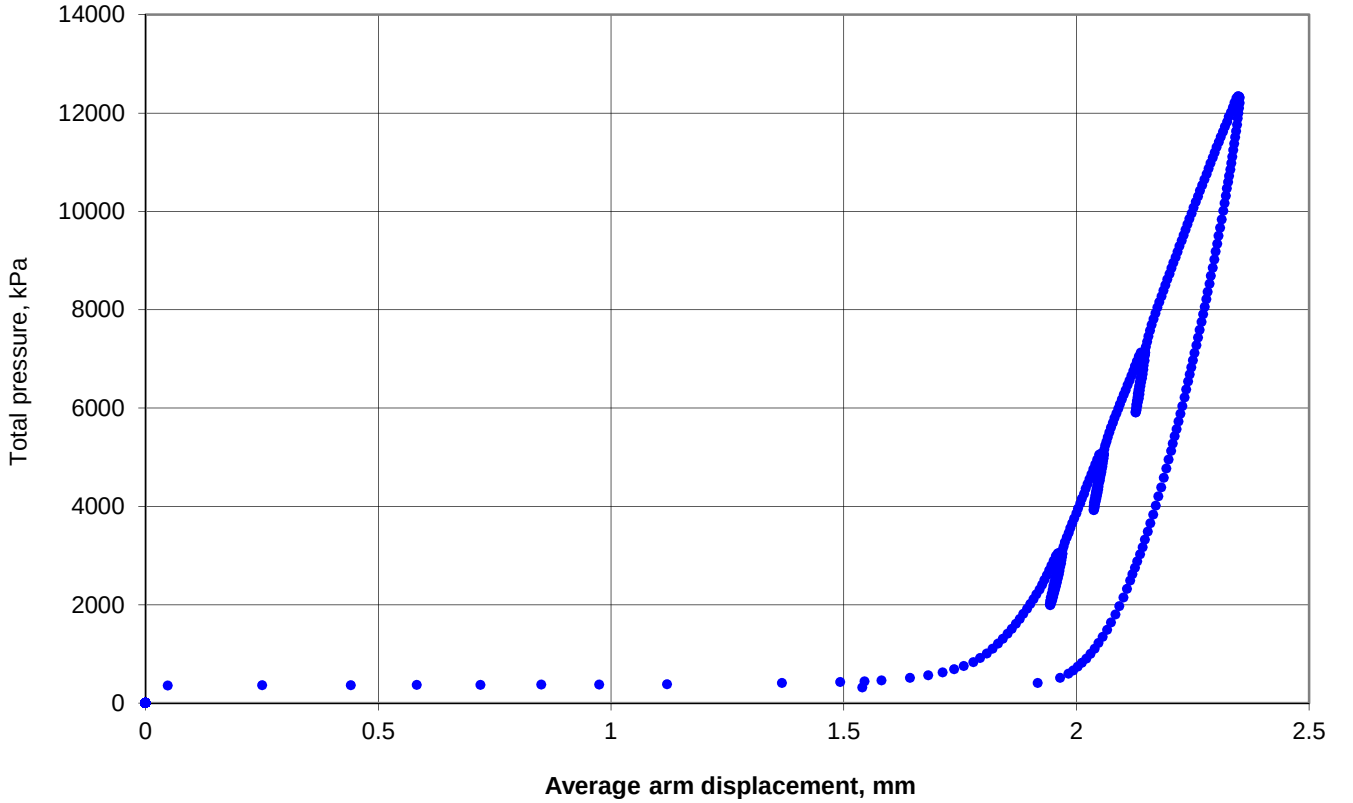
Pressuremeter Test

SOCOTEC

Date	20-Aug-19
Probe	HPD-95 180126
Material	Sandstone

Test reference	B109T6
GWL (mbgl)	0.00
Test pocket (mbgl)	37.50-39.00

BH	BH109
Test	6
Depth, m	38.30



In situ horizontal stress (Average arm)

$P_{o\ BE}$ (kPa)	3000	$P_{o\ LO}$ (kPa)	NA	$P_{o\ MR}$ (kPa)	NA
$P_{o\ curve\ modelling}$ (kPa)	NA			$P_{o\ drained}$ (kPa)	NA

Shear strength (Average arm)

$c_{u\ loading}$ (kPa)	7906	$c_{u\ unloading}$ (kPa)	2664	p_L (kPa)	45326
ϕ_{cv} (deg)	NA	ϕ (deg)	NA	ν (deg)	NA

Initial shear modulus (Average arm)

G_i (MPa)	NA

Unload-reload loop shear modulus (Average arm)

Loop ref	G_{ur} (MPa)	ε_c (%)	Non linear stiffness interpretation				Remarks
			Undrained		Drained		
			β	α (MPa)	Gradient	Intercept, MPa	
1	985	0.109	0.846	304.0	NA	NA	(See below)
2	1302	0.086	0.827	329.4	NA	NA	
3	1496	0.081	0.877	563.6	NA	NA	

Remarks

Max test pressure = 12341 kPa. Max av displ = 2.35 mm. Max arm displ = 3.18 mm (Arm5). No of loops = 3 . Analysis type: Average arm.

Notes:

Project	Crown Street, Manchester
Project No.	M9019-19
Carried out for	Geotechnics

Figure

BH109 T6

APPENDIX A
CALIBRATION REGISTER

DRAFT

High Pressure Dilatometer	HPD-95 180126

Pressuremeter Calibration Register

SOCOTEC

Instrument :	Digital High Pressure Dilatometer 95	Serial No.	180126

	Arm calibrations (mV / mm)						Pressure cell calibrations (mV / MPa)			
Date	Arm 1	Arm 2	Arm 3	Arm 4	Arm 5	Arm 6	TPC A	TPC B		Cable (m)
09-Jul-18	139.6	130.1	139.2	130.6	132.5	139.3	-	-		
30-Jul-18	-	-	-	-	-	-	108.8	110.0	new cells	
21-Aug-18	138.8	131.9	138.3	134.6	134.1	138.8	-	-		
23-Aug-18	-	-	-	-	-	-	108.3	109.3		
18-Jan-19	139.8	133.1	139.2	134.4	134.6	138.5				
07-Feb-19	139.7	132.9	138.9	134.8	135.0	139.2	109.3	110.0		
Average	**139**	**132**	**139**	**134**	**134**	**139**	**109**	**110**		

	Calculated arm zeroes (mV)						Calculated pressure cell zeroes (mV)			
09-Jul-18	-2005.3	-1963.7	-2043.1	-1964.3	-2078.2	-1966.9	-	-		
30-Jul-18	-	-	-	-	-	-	-1924.0	-2524.6	new cells	
21-Aug-18	-2069.5	-2013.3	-2111.6	-1960.2	-2082.3	-1977.1	-	-		
23-Aug-18	-	-	-	-	-	-	-1923.8	-2517.9		
18-Jan-19	-2051.9	-2011.0	-2100.3	-2010.3	-2019.2	-1947.1				
07-Feb-19	-2062.4	-1960.5	-2043.1	-1989.0	-2069.3	-1979.8	-1925.2	-2498.1		
Average	**-2047**	**-1987**	**-2075**	**-1981**	**-2062**	**-1968**	**-1924**	**-2514**		

Date	Membrane and system compliance calibrations					Tests	Remarks
	File ref.	Intercept (kPa)	Slope (kPa/mm)	Compress (mm/GPa)	Cylinder (mm/GPa)		
31-Jul-18	C01T1	29.8	9.0	6.8	2.7		
15-Aug-18	B0T0	18.2	6.4				
23-Aug-18	B8888T2			5.1	2.7		
07-Feb-19	C7T2			3.7	2.7		
Average				**5.2**			

Diameter over probe	94.00	mm
Diameter under membrane	82.00	mm
Chinese lantern thickness	0.53	mm

Notes:
Detachable cable with 6 pin plug
System compliance calibrations without Christmas Trees fitted

Notes: Update data charts	Project Project No. Carried out for	Table HPD95CAL

APPENDIX B

PRESSUREMETER TEST ANALYSIS

Pressuremeter Analysis

BH103 Tests 1 to 6 (66 sheets)
BH109 Tests 1 to 6 (62 sheets)

DRAFT

B103T1 - SUMMARY OF RESULTS
[File made with WinSitu Version 3.9.1.1]

[DETAILS OF TEST]
Project : Crown Street, Manchester
Site : M9019
Borehole : BH103
Test name : B103T1
Test date : 22 Aug 19
Test depth : 11.30 Metres
Water table : 3.00 Metres
Ambient PWP : 81.4 kPa
Material : Sandstone
Probe : 95mm High Pressure Dilatometer
Diameter : 94.0 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out

Analysed by IRC on 23 Aug 19

Remarks: Pocket 10.5-12m in at 0830 WL at 6m

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm) : "Arm ave=2.39"
Best estimate of Po (kPa) : "Arm ave=2200.0"

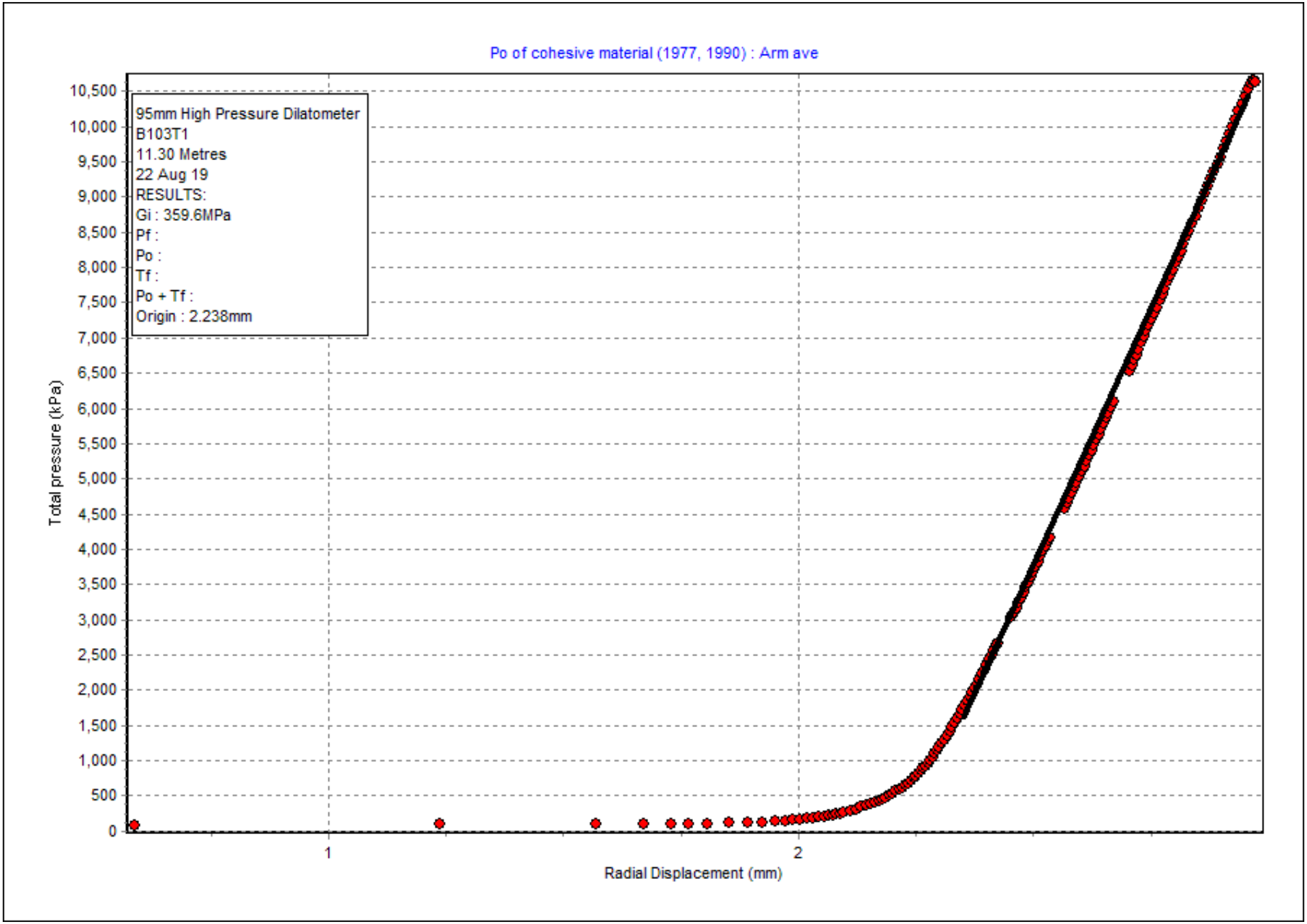
[UNDRAINED STRENGTH PARAMETERS]
Gibson & Anderson 1961 - Cu (kPa) : "Arm ave=7838.6"
Limit pressure (kPa) : "Arm ave=40168"
Jefferies 1988 - Cu (kPa) : "Arm ave=2208.8"

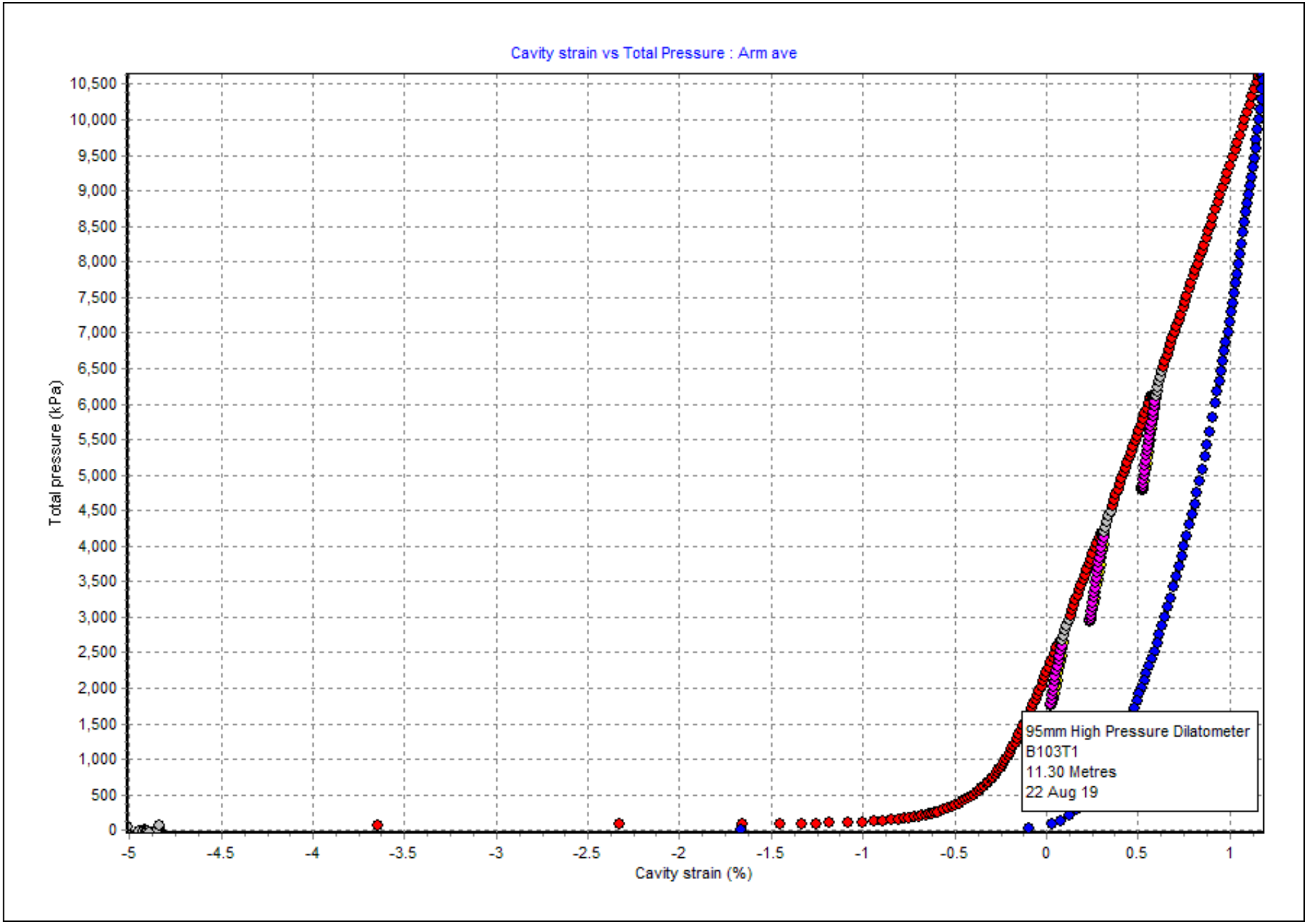
[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=359.6"

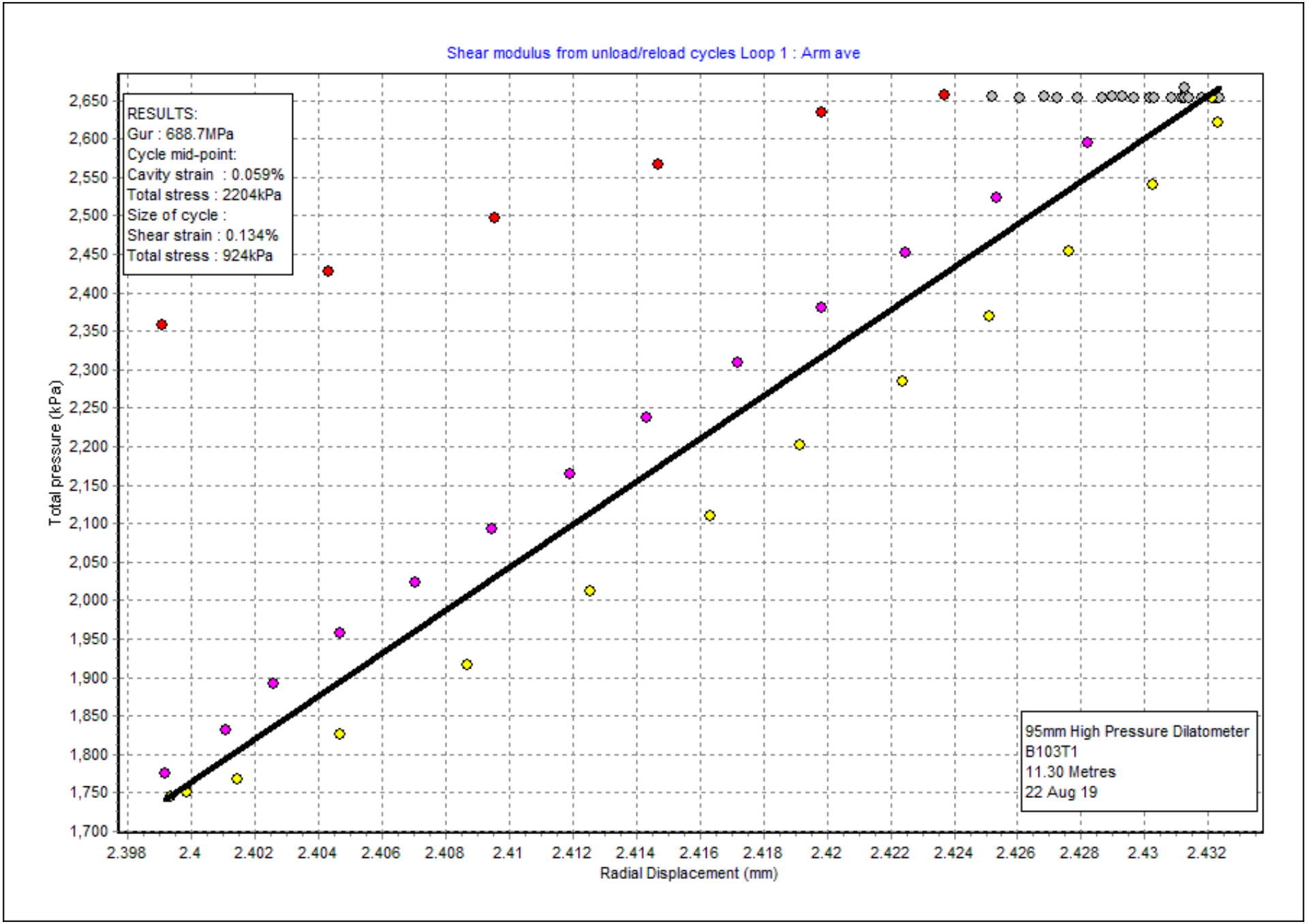
Axis	Loop No	Value (MPa)	Mean Strain (%)	Mean Pc (kPa)	dE (%)	dPc (kPa)
Arm ave	1	688.7	0.059	2204	0.134	924
Arm ave	2	786.8	0.277	3531	0.150	1184
Arm ave	3	897.4	0.560	5426	0.141	1264

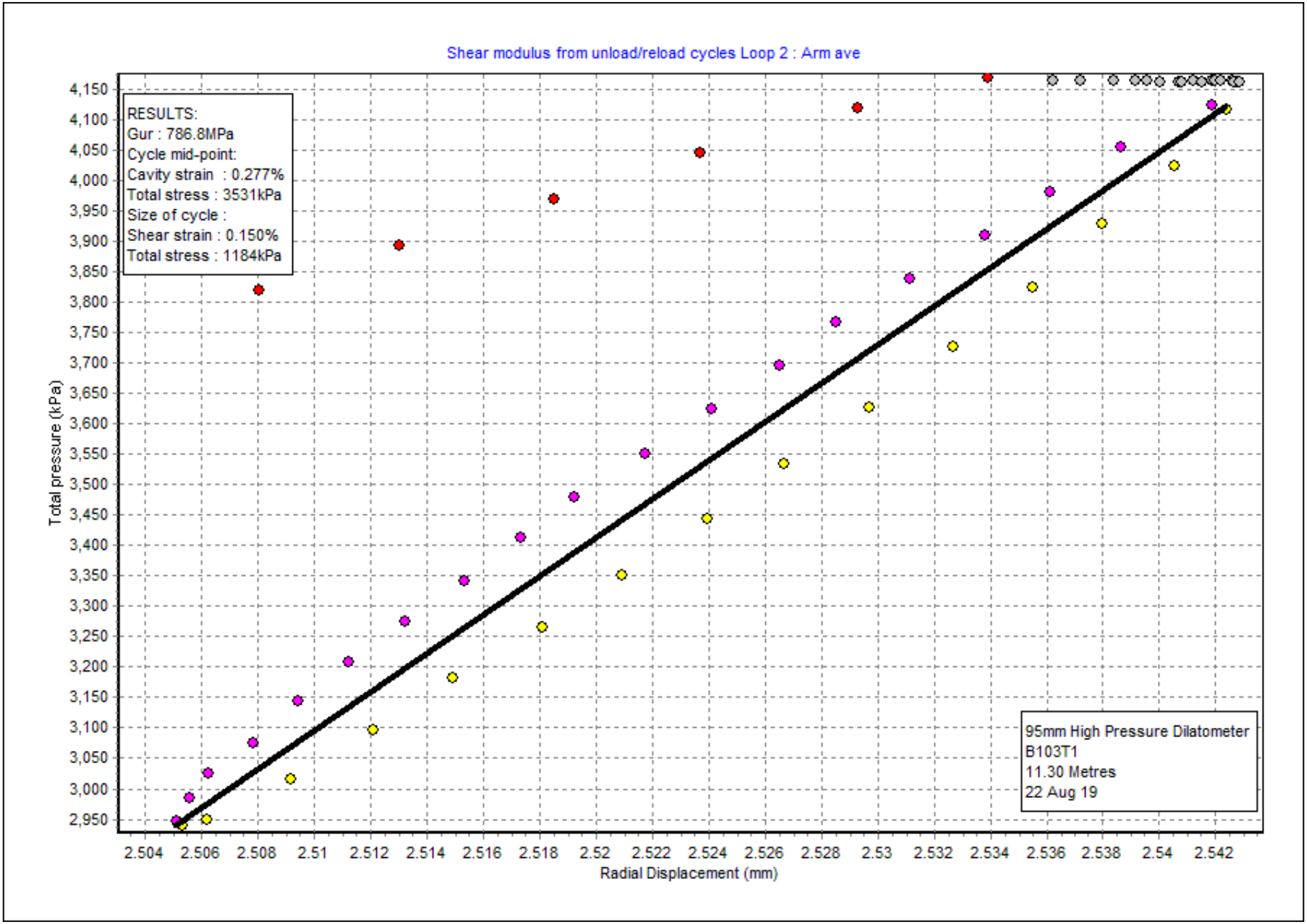
[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]

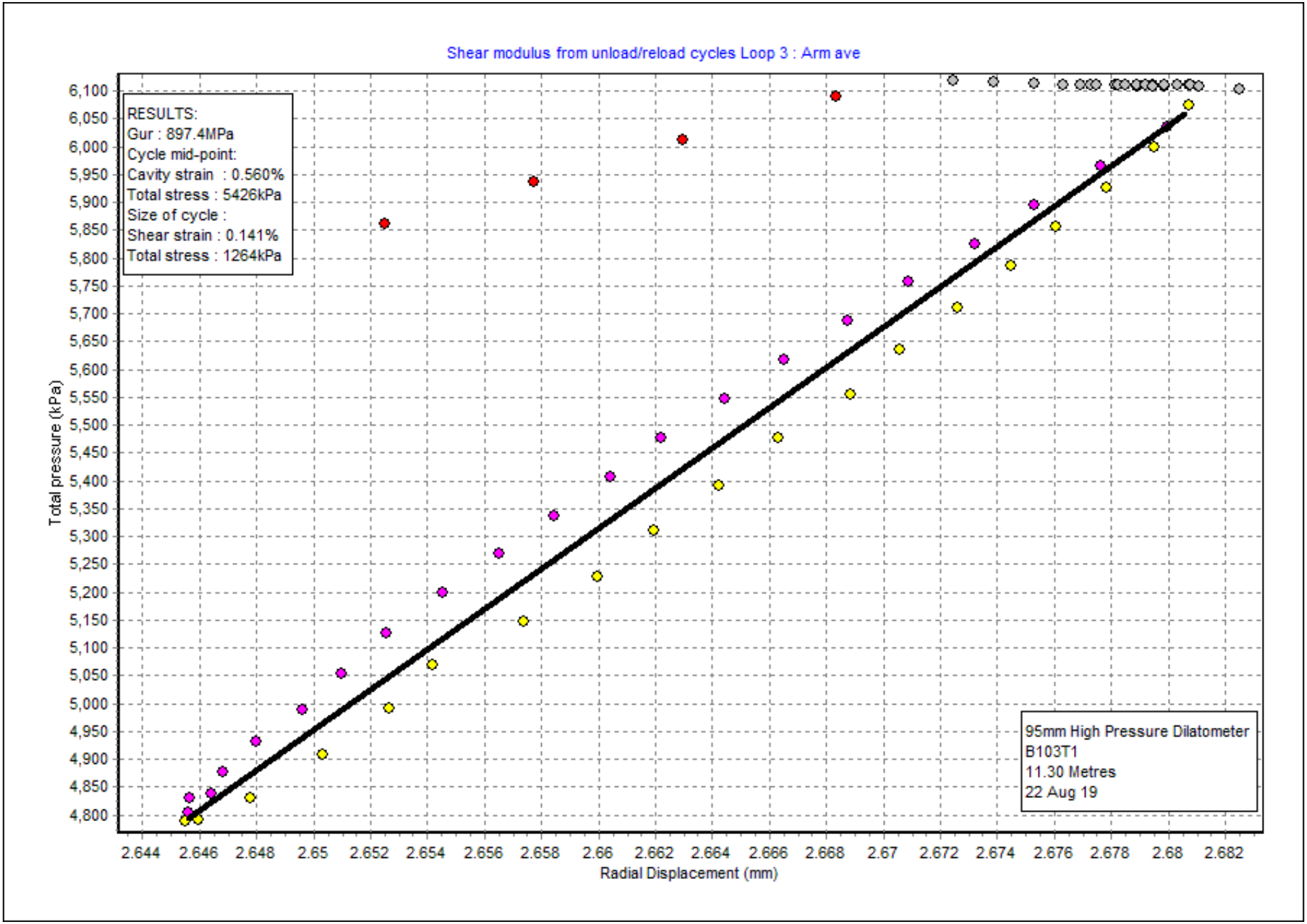
Axis	Loop No	Intercept (MPa)	Alpha (MPa)	Gradient
Arm ave	1	235.706	196.780	0.835
Arm ave	2	278.394	232.685	0.836
Arm ave	3	285.744	235.986	0.826

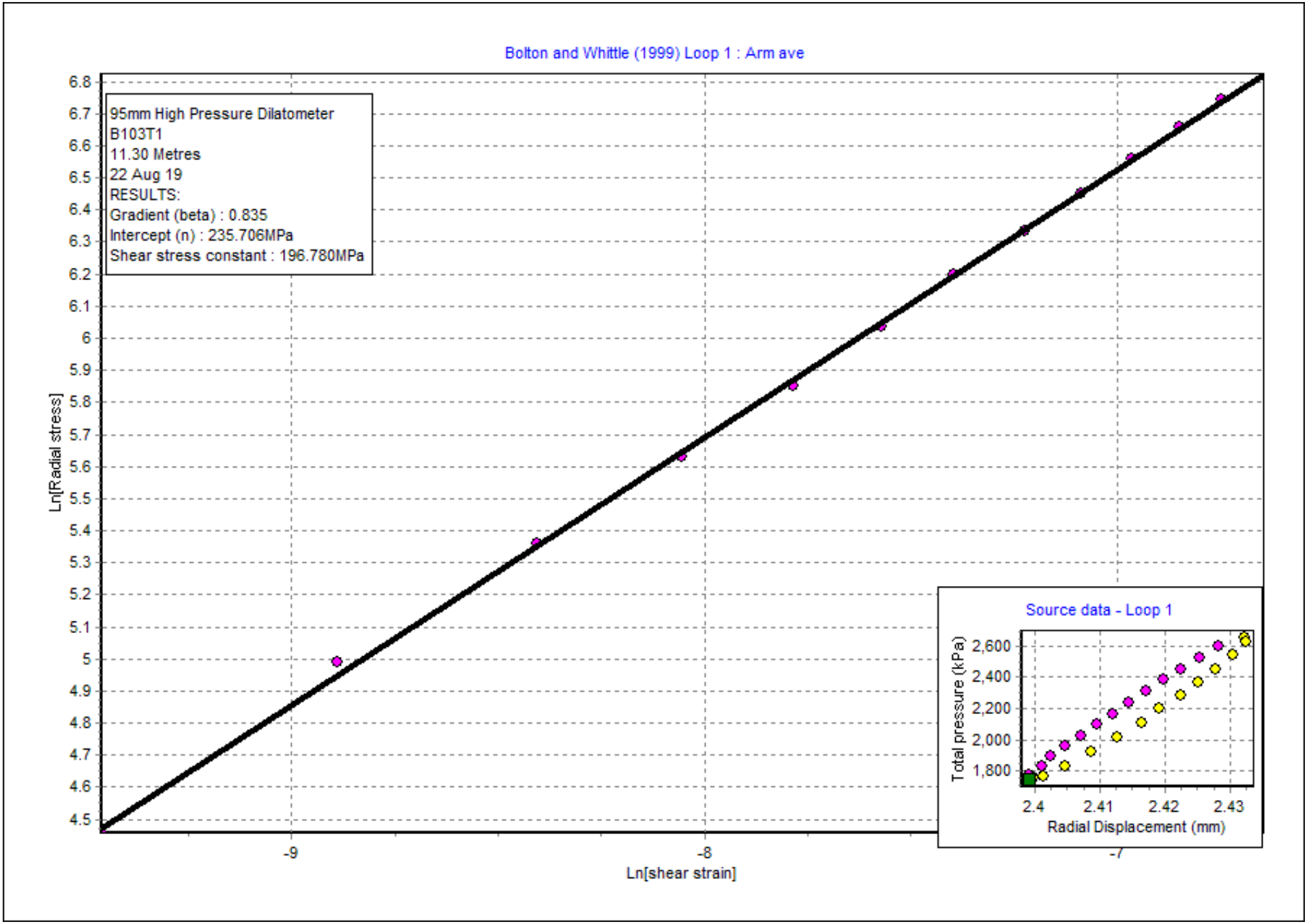

Po of cohesive material (1977, 1990) : Arm ave
95mm High Pressure Dilatometer
B103T1
11.30 Metres
22 Aug 19
RESULTS:
Gi : 359.6MPa
Pf :
Po :
Tf :
Po + Tf :
Origin : 2.238mm
Total pressure (kPa)
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1
2
Radial Displacement (mm)

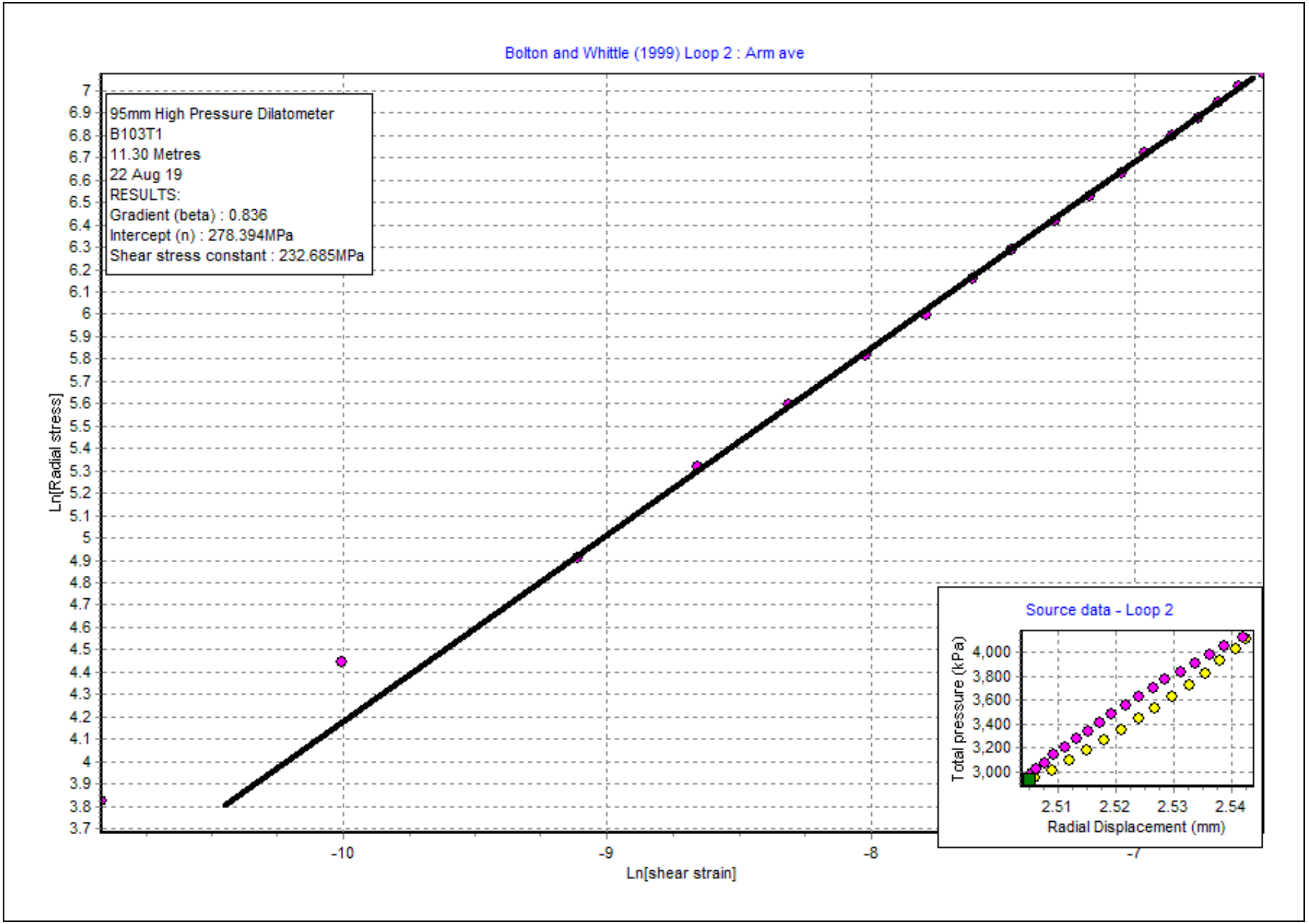

Cavity strain vs Total Pressure : Arm ave
Total pressure (kPa)
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
-5
-4.5
-4
-3.5
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
1
Cavity strain (%)
95mm High Pressure Dilatometer
B103T1
11.30 Metres
22 Aug 19

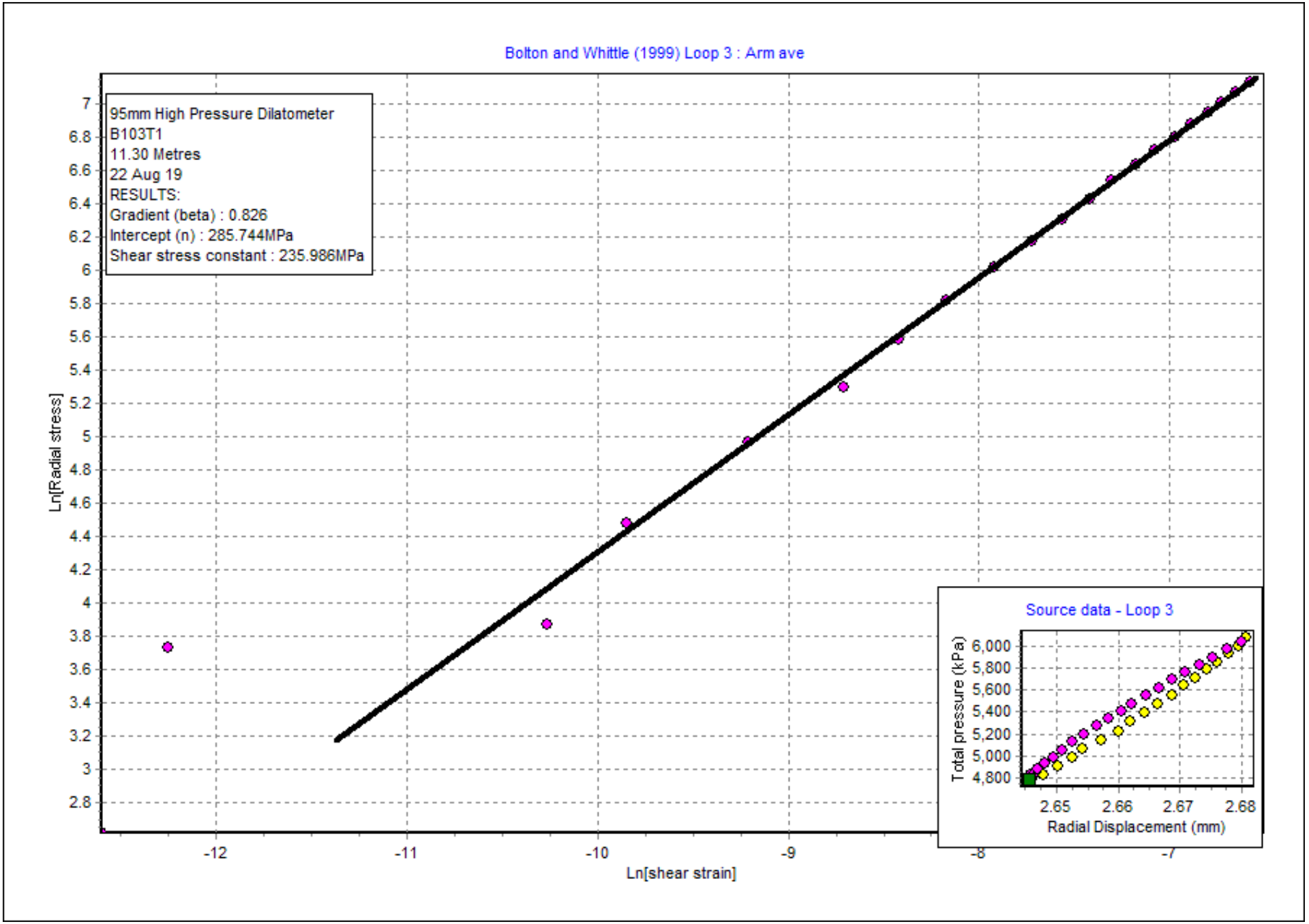

Shear modulus from unload/reload cycles Loop 1 : Arm ave
RESULTS:
Gur : 688.7MPa
Cycle mid-point:
Cavity strain : 0.059%
Total stress : 2204kPa
Size of cycle :
Shear strain : 0.134%
Total stress : 924kPa
95mm High Pressure Dilatometer
B103T1
11.30 Metres
22 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
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
1,750
1,700
2.398
2.4
2.402
2.404
2.406
2.408
2.41
2.412
2.414
2.416
2.418
2.42
2.422
2.424
2.426
2.428
2.43
2.432

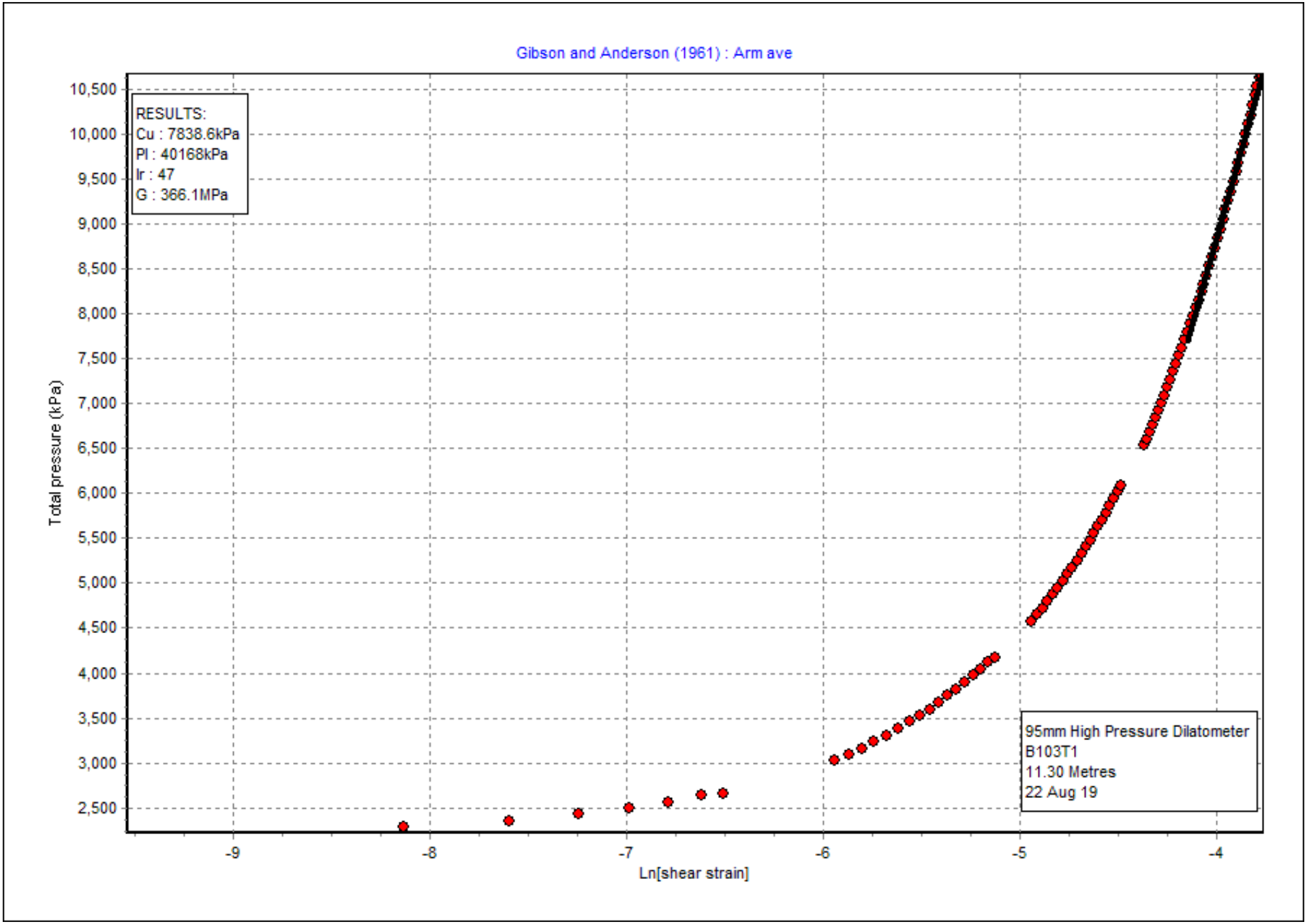

Shear modulus from unload/reload cycles Loop 2 : Arm ave
RESULTS:
Gur : 786.8MPa
Cycle mid-point:
Cavity strain : 0.277%
Total stress : 3531kPa
Size of cycle :
Shear strain : 0.150%
Total stress : 1184kPa
95mm High Pressure Dilatometer
B103T1
11.30 Metres
22 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
4,150
4,100
4,050
4,000
3,950
3,900
3,850
3,800
3,750
3,700
3,650
3,600
3,550
3,500
3,450
3,400
3,350
3,300
3,250
3,200
3,150
3,100
3,050
3,000
2,950
2.504
2.506
2.508
2.51
2.512
2.514
2.516
2.518
2.52
2.522
2.524
2.526
2.528
2.53
2.532
2.534
2.536
2.538
2.54
2.542

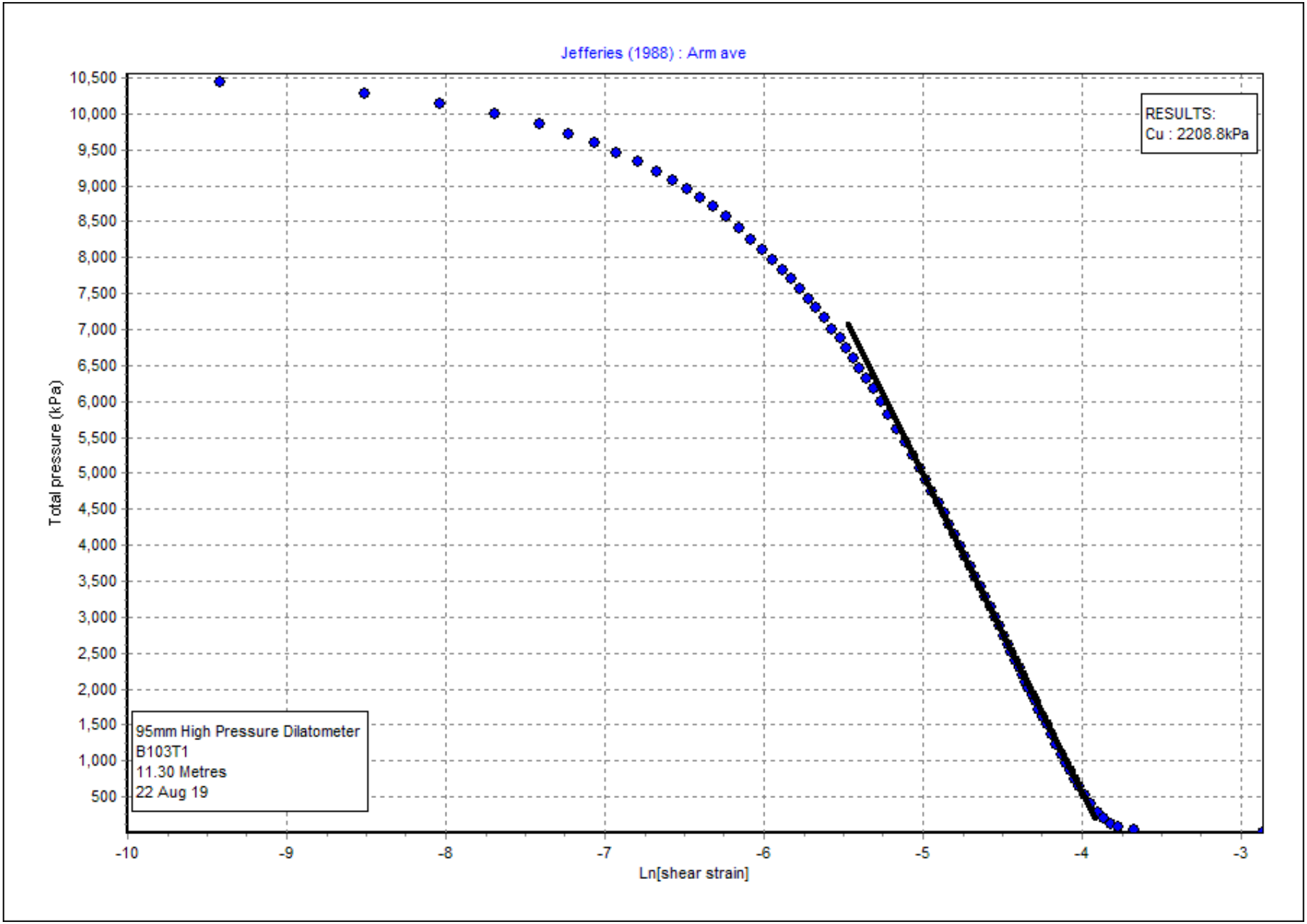

Shear modulus from unload/reload cycles Loop 3 : Arm ave
RESULTS:
Gur : 897.4MPa
Cycle mid-point:
Cavity strain : 0.560%
Total stress : 5426kPa
Size of cycle :
Shear strain : 0.141%
Total stress : 1264kPa
95mm High Pressure Dilatometer
B103T1
11.30 Metres
22 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
6,100
6,050
6,000
5,950
5,900
5,850
5,800
5,750
5,700
5,650
5,600
5,550
5,500
5,450
5,400
5,350
5,300
5,250
5,200
5,150
5,100
5,050
5,000
4,950
4,900
4,850
4,800
2.644
2.646
2.648
2.65
2.652
2.654
2.656
2.658
2.66
2.662
2.664
2.666
2.668
2.67
2.672
2.674
2.676
2.678
2.68
2.682


Bolton and Whittle (1999) Loop 1 : Arm ave
95mm High Pressure Dilatometer
B103T1
11.30 Metres
22 Aug 19
RESULTS:
Gradient (beta) : 0.835
Intercept (n) : 235.706MPa
Shear stress constant : 196.780MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 1
Total pressure (kPa)
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 2 : Arm ave
95mm High Pressure Dilatometer
B103T1
11.30 Metres
22 Aug 19
RESULTS:
Gradient (beta) : 0.836
Intercept (n) : 278.394MPa
Shear stress constant : 232.685MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 2
Total pressure (kPa)
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 3 : Arm ave
95mm High Pressure Dilatometer
B103T1
11.30 Metres
22 Aug 19
RESULTS:
Gradient (beta) : 0.826
Intercept (n) : 285.744MPa
Shear stress constant : 235.986MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 3
Total pressure (kPa)
Radial Displacement (mm)


Gibson and Anderson (1961) : Arm ave
RESULTS:
Cu : 7838.6kPa
PI : 40168kPa
Ir : 47
G : 366.1MPa
95mm High Pressure Dilatometer
B103T1
11.30 Metres
22 Aug 19
Total pressure (kPa)
Ln[shear strain]
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
-9
-8
-7
-6
-5
-4


Jefferies (1988) : Arm ave
RESULTS:
Cu : 2208.8kPa
95mm High Pressure Dilatometer
B103T1
11.30 Metres
22 Aug 19
Total pressure (kPa)
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
-10
-9
-8
-7
-6
-5
-4
-3
Ln[shear strain]

B103T2 - SUMMARY OF RESULTS
[File made with WinSitu Version 3.9.1.1]

[DETAILS OF TEST]
Project : Crown Street, Manchester
Site : M9019
Borehole : BH103
Test name : B103T2
Test date : 22 Aug 19
Test depth : 15.80 Metres
Water table : 3.00 Metres
Ambient PWP : 125.6 kPa
Material : Sandstone
Probe : 95mm High Pressure Dilatometer
Diameter : 94.0 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out

Analysed by IRC on 23 Aug 19

Remarks: Pocket 15-16.5. 1200pm

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm) : "Arm ave=2.07"
Best estimate of Po (kPa) : "Arm ave=1200.0"

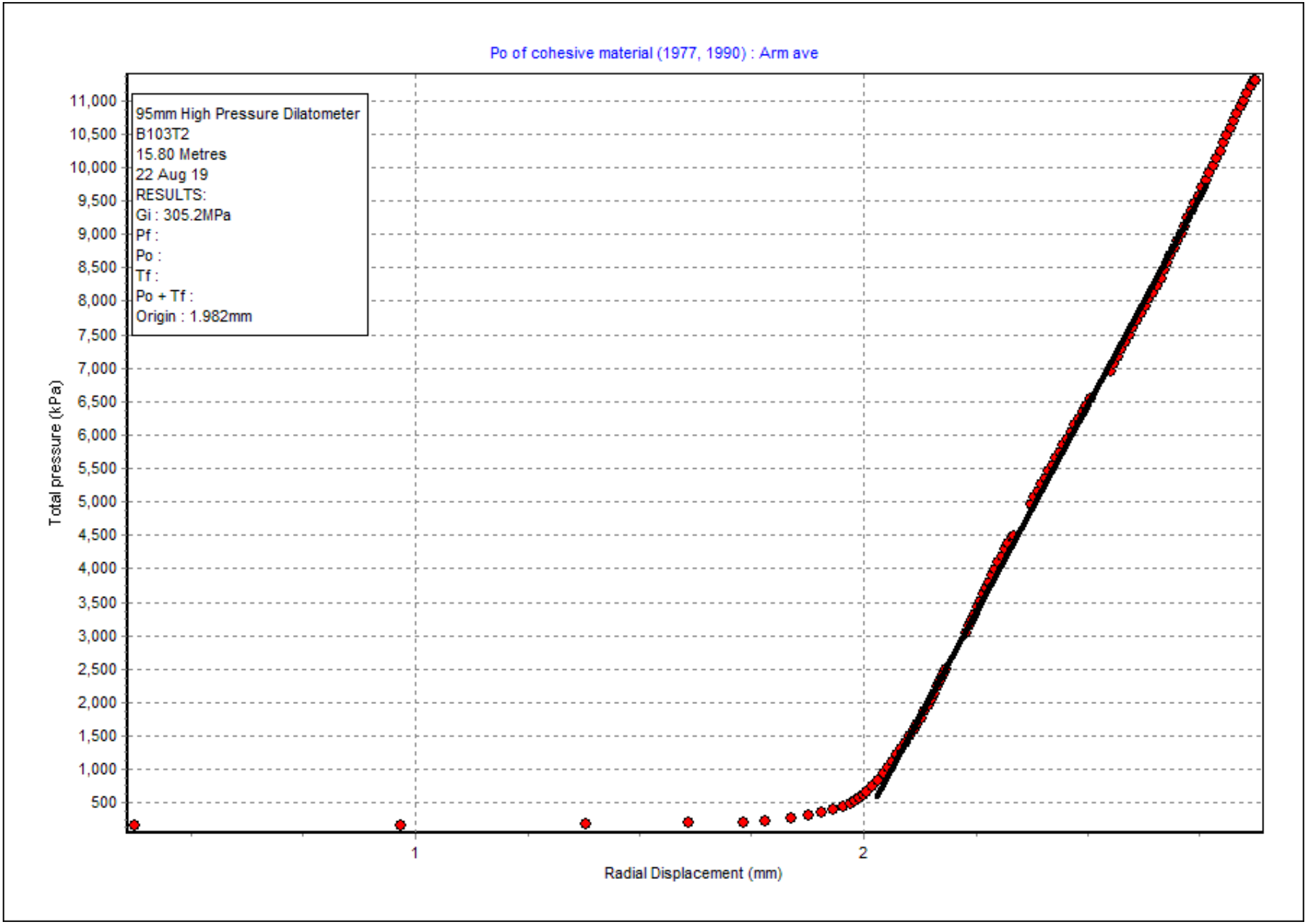
[UNDRAINED STRENGTH PARAMETERS]
Gibson & Anderson 1961 - Cu (kPa) : "Arm ave=10147.5"
Limit pressure (kPa) : "Arm ave=46297"
Jefferies 1988 - Cu (kPa) : "Arm ave=2243.1"

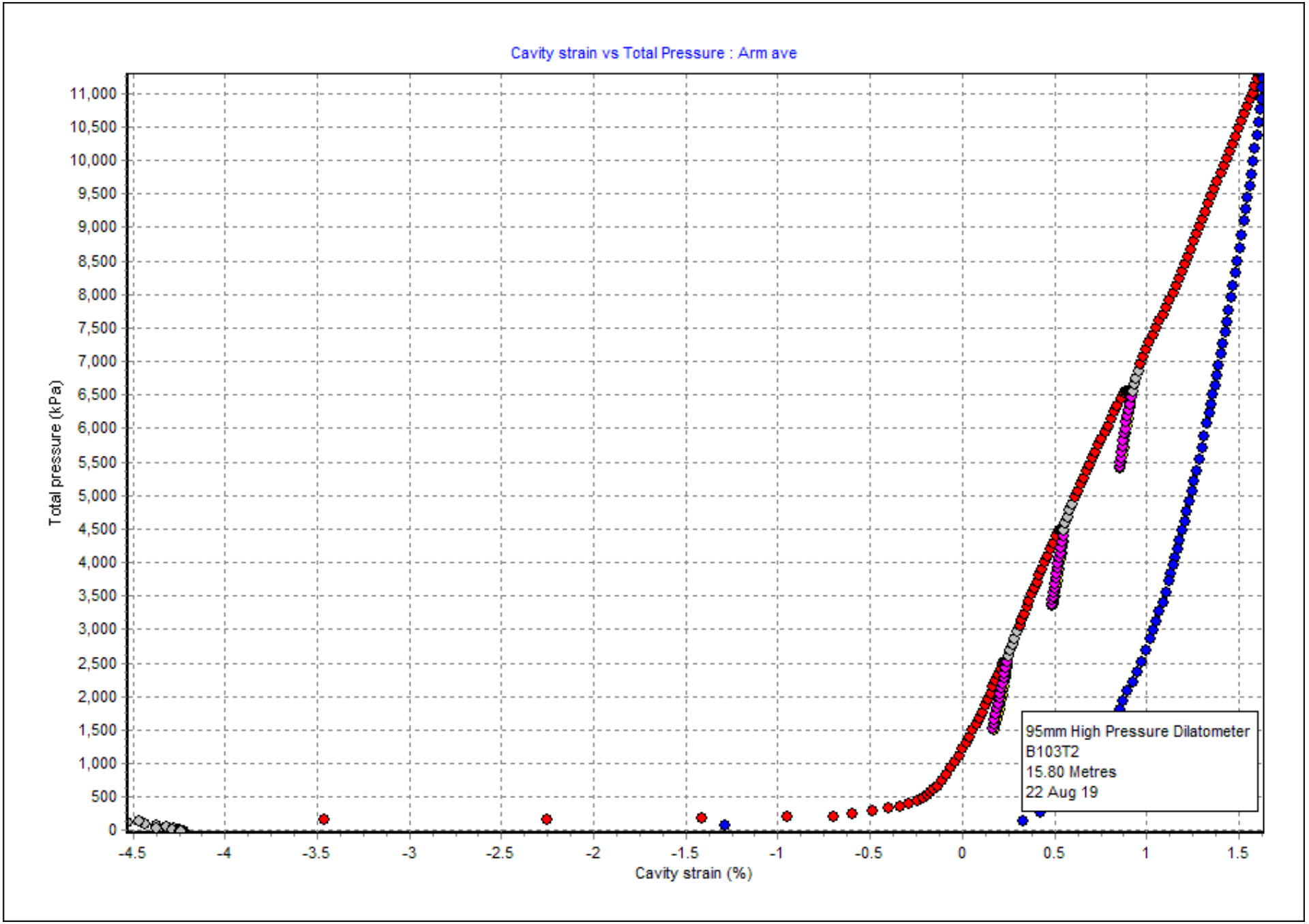
[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=305.2"

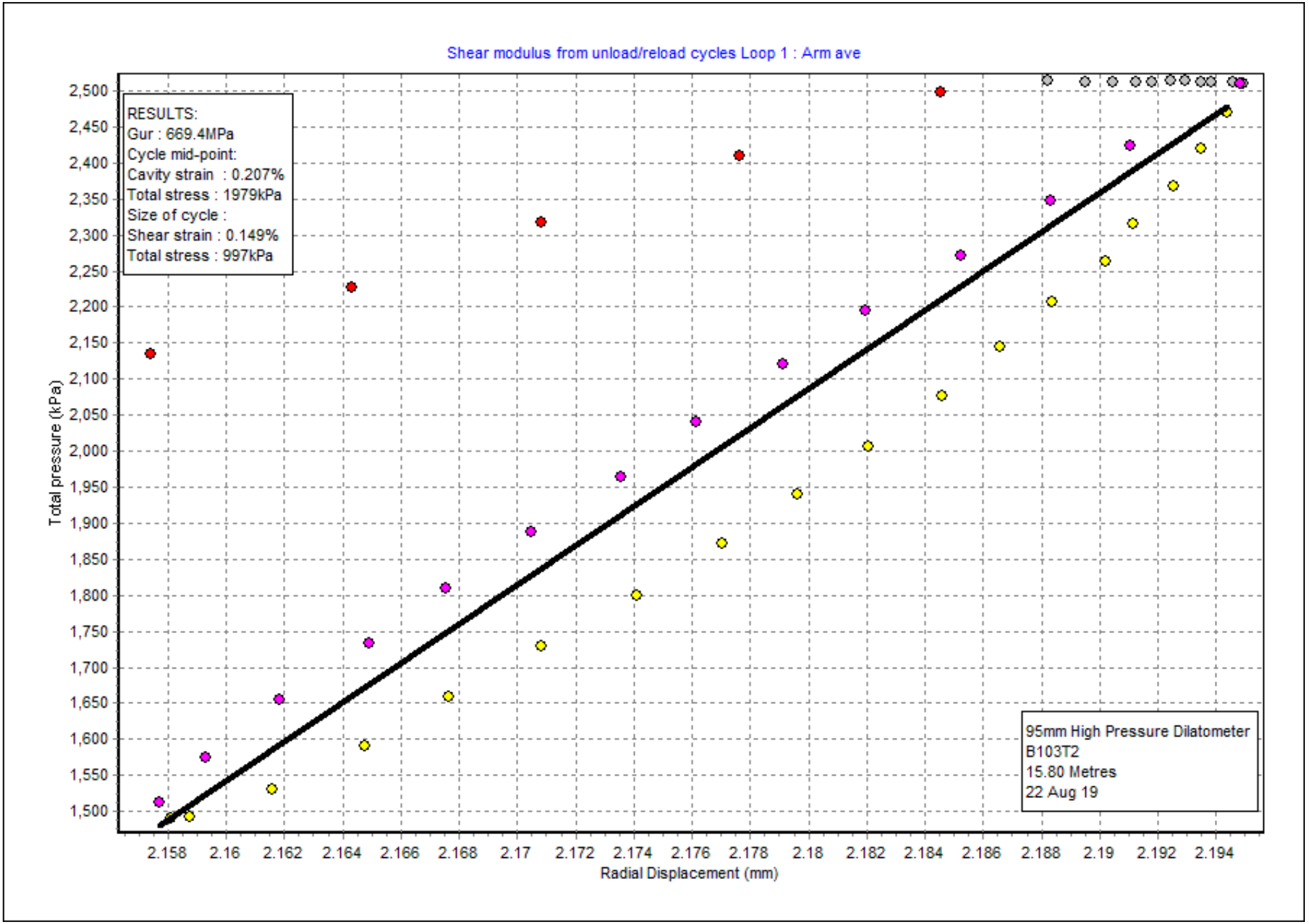
Axis	Loop No	Value (MPa)	Mean Strain (%)	Mean Pc (kPa)	dE (%)	dPc (kPa)
Arm ave	1	669.4	0.207	1979	0.149	997
Arm ave	2	876.0	0.521	3908	0.126	1107
Arm ave	3	908.3	0.888	5942	0.116	1053

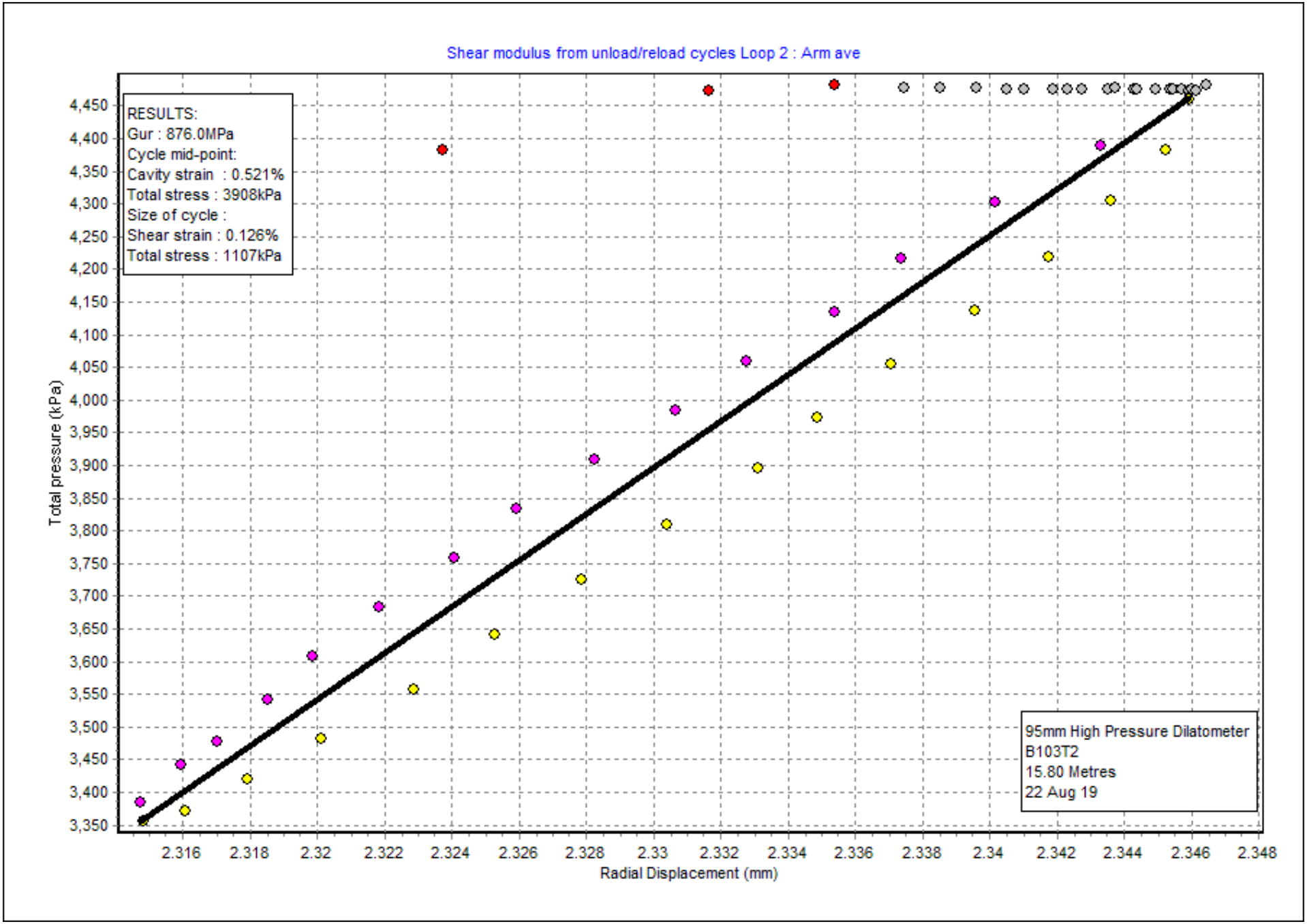
[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]

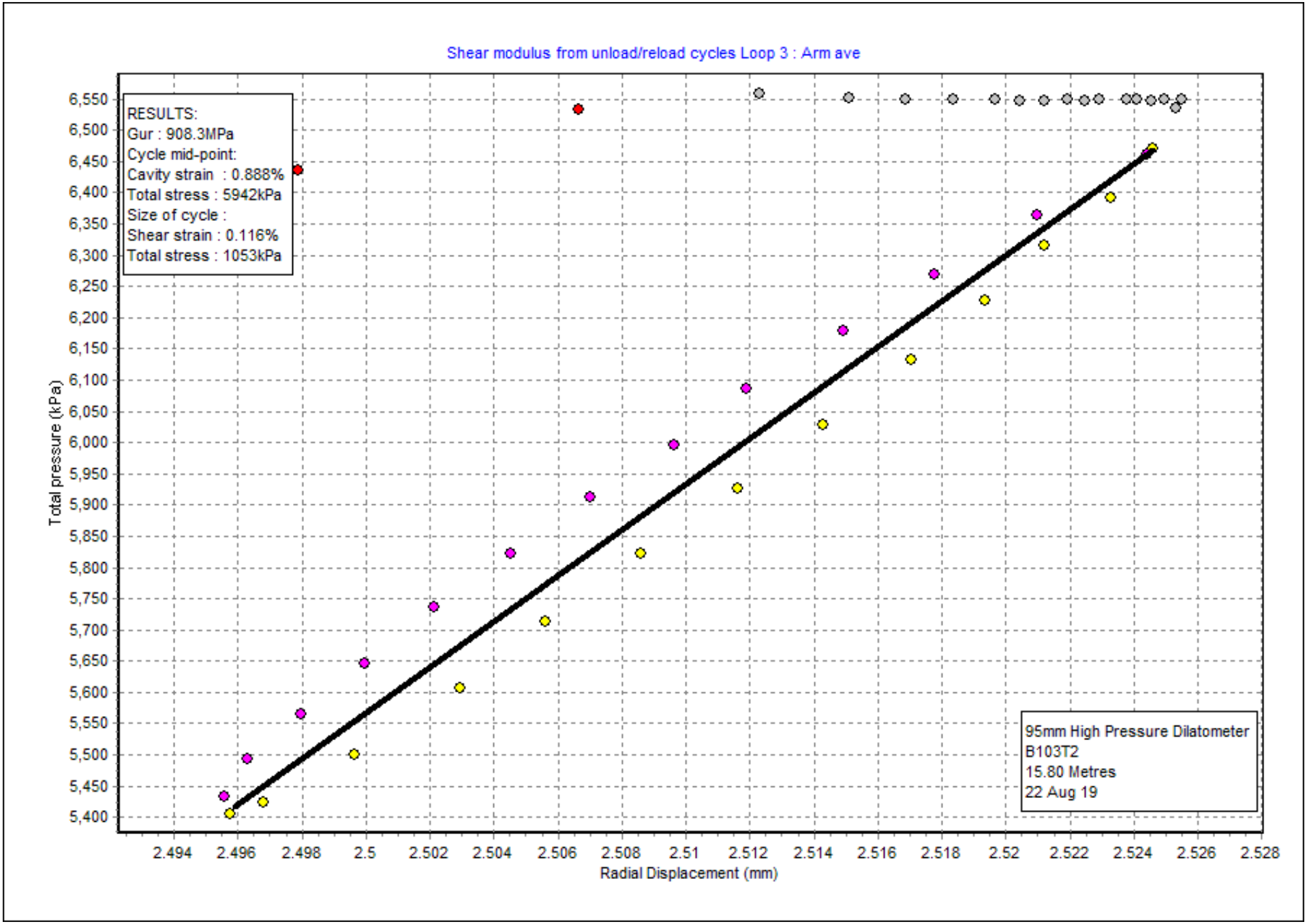
Axis	Loop No	Intercept (MPa)	Alpha (MPa)	Gradient
Arm ave	1	320.763	283.632	0.884
Arm ave	2	292.055	243.712	0.834
Arm ave	3	211.659	166.236	0.785

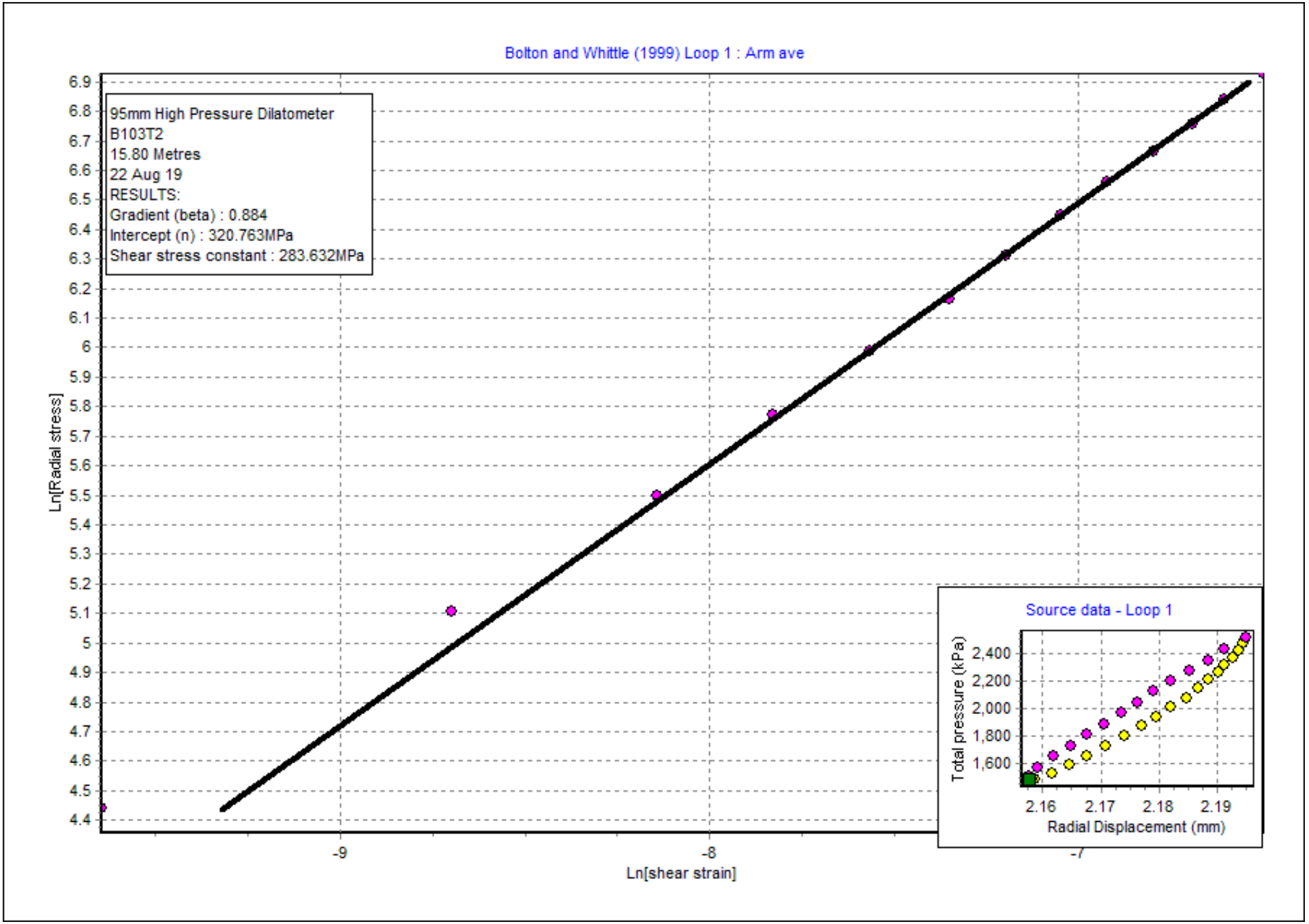

Po of cohesive material (1977, 1990) : Arm ave
95mm High Pressure Dilatometer
B103T2
15.80 Metres
22 Aug 19
RESULTS:
Gi : 305.2MPa
Pf :
Po :
Tf :
Po + Tf :
Origin : 1.982mm
Total pressure (kPa)
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
1
2
Radial Displacement (mm)

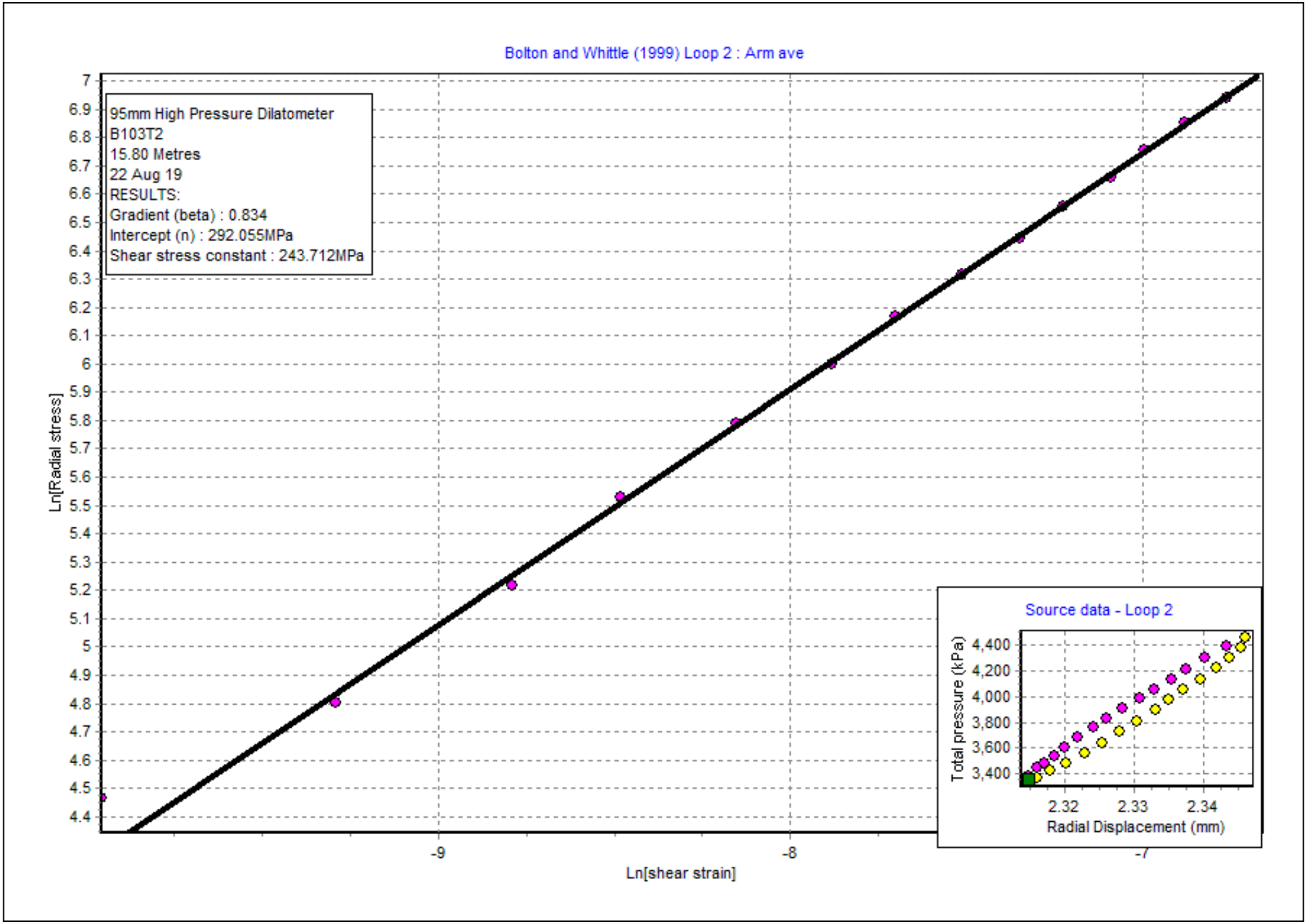

Cavity strain vs Total Pressure : Arm ave
Total pressure (kPa)
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
-4.5
-4
-3.5
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
1
1.5
Cavity strain (%)
95mm High Pressure Dilatometer
B103T2
15.80 Metres
22 Aug 19

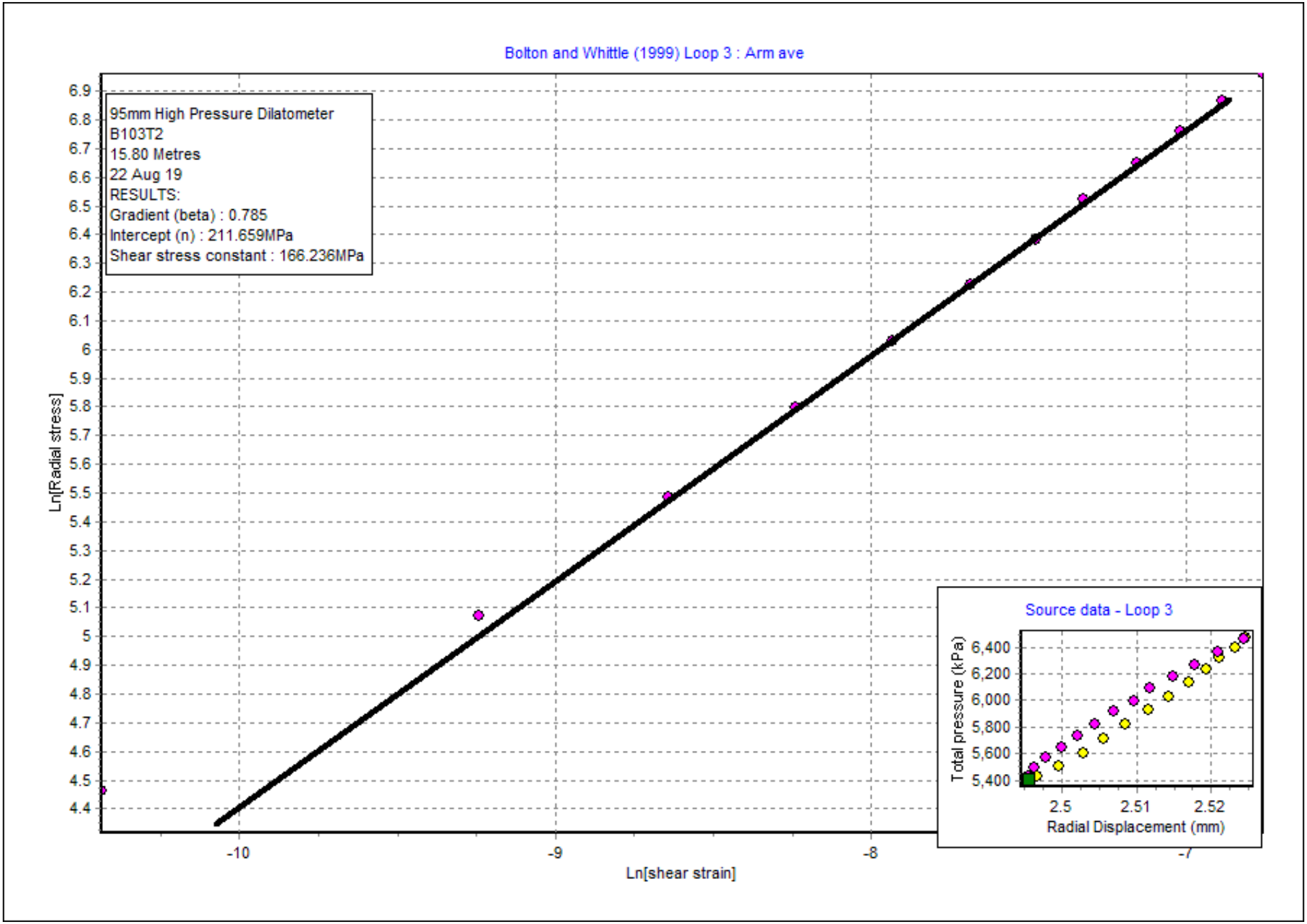

Shear modulus from unload/reload cycles Loop 1 : Arm ave
RESULTS:
Gur : 669.4MPa
Cycle mid-point:
Cavity strain : 0.207%
Total stress : 1979kPa
Size of cycle :
Shear strain : 0.149%
Total stress : 997kPa
95mm High Pressure Dilatometer
B103T2
15.80 Metres
22 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
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
1,750
1,700
1,650
1,600
1,550
1,500
2.158
2.16
2.162
2.164
2.166
2.168
2.17
2.172
2.174
2.176
2.178
2.18
2.182
2.184
2.186
2.188
2.19
2.192
2.194

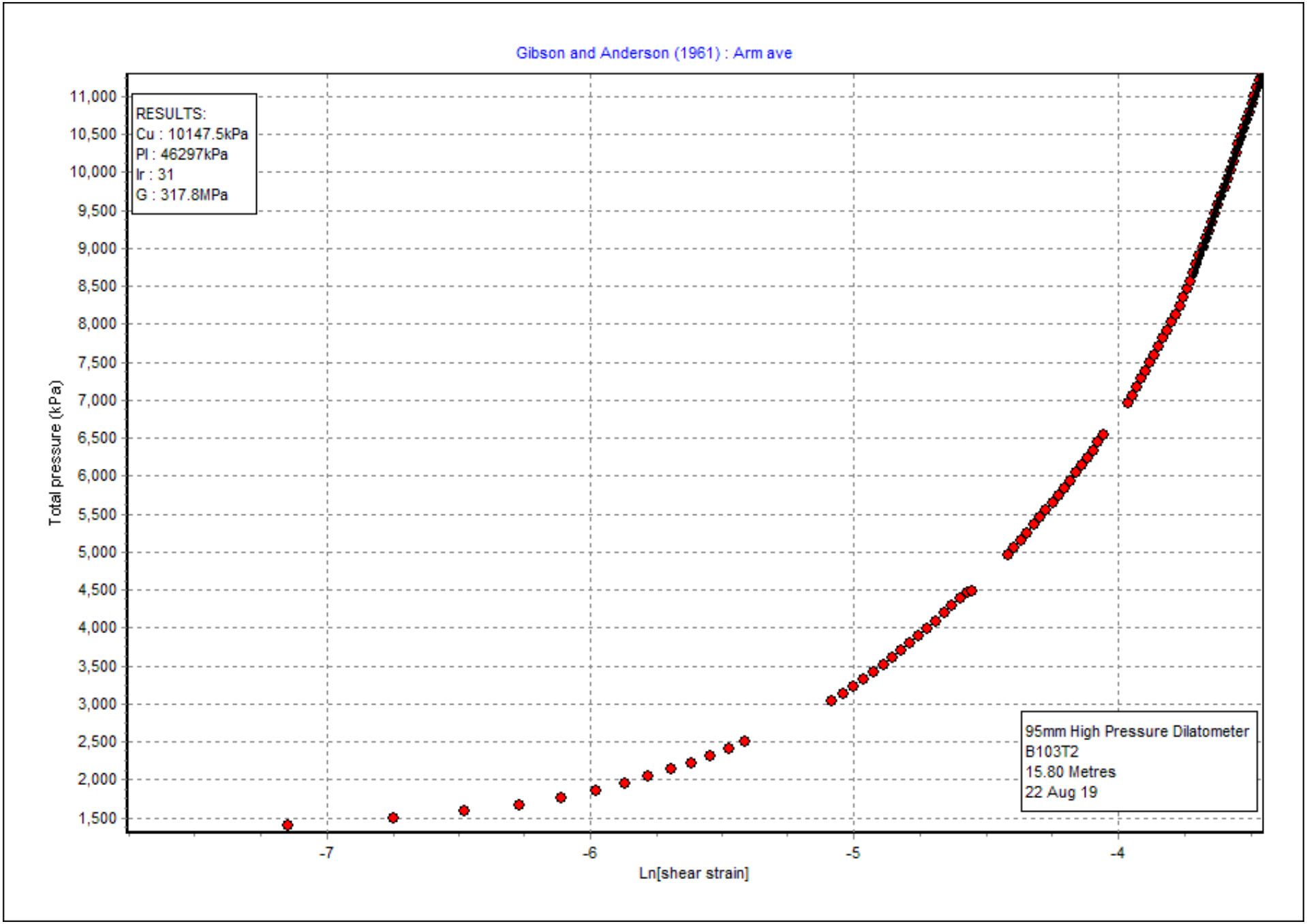

Shear modulus from unload/reload cycles Loop 2 : Arm ave
RESULTS:
Gur : 876.0MPa
Cycle mid-point:
Cavity strain : 0.521%
Total stress : 3908kPa
Size of cycle :
Shear strain : 0.126%
Total stress : 1107kPa
95mm High Pressure Dilatometer
B103T2
15.80 Metres
22 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
4,450
4,400
4,350
4,300
4,250
4,200
4,150
4,100
4,050
4,000
3,950
3,900
3,850
3,800
3,750
3,700
3,650
3,600
3,550
3,500
3,450
3,400
3,350
2.316
2.318
2.32
2.322
2.324
2.326
2.328
2.33
2.332
2.334
2.336
2.338
2.34
2.342
2.344
2.346
2.348

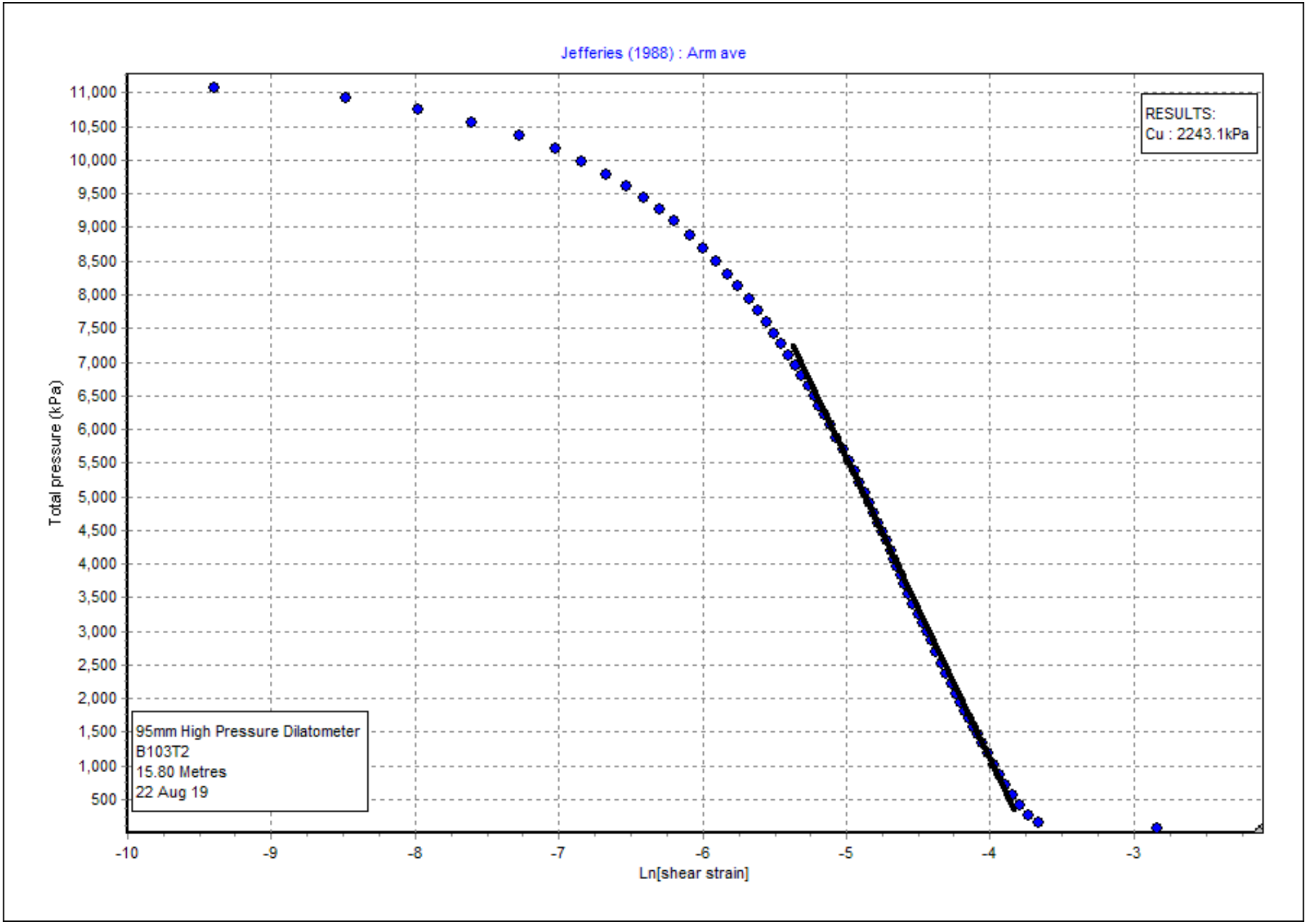

Shear modulus from unload/reload cycles Loop 3 : Arm ave
RESULTS:
Gur : 908.3MPa
Cycle mid-point:
Cavity strain : 0.888%
Total stress : 5942kPa
Size of cycle :
Shear strain : 0.116%
Total stress : 1053kPa
95mm High Pressure Dilatometer
B103T2
15.80 Metres
22 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
6,550
6,500
6,450
6,400
6,350
6,300
6,250
6,200
6,150
6,100
6,050
6,000
5,950
5,900
5,850
5,800
5,750
5,700
5,650
5,600
5,550
5,500
5,450
5,400
2.494
2.496
2.498
2.5
2.502
2.504
2.506
2.508
2.51
2.512
2.514
2.516
2.518
2.52
2.522
2.524
2.526
2.528


Bolton and Whittle (1999) Loop 1 : Arm ave
95mm High Pressure Dilatometer
B103T2
15.80 Metres
22 Aug 19
RESULTS:
Gradient (beta) : 0.884
Intercept (n) : 320.763MPa
Shear stress constant : 283.632MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 1
Total pressure (kPa)
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 2 : Arm ave
95mm High Pressure Dilatometer
B103T2
15.80 Metres
22 Aug 19
RESULTS:
Gradient (beta) : 0.834
Intercept (n) : 292.055MPa
Shear stress constant : 243.712MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 2
Total pressure (kPa)
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 3 : Arm ave
95mm High Pressure Dilatometer
B103T2
15.80 Metres
22 Aug 19
RESULTS:
Gradient (beta) : 0.785
Intercept (n) : 211.659MPa
Shear stress constant : 166.236MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 3
Total pressure (kPa)
Radial Displacement (mm)


Gibson and Anderson (1961) : Arm ave
RESULTS:
Cu : 10147.5kPa
Pl : 46297kPa
Ir : 31
G : 317.8MPa
Total pressure (kPa)
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
-7
-6
-5
-4
Ln[shear strain]
95mm High Pressure Dilatometer
B103T2
15.80 Metres
22 Aug 19


Jefferies (1988) : Arm ave
RESULTS:
Cu : 2243.1kPa
95mm High Pressure Dilatometer
B103T2
15.80 Metres
22 Aug 19
Total pressure (kPa)
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
-10
-9
-8
-7
-6
-5
-4
-3
Ln[shear strain]

B103T3 - SUMMARY OF RESULTS
[File made with WinSitu Version 3.9.1.1]

[DETAILS OF TEST]
Project : Crown Street, Manchester
Site : M9019 Crown Street
Borehole : BH103
Test name : B103T3
Test date : 23 Aug 19
Test depth : 21.80 Metres
Water table : 3.00 Metres
Ambient PWP : 184.4 kPa
Material : Sandstone
Probe : 95mm High Pressure Dilatometer
Diameter : 94.0 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out

Analysed by IRC on 27 Aug 19

Remarks: Pocket 21-22.5m

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm) : "Arm ave=2.17"
Best estimate of Po (kPa) : "Arm ave=2000.0"

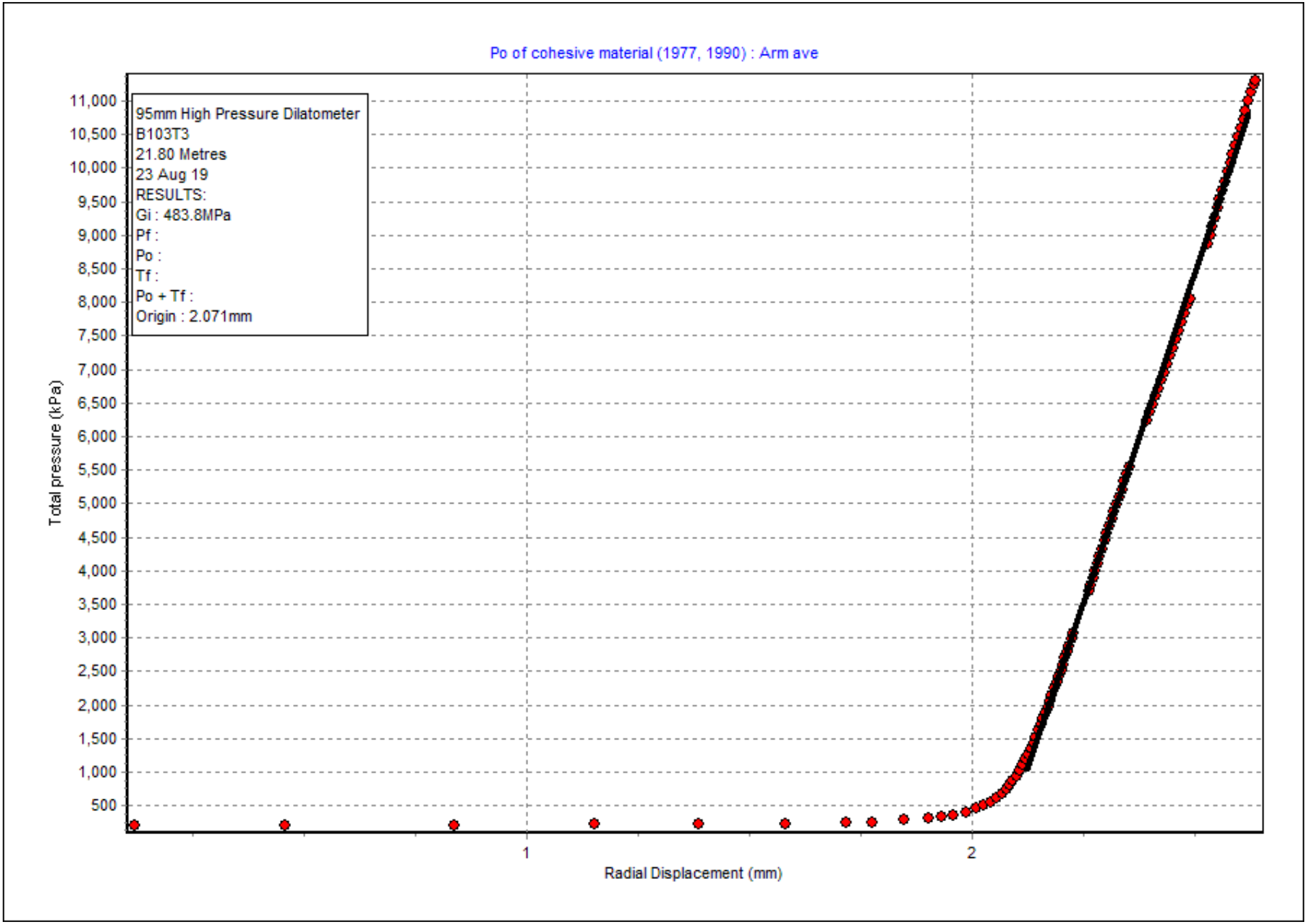
[UNDRAINED STRENGTH PARAMETERS]
Gibson & Anderson 1961 - Cu (kPa) : "Arm ave=8819.7"
Limit pressure (kPa) : "Arm ave=46360"
Jefferies 1988 - Cu (kPa) : "Arm ave=2144.1"

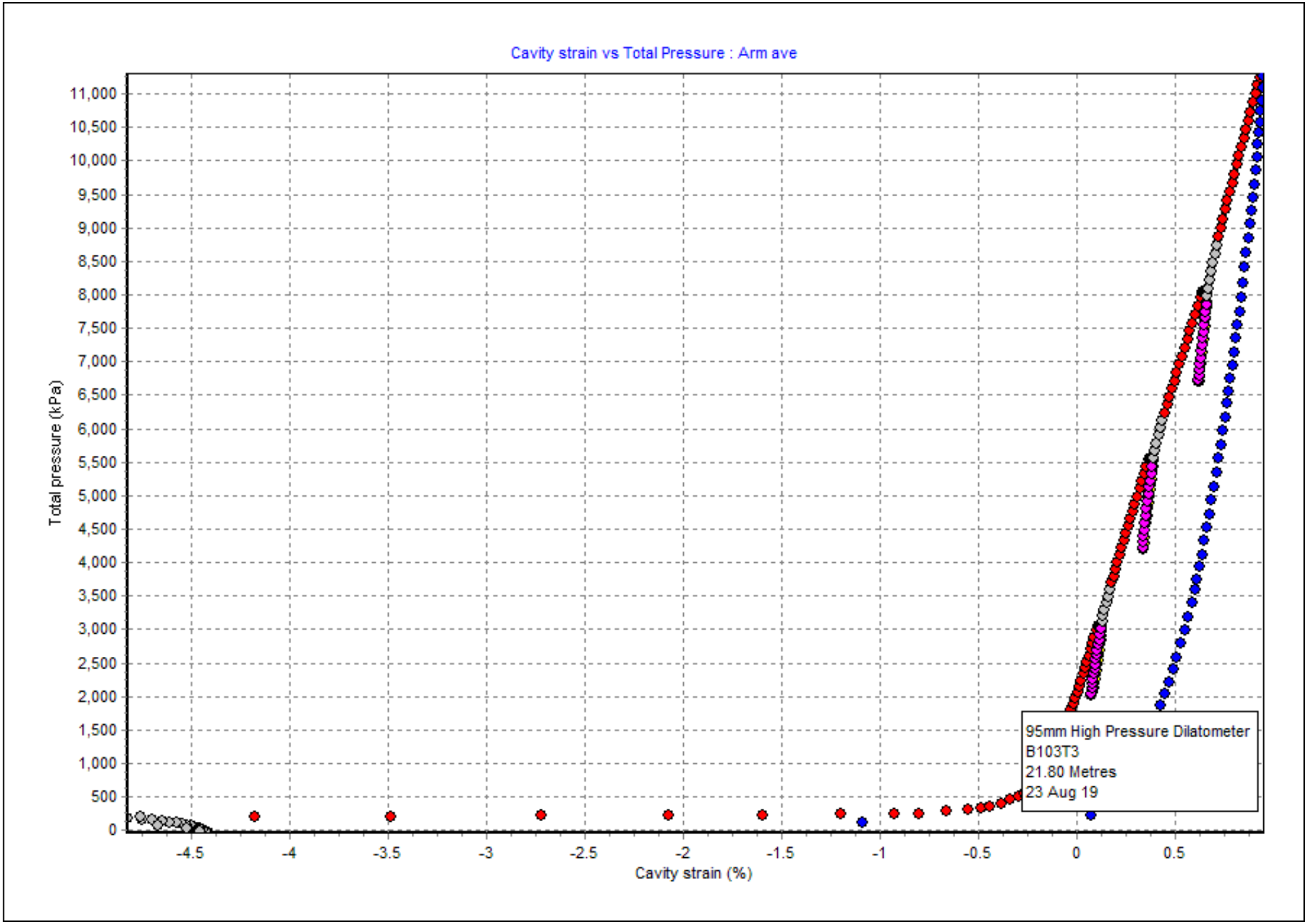
[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=483.8"

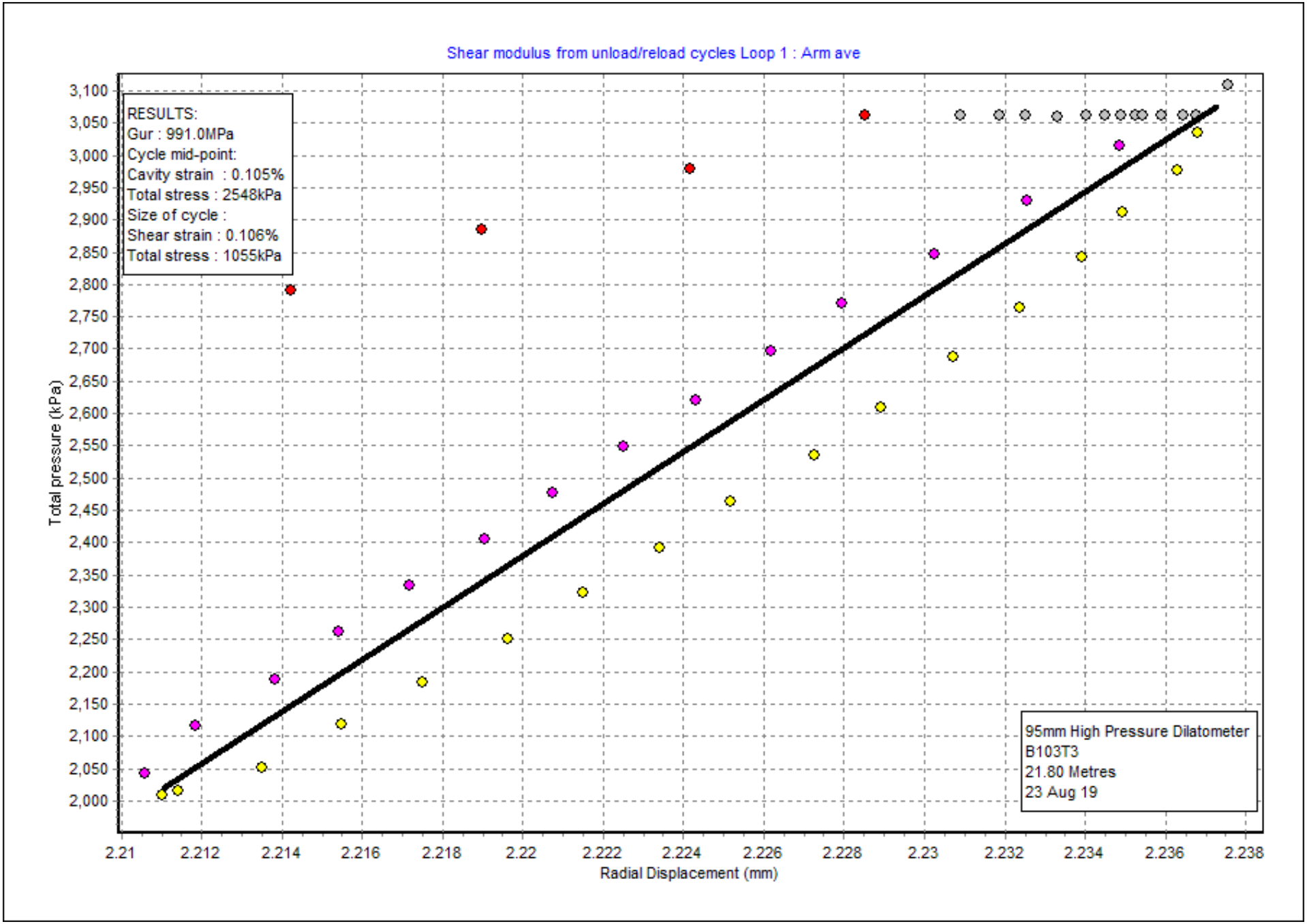
Axis	Loop No	Value (MPa)	Mean Strain (%)	Mean Pc (kPa)	dE (%)	dPc (kPa)
Arm ave	1	991.0	0.105	2548	0.106	1055
Arm ave	2	1233.6	0.366	4879	0.105	1298
Arm ave	3	1467.6	0.645	7286	0.080	1174

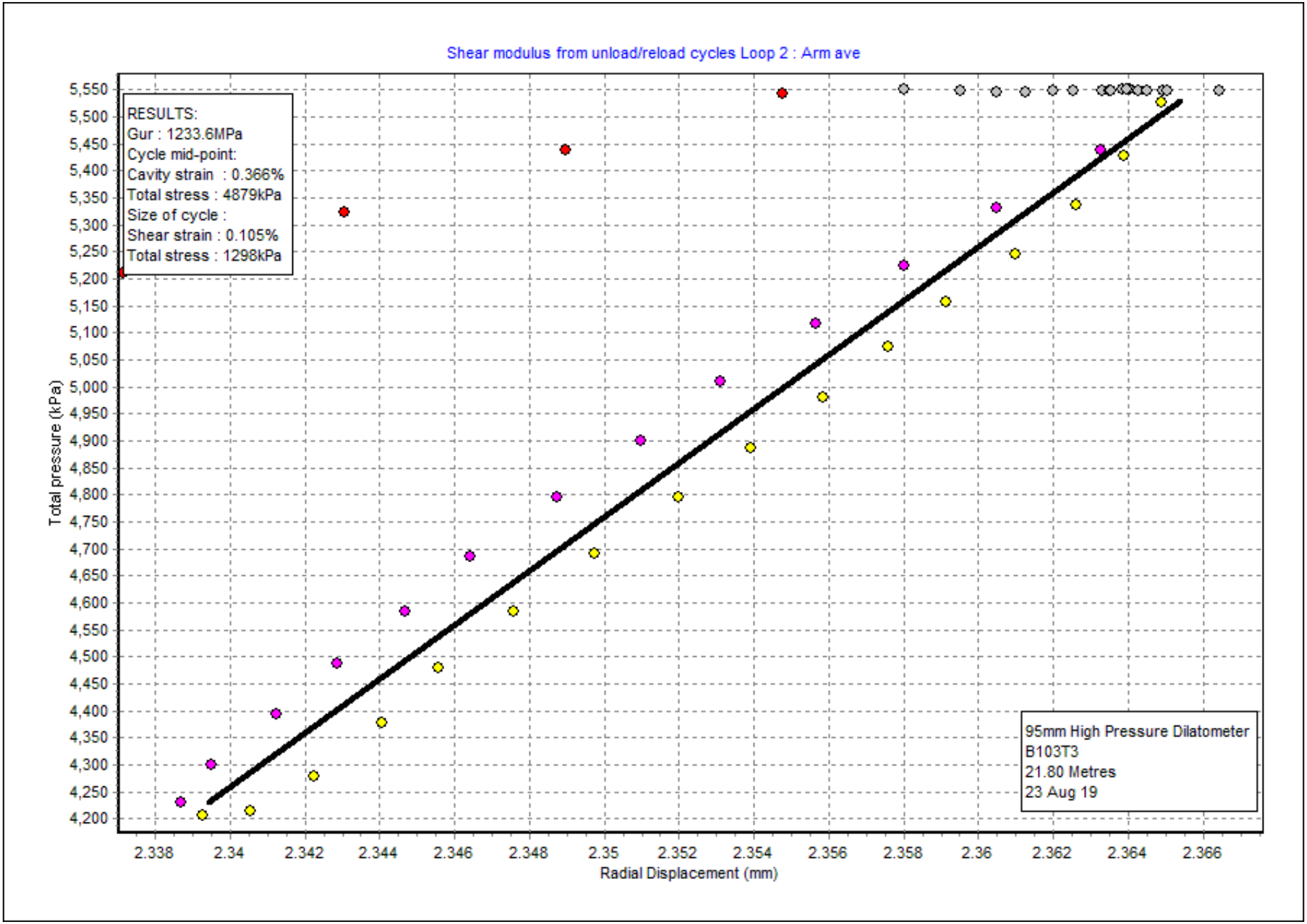
[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]

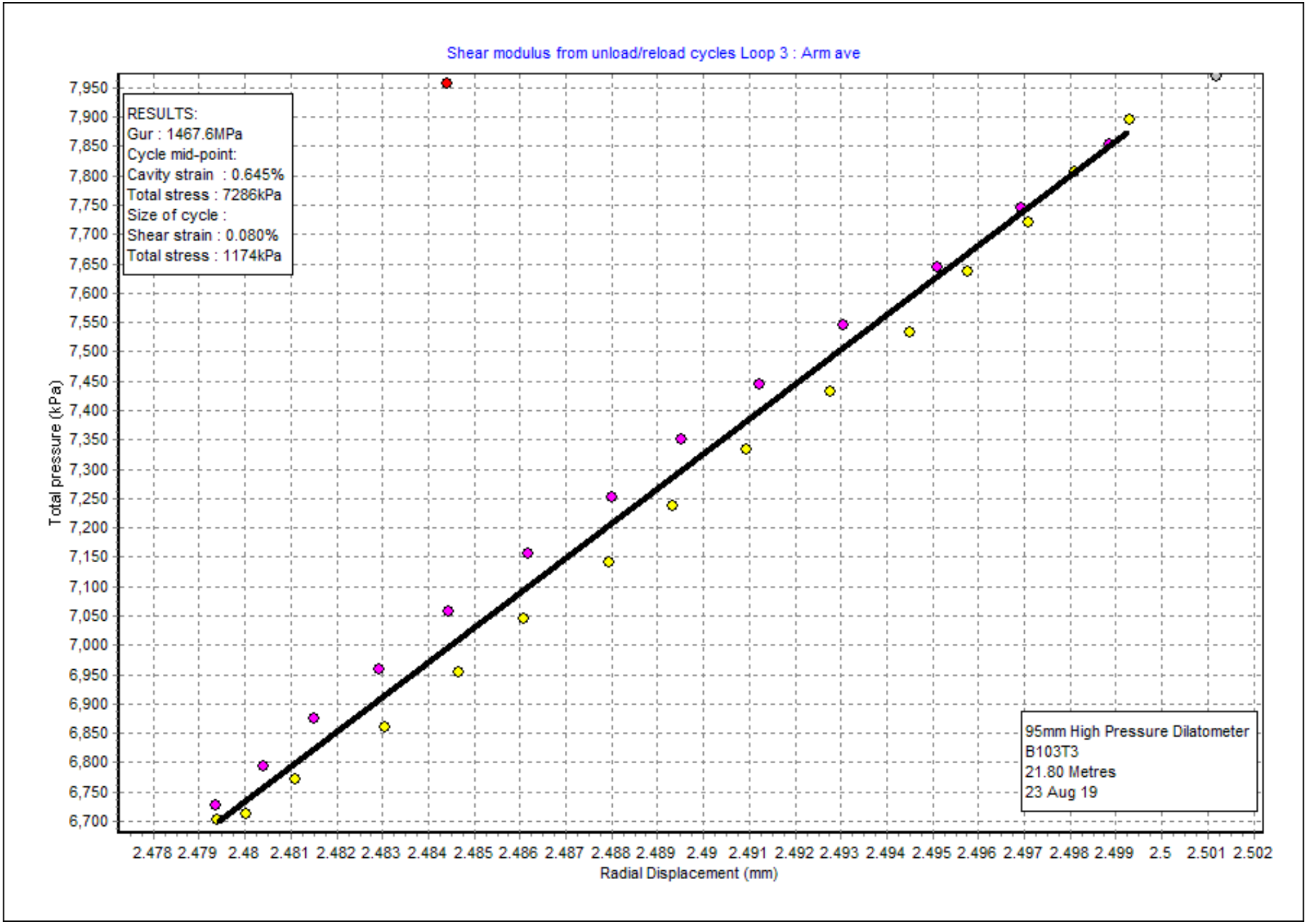
Axis	Loop No	Intercept (MPa)	Alpha (MPa)	Gradient
Arm ave	1	386.936	332.669	0.860
Arm ave	2	391.328	326.064	0.833
Arm ave	3	557.734	483.451	0.867

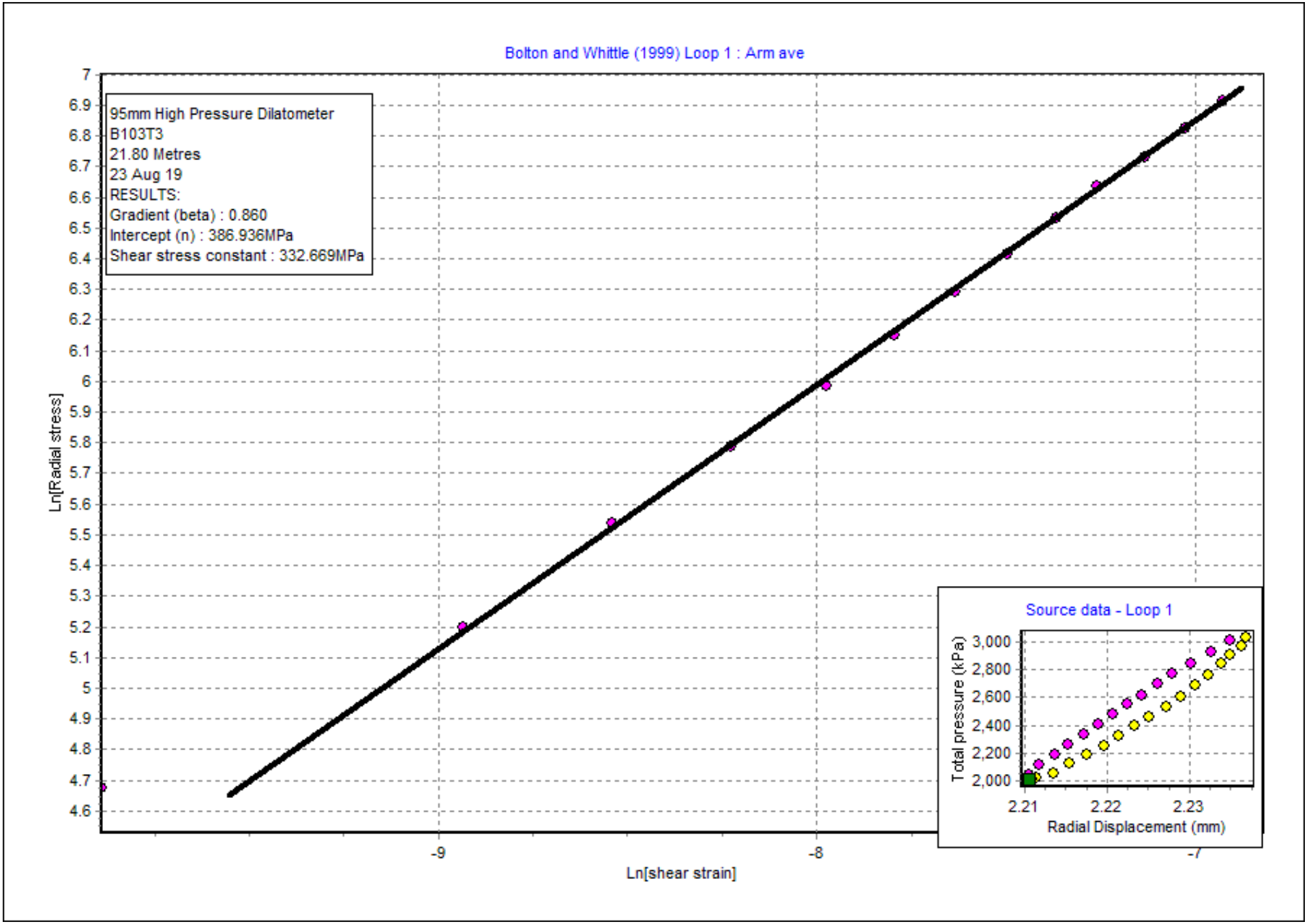

Po of cohesive material (1977, 1990) : Arm ave
95mm High Pressure Dilatometer
B103T3
21.80 Metres
23 Aug 19
RESULTS:
Gi : 483.8MPa
Pf :
Po :
Tf :
Po + Tf :
Origin : 2.071mm
Total pressure (kPa)
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
1
2
Radial Displacement (mm)

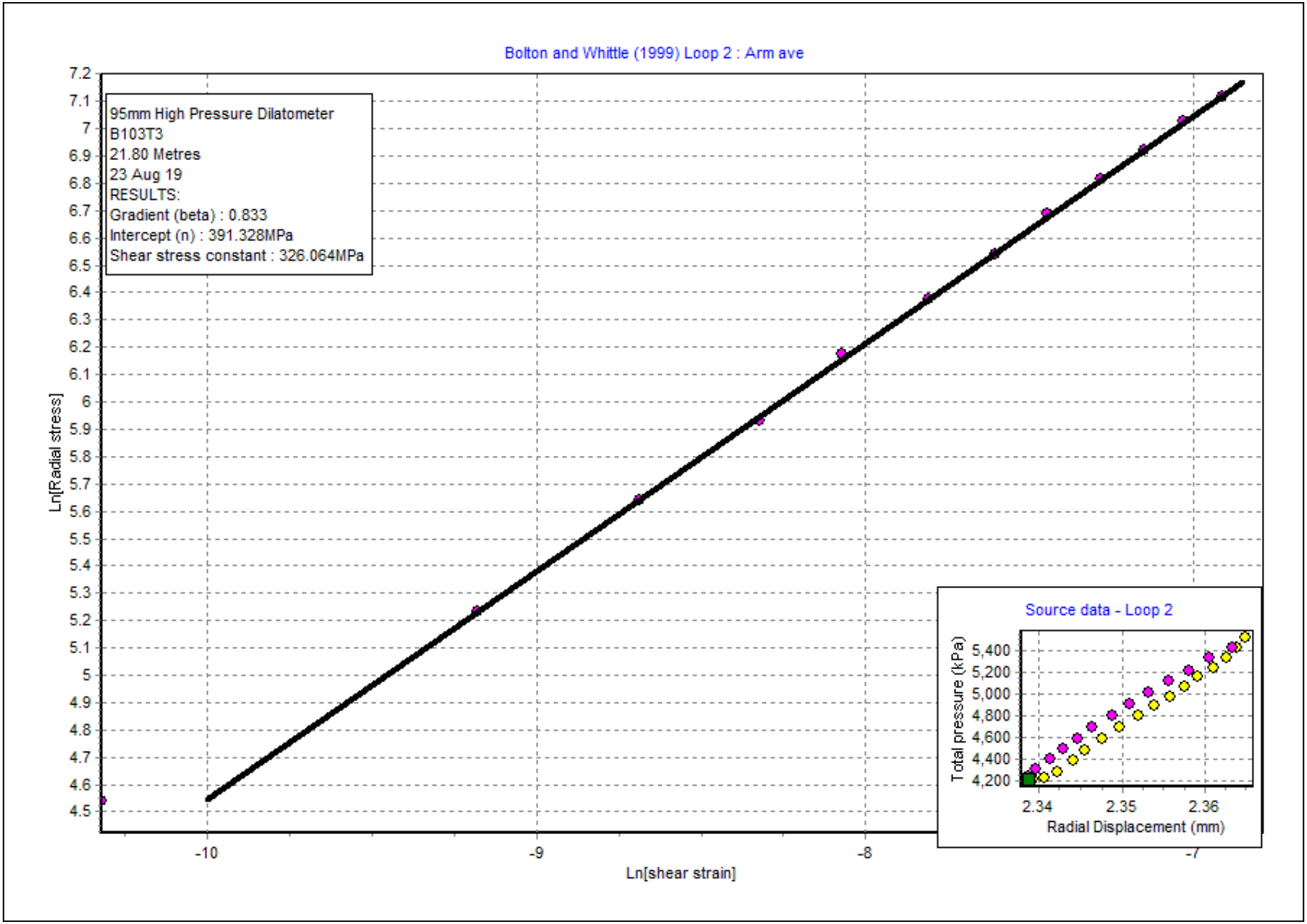

Cavity strain vs Total Pressure : Arm ave
Total pressure (kPa)
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
-4.5
-4
-3.5
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
Cavity strain (%)
95mm High Pressure Dilatometer
B103T3
21.80 Metres
23 Aug 19

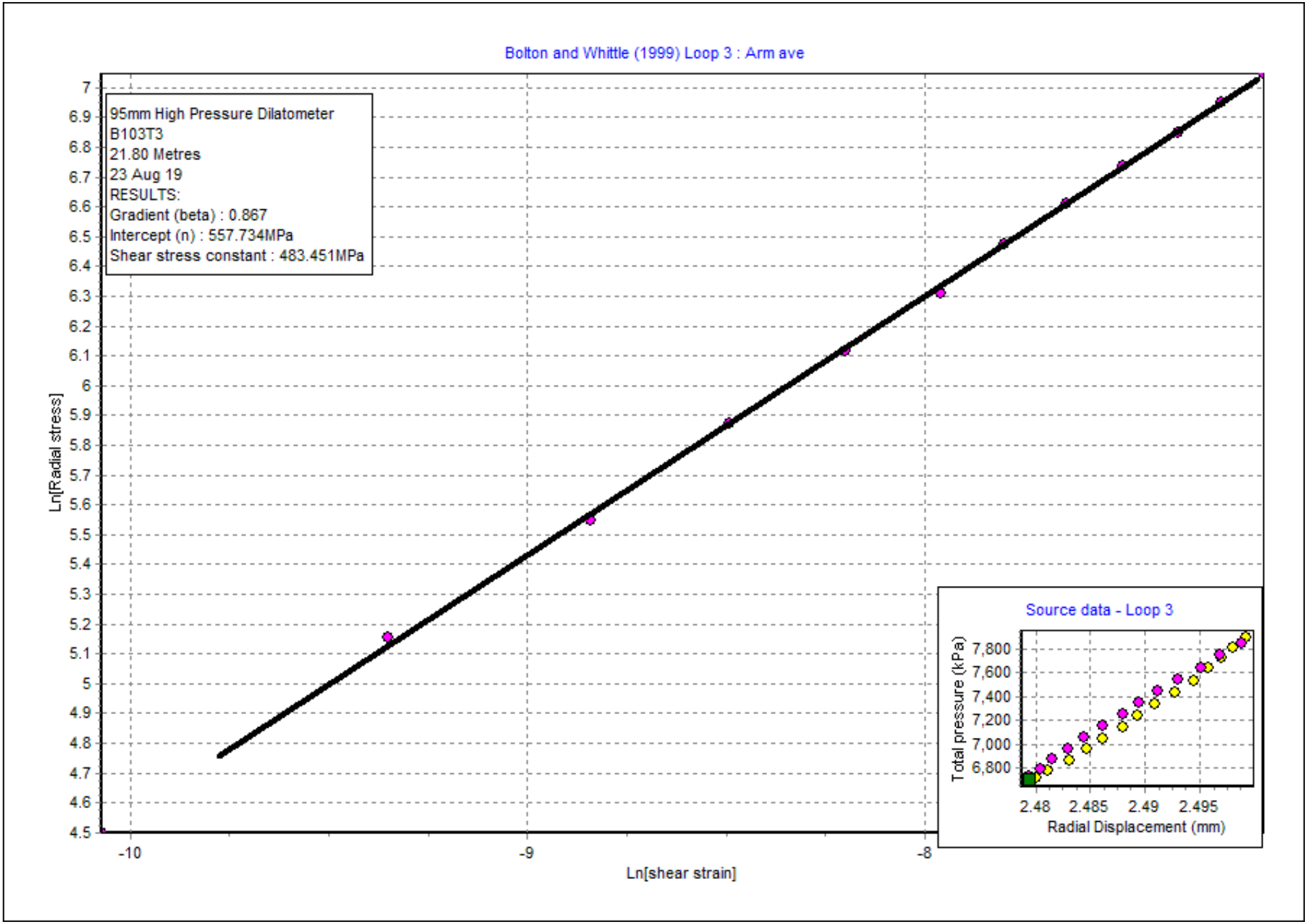

Shear modulus from unload/reload cycles Loop 1 : Arm ave
RESULTS:
Gur : 991.0MPa
Cycle mid-point:
Cavity strain : 0.105%
Total stress : 2548kPa
Size of cycle :
Shear strain : 0.106%
Total stress : 1055kPa
95mm High Pressure Dilatometer
B103T3
21.80 Metres
23 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
3,100
3,050
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
2,000
2.21
2.212
2.214
2.216
2.218
2.22
2.222
2.224
2.226
2.228
2.23
2.232
2.234
2.236
2.238

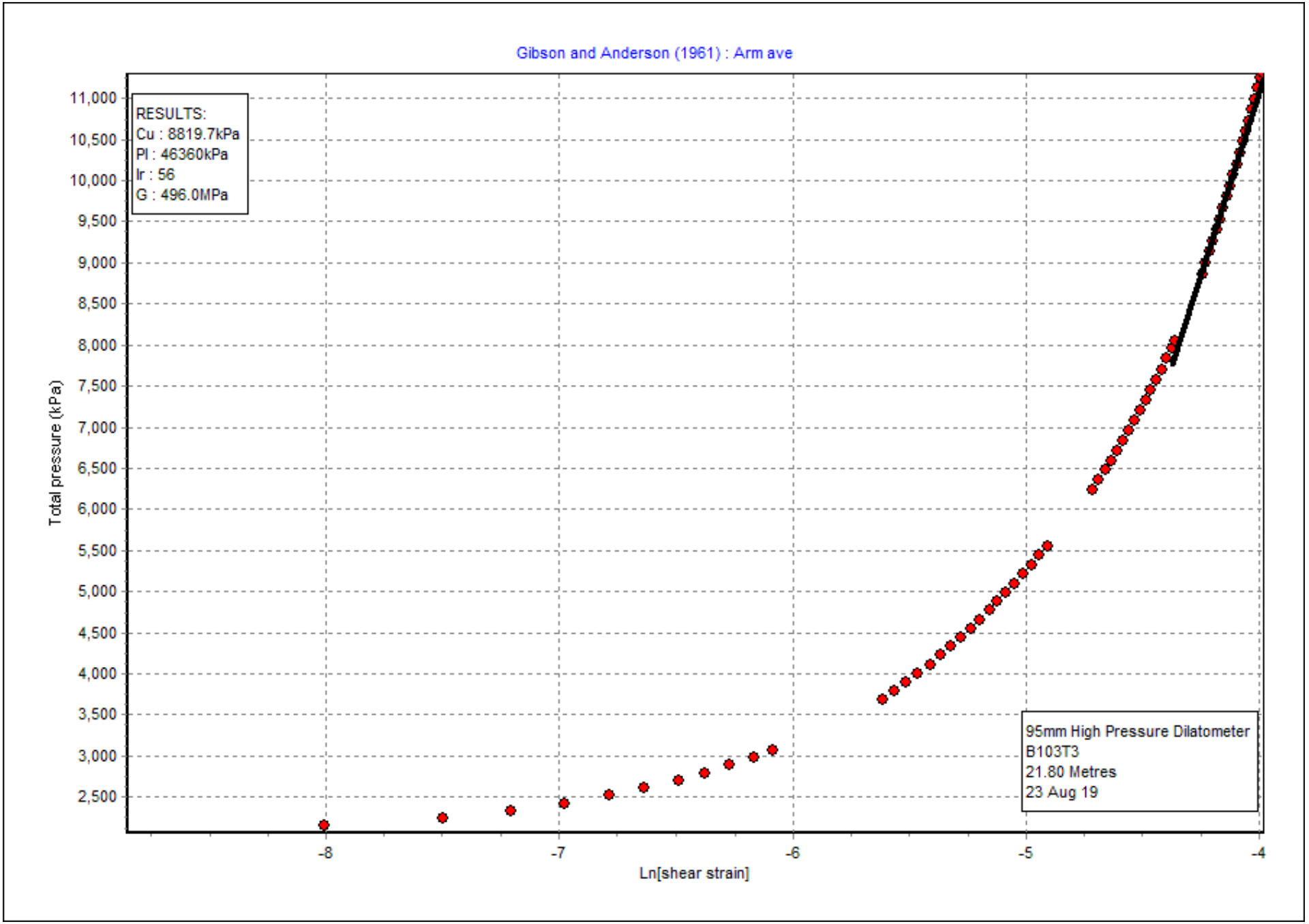

Shear modulus from unload/reload cycles Loop 2 : Arm ave
RESULTS:
Gur : 1233.6MPa
Cycle mid-point:
Cavity strain : 0.366%
Total stress : 4879kPa
Size of cycle :
Shear strain : 0.105%
Total stress : 1298kPa
95mm High Pressure Dilatometer
B103T3
21.80 Metres
23 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
5,550
5,500
5,450
5,400
5,350
5,300
5,250
5,200
5,150
5,100
5,050
5,000
4,950
4,900
4,850
4,800
4,750
4,700
4,650
4,600
4,550
4,500
4,450
4,400
4,350
4,300
4,250
4,200
2.338
2.34
2.342
2.344
2.346
2.348
2.35
2.352
2.354
2.356
2.358
2.36
2.362
2.364
2.366

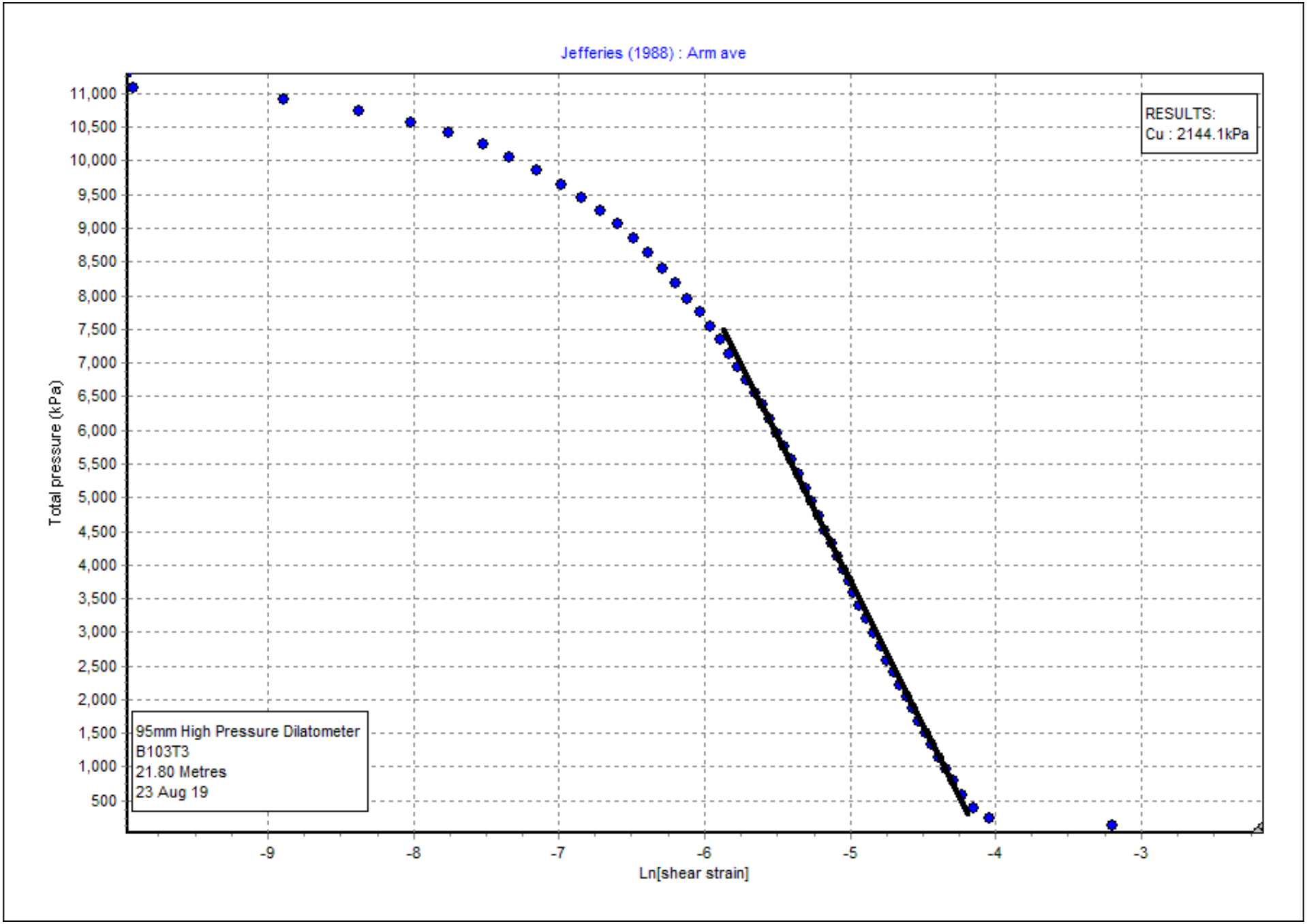

Shear modulus from unload/reload cycles Loop 3 : Arm ave
RESULTS:
Gur : 1467.6MPa
Cycle mid-point:
Cavity strain : 0.645%
Total stress : 7286kPa
Size of cycle :
Shear strain : 0.080%
Total stress : 1174kPa
95mm High Pressure Dilatometer
B103T3
21.80 Metres
23 Aug 19
Total pressure (kPa)
7,950
7,900
7,850
7,800
7,750
7,700
7,650
7,600
7,550
7,500
7,450
7,400
7,350
7,300
7,250
7,200
7,150
7,100
7,050
7,000
6,950
6,900
6,850
6,800
6,750
6,700
2.478 2.479 2.48 2.481 2.482 2.483 2.484 2.485 2.486 2.487 2.488 2.489 2.49 2.491 2.492 2.493 2.494 2.495 2.496 2.497 2.498 2.499 2.5 2.501 2.502
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 1 : Arm ave
95mm High Pressure Dilatometer
B103T3
21.80 Metres
23 Aug 19
RESULTS:
Gradient (beta) : 0.860
Intercept (n) : 386.936MPa
Shear stress constant : 332.669MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 1
Total pressure (kPa)
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 2 : Arm ave
95mm High Pressure Dilatometer
B103T3
21.80 Metres
23 Aug 19
RESULTS:
Gradient (beta) : 0.833
Intercept (n) : 391.328MPa
Shear stress constant : 326.064MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 2
Total pressure (kPa)
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 3 : Arm ave
95mm High Pressure Dilatometer
B103T3
21.80 Metres
23 Aug 19
RESULTS:
Gradient (beta) : 0.867
Intercept (n) : 557.734MPa
Shear stress constant : 483.451MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 3
Total pressure (kPa)
Radial Displacement (mm)


Gibson and Anderson (1961) : Arm ave
RESULTS:
Cu : 8819.7kPa
PI : 46360kPa
Ir : 56
G : 496.0MPa
95mm High Pressure Dilatometer
B103T3
21.80 Metres
23 Aug 19
Total pressure (kPa)
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
-8
-7
-6
-5
-4
Ln[shear strain]


Jefferies (1988) : Arm ave
RESULTS:
Cu : 2144.1kPa
95mm High Pressure Dilatometer
B103T3
21.80 Metres
23 Aug 19
Total pressure (kPa)
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
-9
-8
-7
-6
-5
-4
-3
Ln[shear strain]

B103T4 - SUMMARY OF RESULTS
[File made with WinSitu Version 3.9.1.1]

[DETAILS OF TEST]
Project : Crown Street, Manchester
Site : M9019 Crown Street
Borehole : BH103
Test name : B103T4
Test date : 23 Aug 19
Test depth : 26.30 Metres
Water table : 3.00 Metres
Ambient PWP : 228.6 kPa
Material : Sandstone
Probe : 95mm High Pressure Dilatometer
Diameter : 94.0 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out

Analysed by IRC on 27 Aug 19

Remarks: Pocket 25.5-27m

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm) : "Arm ave=2.05"
Best estimate of Po (kPa) : "Arm ave=2250.0"

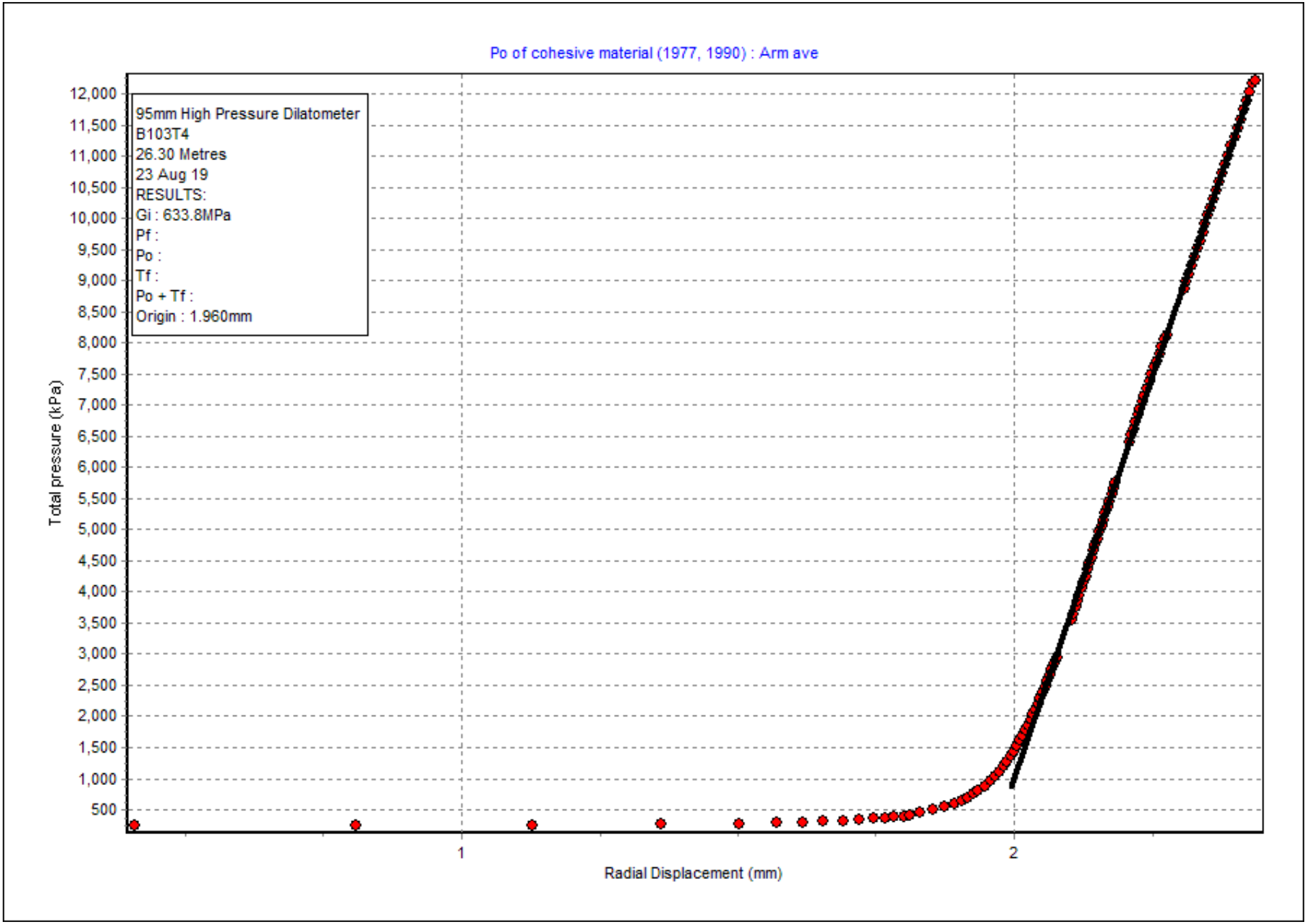
[UNDRAINED STRENGTH PARAMETERS]
Gibson & Anderson 1961 - Cu (kPa) : "Arm ave=8618.0"
Limit pressure (kPa) : "Arm ave=47956"
Jefferies 1988 - Cu (kPa) : "Arm ave=2626.2"

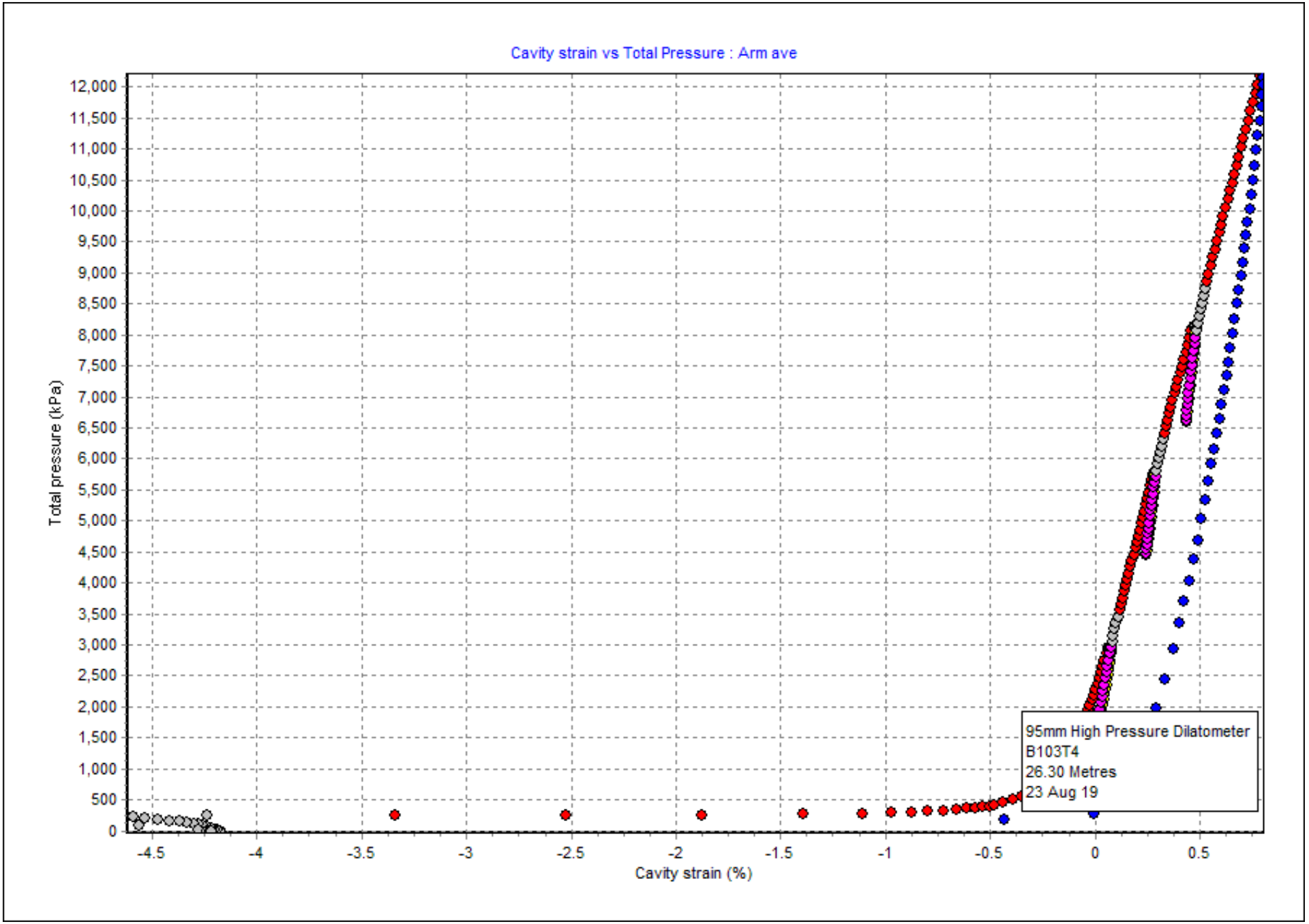
[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=633.8"

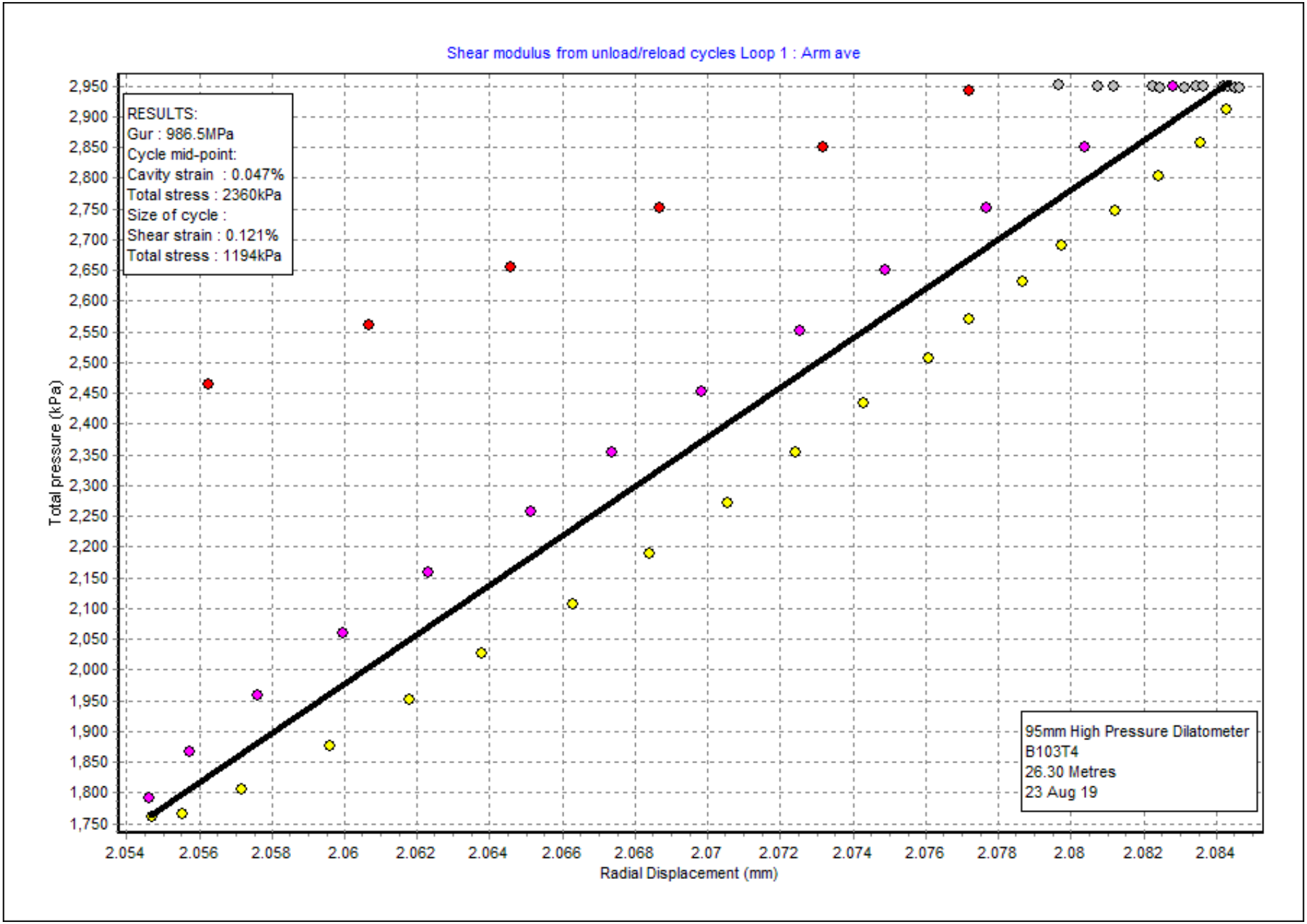
Axis	Loop No	Value (MPa)	Mean Strain (%)	Mean Pc (kPa)	dE (%)	dPc (kPa)
Arm ave	1	986.5	0.047	2360	0.121	1194
Arm ave	2	1449.5	0.267	5089	0.086	1240
Arm ave	3	1509.1	0.457	7282	0.091	1381

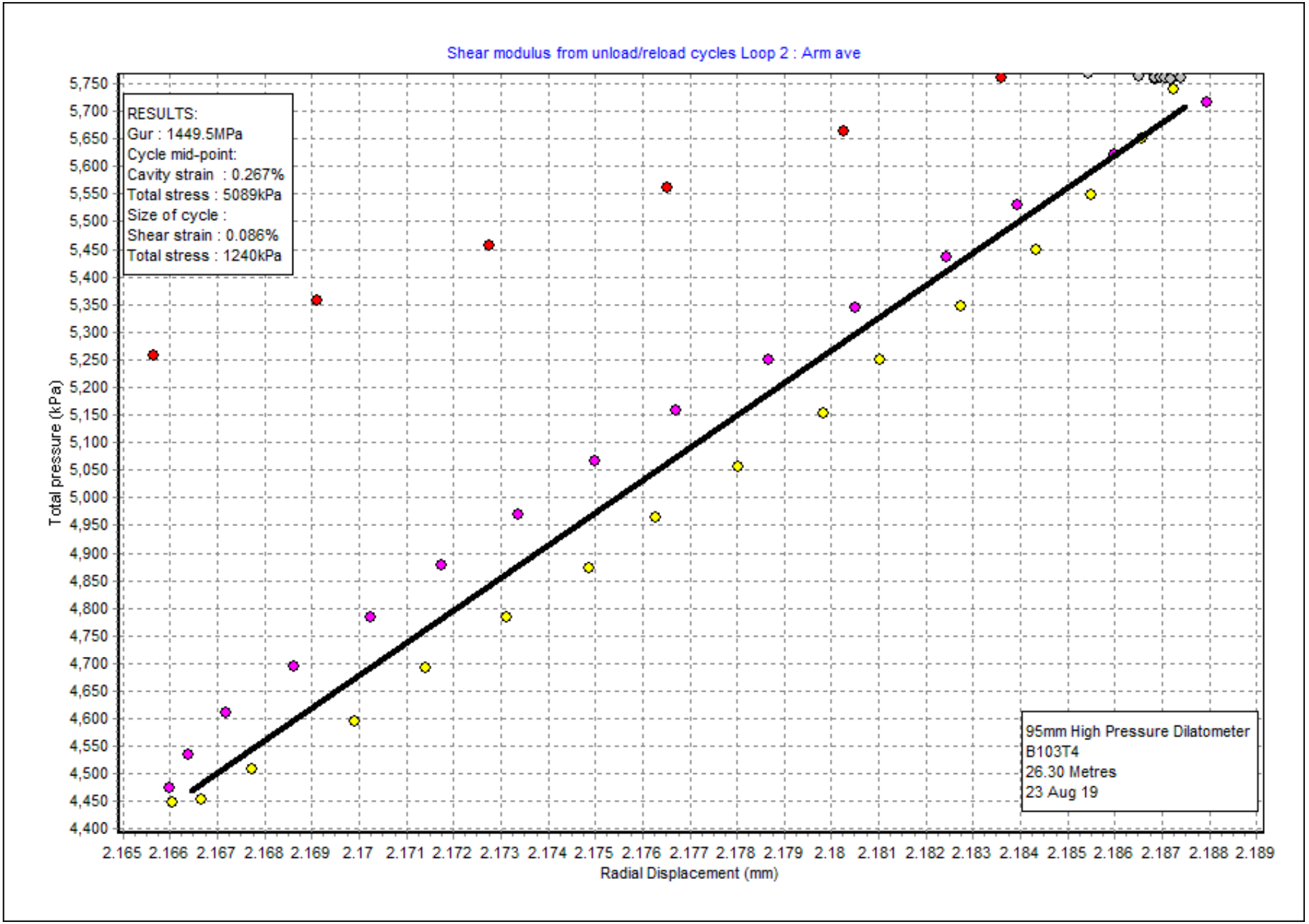
[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]

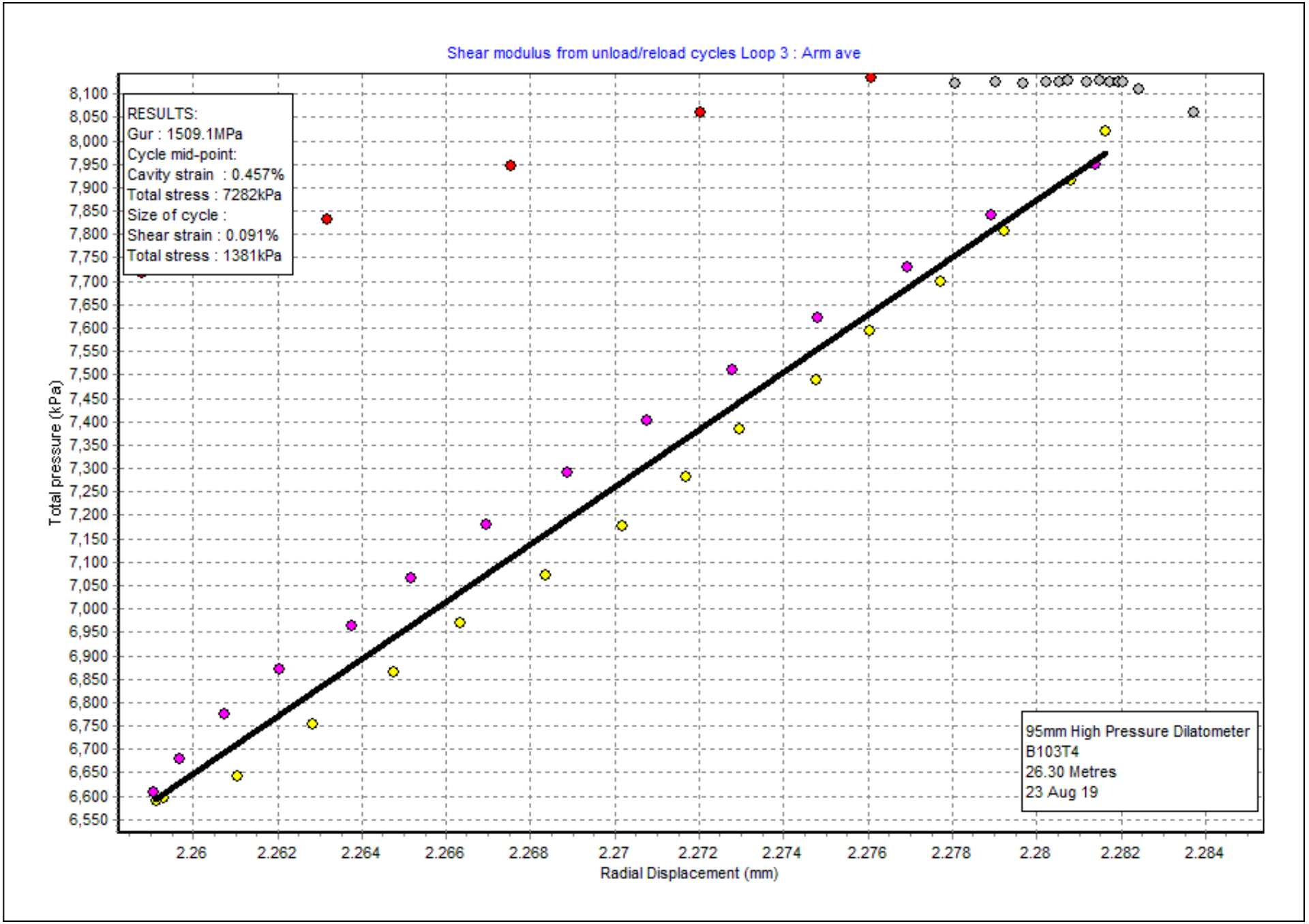
Axis	Loop No	Intercept (MPa)	Alpha (MPa)	Gradient
Arm ave	1	413.381	357.657	0.865
Arm ave	2	354.069	284.278	0.803
Arm ave	3	437.397	359.558	0.822

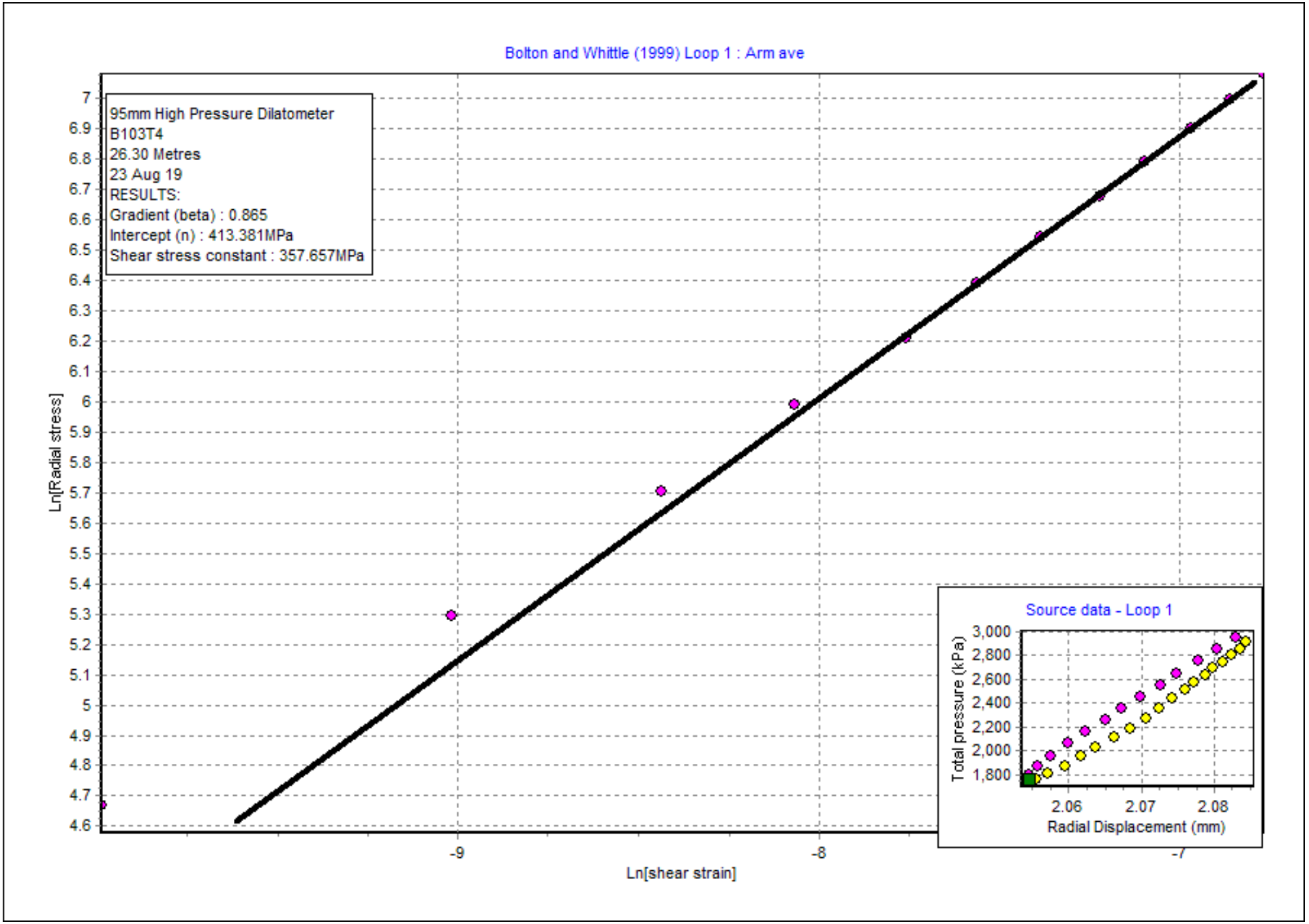

Po of cohesive material (1977, 1990) : Arm ave
95mm High Pressure Dilatometer
B103T4
26.30 Metres
23 Aug 19
RESULTS:
Gi : 633.8MPa
Pf :
Po :
Tf :
Po + Tf :
Origin : 1.960mm
Total pressure (kPa)
12,000
11,500
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
1
2
Radial Displacement (mm)

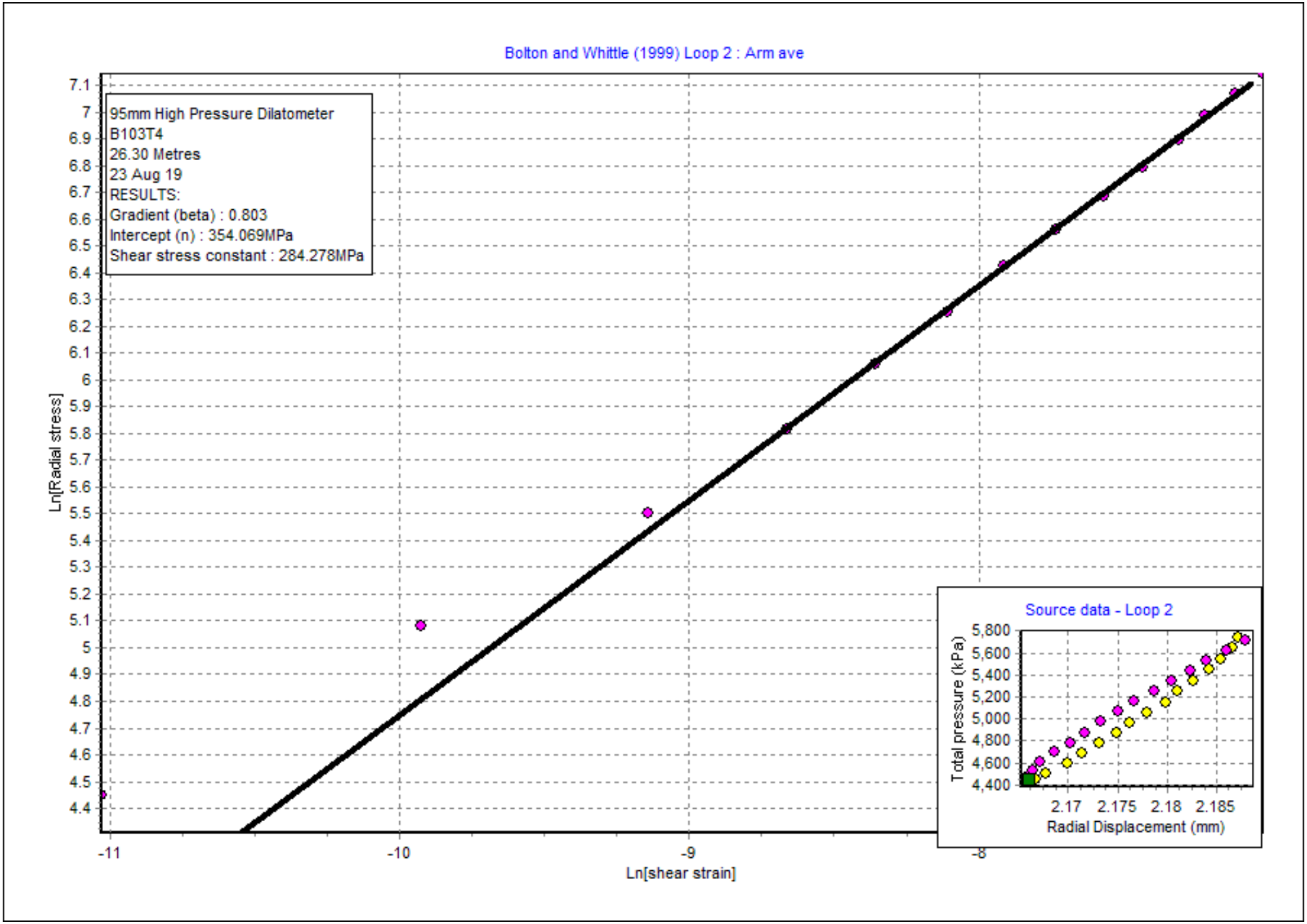

Cavity strain vs Total Pressure : Arm ave
Total pressure (kPa)
12,000
11,500
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
-4.5
-4
-3.5
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
Cavity strain (%)
95mm High Pressure Dilatometer
B103T4
26.30 Metres
23 Aug 19

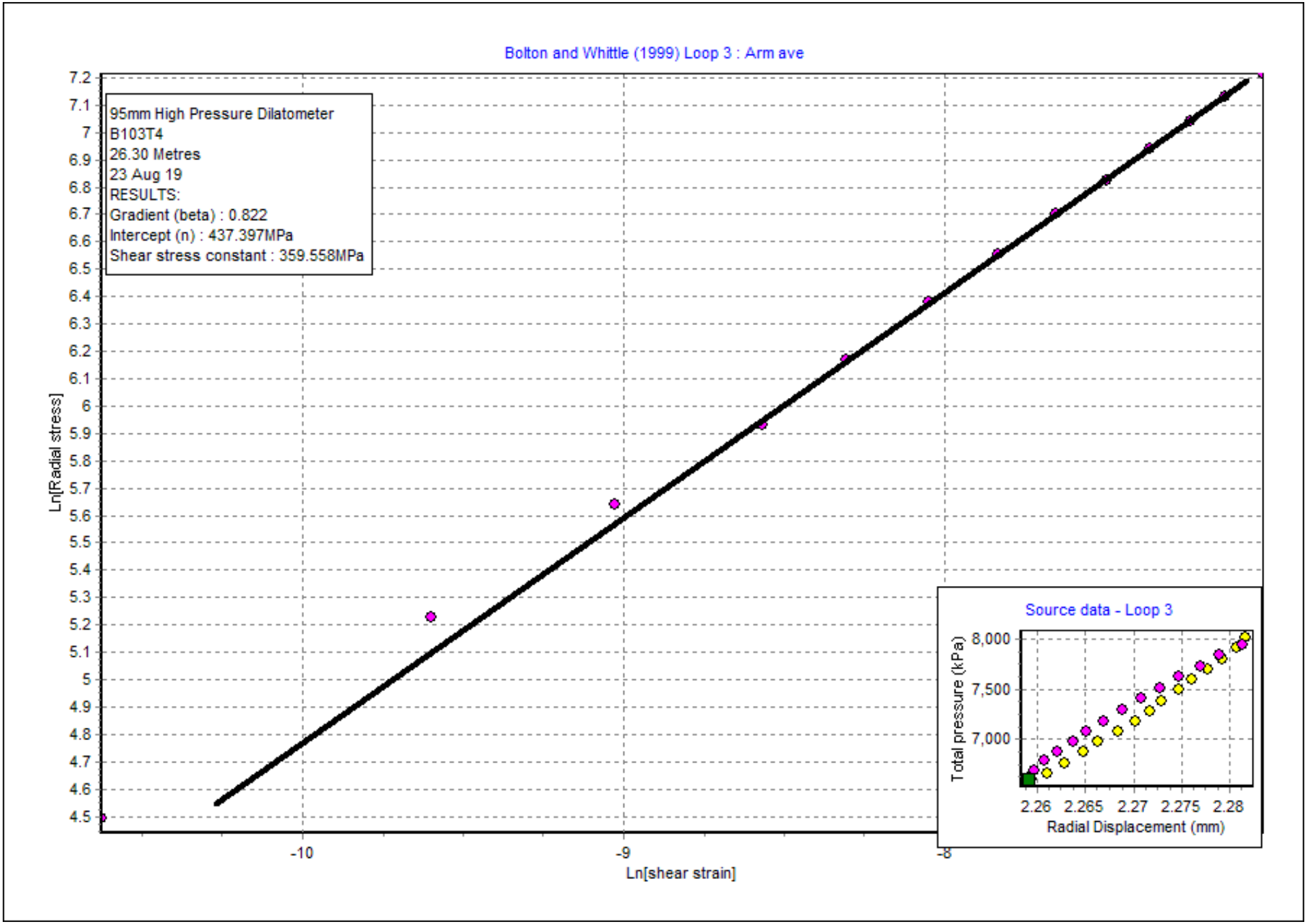

Shear modulus from unload/reload cycles Loop 1 : Arm ave
RESULTS:
Gur : 986.5MPa
Cycle mid-point:
Cavity strain : 0.047%
Total stress : 2360kPa
Size of cycle :
Shear strain : 0.121%
Total stress : 1194kPa
95mm High Pressure Dilatometer
B103T4
26.30 Metres
23 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
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
2,000
1,950
1,900
1,850
1,800
1,750
2.054
2.056
2.058
2.06
2.062
2.064
2.066
2.068
2.07
2.072
2.074
2.076
2.078
2.08
2.082
2.084

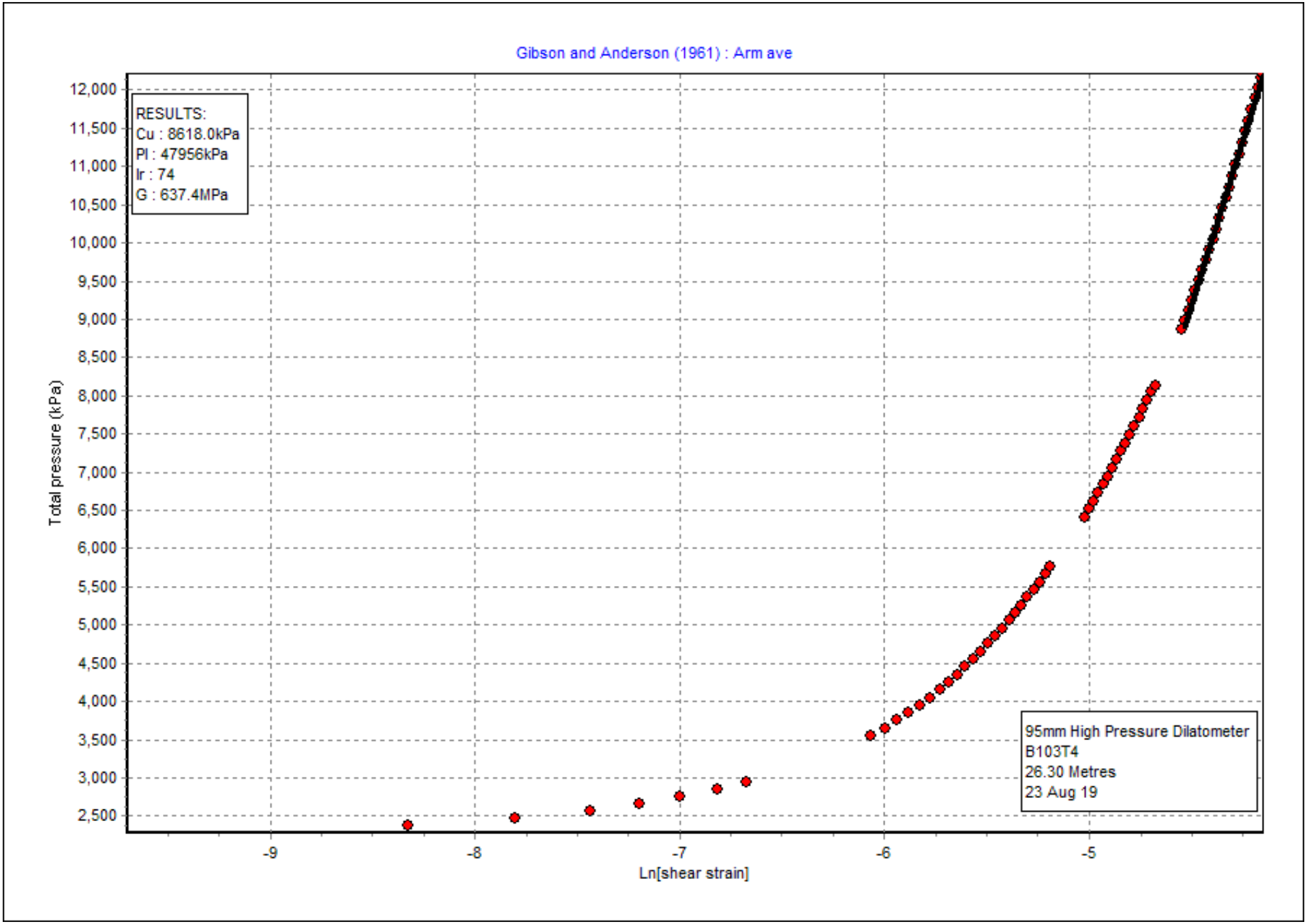

Shear modulus from unload/reload cycles Loop 2 : Arm ave
RESULTS:
Gur : 1449.5MPa
Cycle mid-point:
Cavity strain : 0.267%
Total stress : 5089kPa
Size of cycle :
Shear strain : 0.086%
Total stress : 1240kPa
95mm High Pressure Dilatometer
B103T4
26.30 Metres
23 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
5,750
5,700
5,650
5,600
5,550
5,500
5,450
5,400
5,350
5,300
5,250
5,200
5,150
5,100
5,050
5,000
4,950
4,900
4,850
4,800
4,750
4,700
4,650
4,600
4,550
4,500
4,450
4,400
2.165 2.166 2.167 2.168 2.169 2.17 2.171 2.172 2.173 2.174 2.175 2.176 2.177 2.178 2.179 2.18 2.181 2.182 2.183 2.184 2.185 2.186 2.187 2.188 2.189

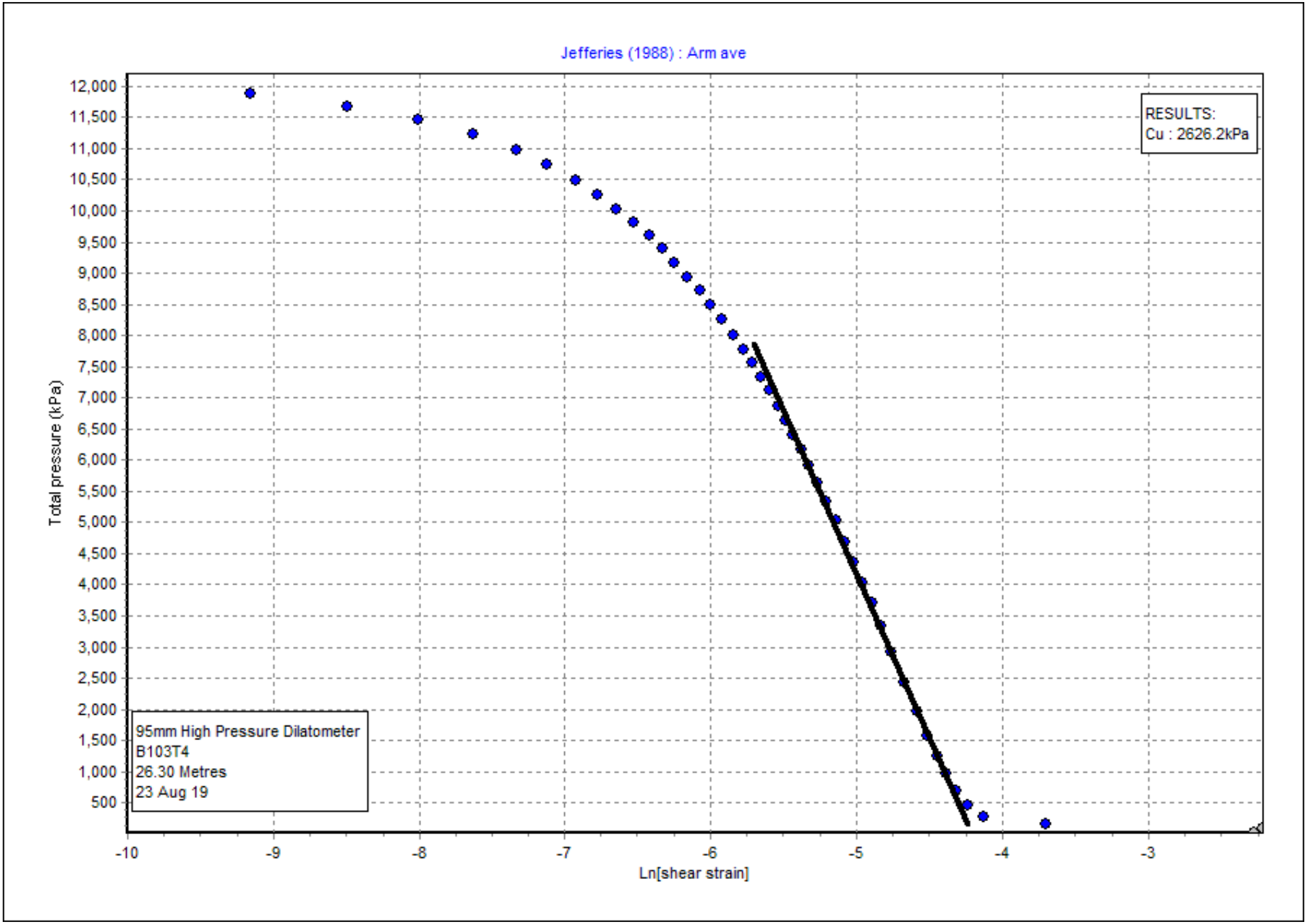

Shear modulus from unload/reload cycles Loop 3 : Arm ave
RESULTS:
Gur : 1509.1MPa
Cycle mid-point:
Cavity strain : 0.457%
Total stress : 7282kPa
Size of cycle :
Shear strain : 0.091%
Total stress : 1381kPa
95mm High Pressure Dilatometer
B103T4
26.30 Metres
23 Aug 19
Total pressure (kPa)
8,100
8,050
8,000
7,950
7,900
7,850
7,800
7,750
7,700
7,650
7,600
7,550
7,500
7,450
7,400
7,350
7,300
7,250
7,200
7,150
7,100
7,050
7,000
6,950
6,900
6,850
6,800
6,750
6,700
6,650
6,600
6,550
2.26
2.262
2.264
2.266
2.268
2.27
2.272
2.274
2.276
2.278
2.28
2.282
2.284
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 1 : Arm ave
95mm High Pressure Dilatometer
B103T4
26.30 Metres
23 Aug 19
RESULTS:
Gradient (beta) : 0.865
Intercept (n) : 413.381MPa
Shear stress constant : 357.657MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 1
Total pressure (kPa)
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 2 : Arm ave
95mm High Pressure Dilatometer
B103T4
26.30 Metres
23 Aug 19
RESULTS:
Gradient (beta) : 0.803
Intercept (n) : 354.069MPa
Shear stress constant : 284.278MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 2
Total pressure (kPa)
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 3 : Arm ave
95mm High Pressure Dilatometer
B103T4
26.30 Metres
23 Aug 19
RESULTS:
Gradient (beta) : 0.822
Intercept (n) : 437.397MPa
Shear stress constant : 359.558MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 3
Total pressure (kPa)
Radial Displacement (mm)


Gibson and Anderson (1961) : Arm ave
RESULTS:
Cu : 8618.0kPa
PI : 47956kPa
Ir : 74
G : 637.4MPa
95mm High Pressure Dilatometer
B103T4
26.30 Metres
23 Aug 19
Total pressure (kPa)
12,000
11,500
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
-9
-8
-7
-6
-5
Ln[shear strain]


Jefferies (1988) : Arm ave
RESULTS:
Cu : 2626.2kPa
95mm High Pressure Dilatometer
B103T4
26.30 Metres
23 Aug 19
Total pressure (kPa)
12,000
11,500
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
-10
-9
-8
-7
-6
-5
-4
-3
Ln[shear strain]

B103T5 - SUMMARY OF RESULTS
[File made with WinSitu Version 3.9.1.1]

[DETAILS OF TEST]
Project : Crown Street, Manchester
Site : M9019 Crown Street
Borehole : BH103
Test name : B103T5
Test date : 27 Aug 19
Test depth : 30.80 Metres
Water table : 3.00 Metres
Ambient PWP : 272.7 kPa
Material : Sandstone
Probe : 95mm High Pressure Dilatometer
Diameter : 94.0 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out

Analysed by IRC on 28 Aug 19

Remarks: Pocket 30-31.5m 1055am

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm) : "Arm ave=1.93"
Best estimate of Po (kPa) : "Arm ave=2200.0"

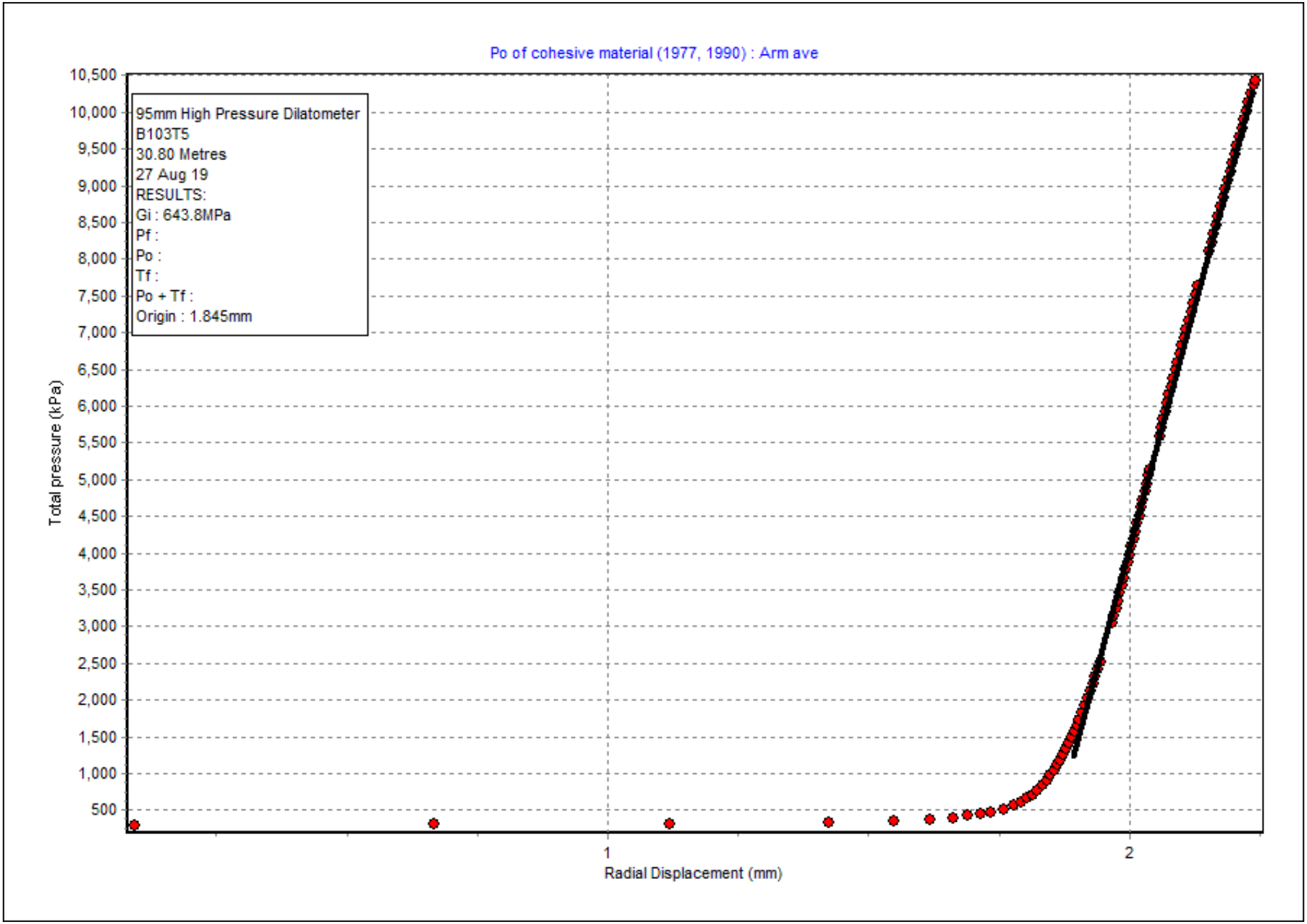
[UNDRAINED STRENGTH PARAMETERS]
Gibson & Anderson 1961 - Cu (kPa) : "Arm ave=7118.3"
Limit pressure (kPa) : "Arm ave=41508"
Jefferies 1988 - Cu (kPa) : "Arm ave=2169.9"

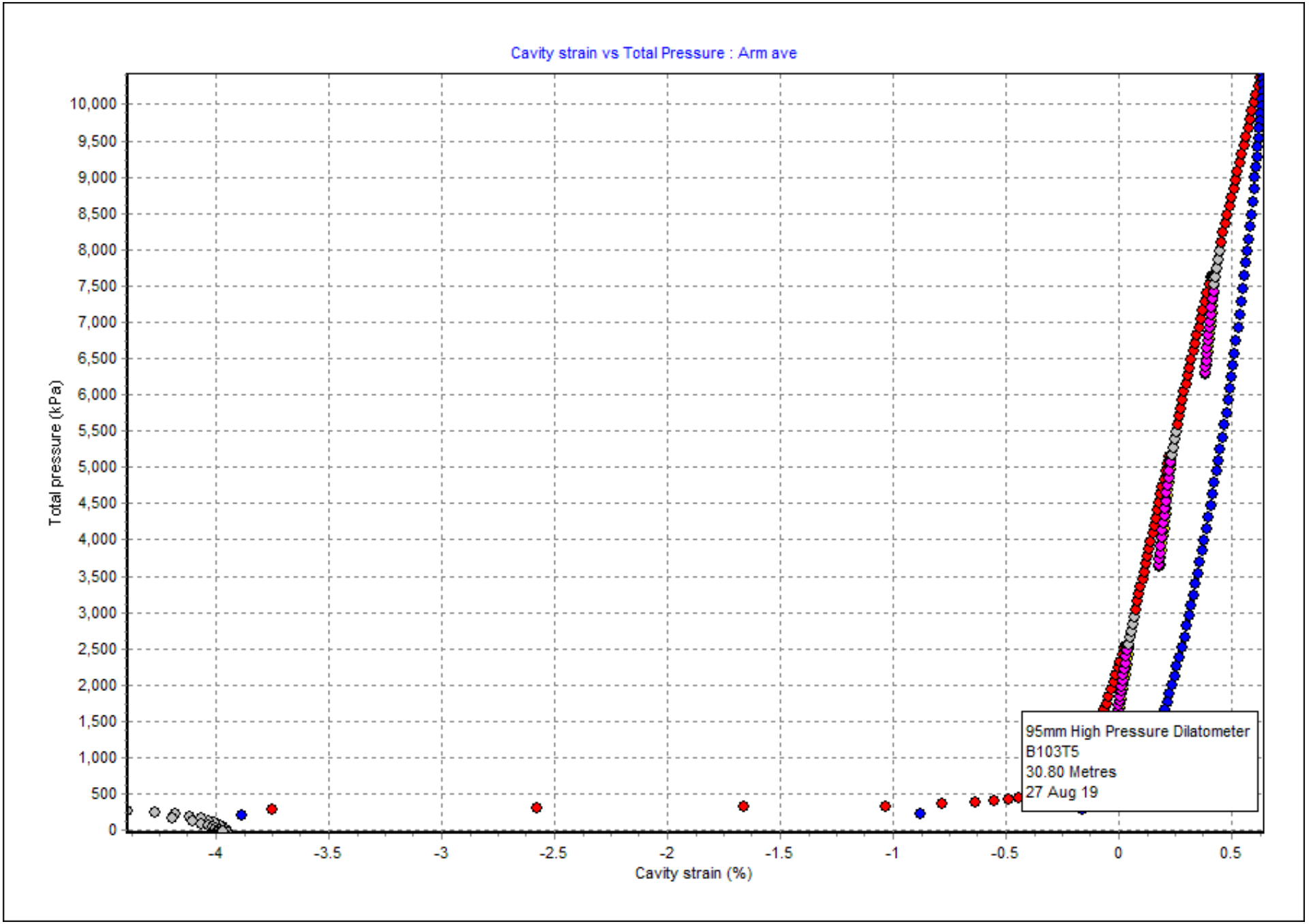
[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=643.8"

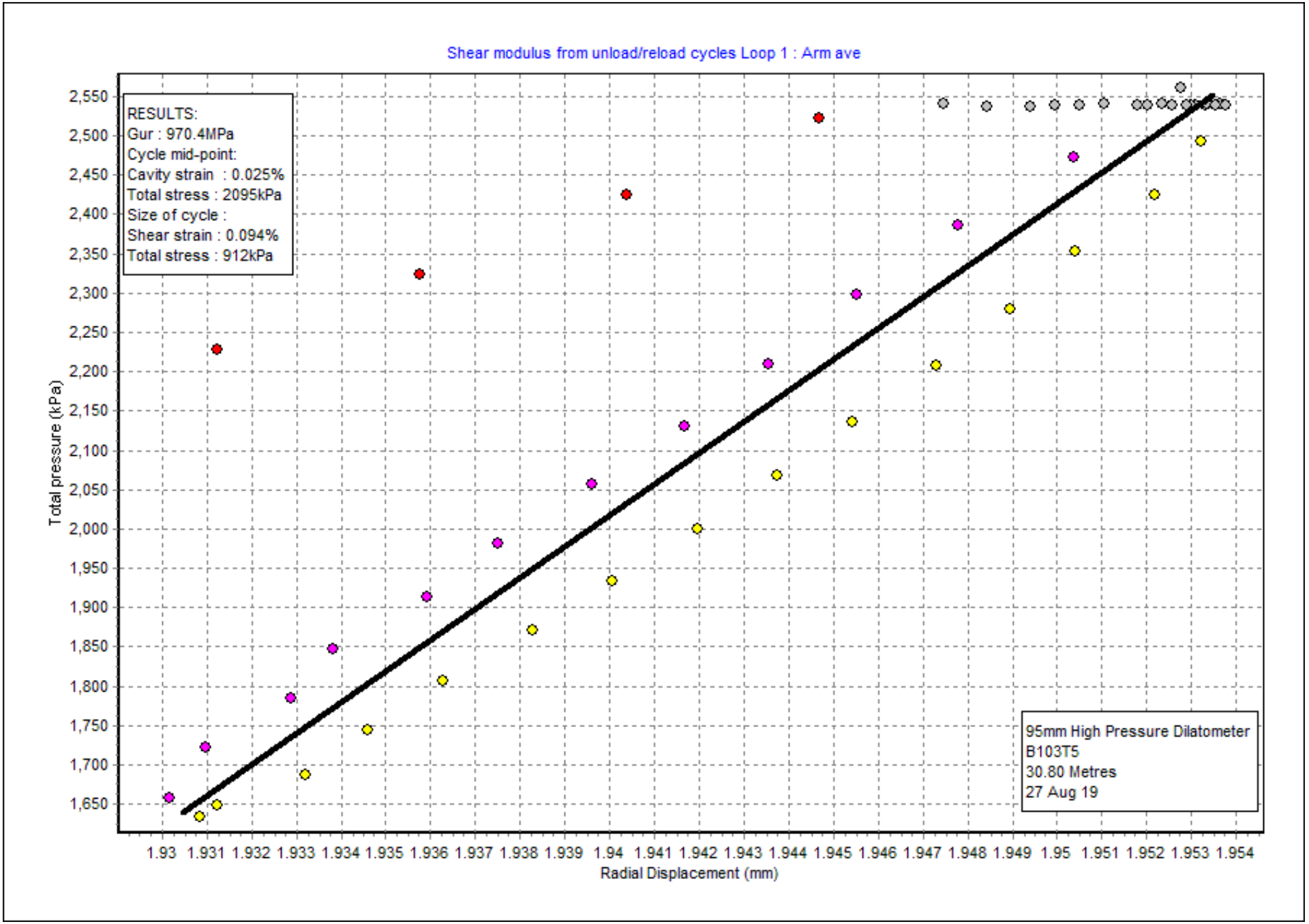
Axis	Loop No	Value (MPa)	Mean Strain (%)	Mean Pc (kPa)	dE (%)	dPc (kPa)
Arm ave	1	970.4	0.025	2095	0.094	912
Arm ave	2	1437.6	0.209	4368	0.102	1473
Arm ave	3	1540.1	0.407	6875	0.078	1203

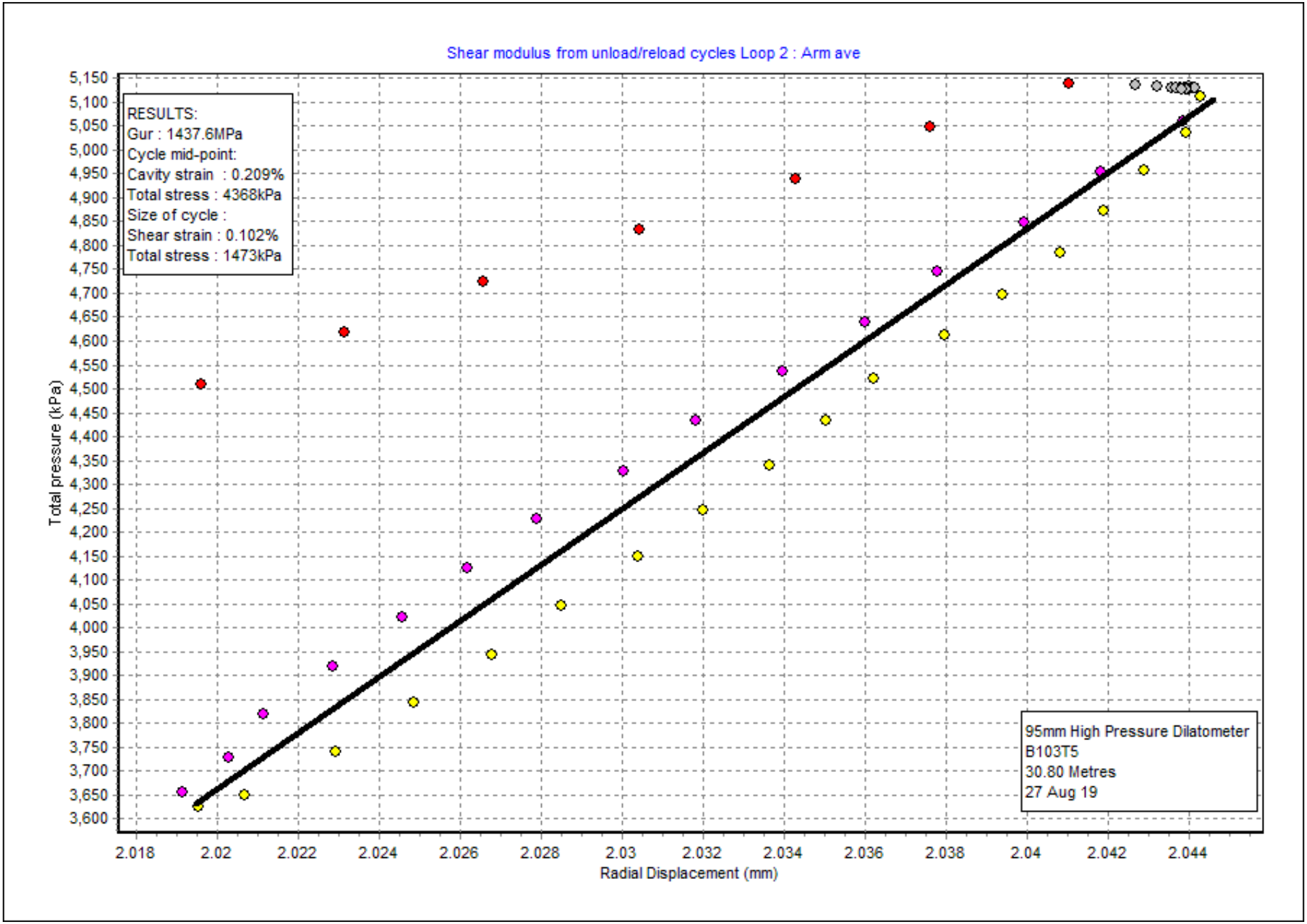
[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]

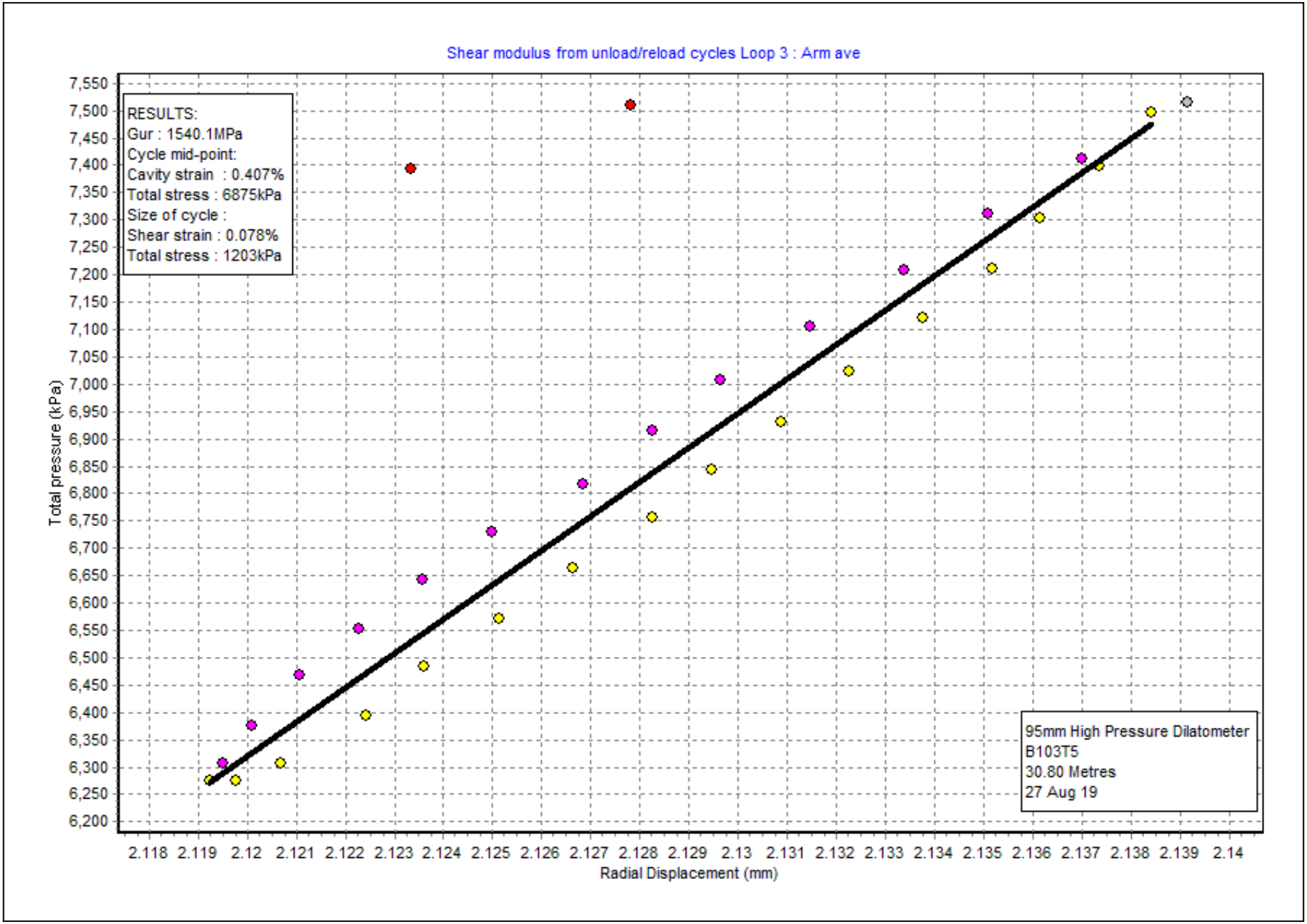
Axis	Loop No	Intercept (MPa)	Alpha (MPa)	Gradient
Arm ave	1	423.487	371.798	0.878
Arm ave	2	426.353	352.820	0.828
Arm ave	3	354.845	282.655	0.797

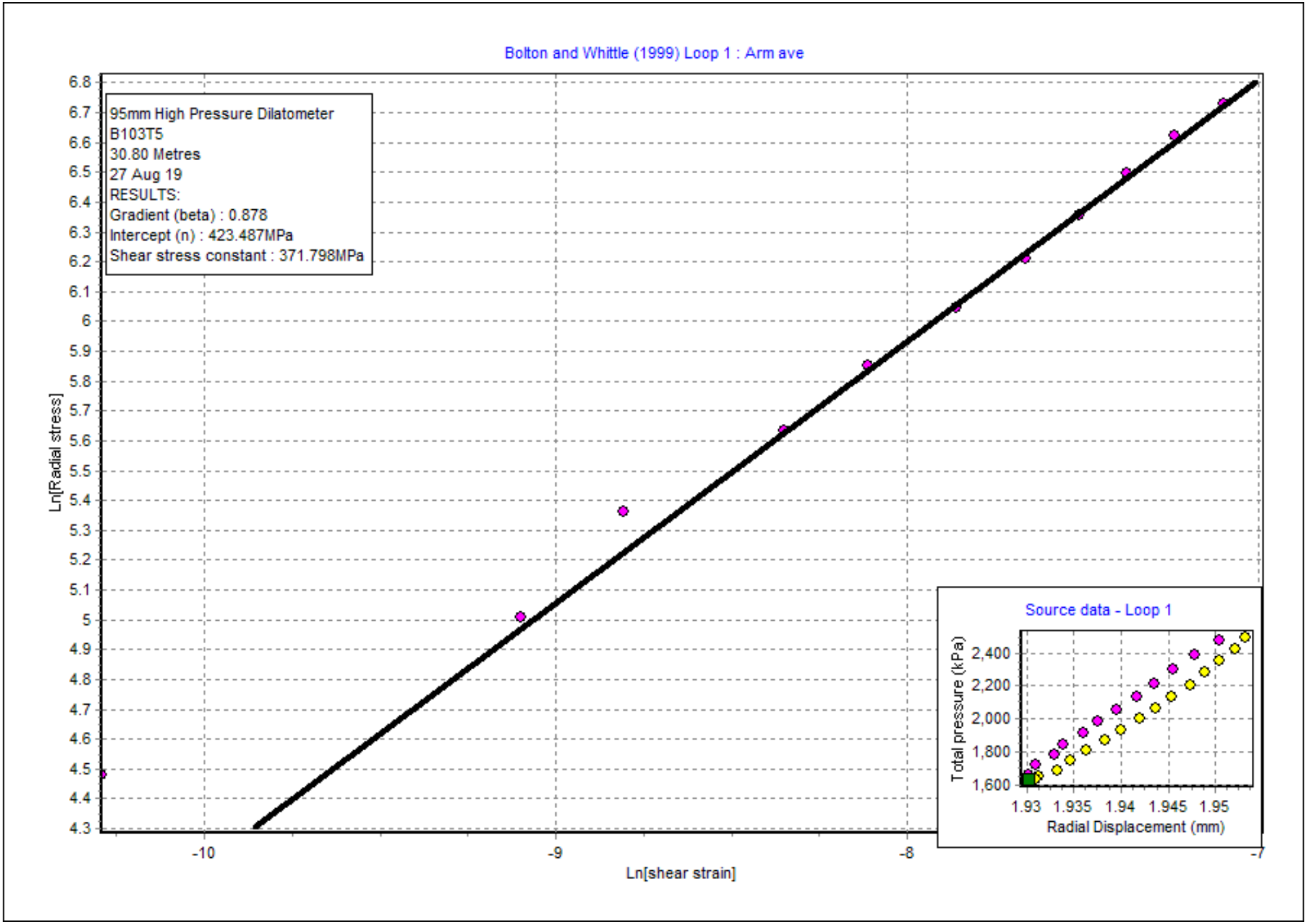

Po of cohesive material (1977, 1990) : Arm ave
95mm High Pressure Dilatometer
B103T5
30.80 Metres
27 Aug 19
RESULTS:
Gi : 643.8MPa
Pf :
Po :
Tf :
Po + Tf :
Origin : 1.845mm
Total pressure (kPa)
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
1
2
Radial Displacement (mm)

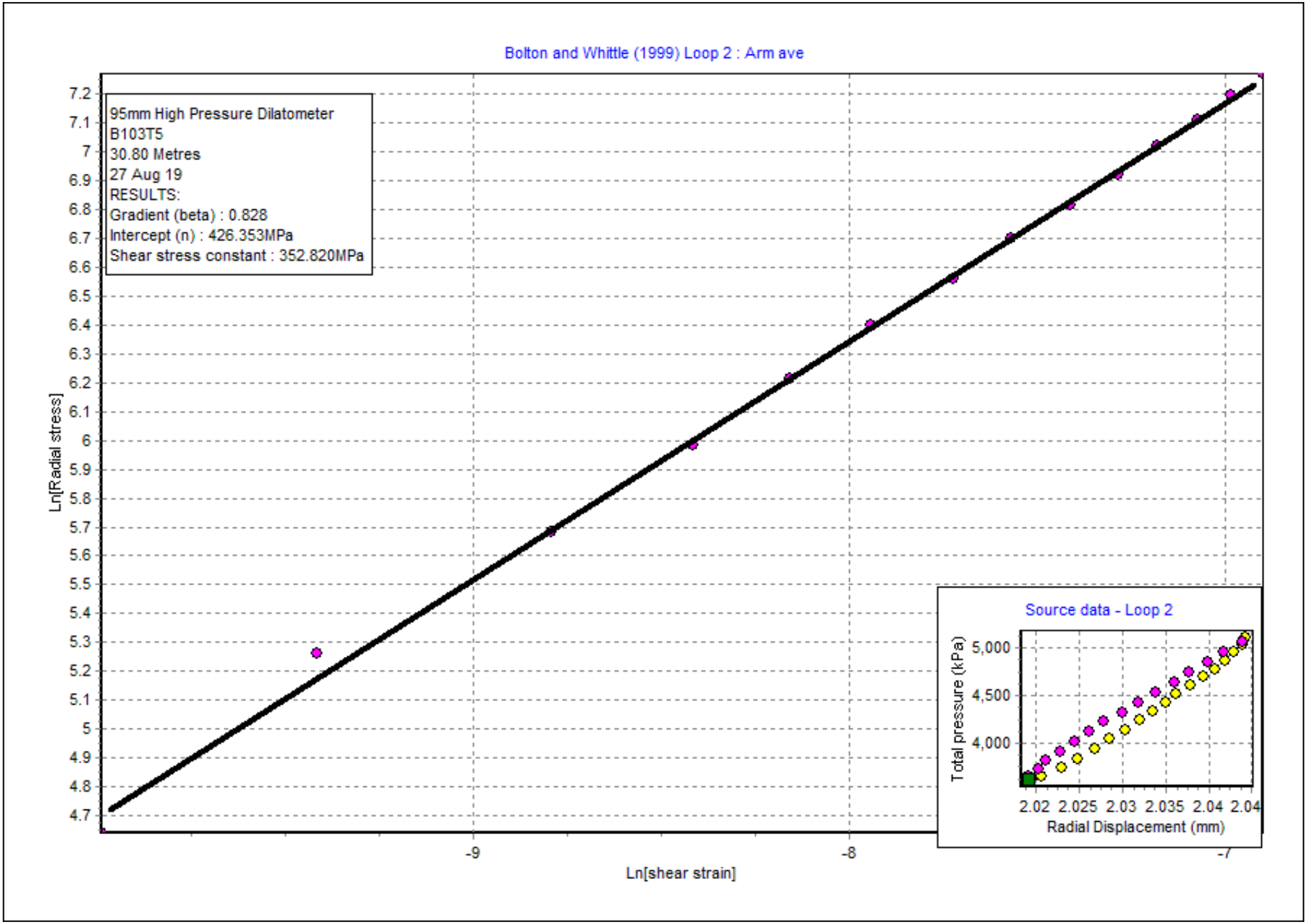

Cavity strain vs Total Pressure : Arm ave
Total pressure (kPa)
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
-4
-3.5
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
Cavity strain (%)
95mm High Pressure Dilatometer
B103T5
30.80 Metres
27 Aug 19

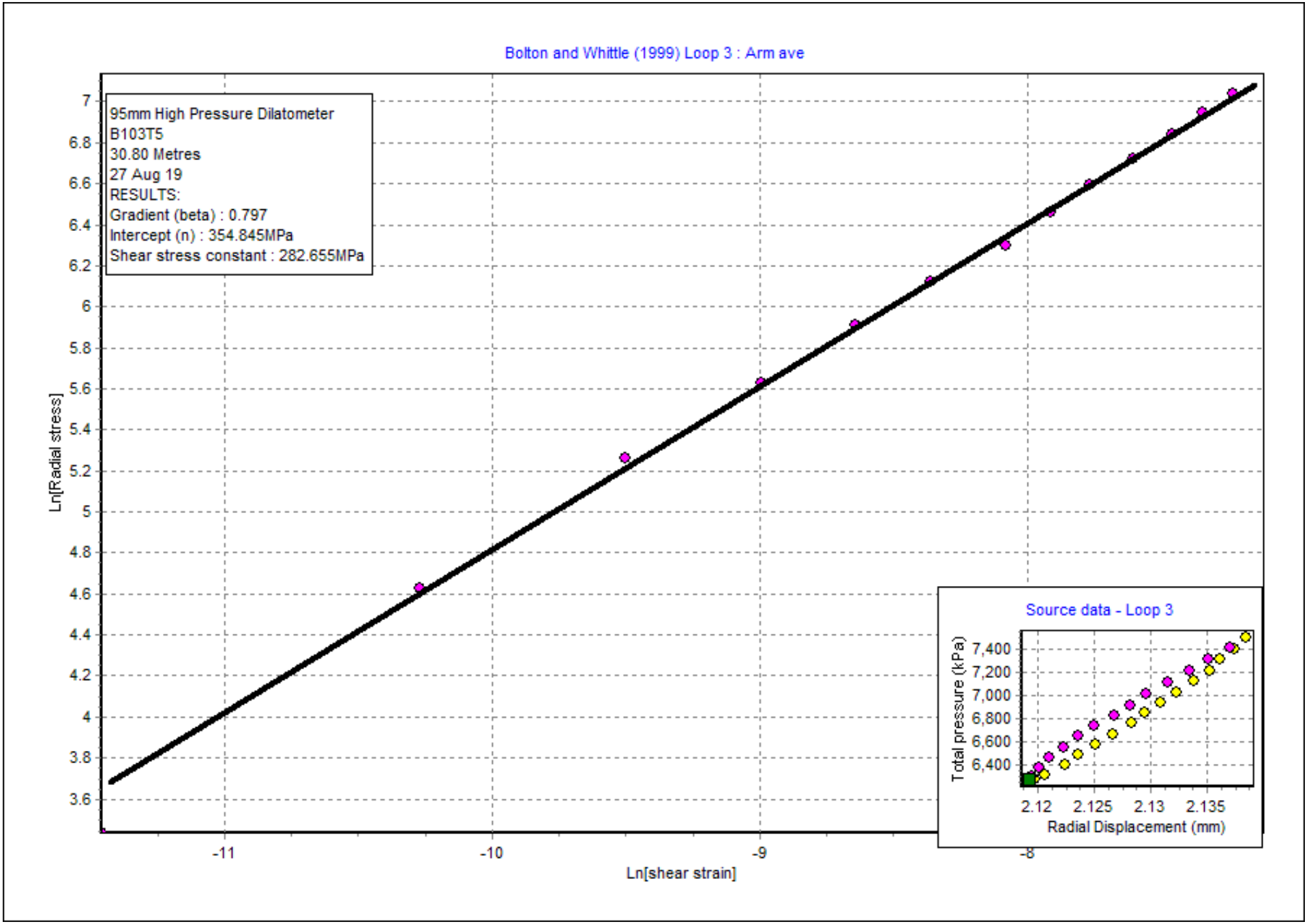

Shear modulus from unload/reload cycles Loop 1 : Arm ave
RESULTS:
Gur : 970.4MPa
Cycle mid-point:
Cavity strain : 0.025%
Total stress : 2095kPa
Size of cycle :
Shear strain : 0.094%
Total stress : 912kPa
95mm High Pressure Dilatometer
B103T5
30.80 Metres
27 Aug 19
Total pressure (kPa)
2,550
2,500
2,450
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
1,750
1,700
1,650
1.93 1.931 1.932 1.933 1.934 1.935 1.936 1.937 1.938 1.939 1.94 1.941 1.942 1.943 1.944 1.945 1.946 1.947 1.948 1.949 1.95 1.951 1.952 1.953 1.954
Radial Displacement (mm)

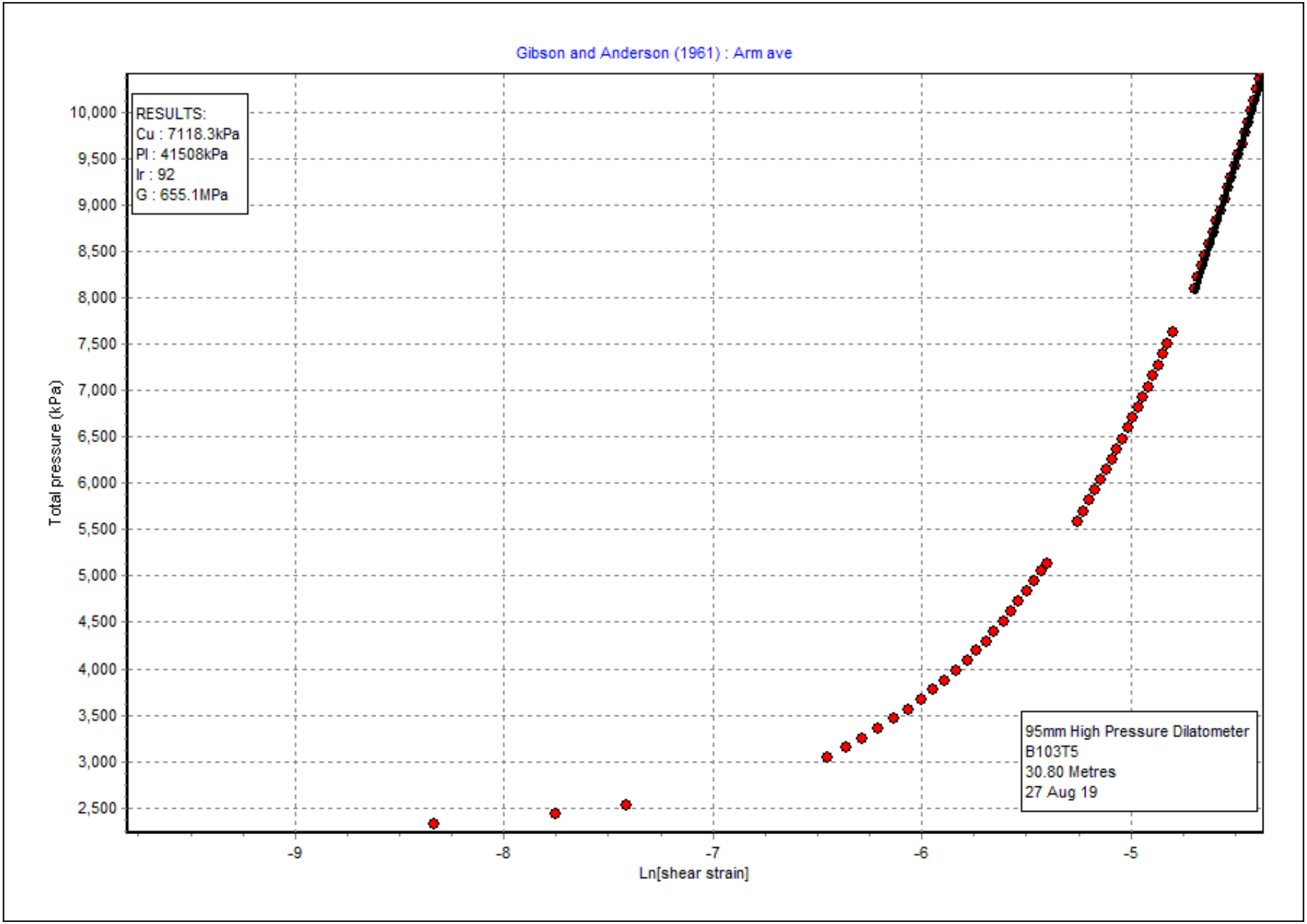

Shear modulus from unload/reload cycles Loop 2 : Arm ave
RESULTS:
Gur : 1437.6MPa
Cycle mid-point:
Cavity strain : 0.209%
Total stress : 4368kPa
Size of cycle :
Shear strain : 0.102%
Total stress : 1473kPa
95mm High Pressure Dilatometer
B103T5
30.80 Metres
27 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
5,150
5,100
5,050
5,000
4,950
4,900
4,850
4,800
4,750
4,700
4,650
4,600
4,550
4,500
4,450
4,400
4,350
4,300
4,250
4,200
4,150
4,100
4,050
4,000
3,950
3,900
3,850
3,800
3,750
3,700
3,650
3,600
2.018
2.02
2.022
2.024
2.026
2.028
2.03
2.032
2.034
2.036
2.038
2.04
2.042
2.044

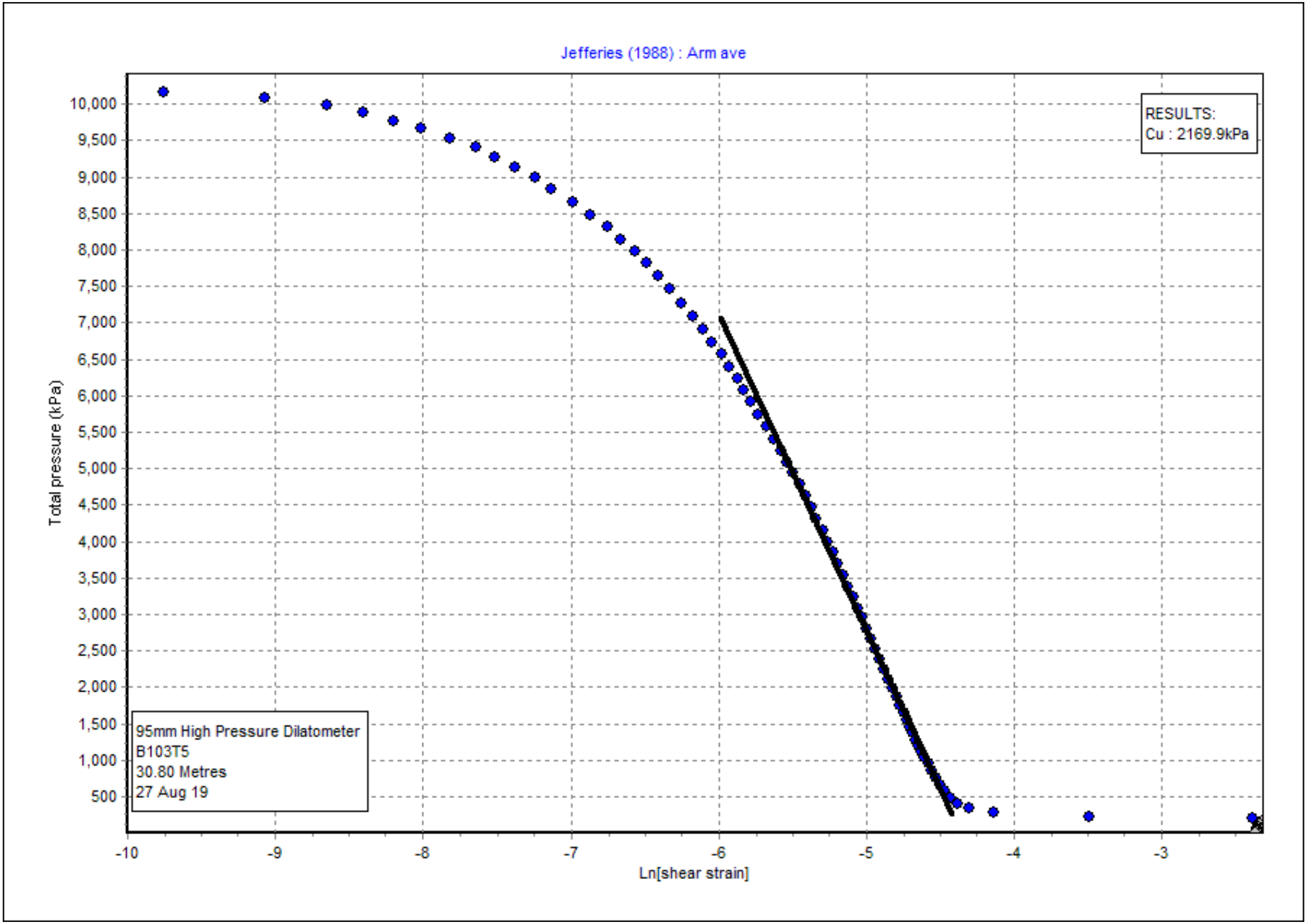

Shear modulus from unload/reload cycles Loop 3 : Arm ave
RESULTS:
Gur : 1540.1MPa
Cycle mid-point:
Cavity strain : 0.407%
Total stress : 6875kPa
Size of cycle :
Shear strain : 0.078%
Total stress : 1203kPa
95mm High Pressure Dilatometer
B103T5
30.80 Metres
27 Aug 19
Total pressure (kPa)
7,550
7,500
7,450
7,400
7,350
7,300
7,250
7,200
7,150
7,100
7,050
7,000
6,950
6,900
6,850
6,800
6,750
6,700
6,650
6,600
6,550
6,500
6,450
6,400
6,350
6,300
6,250
6,200
2.118 2.119 2.12 2.121 2.122 2.123 2.124 2.125 2.126 2.127 2.128 2.129 2.13 2.131 2.132 2.133 2.134 2.135 2.136 2.137 2.138 2.139 2.14
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 1 : Arm ave
95mm High Pressure Dilatometer
B103T5
30.80 Metres
27 Aug 19
RESULTS:
Gradient (beta) : 0.878
Intercept (n) : 423.487MPa
Shear stress constant : 371.798MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 1
Total pressure (kPa)
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 2 : Arm ave
95mm High Pressure Dilatometer
B103T5
30.80 Metres
27 Aug 19
RESULTS:
Gradient (beta) : 0.828
Intercept (n) : 426.353MPa
Shear stress constant : 352.820MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 2
Total pressure (kPa)
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 3 : Arm ave
95mm High Pressure Dilatometer
B103T5
30.80 Metres
27 Aug 19
RESULTS:
Gradient (beta) : 0.797
Intercept (n) : 354.845MPa
Shear stress constant : 282.655MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 3
Total pressure (kPa)
Radial Displacement (mm)


Gibson and Anderson (1961) : Arm ave
RESULTS:
Cu : 7118.3kPa
PI : 41508kPa
Ir : 92
G : 655.1MPa
95mm High Pressure Dilatometer
B103T5
30.80 Metres
27 Aug 19
Total pressure (kPa)
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
-9
-8
-7
-6
-5
Ln[shear strain]


Jefferies (1988) : Arm ave
RESULTS:
Cu : 2169.9kPa
95mm High Pressure Dilatometer
B103T5
30.80 Metres
27 Aug 19
Total pressure (kPa)
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
-10
-9
-8
-7
-6
-5
-4
-3
Ln[shear strain]

B103T6 - SUMMARY OF RESULTS
[File made with WinSitu Version 3.9.1.1]

[DETAILS OF TEST]
Project : Crown Street, Manchester
Site : M9019 Crown Street
Borehole : BH103
Test name : B103T6
Test date : 28 Aug 19
Test depth : 39.80 Metres
Water table : 3.00 Metres
Ambient PWP : 361.0 kPa
Material : Sandstone
Probe : 95mm High Pressure Dilatometer
Diameter : 94.0 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out

Analysed by IRC on 28 Aug 19

Remarks: Pocket 39-40.5m. 0855am

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm) : "Arm ave=2.06"
Best estimate of Po (kPa) : "Arm ave=2300.0"

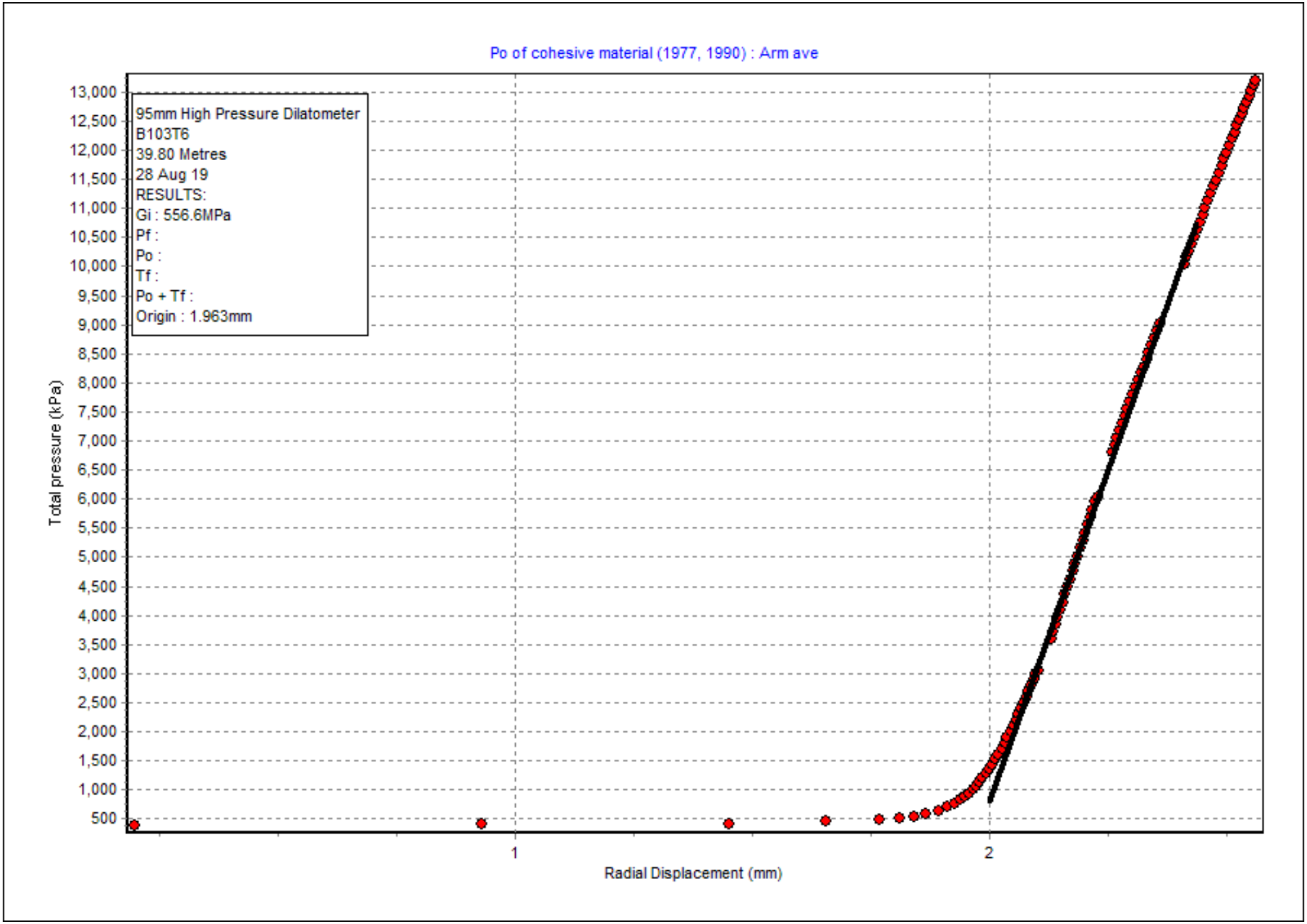
[UNDRAINED STRENGTH PARAMETERS]
Gibson & Anderson 1961 - Cu (kPa) : "Arm ave=9226.8"
Limit pressure (kPa) : "Arm ave=49261"
Jefferies 1988 - Cu (kPa) : "Arm ave=2978.8"

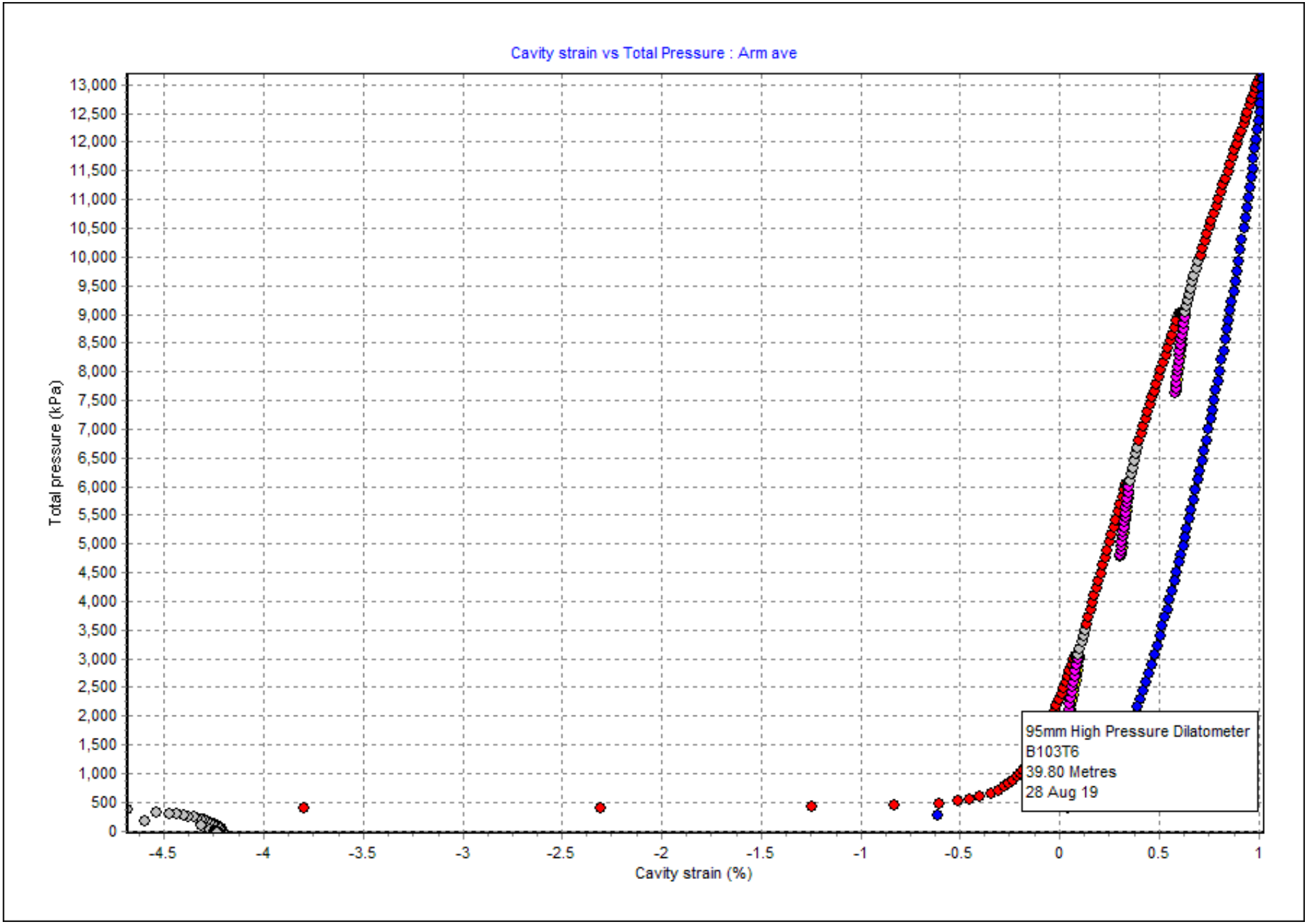
[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=556.6"

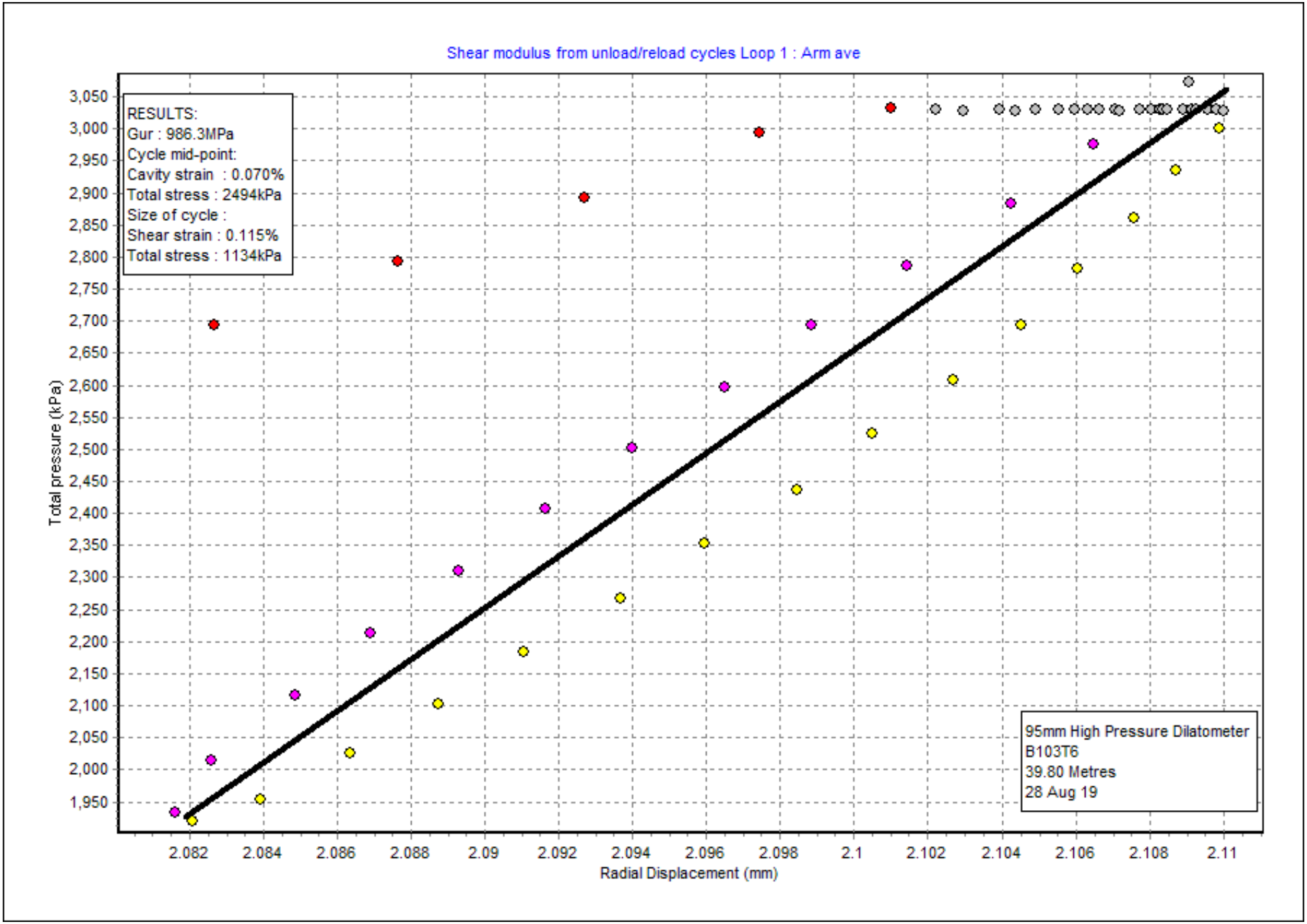
Axis	Loop No	Value (MPa)	Mean Strain (%)	Mean Pc (kPa)	dE (%)	dPc (kPa)
Arm ave	1	986.3	0.070	2494	0.115	1134
Arm ave	2	1417.5	0.329	5385	0.087	1232
Arm ave	3	1451.0	0.606	8286	0.090	1309

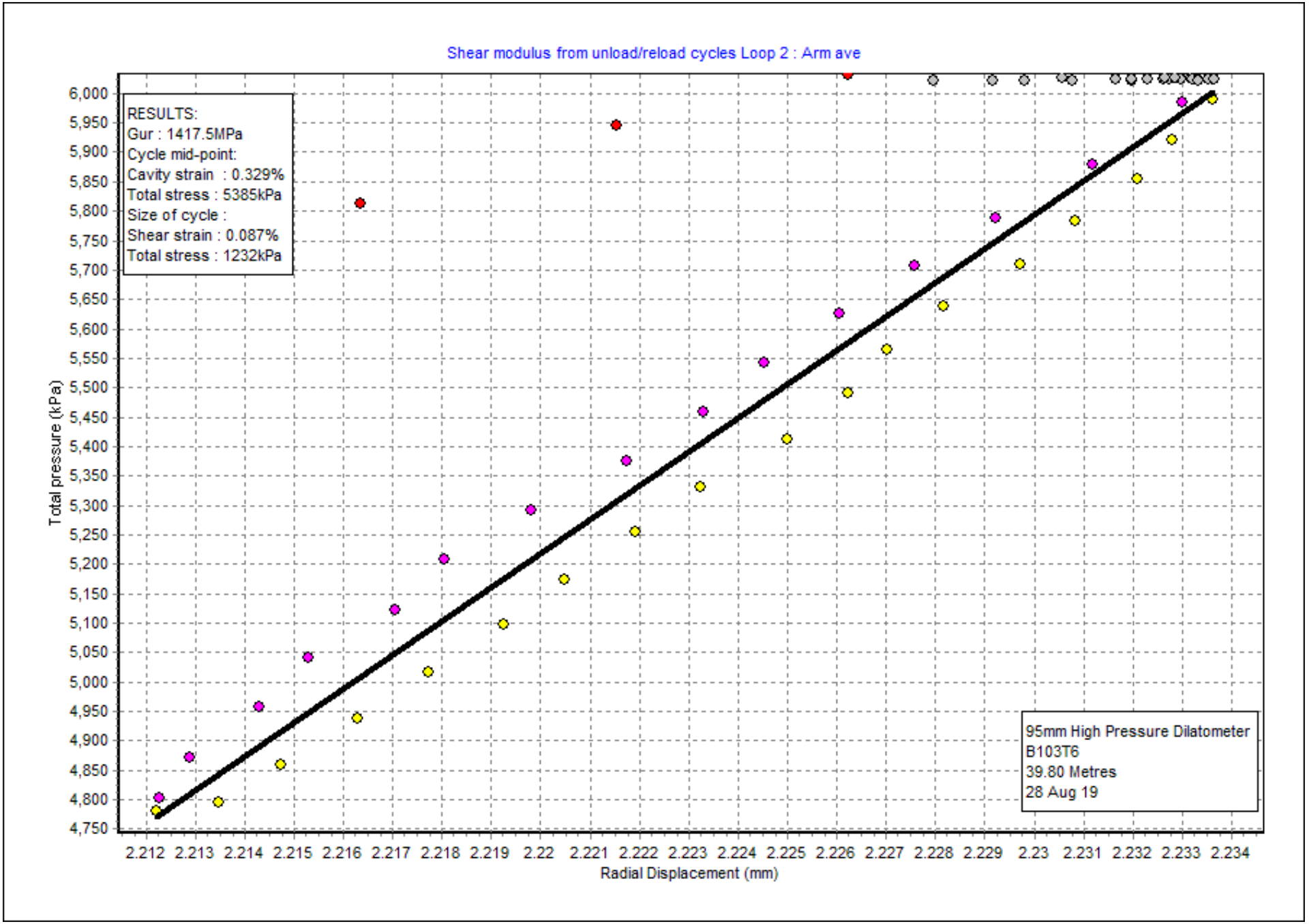
[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]

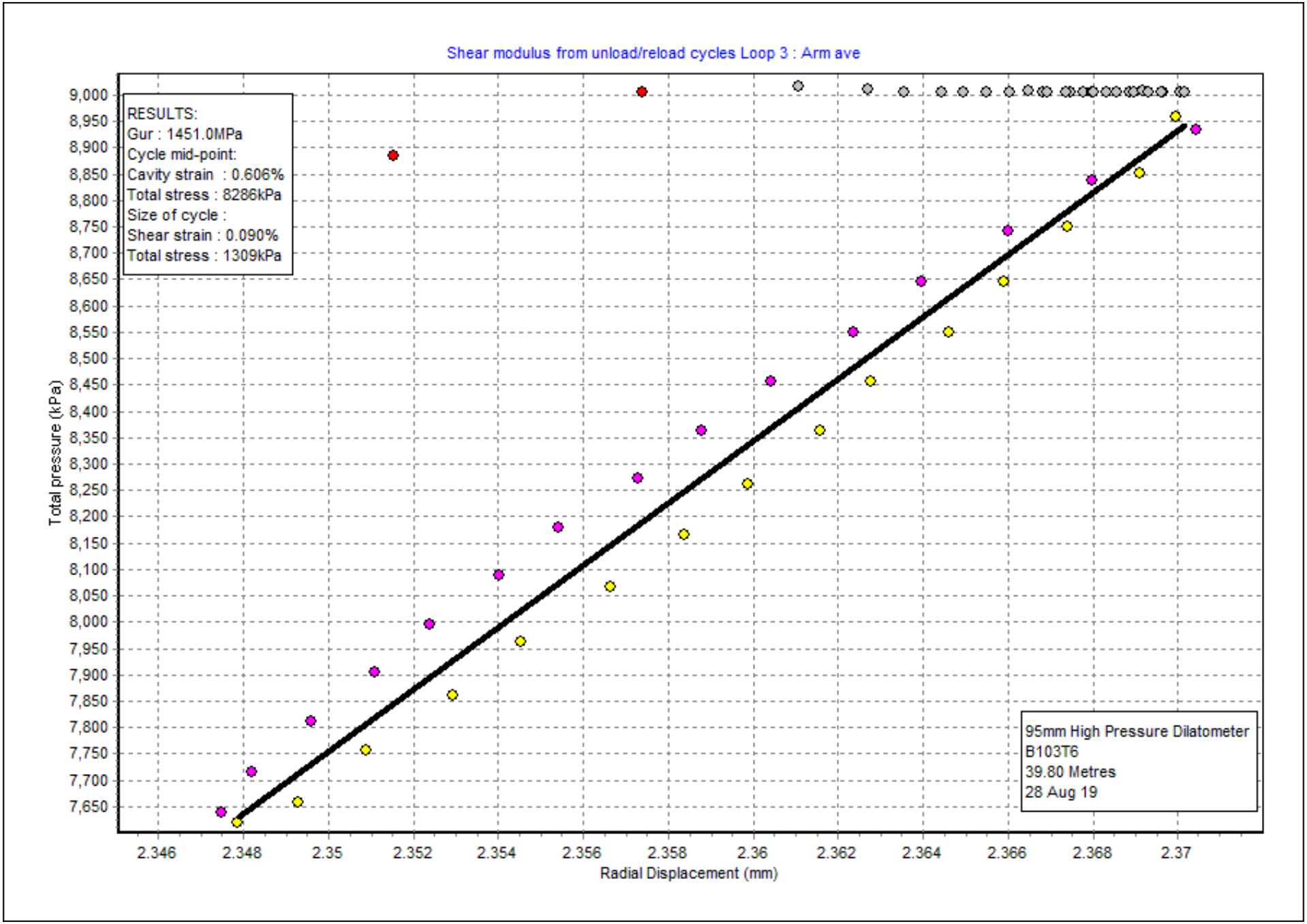
Axis	Loop No	Intercept (MPa)	Alpha (MPa)	Gradient
Arm ave	1	317.011	262.617	0.828
Arm ave	2	646.467	572.358	0.885
Arm ave	3	475.116	398.628	0.839

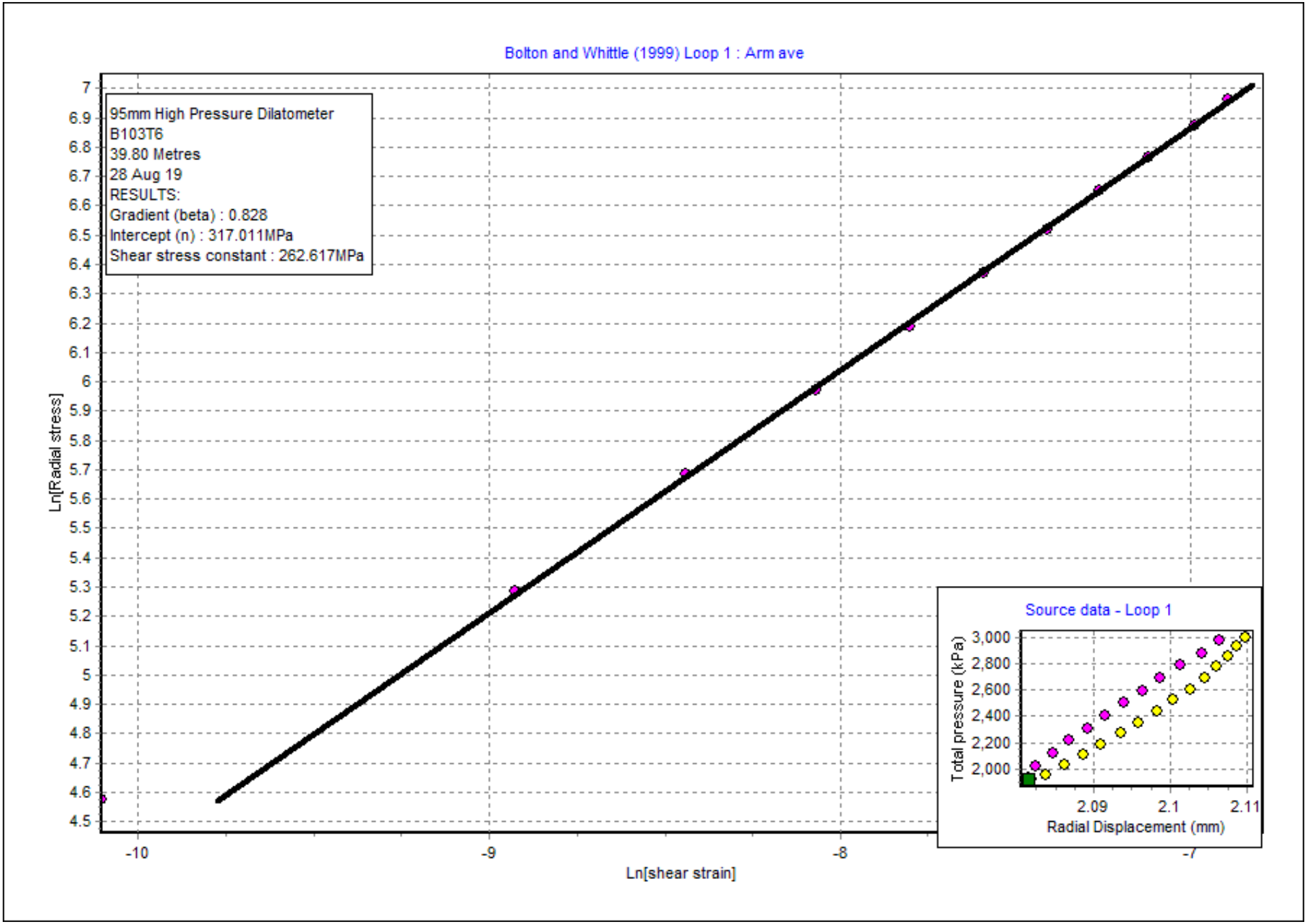

Po of cohesive material (1977, 1990) : Arm ave
95mm High Pressure Dilatometer
B103T6
39.80 Metres
28 Aug 19
RESULTS:
Gi : 556.6MPa
Pf :
Po :
Tf :
Po + Tf :
Origin : 1.963mm
Total pressure (kPa)
13,000
12,500
12,000
11,500
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
1
2
Radial Displacement (mm)

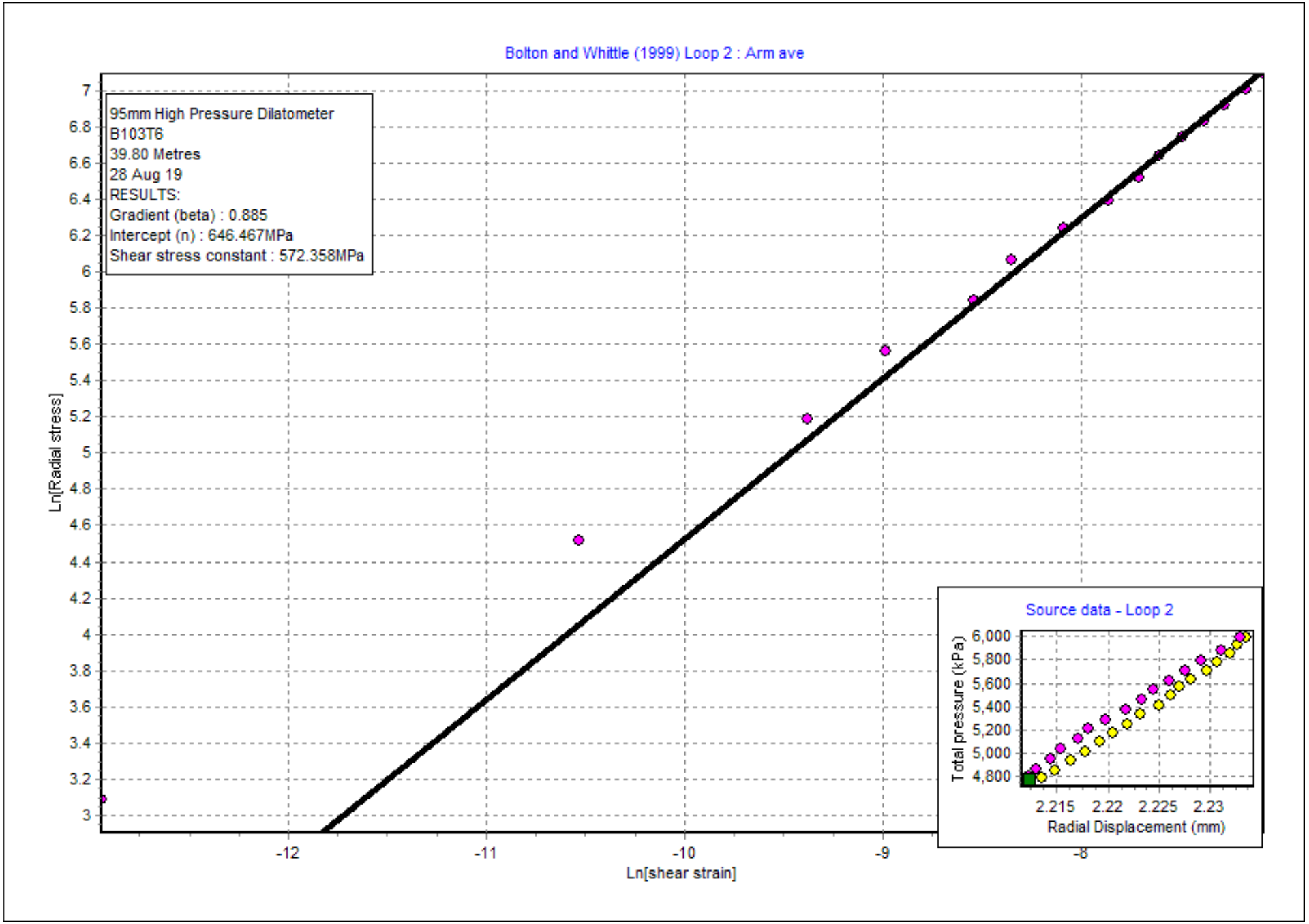

Cavity strain vs Total Pressure : Arm ave
Total pressure (kPa)
13,000
12,500
12,000
11,500
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
-4.5
-4
-3.5
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
1
Cavity strain (%)
95mm High Pressure Dilatometer
B103T6
39.80 Metres
28 Aug 19

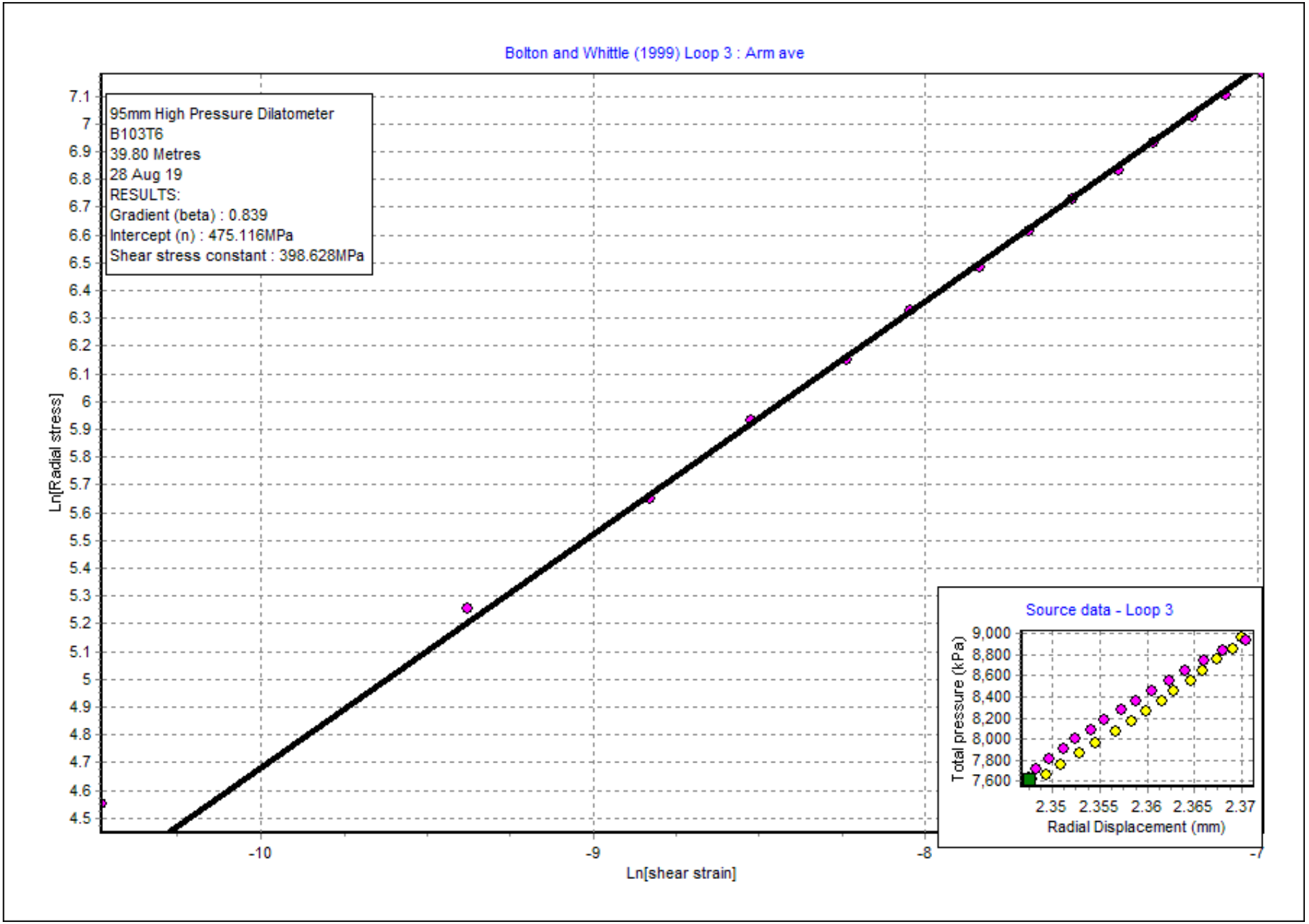

Shear modulus from unload/reload cycles Loop 1 : Arm ave
RESULTS:
Gur : 986.3MPa
Cycle mid-point:
Cavity strain : 0.070%
Total stress : 2494kPa
Size of cycle :
Shear strain : 0.115%
Total stress : 1134kPa
95mm High Pressure Dilatometer
B103T6
39.80 Metres
28 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
3,050
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
2,000
1,950
2.082
2.084
2.086
2.088
2.09
2.092
2.094
2.096
2.098
2.1
2.102
2.104
2.106
2.108
2.11

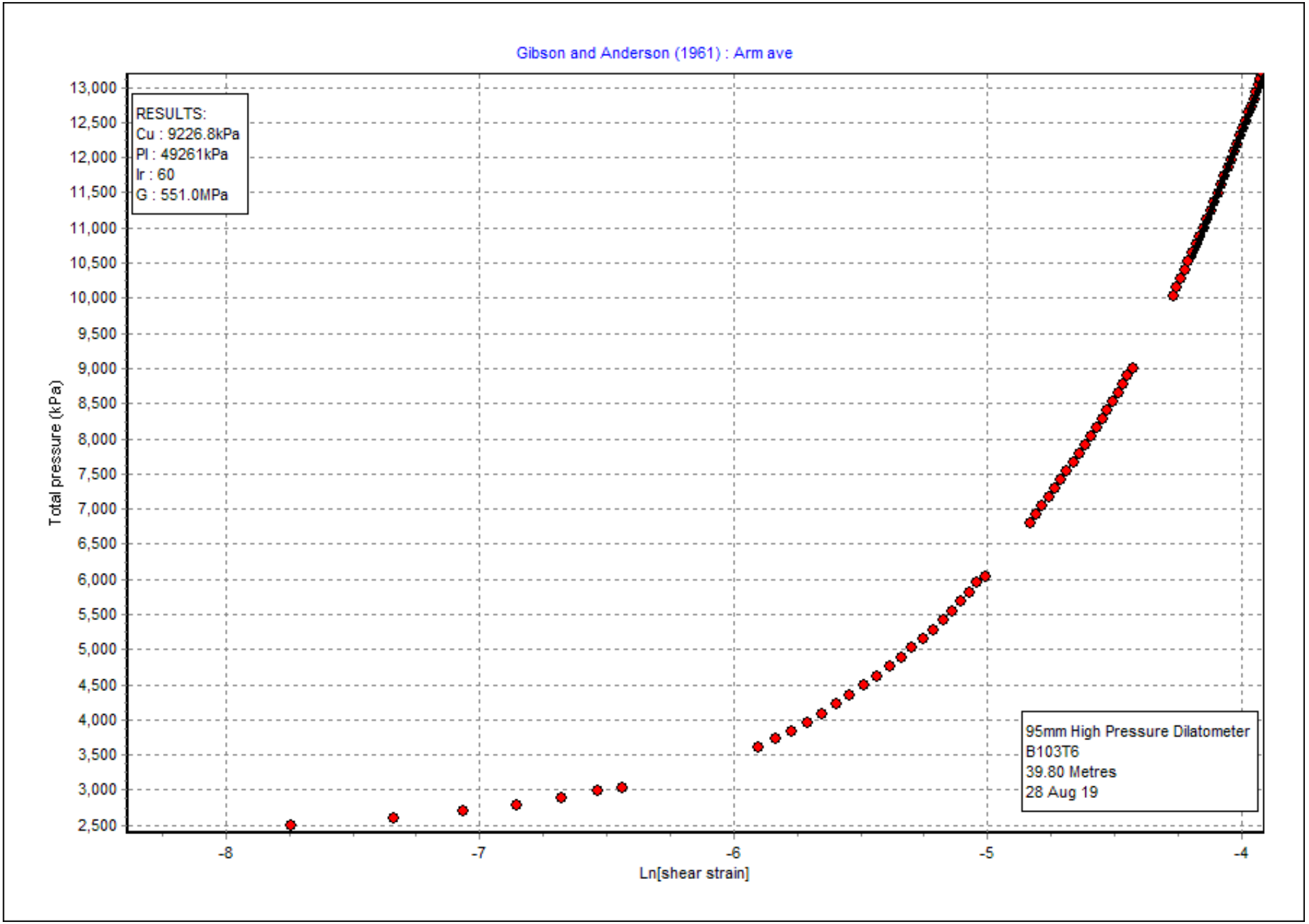

Shear modulus from unload/reload cycles Loop 2 : Arm ave
RESULTS:
Gur : 1417.5MPa
Cycle mid-point:
Cavity strain : 0.329%
Total stress : 5385kPa
Size of cycle :
Shear strain : 0.087%
Total stress : 1232kPa
95mm High Pressure Dilatometer
B103T6
39.80 Metres
28 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
6,000
5,950
5,900
5,850
5,800
5,750
5,700
5,650
5,600
5,550
5,500
5,450
5,400
5,350
5,300
5,250
5,200
5,150
5,100
5,050
5,000
4,950
4,900
4,850
4,800
4,750
2.212
2.213
2.214
2.215
2.216
2.217
2.218
2.219
2.22
2.221
2.222
2.223
2.224
2.225
2.226
2.227
2.228
2.229
2.23
2.231
2.232
2.233
2.234

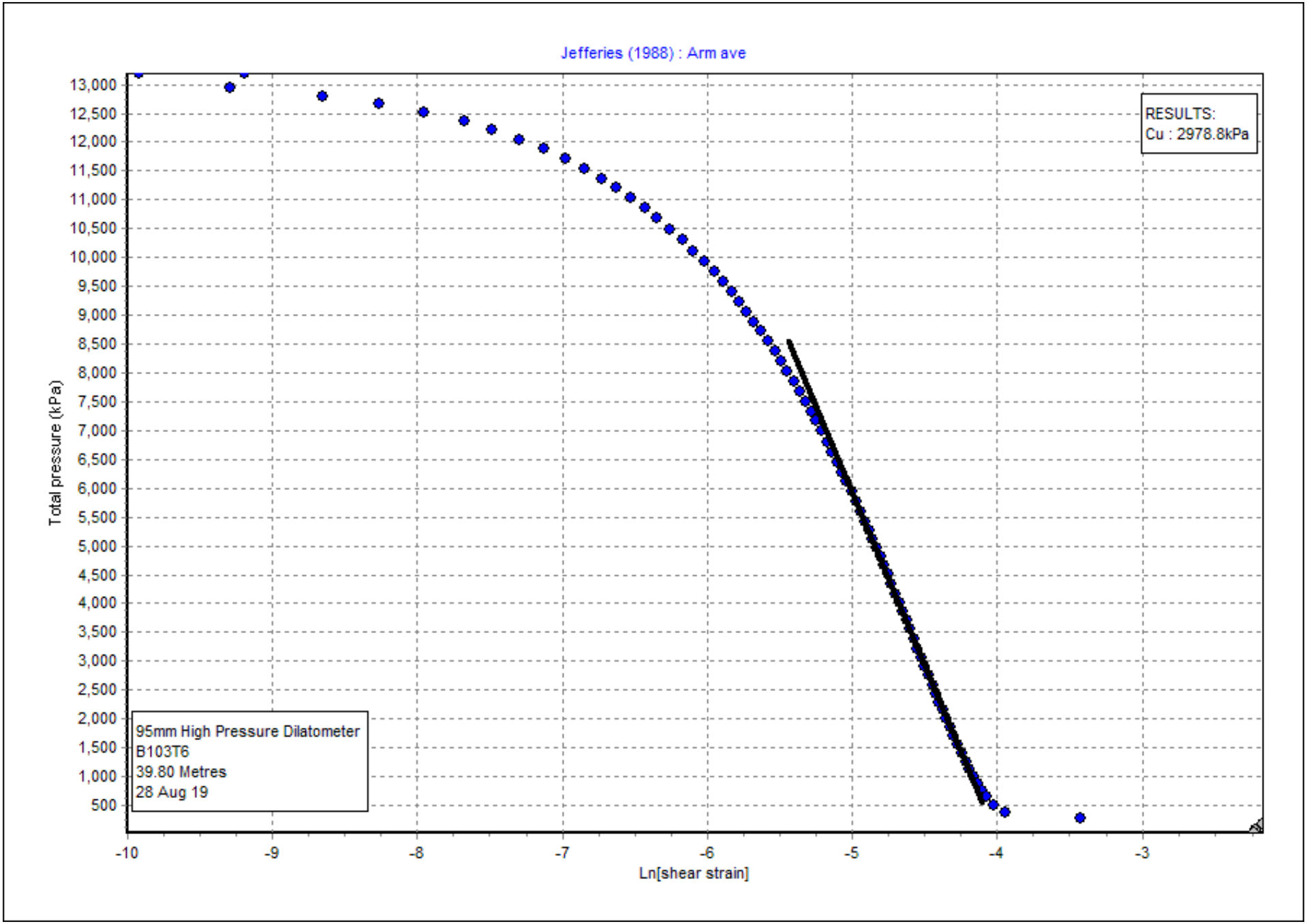

Shear modulus from unload/reload cycles Loop 3 : Arm ave
RESULTS:
Gur : 1451.0MPa
Cycle mid-point:
Cavity strain : 0.606%
Total stress : 8286kPa
Size of cycle :
Shear strain : 0.090%
Total stress : 1309kPa
95mm High Pressure Dilatometer
B103T6
39.80 Metres
28 Aug 19
Total pressure (kPa)
9,000
8,950
8,900
8,850
8,800
8,750
8,700
8,650
8,600
8,550
8,500
8,450
8,400
8,350
8,300
8,250
8,200
8,150
8,100
8,050
8,000
7,950
7,900
7,850
7,800
7,750
7,700
7,650
2.346
2.348
2.35
2.352
2.354
2.356
2.358
2.36
2.362
2.364
2.366
2.368
2.37
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 1 : Arm ave
95mm High Pressure Dilatometer
B103T6
39.80 Metres
28 Aug 19
RESULTS:
Gradient (beta) : 0.828
Intercept (n) : 317.011MPa
Shear stress constant : 262.617MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 1
Total pressure (kPa)
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 2 : Arm ave
95mm High Pressure Dilatometer
B103T6
39.80 Metres
28 Aug 19
RESULTS:
Gradient (beta) : 0.885
Intercept (n) : 646.467MPa
Shear stress constant : 572.358MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 2
Total pressure (kPa)
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 3 : Arm ave
95mm High Pressure Dilatometer
B103T6
39.80 Metres
28 Aug 19
RESULTS:
Gradient (beta) : 0.839
Intercept (n) : 475.116MPa
Shear stress constant : 398.628MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 3
Total pressure (kPa)
Radial Displacement (mm)


Gibson and Anderson (1961) : Arm ave
RESULTS:
Cu : 9226.8kPa
PI : 49261kPa
Ir : 60
G : 551.0MPa
95mm High Pressure Dilatometer
B103T6
39.80 Metres
28 Aug 19
Total pressure (kPa)
13,000
12,500
12,000
11,500
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
-8
-7
-6
-5
-4
Ln[shear strain]


Jefferies (1988) : Arm ave
RESULTS:
Cu : 2978.8kPa
95mm High Pressure Dilatometer
B103T6
39.80 Metres
28 Aug 19
Total pressure (kPa)
13,000
12,500
12,000
11,500
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
-10
-9
-8
-7
-6
-5
-4
-3
Ln[shear strain]

B109T1 - SUMMARY OF RESULTS
[File made with WinSitu Version 3.9.1.1]

[DETAILS OF TEST]
Project : Crown Street, Manchester
Site : M9019
Borehole : BH109
Test name : B109T1
Test date : 15 Aug 19
Test depth : 14.30 Metres
Water table : 3.00 Metres
Ambient PWP : 110.9 kPa
Material : Sandstone
Probe : 95mm High Pressure Dilatometer
Diameter : 94.0 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out

Analysed by IRC on 20 Aug 19

Remarks: pocket 13.5-15m. 1125am. Probe at base.

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm) : "Arm ave=2.06"
Best estimate of Po (kPa) : "Arm ave=4400.0"

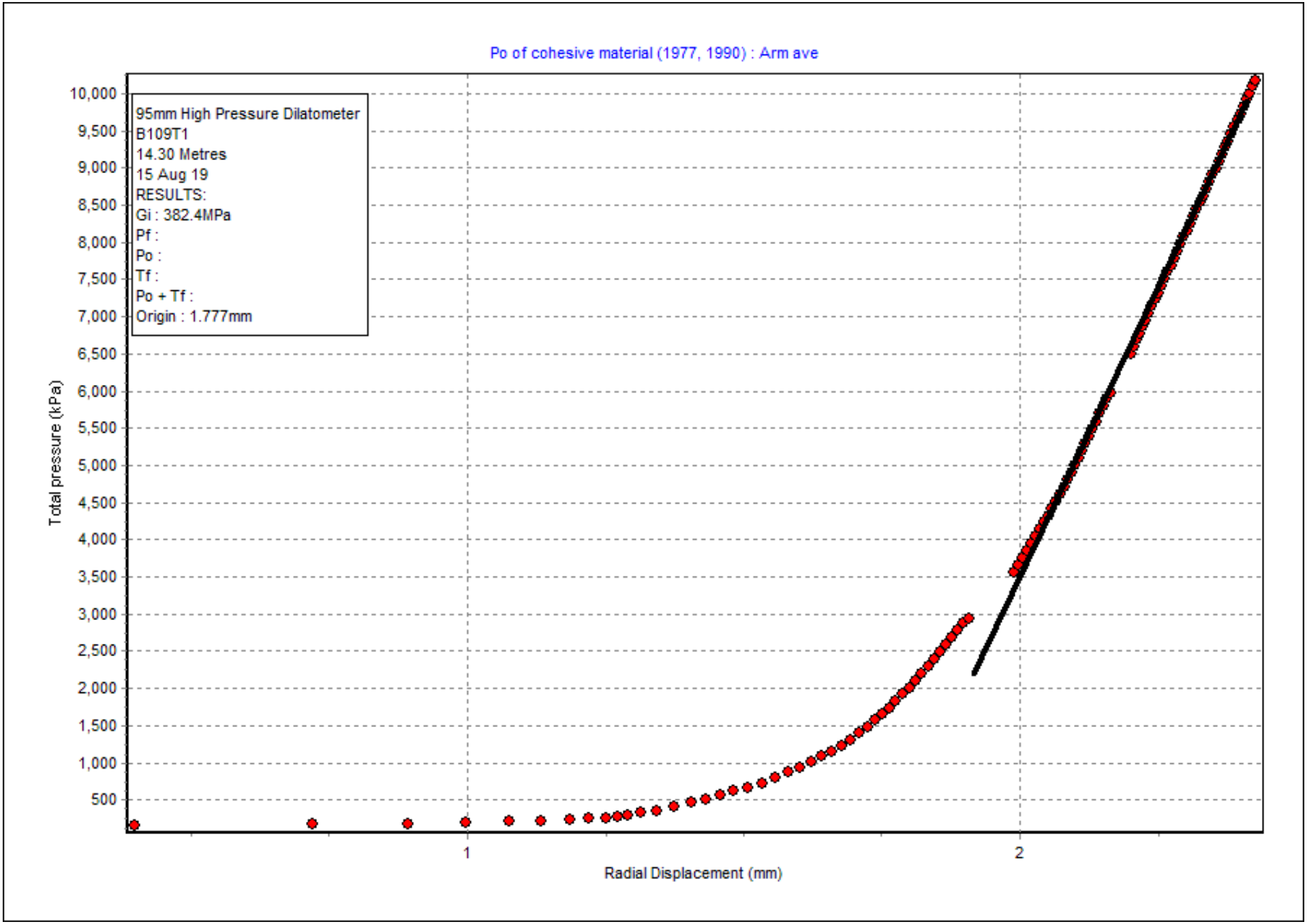
[UNDRAINED STRENGTH PARAMETERS]
Gibson & Anderson 1961 - Cu (kPa) : "Arm ave=5086.2"
Limit pressure (kPa) : "Arm ave=31514"
Jefferies 1988 - Cu (kPa) : "Arm ave=2140.4"

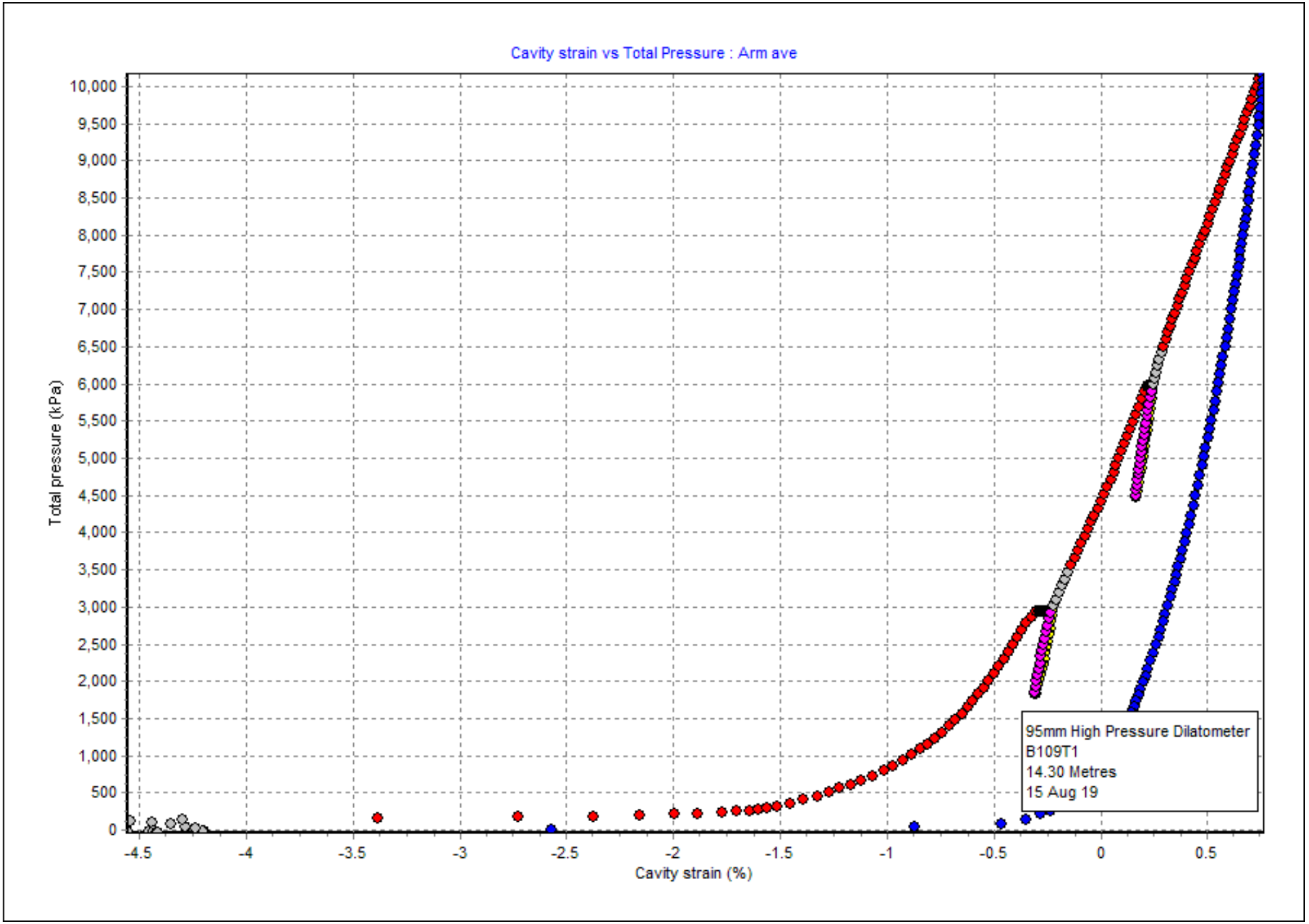
[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=382.4"

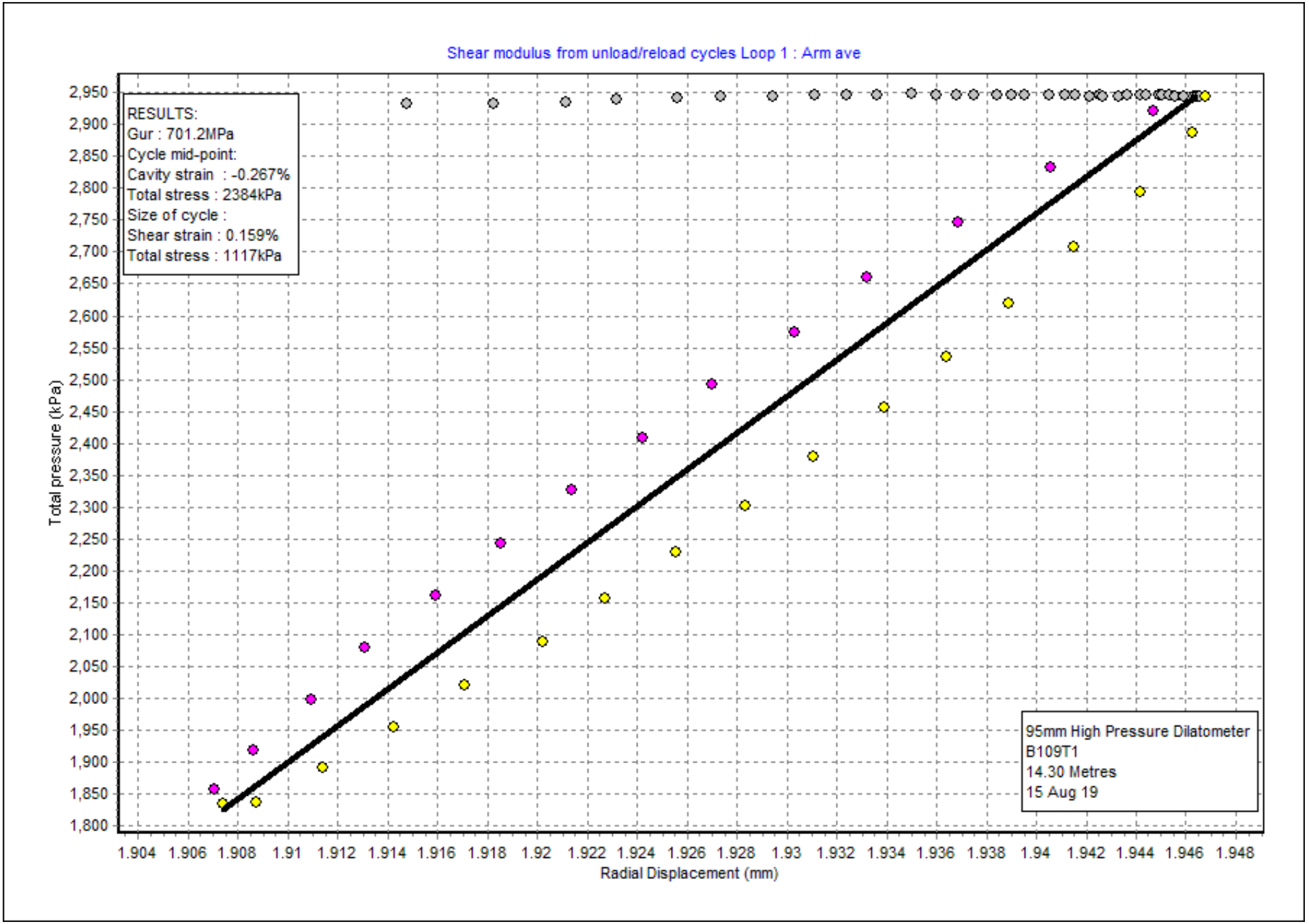
Axis	Loop No	Value (MPa)	Mean Strain (%)	Mean Pc (kPa)	dE (%)	dPc (kPa)
Arm ave	1	701.2	-0.267	2384	0.159	1117
Arm ave	2	937.4	0.203	5201	0.157	1473

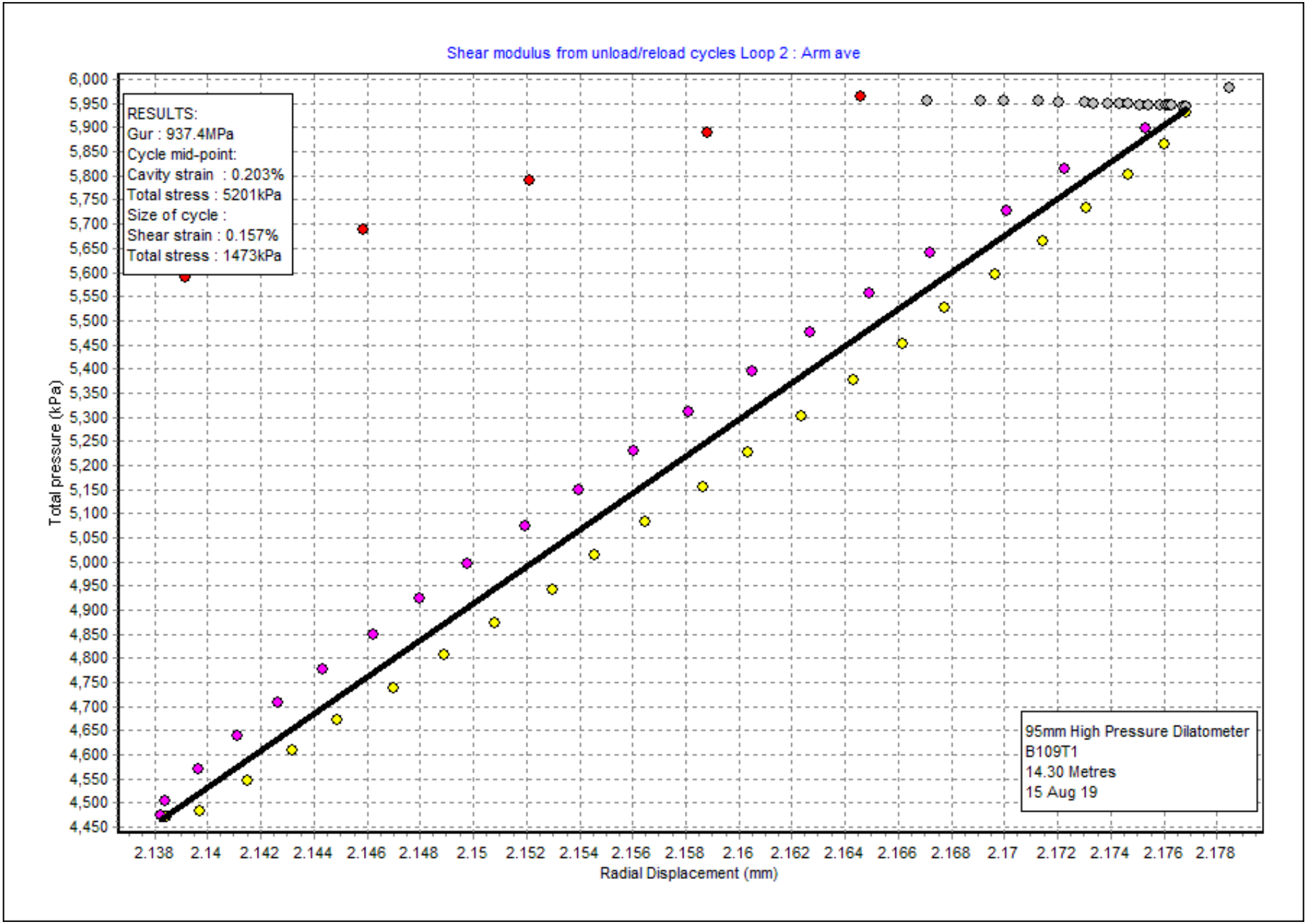
[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]

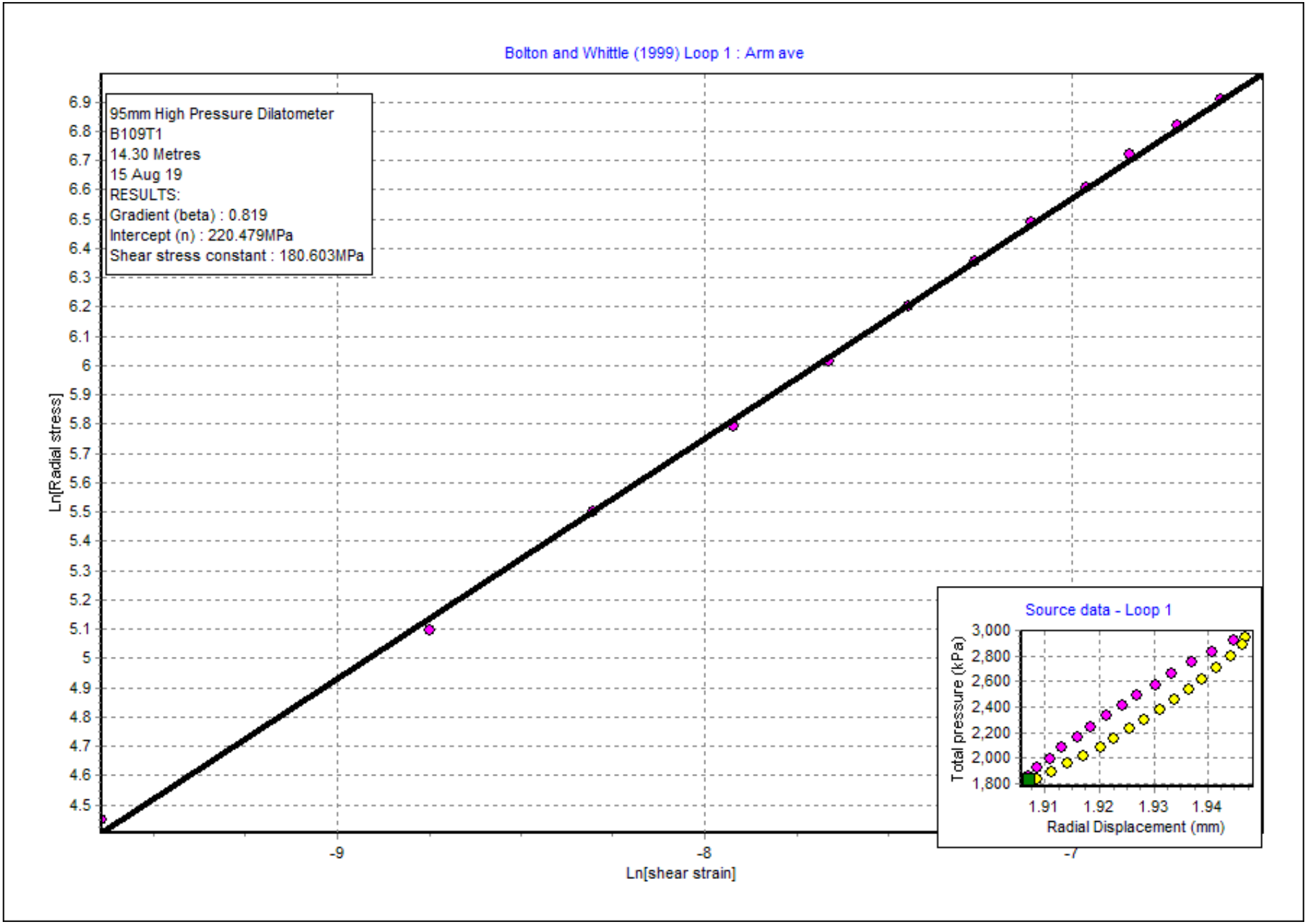
Axis	Loop No	Intercept (MPa)	Alpha (MPa)	Gradient
Arm ave	1	220.479	180.603	0.819
Arm ave	2	356.480	303.273	0.851

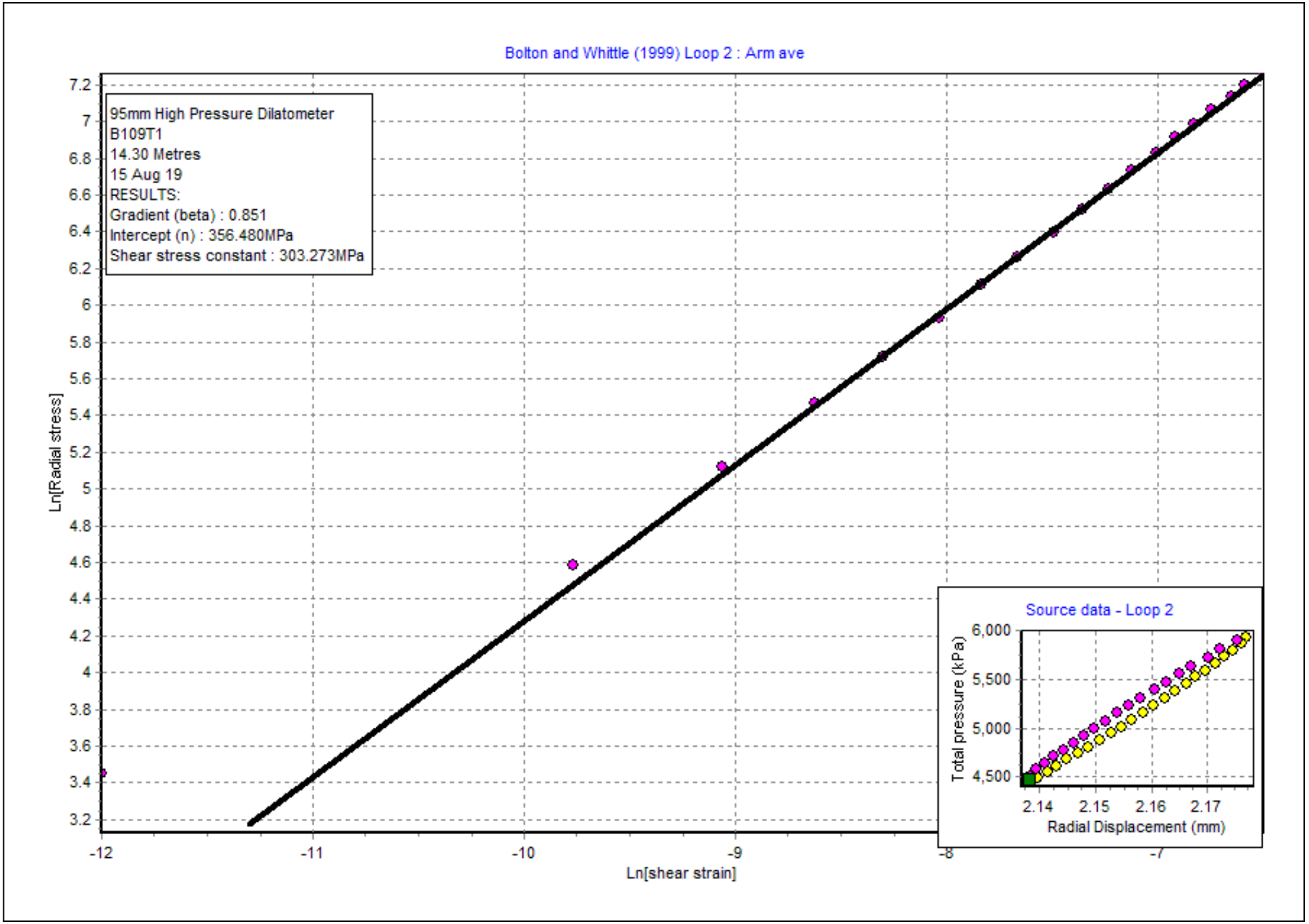

Po of cohesive material (1977, 1990) : Arm ave
95mm High Pressure Dilatometer
B109T1
14.30 Metres
15 Aug 19
RESULTS:
Gi : 382.4MPa
Pf :
Po :
Tf :
Po + Tf :
Origin : 1.777mm
Total pressure (kPa)
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
1
2
Radial Displacement (mm)

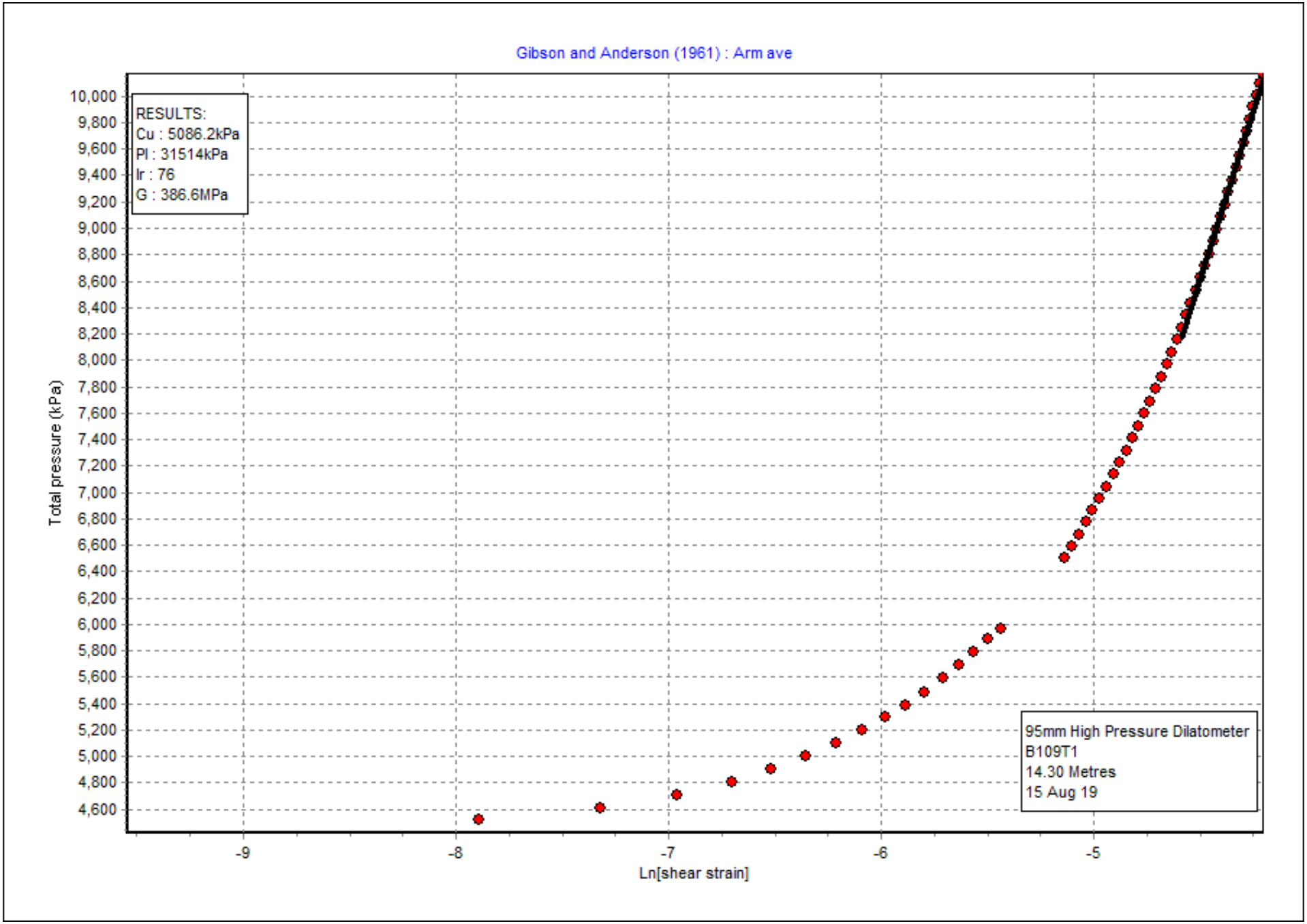

Cavity strain vs Total Pressure : Arm ave
Total pressure (kPa)
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
-4.5
-4
-3.5
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
Cavity strain (%)
95mm High Pressure Dilatometer
B109T1
14.30 Metres
15 Aug 19

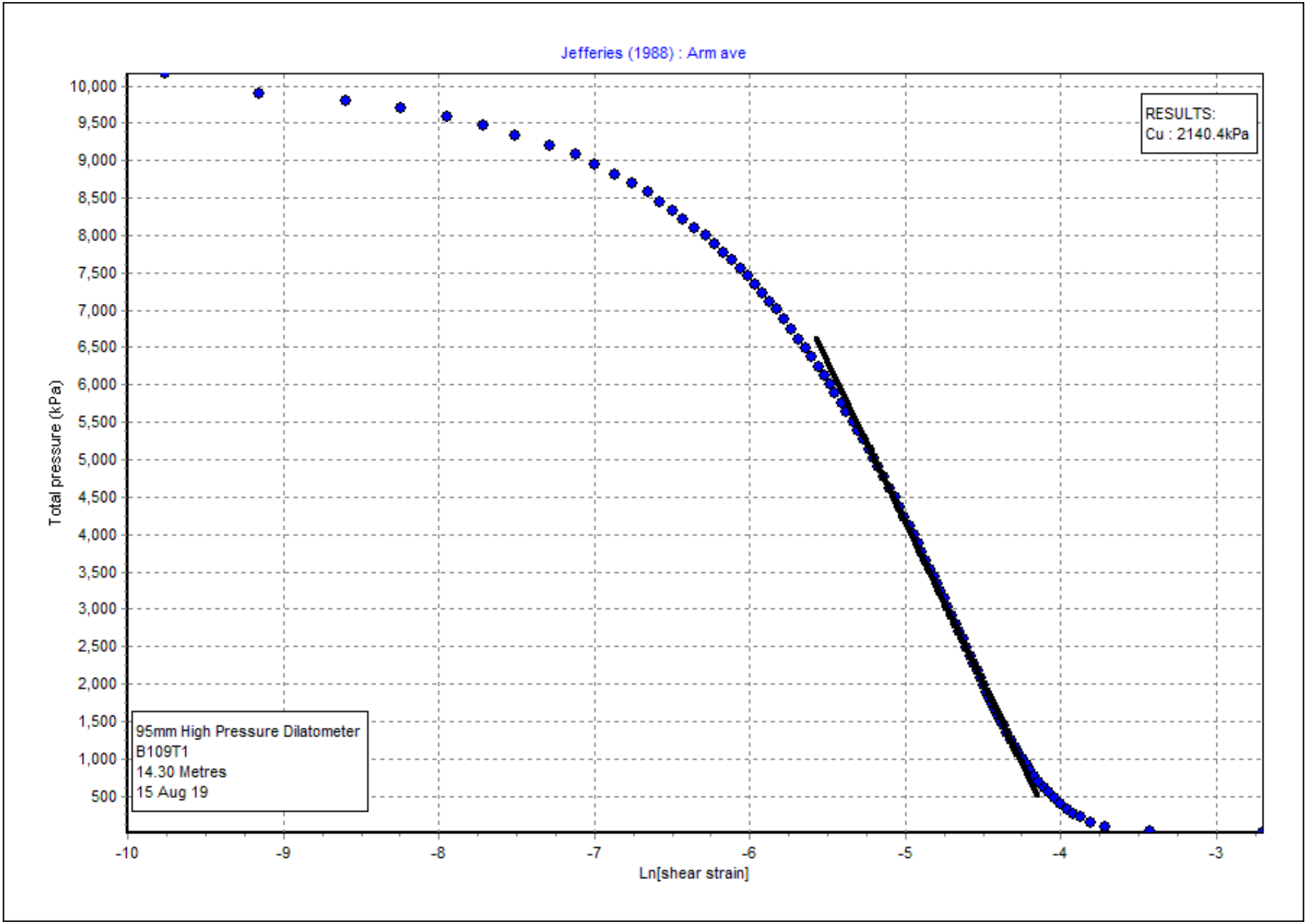

Shear modulus from unload/reload cycles Loop 1 : Arm ave
RESULTS:
Gur : 701.2MPa
Cycle mid-point:
Cavity strain : -0.267%
Total stress : 2384kPa
Size of cycle :
Shear strain : 0.159%
Total stress : 1117kPa
95mm High Pressure Dilatometer
B109T1
14.30 Metres
15 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
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
2,000
1,950
1,900
1,850
1,800
1.904 1.906 1.908 1.91 1.912 1.914 1.916 1.918 1.92 1.922 1.924 1.926 1.928 1.93 1.932 1.934 1.936 1.938 1.94 1.942 1.944 1.946 1.948


Shear modulus from unload/reload cycles Loop 2 : Arm ave
RESULTS:
Gur : 937.4MPa
Cycle mid-point:
Cavity strain : 0.203%
Total stress : 5201kPa
Size of cycle :
Shear strain : 0.157%
Total stress : 1473kPa
95mm High Pressure Dilatometer
B109T1
14.30 Metres
15 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
6,000
5,950
5,900
5,850
5,800
5,750
5,700
5,650
5,600
5,550
5,500
5,450
5,400
5,350
5,300
5,250
5,200
5,150
5,100
5,050
5,000
4,950
4,900
4,850
4,800
4,750
4,700
4,650
4,600
4,550
4,500
4,450
2.138
2.14
2.142
2.144
2.146
2.148
2.15
2.152
2.154
2.156
2.158
2.16
2.162
2.164
2.166
2.168
2.17
2.172
2.174
2.176
2.178


Bolton and Whittle (1999) Loop 1 : Arm ave
95mm High Pressure Dilatometer
B109T1
14.30 Metres
15 Aug 19
RESULTS:
Gradient (beta) : 0.819
Intercept (n) : 220.479MPa
Shear stress constant : 180.603MPa
Ln[Radial stress]
Ln[shear strain]
-9
-8
Source data - Loop 1
Total pressure (kPa)
Radial Displacement (mm)
1.91
1.92
1.93
1.94


Bolton and Whittle (1999) Loop 2 : Arm ave
95mm High Pressure Dilatometer
B109T1
14.30 Metres
15 Aug 19
RESULTS:
Gradient (beta) : 0.851
Intercept (n) : 356.480MPa
Shear stress constant : 303.273MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 2
Total pressure (kPa)
Radial Displacement (mm)


Gibson and Anderson (1961) : Arm ave
RESULTS:
Cu : 5086.2kPa
PI : 31514kPa
Ir : 76
G : 386.6MPa
95mm High Pressure Dilatometer
B109T1
14.30 Metres
15 Aug 19
Total pressure (kPa)
Ln[shear strain]
10,000
9,800
9,600
9,400
9,200
9,000
8,800
8,600
8,400
8,200
8,000
7,800
7,600
7,400
7,200
7,000
6,800
6,600
6,400
6,200
6,000
5,800
5,600
5,400
5,200
5,000
4,800
4,600
-9
-8
-7
-6
-5


Jefferies (1988) : Arm ave
RESULTS:
Cu : 2140.4kPa
95mm High Pressure Dilatometer
B109T1
14.30 Metres
15 Aug 19
Total pressure (kPa)
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
-10
-9
-8
-7
-6
-5
-4
-3
Ln[shear strain]

B109T2 - SUMMARY OF RESULTS
[File made with WinSitu Version 3.9.1.1]

[DETAILS OF TEST]
Project : Crown Street, Manchester
Site : M9019
Borehole : BH109
Test name : B109T2
Test date : 15 Aug 19
Test depth : 18.80 Metres
Water table : 3.00 Metres
Ambient PWP : 155.0 kPa
Material : Sandstone
Probe : 95mm High Pressure Dilatometer
Diameter : 94.0 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out

Analysed by IRC on 20 Aug 19

Remarks: Pocket 18-19.5. Probe at base. WL at GL. 1520.

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm) : "Arm ave=1.98"
Best estimate of Po (kPa) : "Arm ave=4400.0"

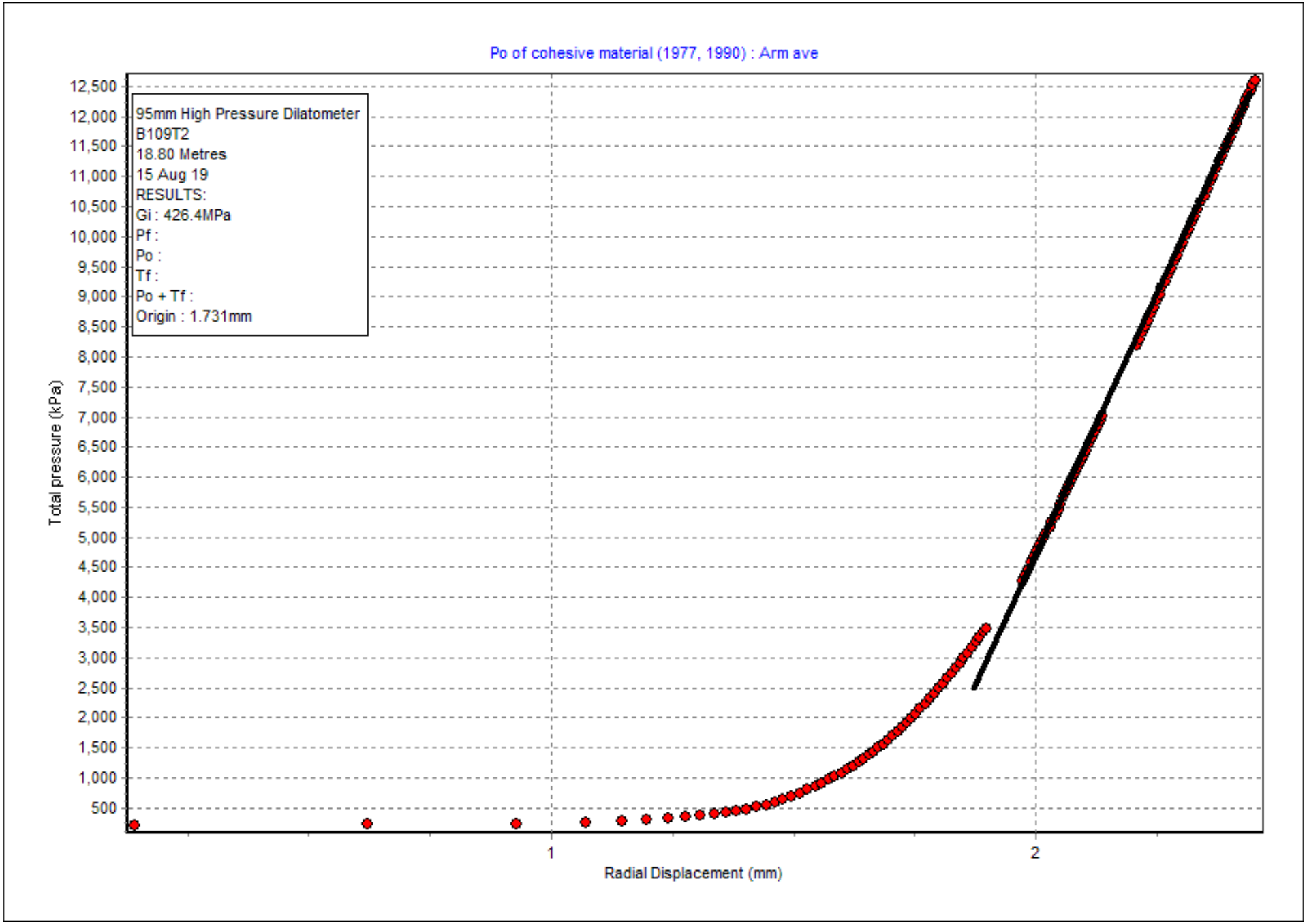
[UNDRAINED STRENGTH PARAMETERS]
Gibson & Anderson 1961 - Cu (kPa) : "Arm ave=7314.1"
Limit pressure (kPa) : "Arm ave=41483"
Jefferies 1988 - Cu (kPa) : "Arm ave=2526.9"

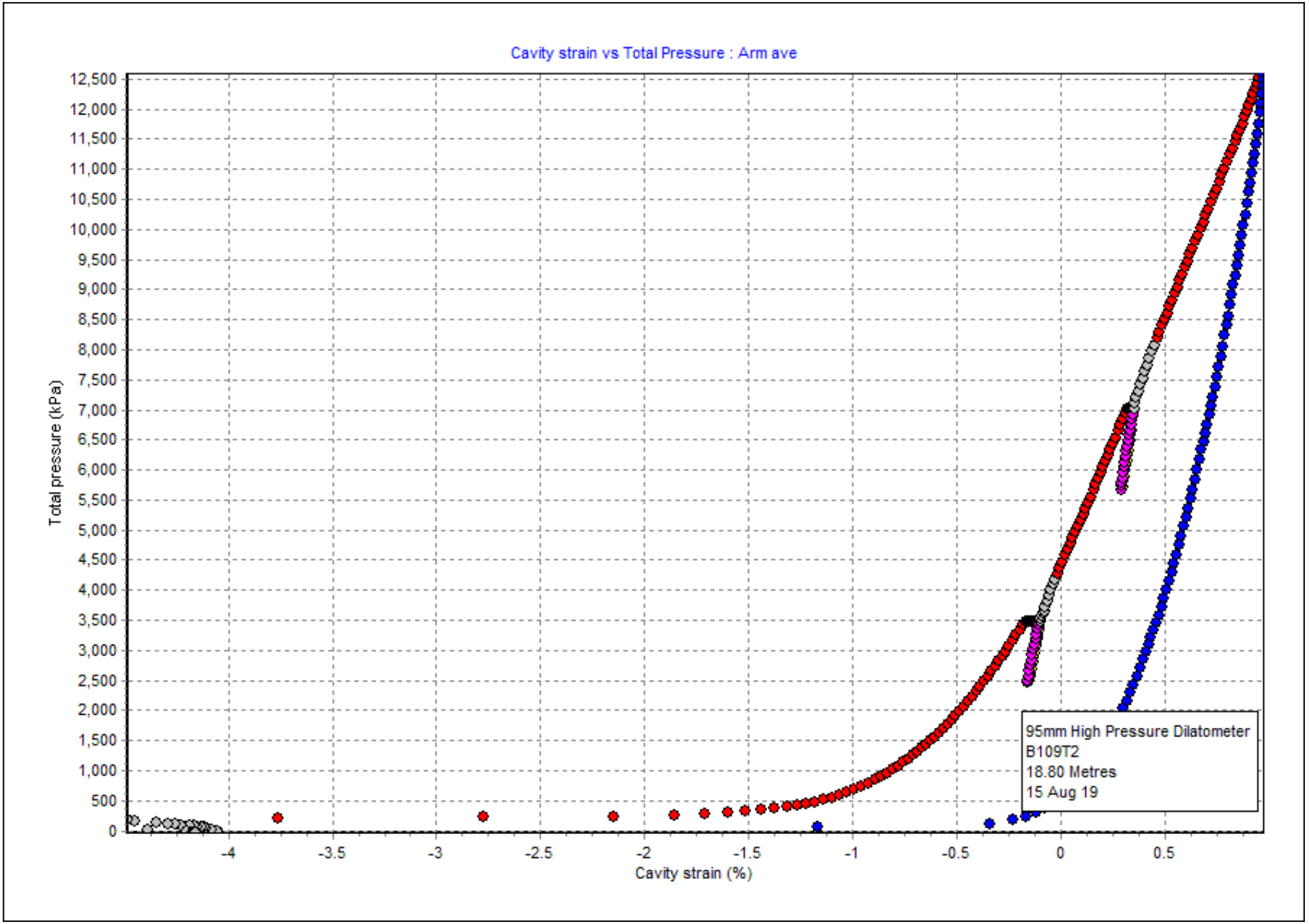
[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=426.4"

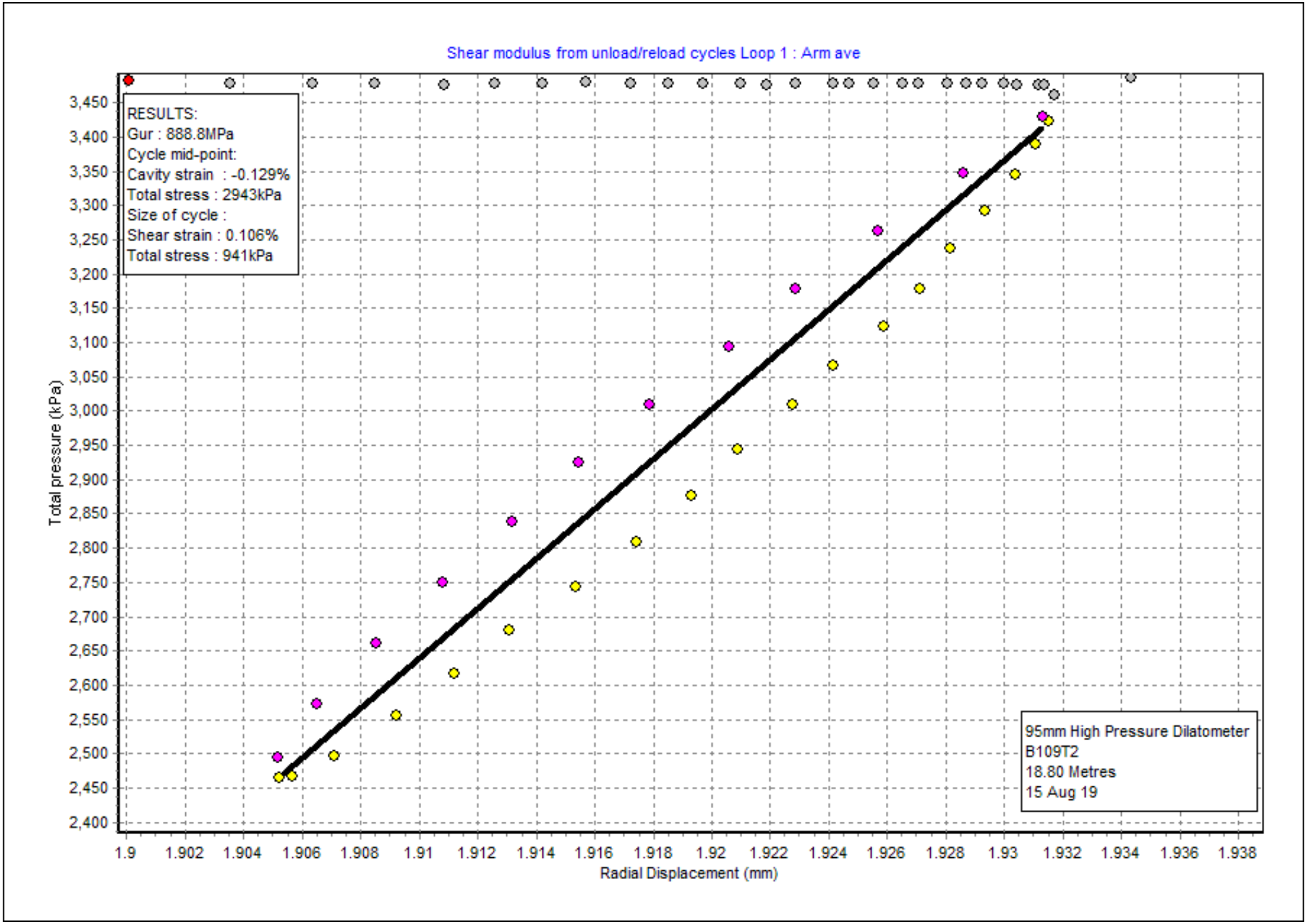
Axis	Loop No	Value (MPa)	Mean Strain (%)	Mean Pc (kPa)	dE (%)	dPc (kPa)
Arm ave	1	888.8	-0.129	2943	0.106	941
Arm ave	2	1169.1	0.321	6278	0.109	1281

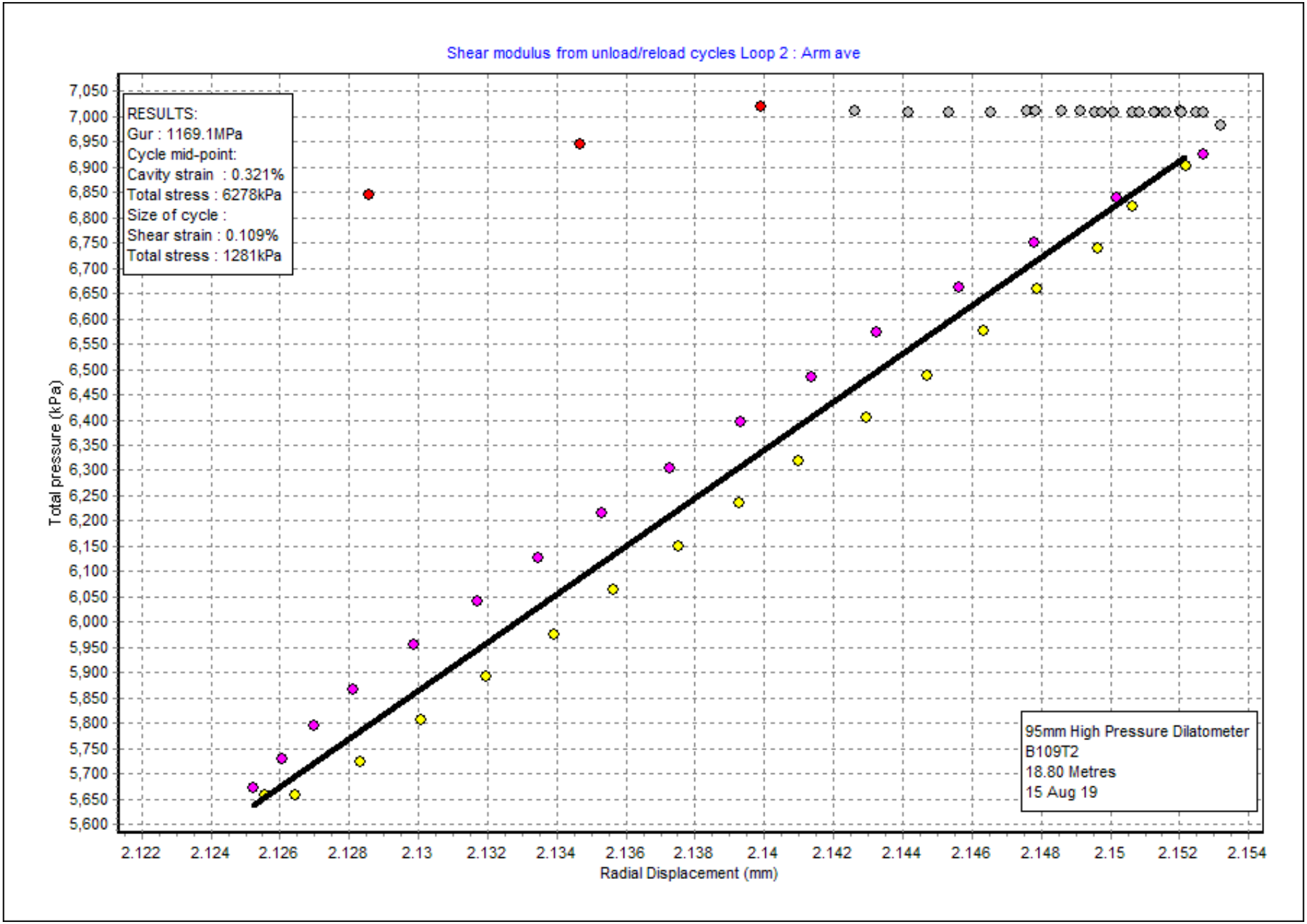
[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]

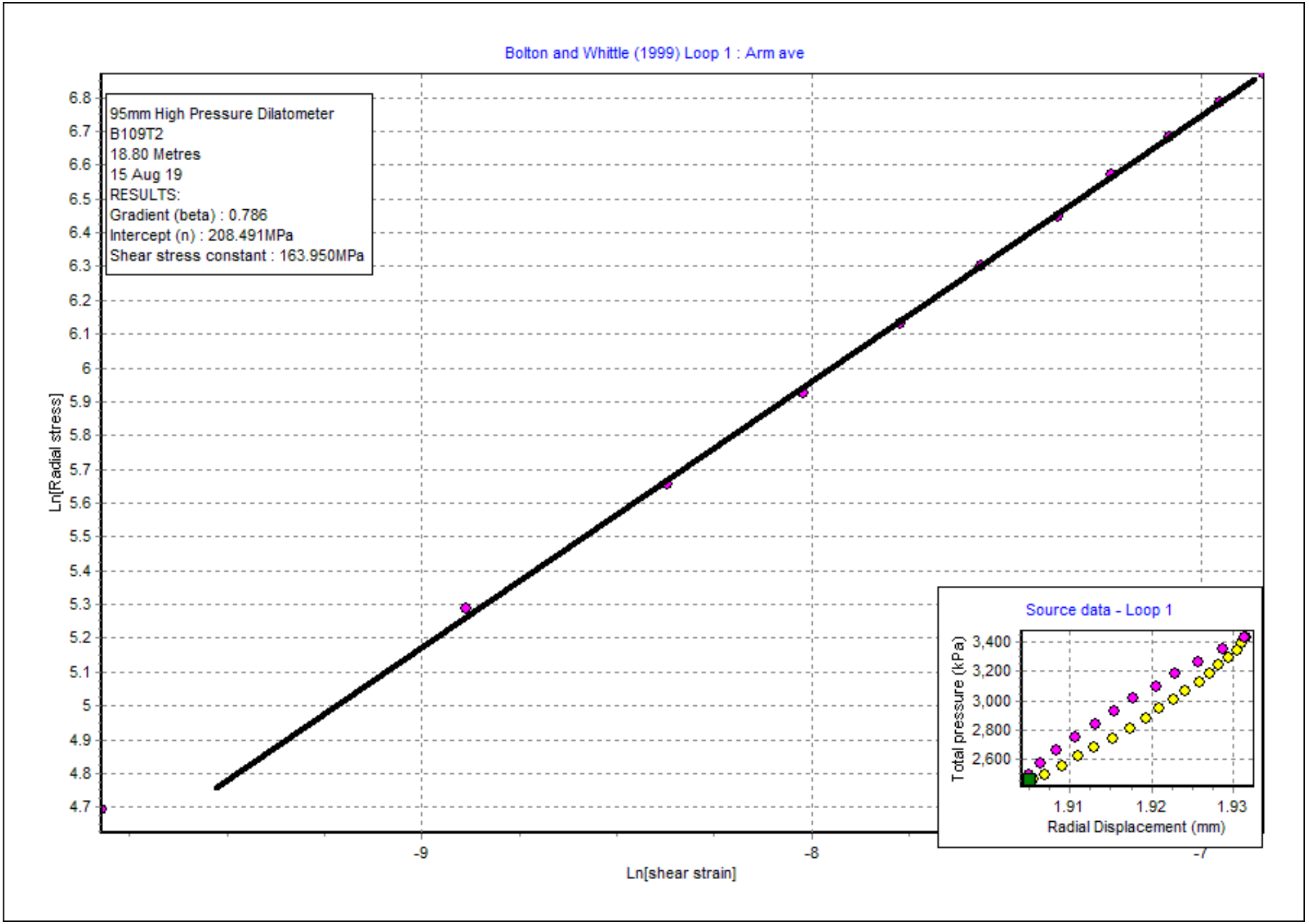
Axis	Loop No	Intercept (MPa)	Alpha (MPa)	Gradient
Arm ave	1	208.491	163.950	0.786
Arm ave	2	337.039	276.534	0.820

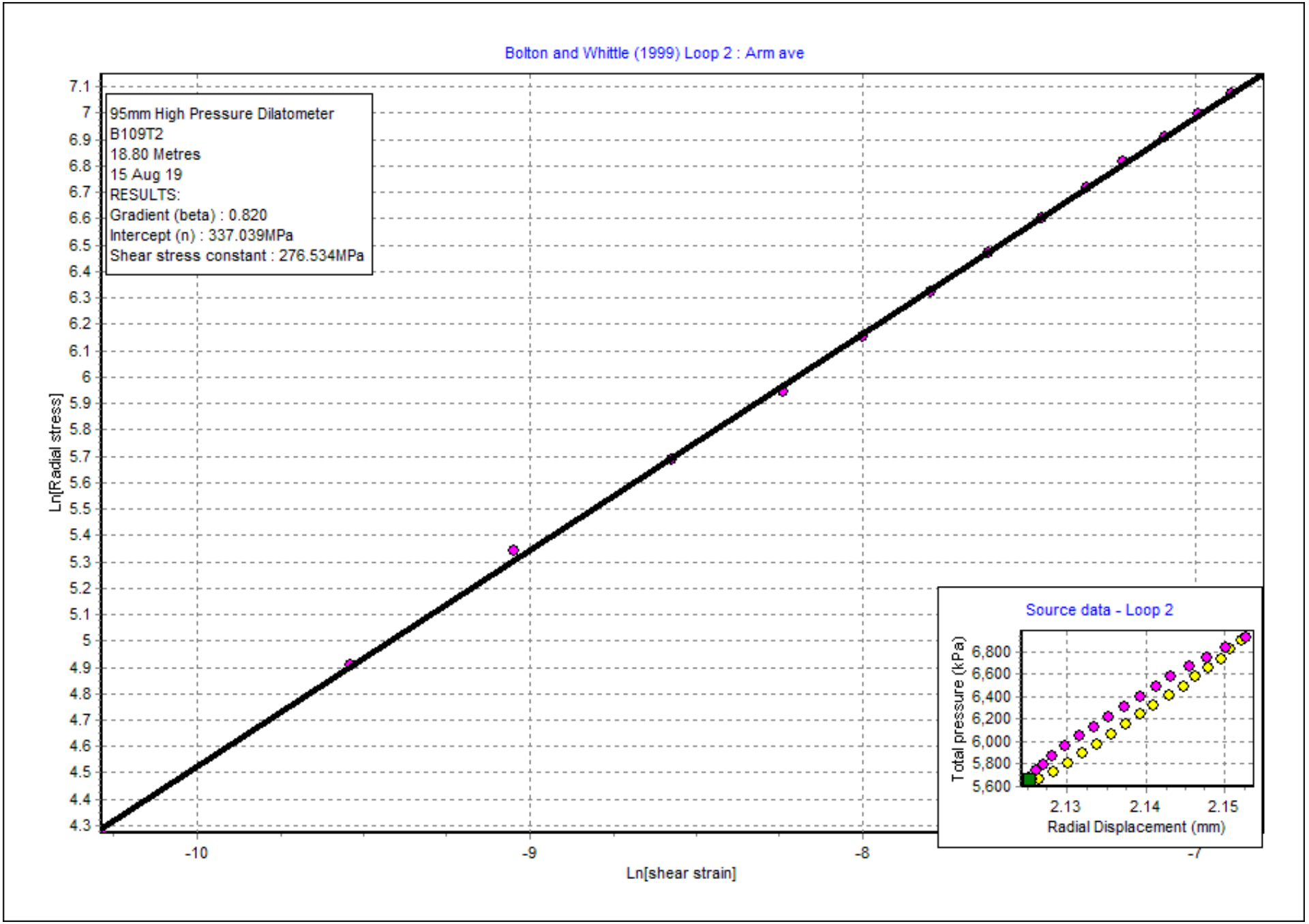

Po of cohesive material (1977, 1990) : Arm ave
95mm High Pressure Dilatometer
B109T2
18.80 Metres
15 Aug 19
RESULTS:
Gi : 426.4MPa
Pf :
Po :
Tf :
Po + Tf :
Origin : 1.731mm
Total pressure (kPa)
12,500
12,000
11,500
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
1
2
Radial Displacement (mm)

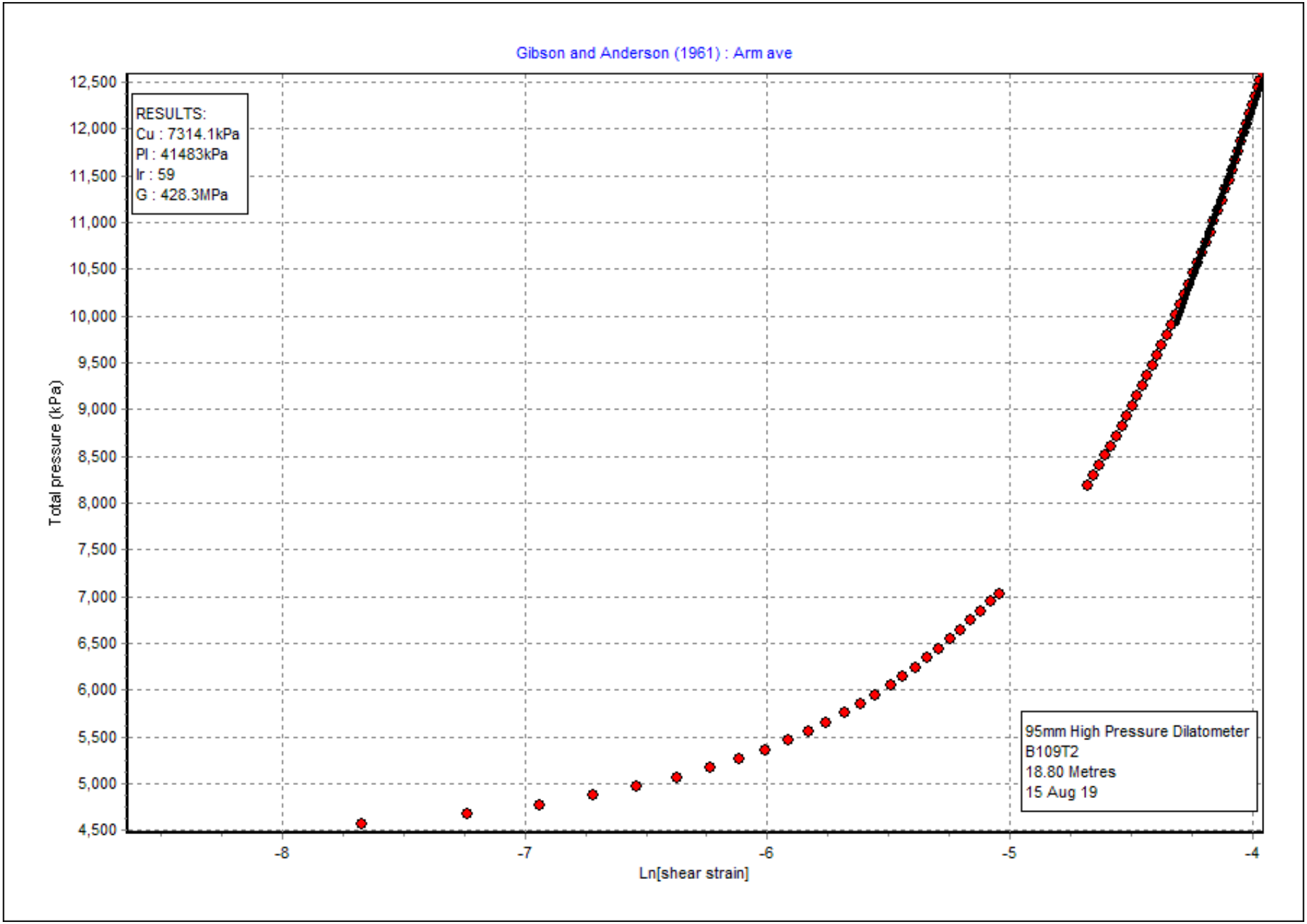

Cavity strain vs Total Pressure : Arm ave
Total pressure (kPa)
12,500
12,000
11,500
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
-4
-3.5
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
Cavity strain (%)
95mm High Pressure Dilatometer
B109T2
18.80 Metres
15 Aug 19

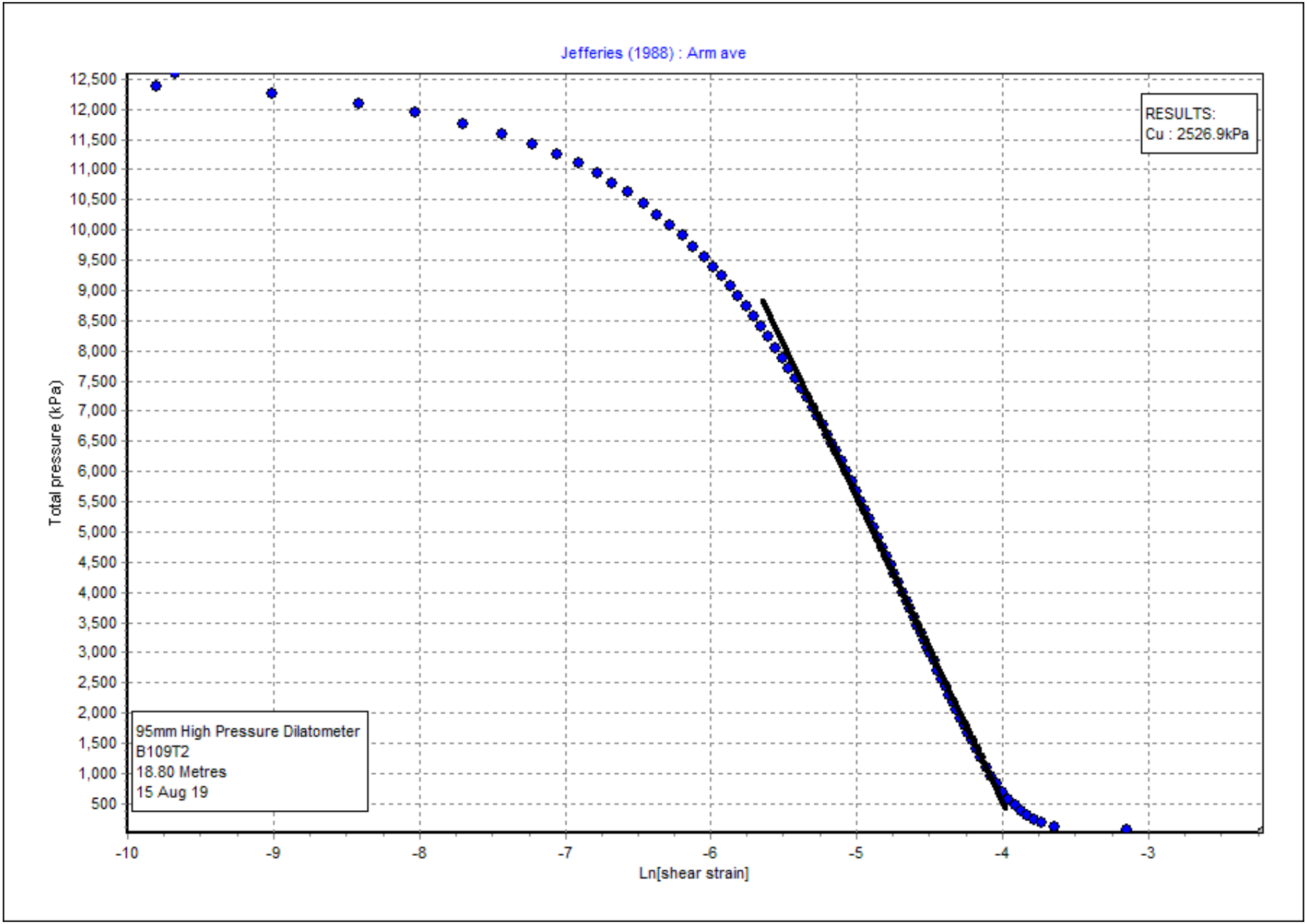

Shear modulus from unload/reload cycles Loop 1 : Arm ave
RESULTS:
Gur : 888.8MPa
Cycle mid-point:
Cavity strain : -0.129%
Total stress : 2943kPa
Size of cycle :
Shear strain : 0.106%
Total stress : 941kPa
95mm High Pressure Dilatometer
B109T2
18.80 Metres
15 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
3,450
3,400
3,350
3,300
3,250
3,200
3,150
3,100
3,050
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
1.9
1.902
1.904
1.906
1.908
1.91
1.912
1.914
1.916
1.918
1.92
1.922
1.924
1.926
1.928
1.93
1.932
1.934
1.936
1.938


Shear modulus from unload/reload cycles Loop 2 : Arm ave
RESULTS:
Gur : 1169.1MPa
Cycle mid-point:
Cavity strain : 0.321%
Total stress : 6278kPa
Size of cycle :
Shear strain : 0.109%
Total stress : 1281kPa
95mm High Pressure Dilatometer
B109T2
18.80 Metres
15 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
7,050
7,000
6,950
6,900
6,850
6,800
6,750
6,700
6,650
6,600
6,550
6,500
6,450
6,400
6,350
6,300
6,250
6,200
6,150
6,100
6,050
6,000
5,950
5,900
5,850
5,800
5,750
5,700
5,650
5,600
2.122
2.124
2.126
2.128
2.13
2.132
2.134
2.136
2.138
2.14
2.142
2.144
2.146
2.148
2.15
2.152
2.154


Bolton and Whittle (1999) Loop 1 : Arm ave
95mm High Pressure Dilatometer
B109T2
18.80 Metres
15 Aug 19
RESULTS:
Gradient (beta) : 0.786
Intercept (n) : 208.491MPa
Shear stress constant : 163.950MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 1
Total pressure (kPa)
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 2 : Arm ave
95mm High Pressure Dilatometer
B109T2
18.80 Metres
15 Aug 19
RESULTS:
Gradient (beta) : 0.820
Intercept (n) : 337.039MPa
Shear stress constant : 276.534MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 2
Total pressure (kPa)
Radial Displacement (mm)


Gibson and Anderson (1961) : Arm ave
RESULTS:
Cu : 7314.1kPa
PI : 41483kPa
Ir : 59
G : 428.3MPa
95mm High Pressure Dilatometer
B109T2
18.80 Metres
15 Aug 19
Total pressure (kPa)
12,500
12,000
11,500
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
-8
-7
-6
-5
-4
Ln[shear strain]


Jefferies (1988) : Arm ave
RESULTS:
Cu : 2526.9kPa
95mm High Pressure Dilatometer
B109T2
18.80 Metres
15 Aug 19
Total pressure (kPa)
12,500
12,000
11,500
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
-10
-9
-8
-7
-6
-5
-4
-3
Ln[shear strain]

B109T3 - SUMMARY OF RESULTS
[File made with WinSitu Version 3.9.1.1]

[DETAILS OF TEST]
Project : Crown Street, Manchester
Site : M9019 Crown Street
Borehole : BH109
Test name : B109T3
Test date : 16 Aug 19
Test depth : 24.70 Metres
Water table : 3.00 Metres
Ambient PWP : 212.9 kPa
Material : Sandstone
Probe : 95mm High Pressure Dilatometer
Diameter : 94.0 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out

Analysed by IRC on 20 Aug 19

Remarks: Pocket 24-25.5. Probe to 25.4 start 1110am.

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm) : "Arm ave=1.81"
Best estimate of Po (kPa) : "Arm ave=4500.0"

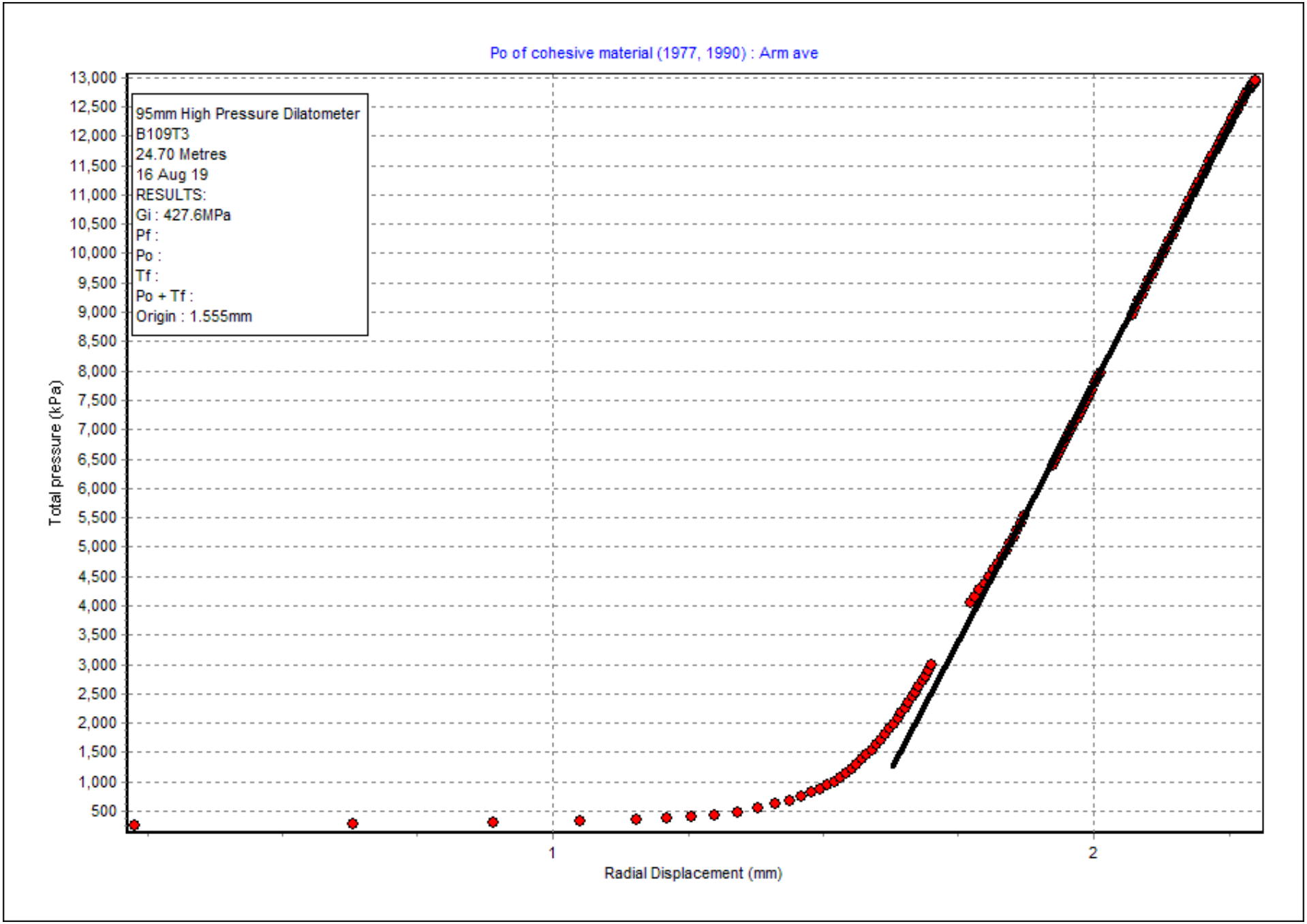
[UNDRAINED STRENGTH PARAMETERS]
Gibson & Anderson 1961 - Cu (kPa) : "Arm ave=7310.5"
Limit pressure (kPa) : "Arm ave=41606"
Jefferies 1988 - Cu (kPa) : "Arm ave=2977.8"

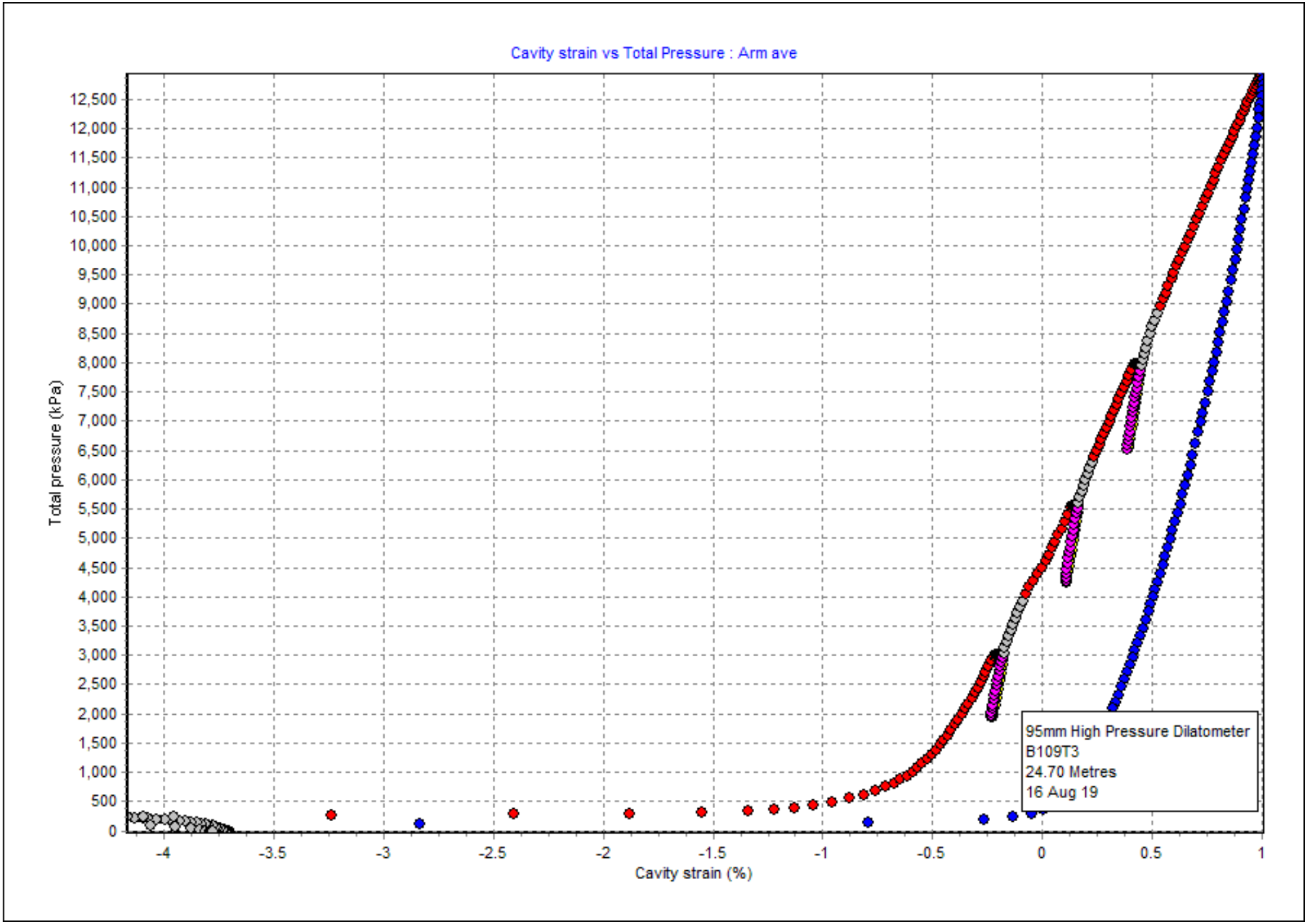
[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=427.6"

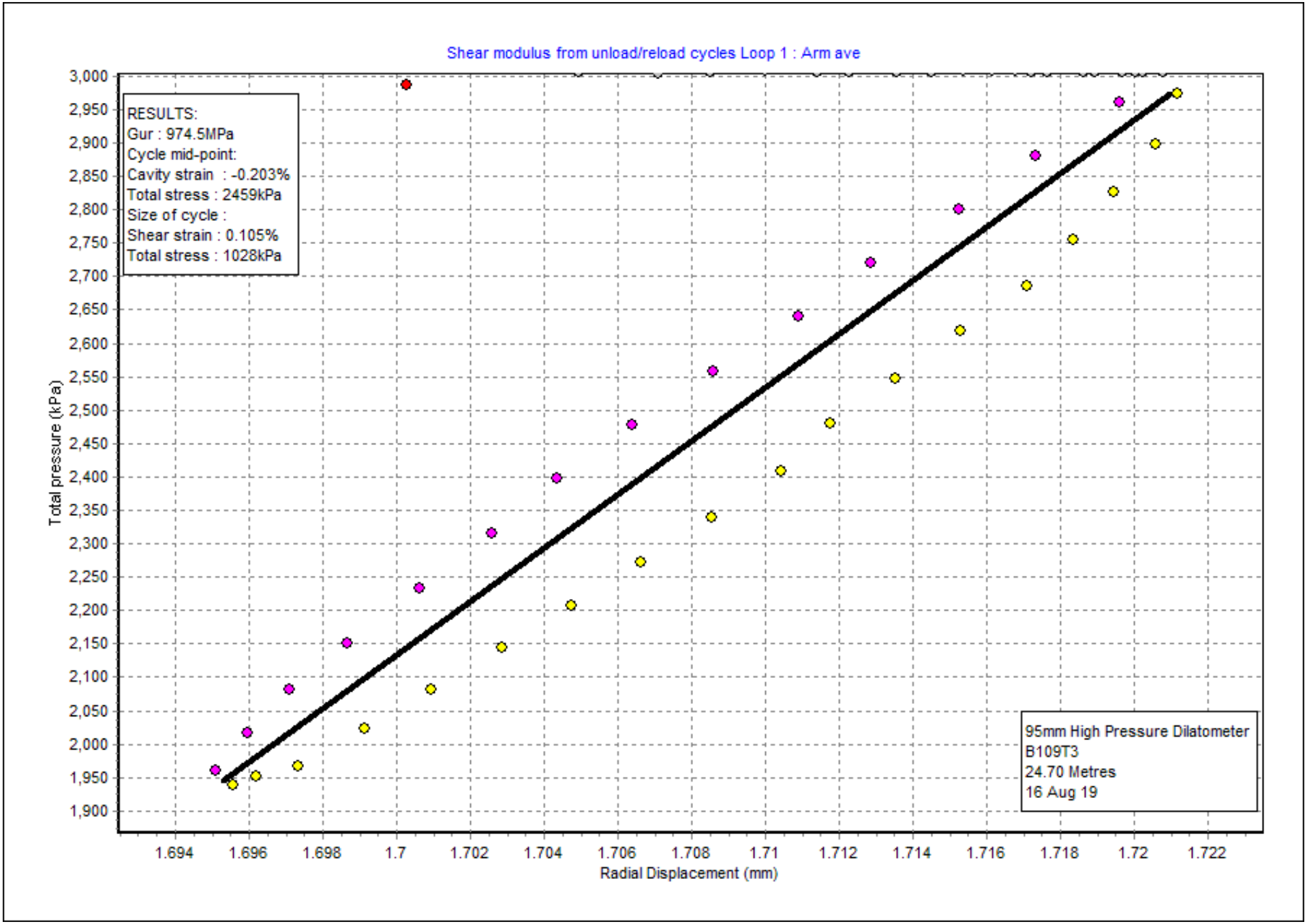
Axis	Loop No	Value (MPa)	Mean Strain (%)	Mean Pc (kPa)	dE (%)	dPc (kPa)
Arm ave	1	974.5	-0.203	2459	0.105	1028
Arm ave	2	1153.2	0.136	4898	0.111	1283
Arm ave	3	1150.7	0.420	7171	0.114	1315

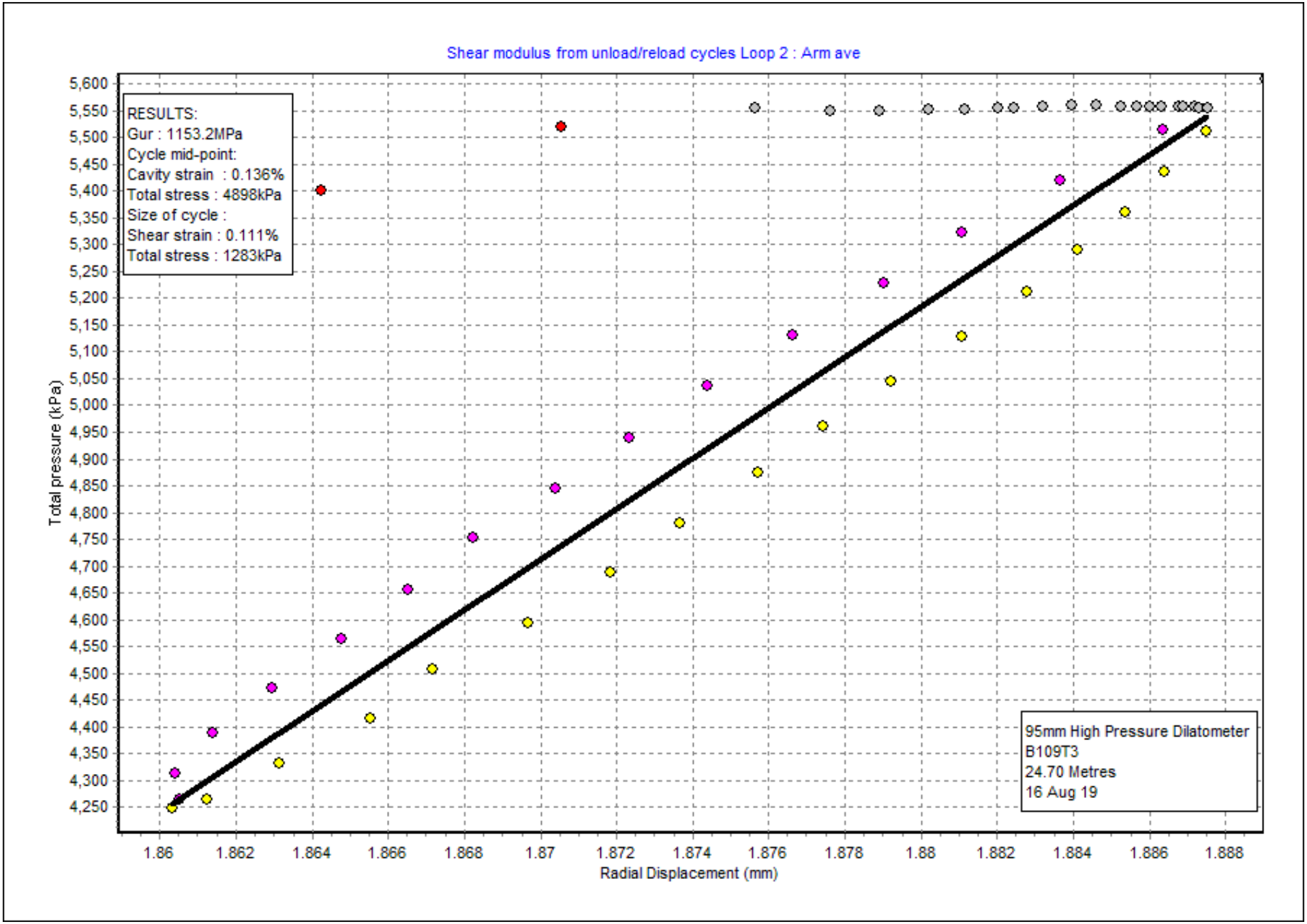
[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]

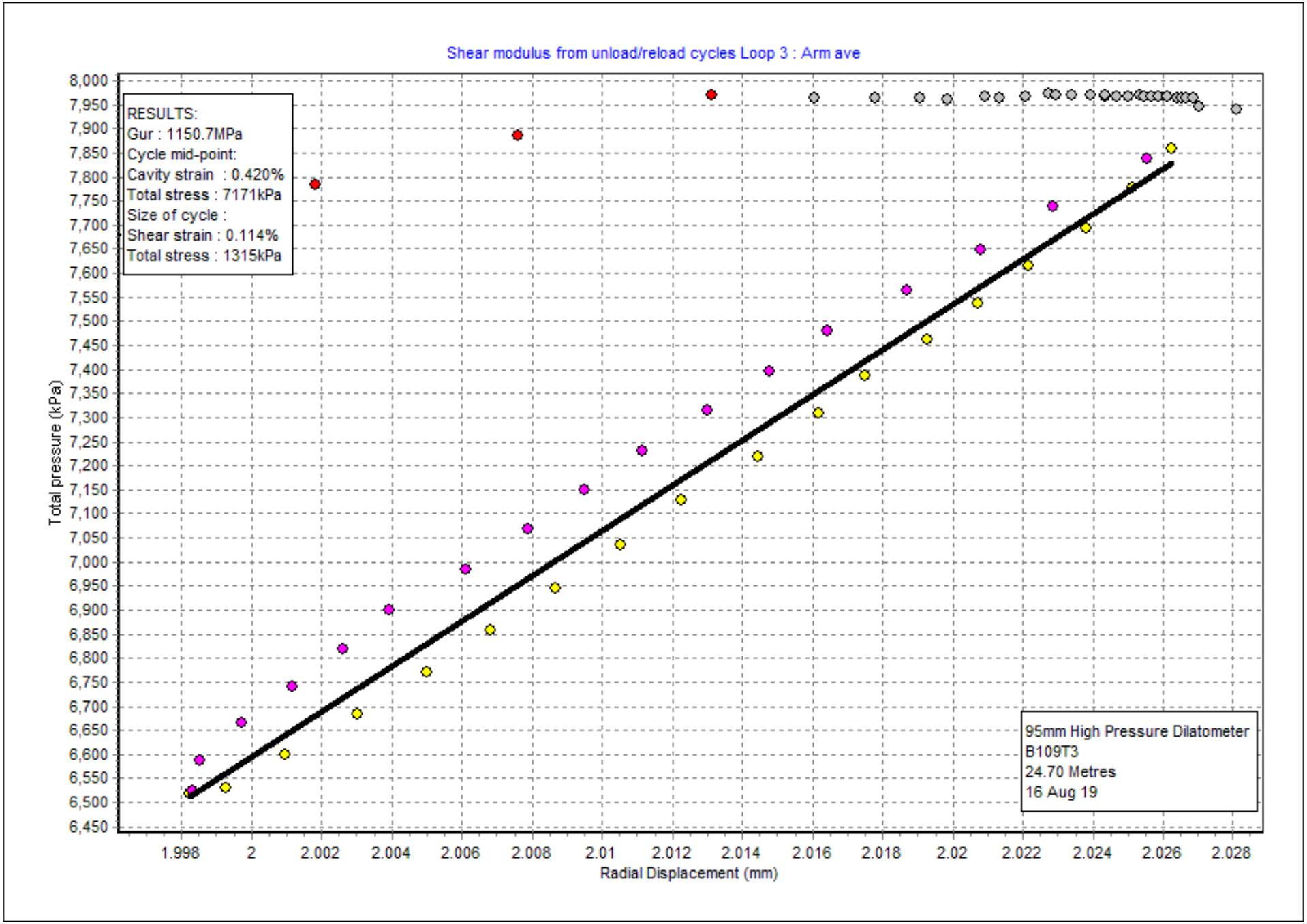
Axis	Loop No	Intercept (MPa)	Alpha (MPa)	Gradient
Arm ave	1	311.902	258.422	0.829
Arm ave	2	301.790	240.720	0.798
Arm ave	3	335.070	272.748	0.814

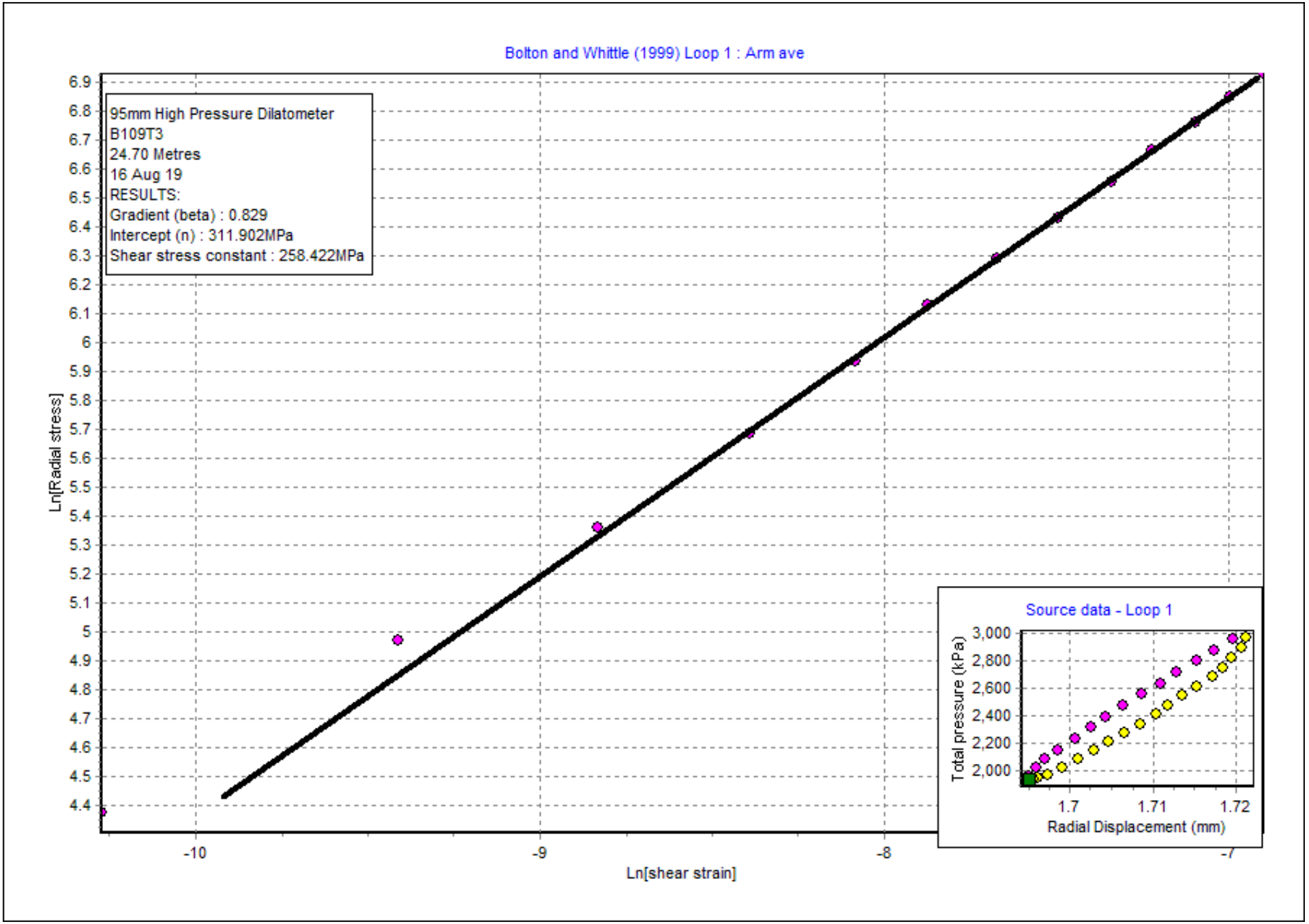

Po of cohesive material (1977, 1990) : Arm ave
95mm High Pressure Dilatometer
B109T3
24.70 Metres
16 Aug 19
RESULTS:
Gi : 427.6MPa
Pf :
Po :
Tf :
Po + Tf :
Origin : 1.555mm
Total pressure (kPa)
13,000
12,500
12,000
11,500
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
1
2
Radial Displacement (mm)

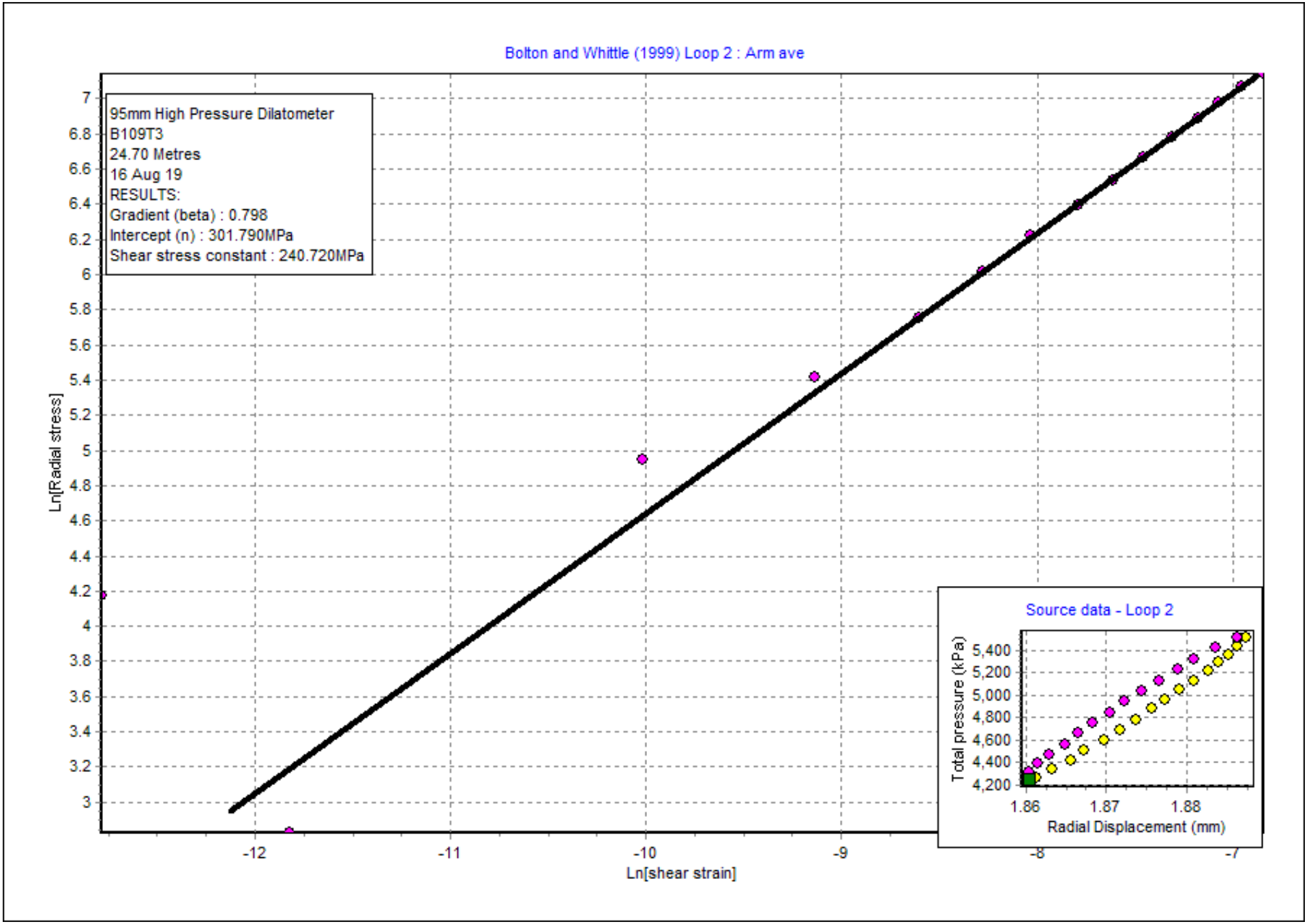

Cavity strain vs Total Pressure : Arm ave
Total pressure (kPa)
12,500
12,000
11,500
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
-4
-3.5
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
1
Cavity strain (%)
95mm High Pressure Dilatometer
B109T3
24.70 Metres
16 Aug 19

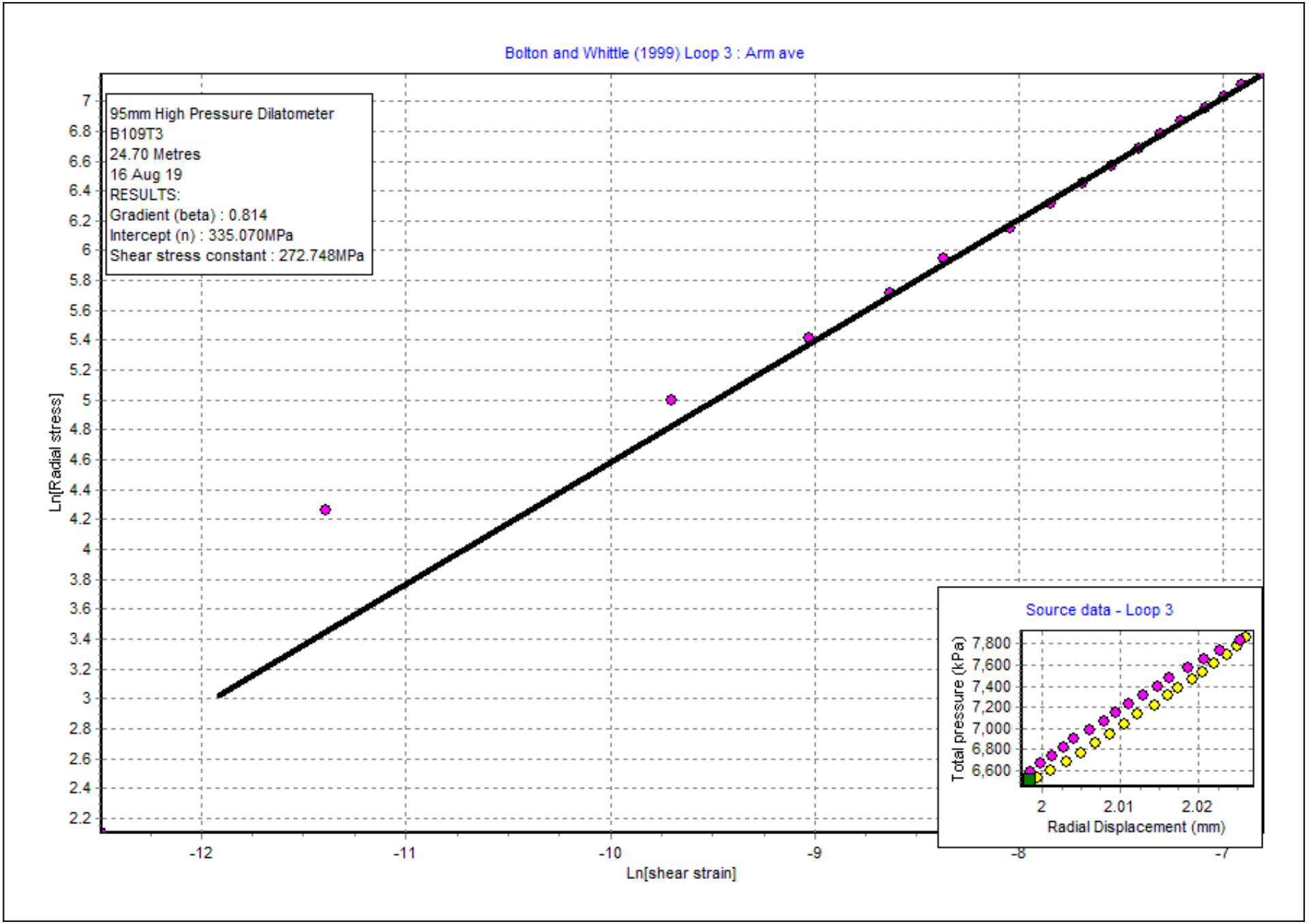

Shear modulus from unload/reload cycles Loop 1 : Arm ave
RESULTS:
Gur : 974.5MPa
Cycle mid-point:
Cavity strain : -0.203%
Total stress : 2459kPa
Size of cycle :
Shear strain : 0.105%
Total stress : 1028kPa
95mm High Pressure Dilatometer
B109T3
24.70 Metres
16 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
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
2,000
1,950
1,900
1.694
1.696
1.698
1.7
1.702
1.704
1.706
1.708
1.71
1.712
1.714
1.716
1.718
1.72
1.722

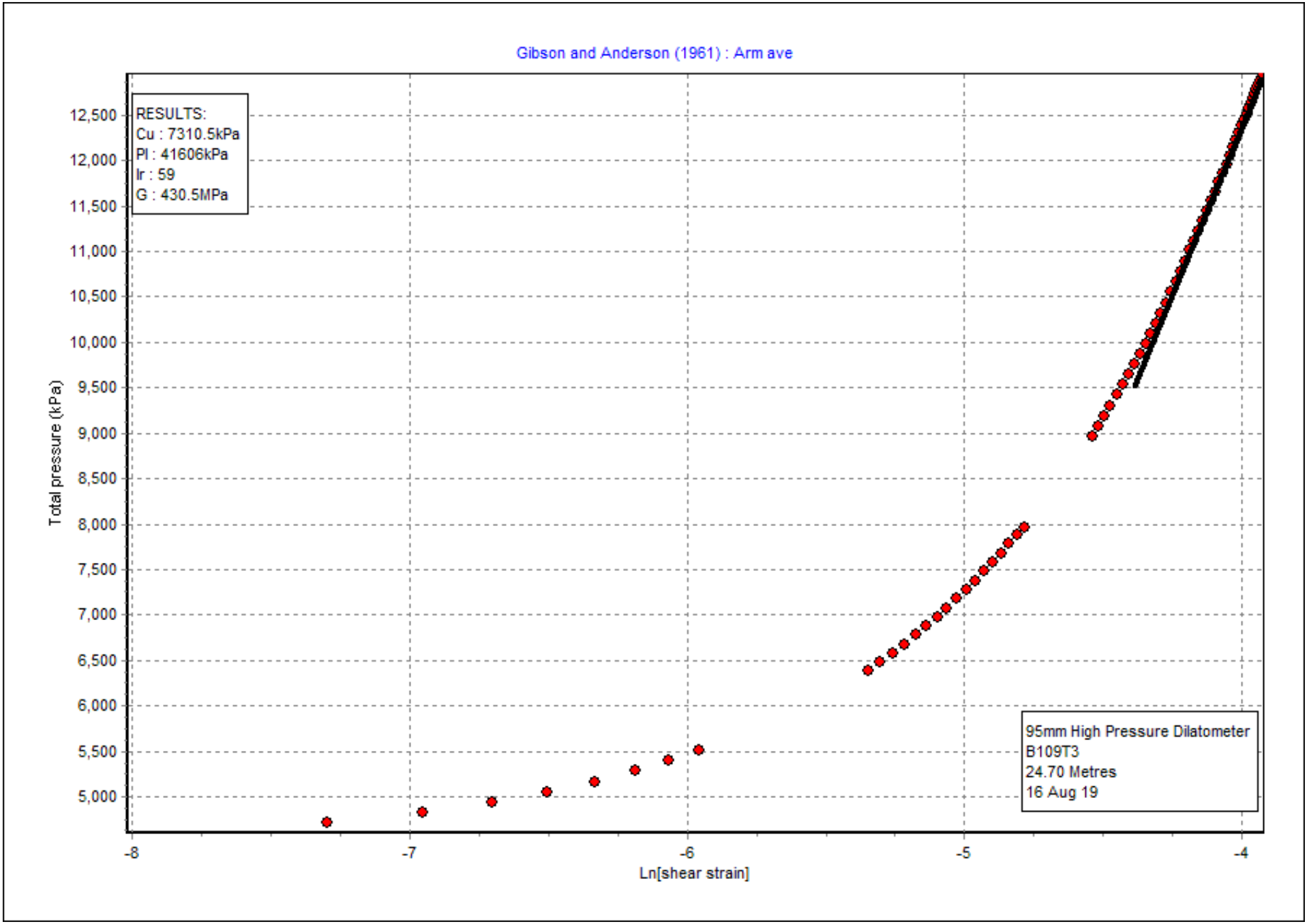

Shear modulus from unload/reload cycles Loop 2 : Arm ave
RESULTS:
Gur : 1153.2MPa
Cycle mid-point:
Cavity strain : 0.136%
Total stress : 4898kPa
Size of cycle :
Shear strain : 0.111%
Total stress : 1283kPa
95mm High Pressure Dilatometer
B109T3
24.70 Metres
16 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
5,600
5,550
5,500
5,450
5,400
5,350
5,300
5,250
5,200
5,150
5,100
5,050
5,000
4,950
4,900
4,850
4,800
4,750
4,700
4,650
4,600
4,550
4,500
4,450
4,400
4,350
4,300
4,250
1.86
1.862
1.864
1.866
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1.872
1.874
1.876
1.878
1.88
1.882
1.884
1.886
1.888

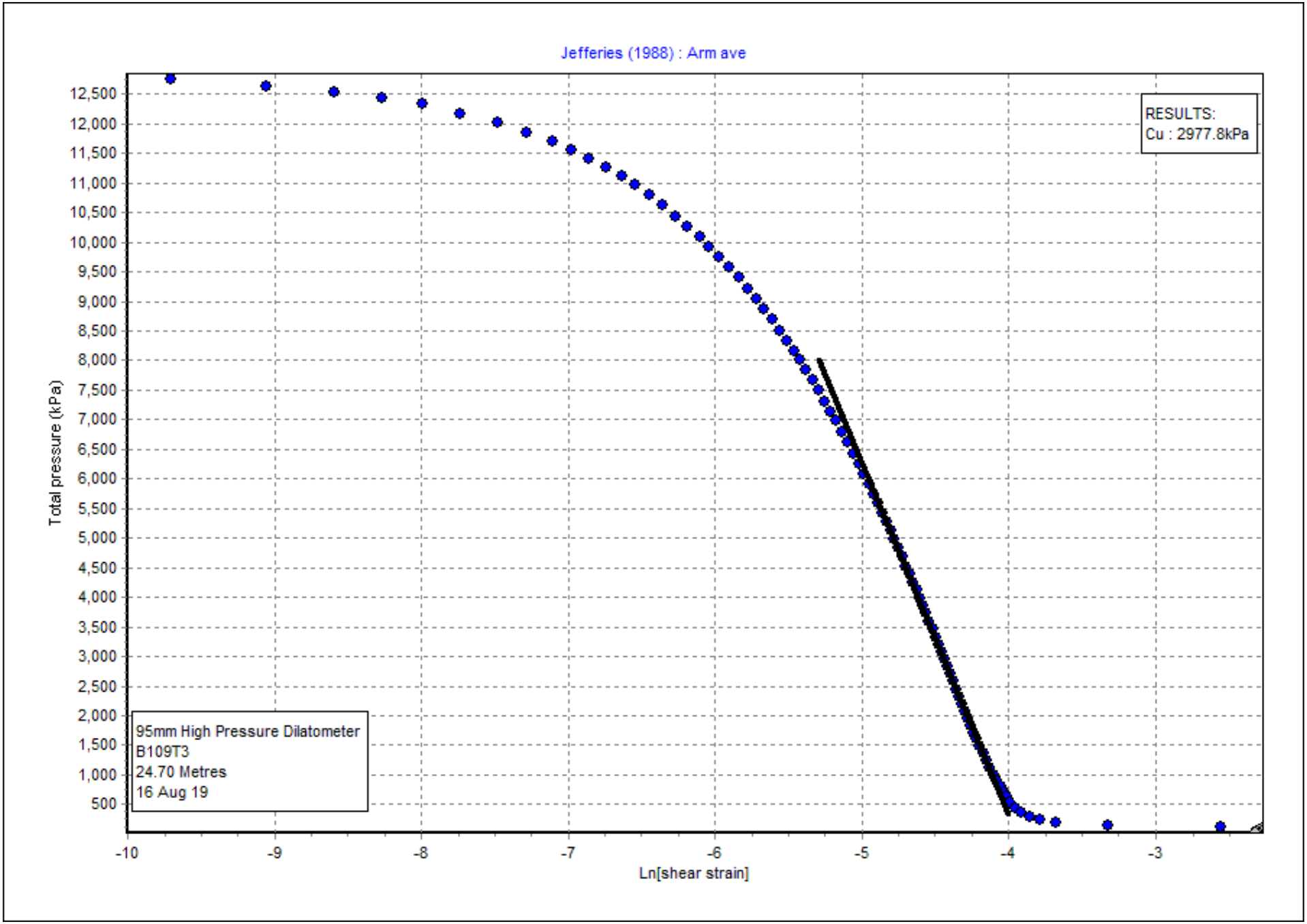

Shear modulus from unload/reload cycles Loop 3 : Arm ave
RESULTS:
Gur : 1150.7MPa
Cycle mid-point:
Cavity strain : 0.420%
Total stress : 7171kPa
Size of cycle :
Shear strain : 0.114%
Total stress : 1315kPa
95mm High Pressure Dilatometer
B109T3
24.70 Metres
16 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
8,000
7,950
7,900
7,850
7,800
7,750
7,700
7,650
7,600
7,550
7,500
7,450
7,400
7,350
7,300
7,250
7,200
7,150
7,100
7,050
7,000
6,950
6,900
6,850
6,800
6,750
6,700
6,650
6,600
6,550
6,500
6,450
1.998
2
2.002
2.004
2.006
2.008
2.01
2.012
2.014
2.016
2.018
2.02
2.022
2.024
2.026
2.028


Bolton and Whittle (1999) Loop 1 : Arm ave
95mm High Pressure Dilatometer
B109T3
24.70 Metres
16 Aug 19
RESULTS:
Gradient (beta) : 0.829
Intercept (n) : 311.902MPa
Shear stress constant : 258.422MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 1
Total pressure (kPa)
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 2 : Arm ave
95mm High Pressure Dilatometer
B109T3
24.70 Metres
16 Aug 19
RESULTS:
Gradient (beta) : 0.798
Intercept (n) : 301.790MPa
Shear stress constant : 240.720MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 2
Total pressure (kPa)
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 3 : Arm ave
95mm High Pressure Dilatometer
B109T3
24.70 Metres
16 Aug 19
RESULTS:
Gradient (beta) : 0.814
Intercept (n) : 335.070MPa
Shear stress constant : 272.748MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 3
Total pressure (kPa)
Radial Displacement (mm)


Gibson and Anderson (1961) : Arm ave
RESULTS:
Cu : 7310.5kPa
PI : 41606kPa
Ir : 59
G : 430.5MPa
95mm High Pressure Dilatometer
B109T3
24.70 Metres
16 Aug 19
Total pressure (kPa)
12,500
12,000
11,500
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
-8
-7
-6
-5
-4
Ln[shear strain]


Jefferies (1988) : Arm ave
RESULTS:
Cu : 2977.8kPa
95mm High Pressure Dilatometer
B109T3
24.70 Metres
16 Aug 19
Total pressure (kPa)
Ln[shear strain]
12,500
12,000
11,500
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
-10
-9
-8
-7
-6
-5
-4
-3

B109T4 - SUMMARY OF RESULTS
[File made with WinSitu Version 3.9.1.1]

[DETAILS OF TEST]
Project : Crown Street, Manchester
Site : M9019 Crown Street
Borehole : BH109
Test name : B109T4
Test date : 19 Aug 19
Test depth : 29.10 Metres
Water table : 3.00 Metres
Ambient PWP : 256.0 kPa
Material : Sandstone
Probe : 95mm High Pressure Dilatometer
Diameter : 94.0 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out

Analysed by IRC on 20 Aug 19

Remarks: pocket 28.5-30 probe 0.2 off base. 0840am

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm) : "Arm ave=2.24"
Best estimate of Po (kPa) : "Arm ave=3000.0"

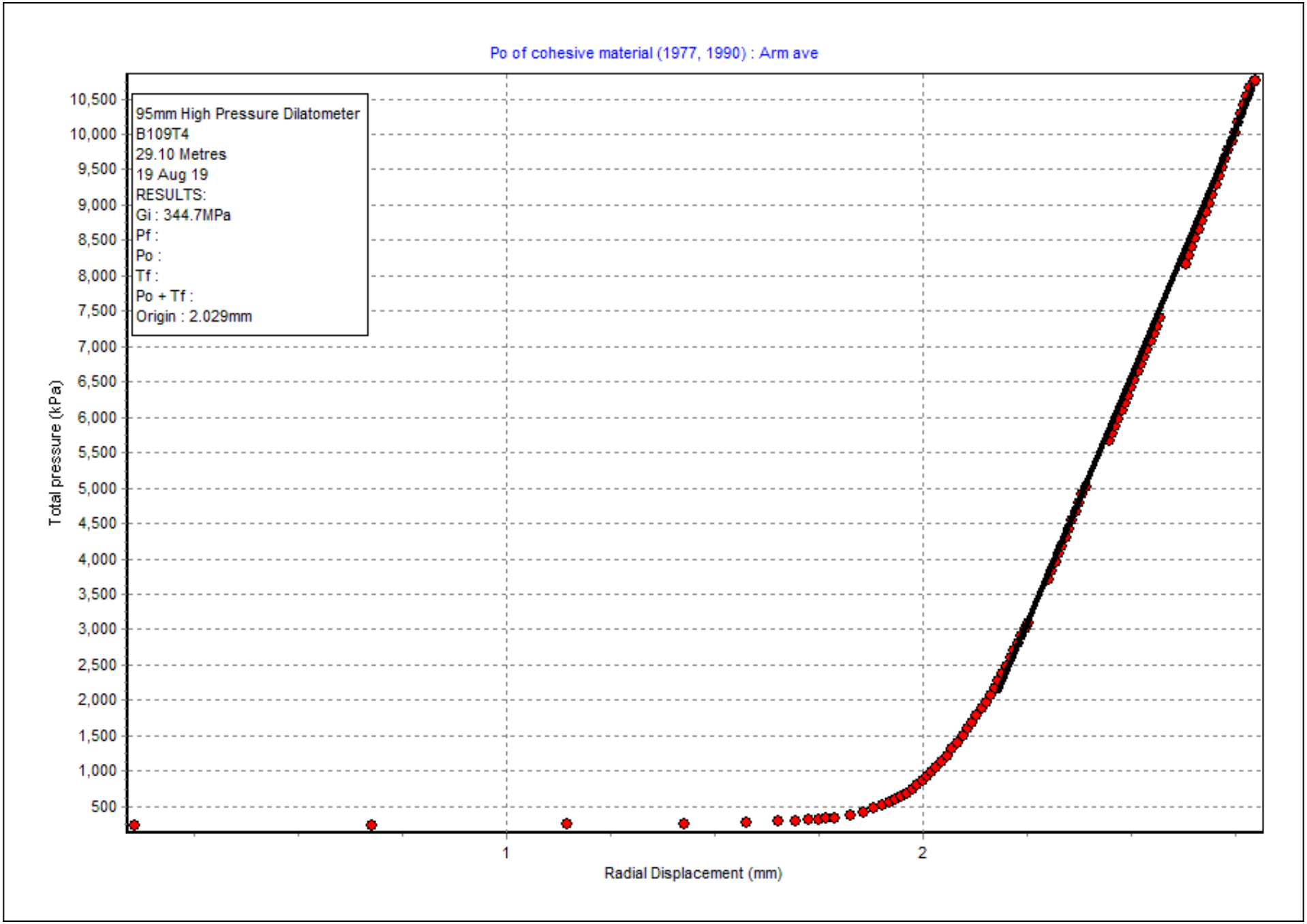
[UNDRAINED STRENGTH PARAMETERS]
Gibson & Anderson 1961 - Cu (kPa) : "Arm ave=7337.9"
Limit pressure (kPa) : "Arm ave=38707"
Jefferies 1988 - Cu (kPa) : "Arm ave=1945.2"

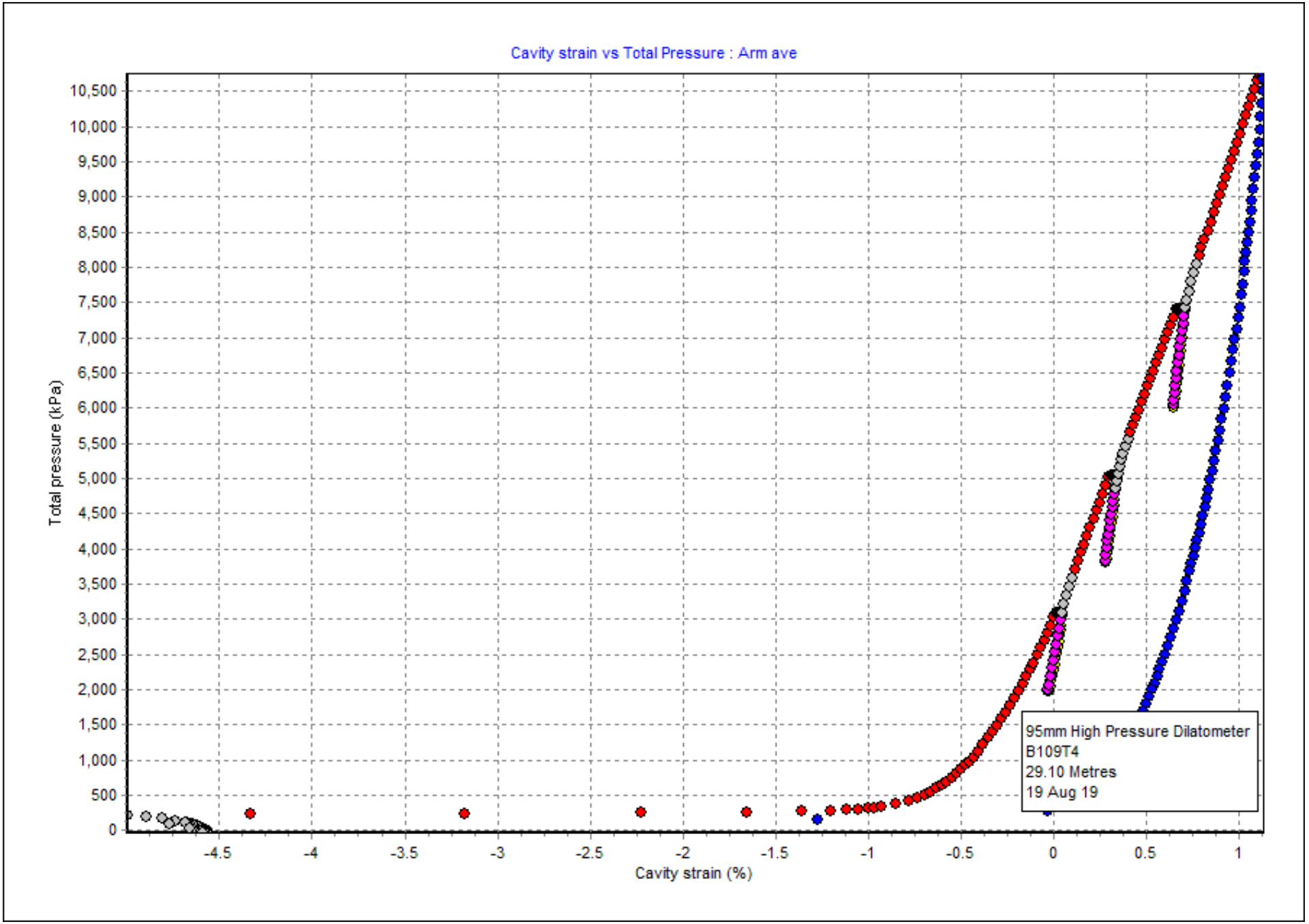
[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=344.7"

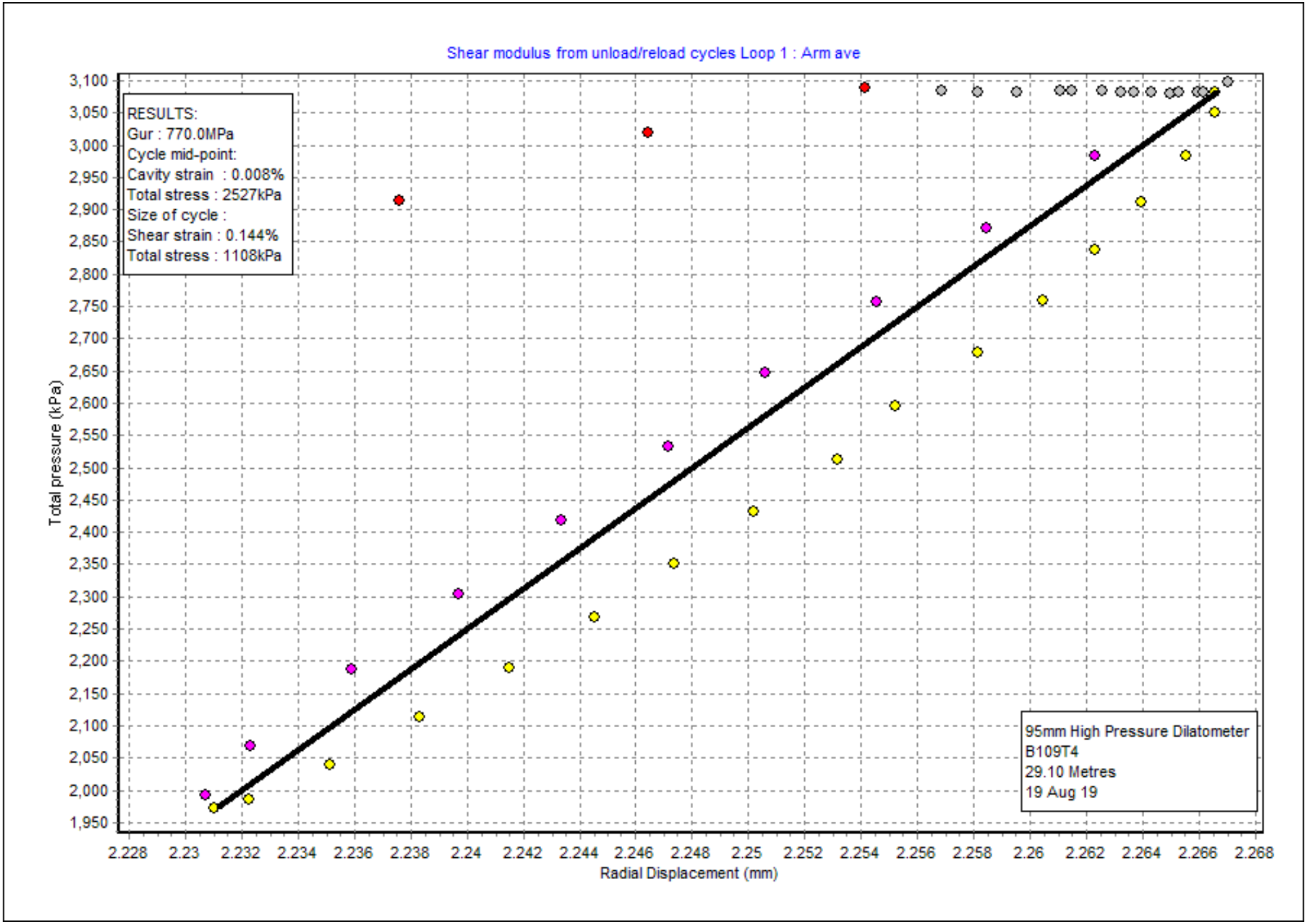
Axis	Loop No	Value (MPa)	Mean Strain (%)	Mean Pc (kPa)	dE (%)	dPc (kPa)
Arm ave	1	770.0	0.008	2527	0.144	1108
Arm ave	2	972.8	0.307	4338	0.108	1053
Arm ave	3	1131.1	0.676	6694	0.120	1353

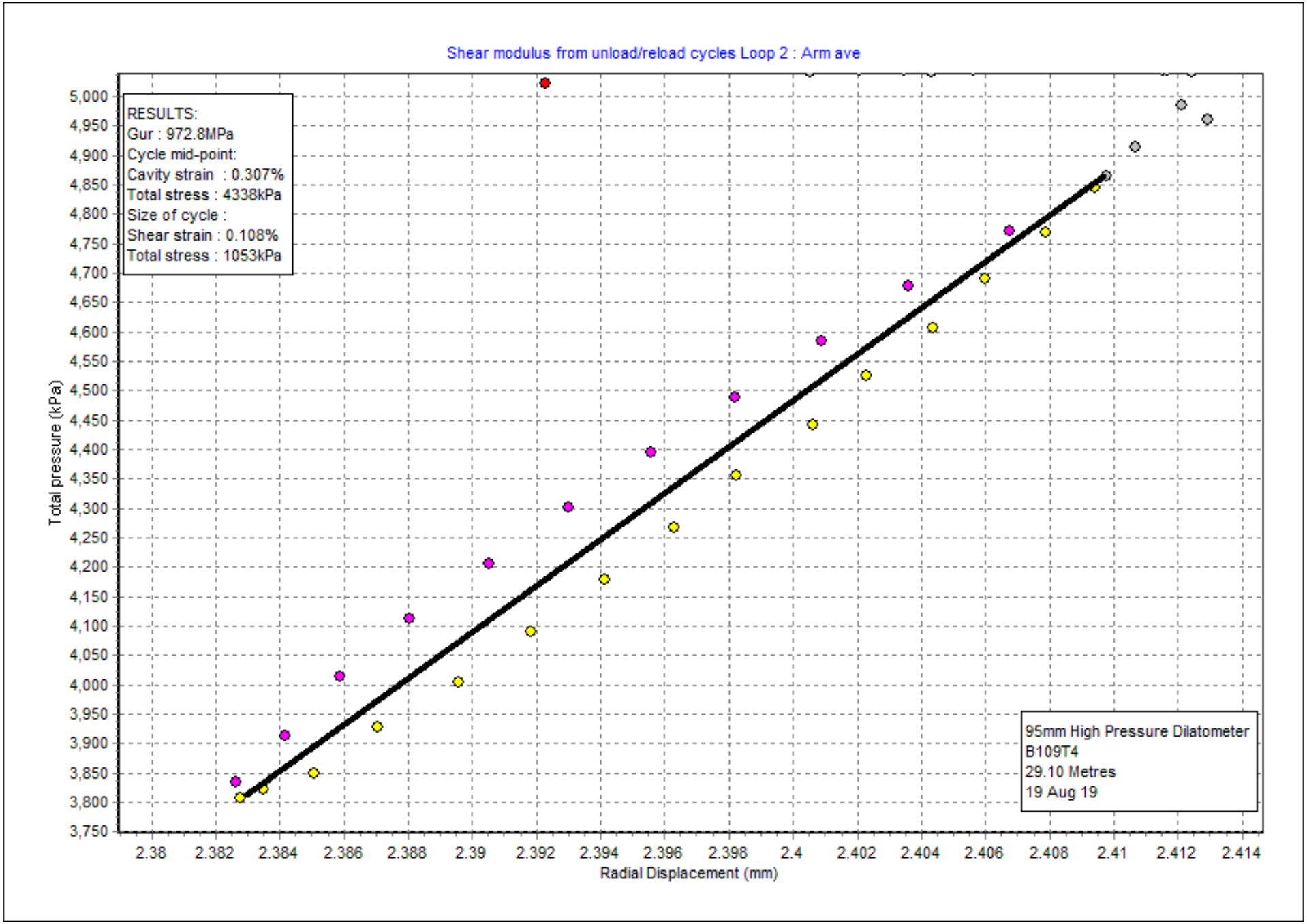
[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]

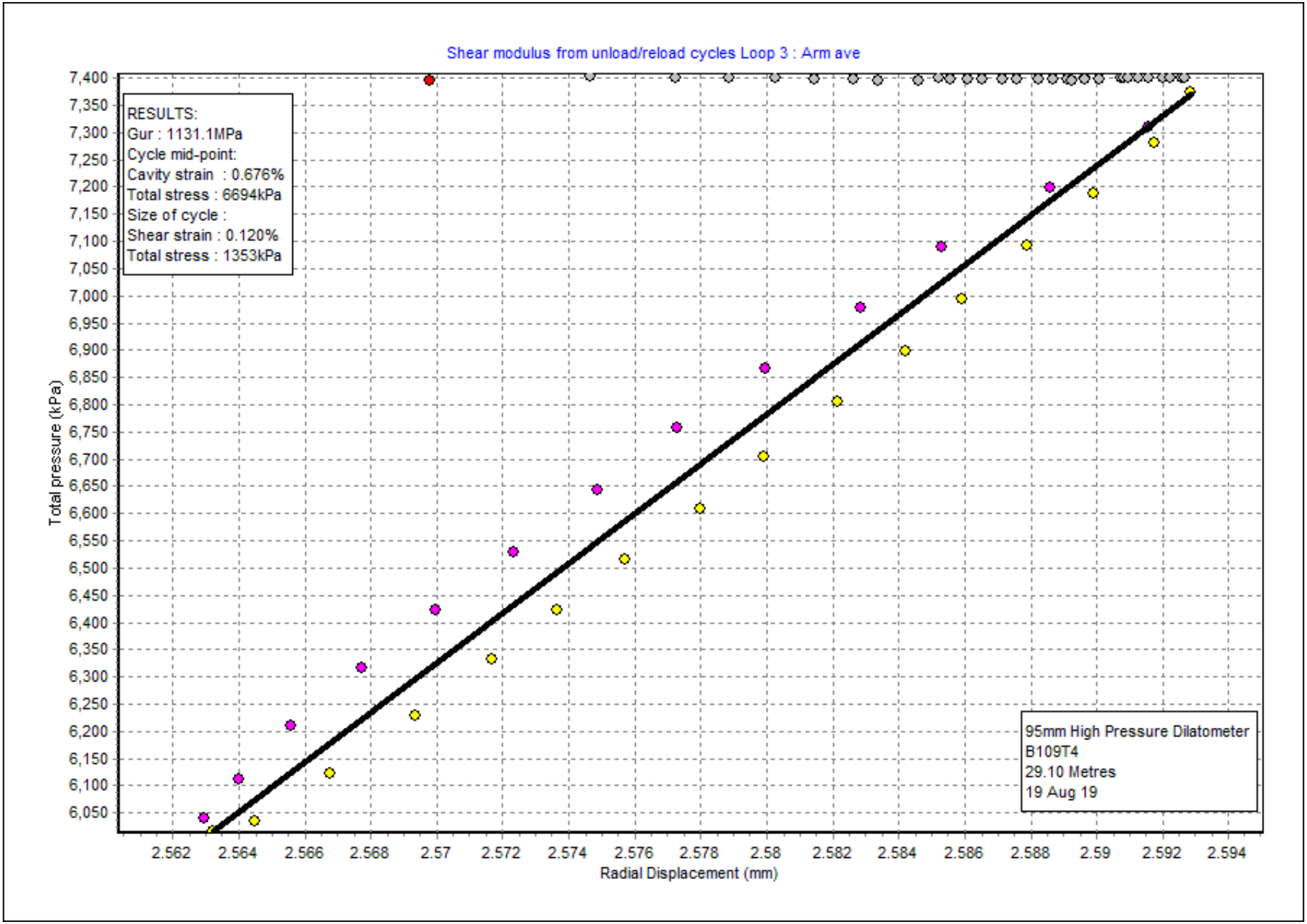
Axis	Loop No	Intercept (MPa)	Alpha (MPa)	Gradient
Arm ave	1	336.534	293.947	0.873
Arm ave	2	229.919	181.391	0.789
Arm ave	3	309.041	249.989	0.809

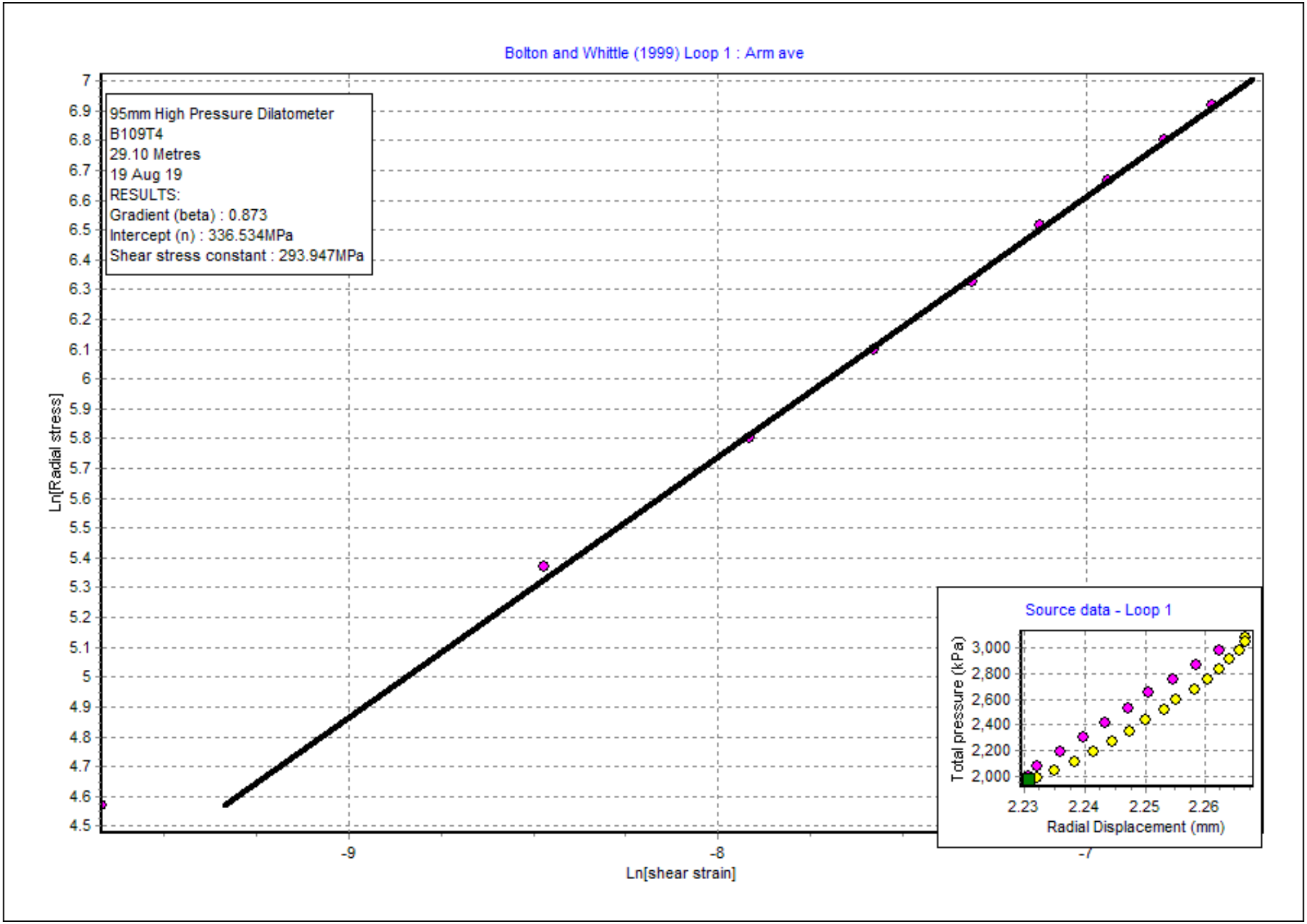

Po of cohesive material (1977, 1990) : Arm ave
95mm High Pressure Dilatometer
B109T4
29.10 Metres
19 Aug 19
RESULTS:
Gi : 344.7MPa
Pf :
Po :
Tf :
Po + Tf :
Origin : 2.029mm
Total pressure (kPa)
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
1
2
Radial Displacement (mm)

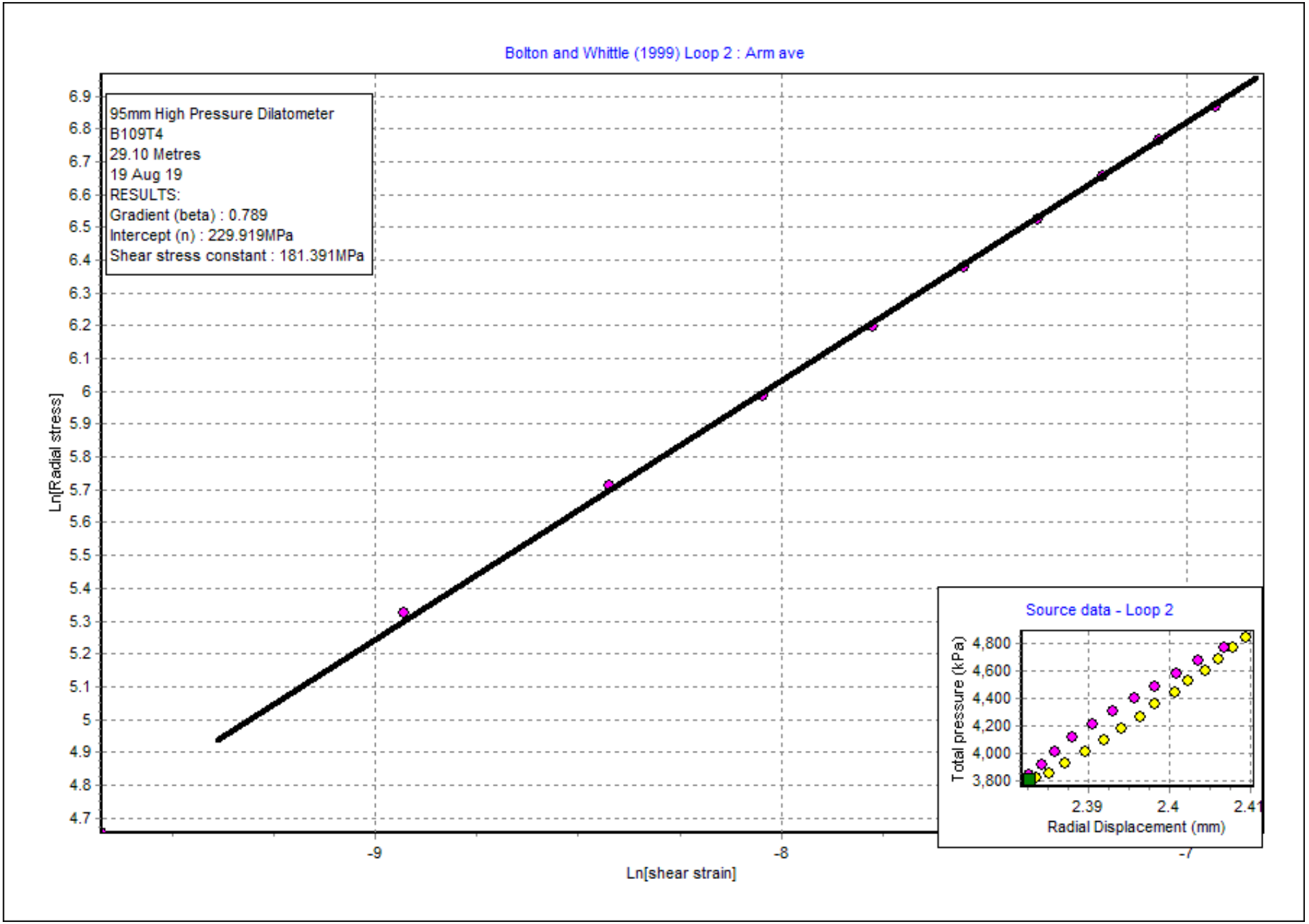

Cavity strain vs Total Pressure : Arm ave
Total pressure (kPa)
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
-4.5
-4
-3.5
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
1
Cavity strain (%)
95mm High Pressure Dilatometer
B109T4
29.10 Metres
19 Aug 19

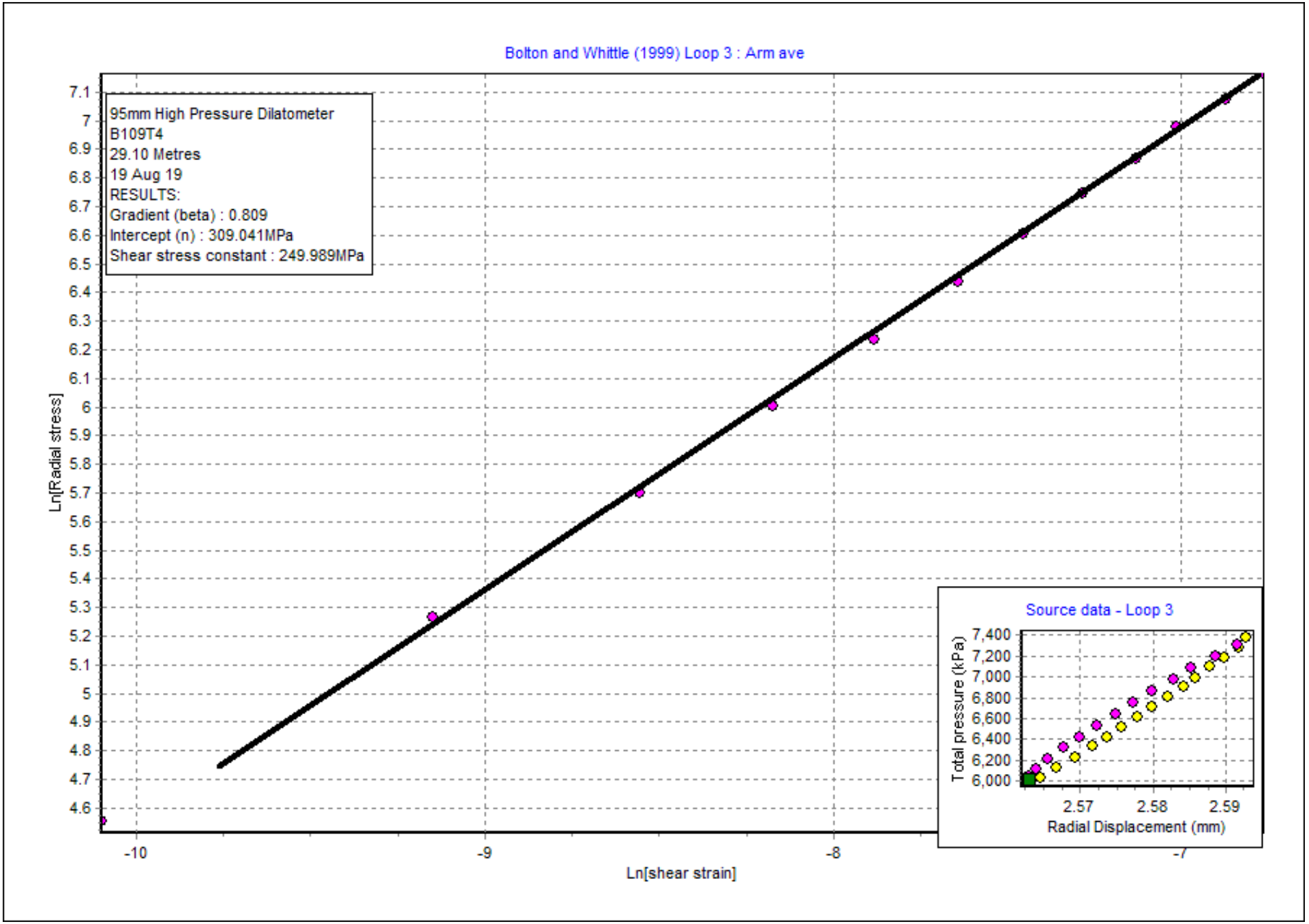

Shear modulus from unload/reload cycles Loop 1 : Arm ave
RESULTS:
Gur : 770.0MPa
Cycle mid-point:
Cavity strain : 0.008%
Total stress : 2527kPa
Size of cycle :
Shear strain : 0.144%
Total stress : 1108kPa
95mm High Pressure Dilatometer
B109T4
29.10 Metres
19 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
3,100
3,050
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
2,000
1,950
2.228
2.23
2.232
2.234
2.236
2.238
2.24
2.242
2.244
2.246
2.248
2.25
2.252
2.254
2.256
2.258
2.26
2.262
2.264
2.266
2.268

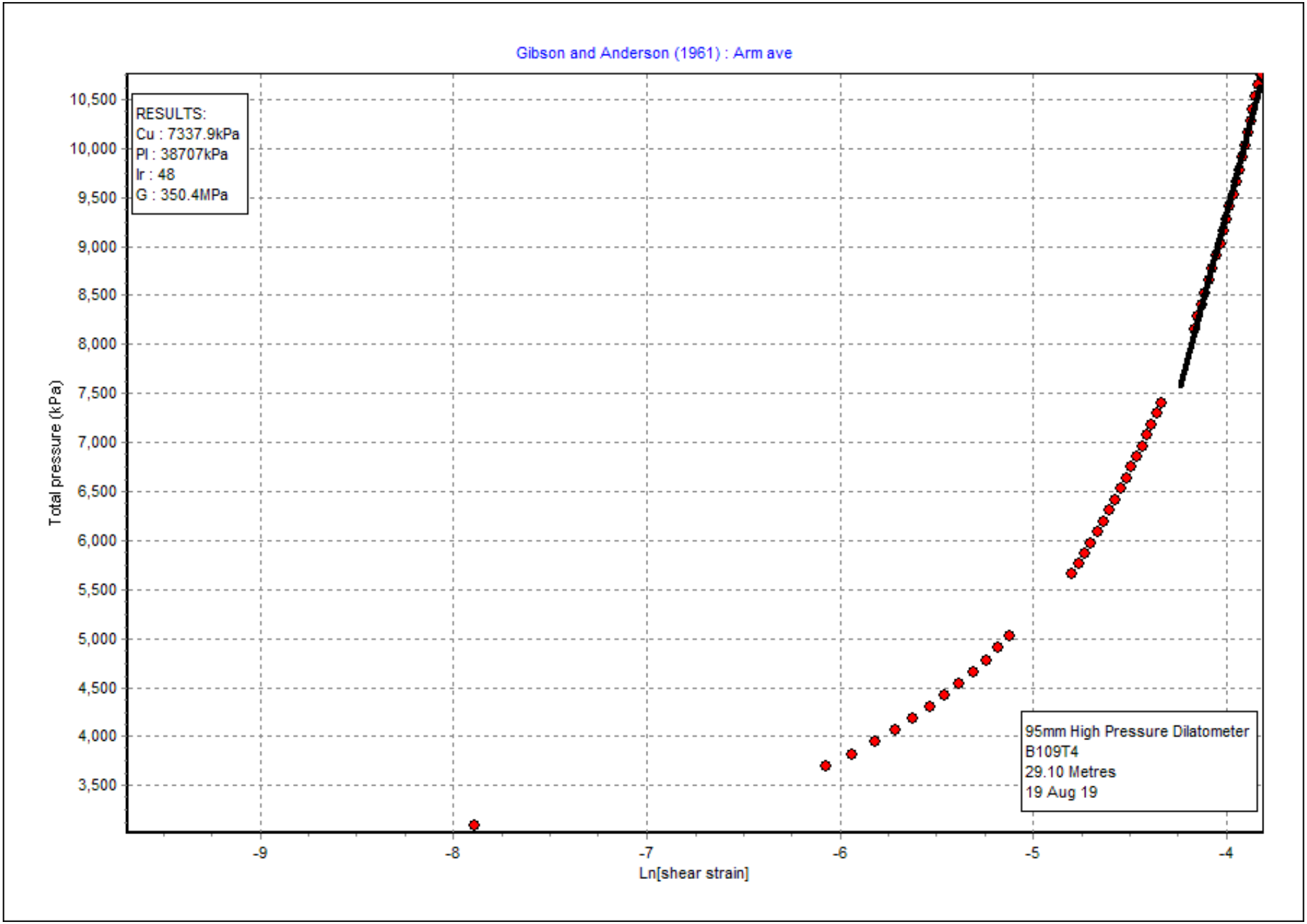

Shear modulus from unload/reload cycles Loop 2 : Arm ave
RESULTS:
Gur : 972.8MPa
Cycle mid-point:
Cavity strain : 0.307%
Total stress : 4338kPa
Size of cycle :
Shear strain : 0.108%
Total stress : 1053kPa
95mm High Pressure Dilatometer
B109T4
29.10 Metres
19 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
5,000
4,950
4,900
4,850
4,800
4,750
4,700
4,650
4,600
4,550
4,500
4,450
4,400
4,350
4,300
4,250
4,200
4,150
4,100
4,050
4,000
3,950
3,900
3,850
3,800
3,750
2.38
2.382
2.384
2.386
2.388
2.39
2.392
2.394
2.396
2.398
2.4
2.402
2.404
2.406
2.408
2.41
2.412
2.414

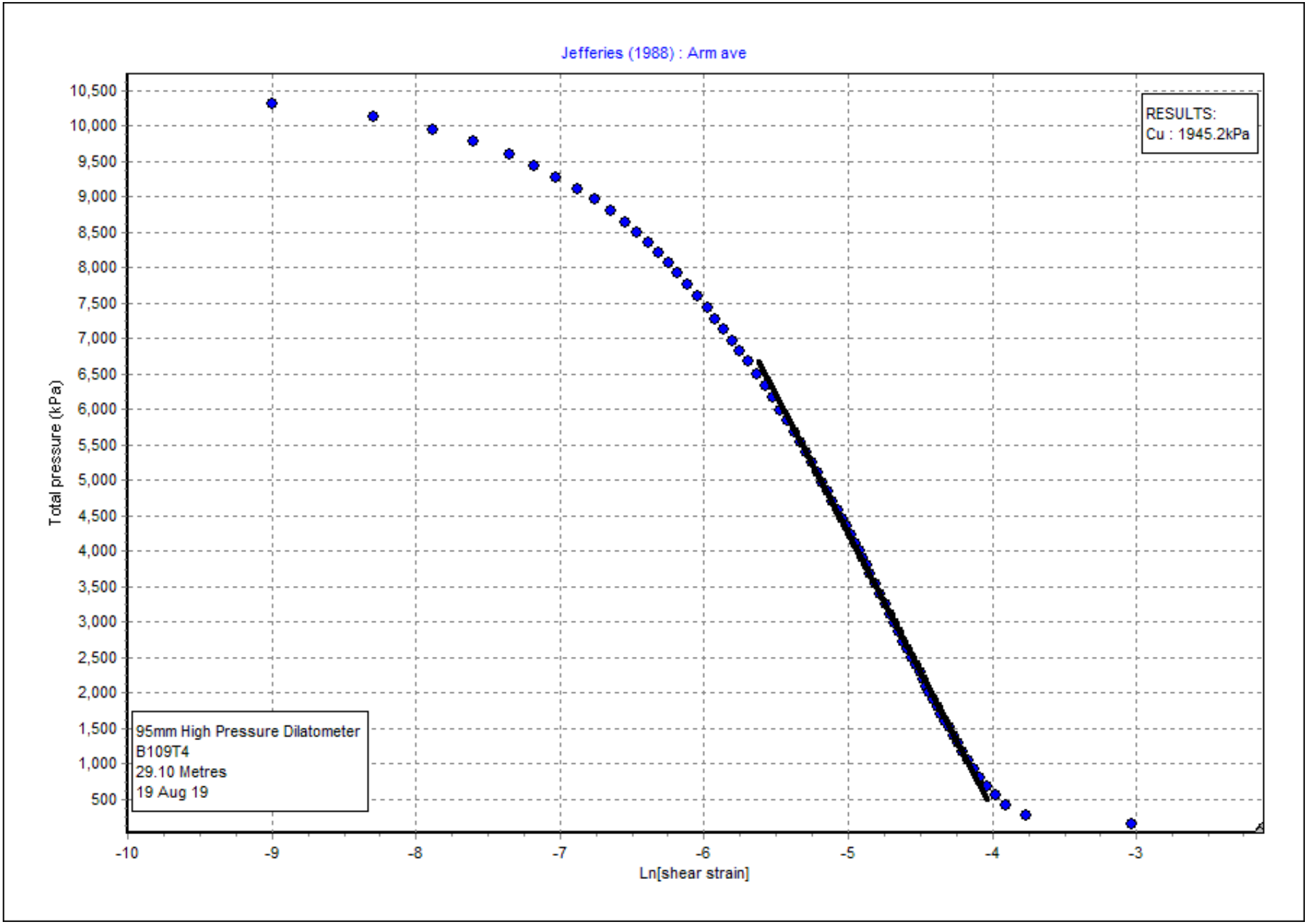

Shear modulus from unload/reload cycles Loop 3 : Arm ave
RESULTS:
Gur : 1131.1MPa
Cycle mid-point:
Cavity strain : 0.676%
Total stress : 6694kPa
Size of cycle :
Shear strain : 0.120%
Total stress : 1353kPa
95mm High Pressure Dilatometer
B109T4
29.10 Metres
19 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
7,400
7,350
7,300
7,250
7,200
7,150
7,100
7,050
7,000
6,950
6,900
6,850
6,800
6,750
6,700
6,650
6,600
6,550
6,500
6,450
6,400
6,350
6,300
6,250
6,200
6,150
6,100
6,050
2.562
2.564
2.566
2.568
2.57
2.572
2.574
2.576
2.578
2.58
2.582
2.584
2.586
2.588
2.59
2.592
2.594


Bolton and Whittle (1999) Loop 1 : Arm ave
95mm High Pressure Dilatometer
B109T4
29.10 Metres
19 Aug 19
RESULTS:
Gradient (beta) : 0.873
Intercept (n) : 336.534MPa
Shear stress constant : 293.947MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 1
Total pressure (kPa)
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 2 : Arm ave
95mm High Pressure Dilatometer
B109T4
29.10 Metres
19 Aug 19
RESULTS:
Gradient (beta) : 0.789
Intercept (n) : 229.919MPa
Shear stress constant : 181.391MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 2
Total pressure (kPa)
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 3 : Arm ave
95mm High Pressure Dilatometer
B109T4
29.10 Metres
19 Aug 19
RESULTS:
Gradient (beta) : 0.809
Intercept (n) : 309.041MPa
Shear stress constant : 249.989MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 3
Total pressure (kPa)
Radial Displacement (mm)


Gibson and Anderson (1961) : Arm ave
RESULTS:
Cu : 7337.9kPa
PI : 38707kPa
Ir : 48
G : 350.4MPa
95mm High Pressure Dilatometer
B109T4
29.10 Metres
19 Aug 19
Total pressure (kPa)
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
-9
-8
-7
-6
-5
-4
Ln[shear strain]


Jefferies (1988) : Arm ave
RESULTS:
Cu : 1945.2kPa
95mm High Pressure Dilatometer
B109T4
29.10 Metres
19 Aug 19
Total pressure (kPa)
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
-10
-9
-8
-7
-6
-5
-4
-3
Ln[shear strain]

B109T5 - SUMMARY OF RESULTS
[File made with WinSitu Version 3.9.1.1]

[DETAILS OF TEST]
Project : Crown Street, Manchester
Site : M9019 Crown Street
Borehole : BH109
Test name : B109T5
Test date : 19 Aug 19
Test depth : 33.80 Metres
Water table : 3.00 Metres
Ambient PWP : 302.1 kPa
Material : Sandstone
Probe : 95mm High Pressure Dilatometer
Diameter : 94.0 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out

Analysed by IRC on 20 Aug 19

Remarks: pocket 33-34.5m probe at base. 1355pm

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm) : "Arm ave=1.90"
Best estimate of Po (kPa) : "Arm ave=2300.0"

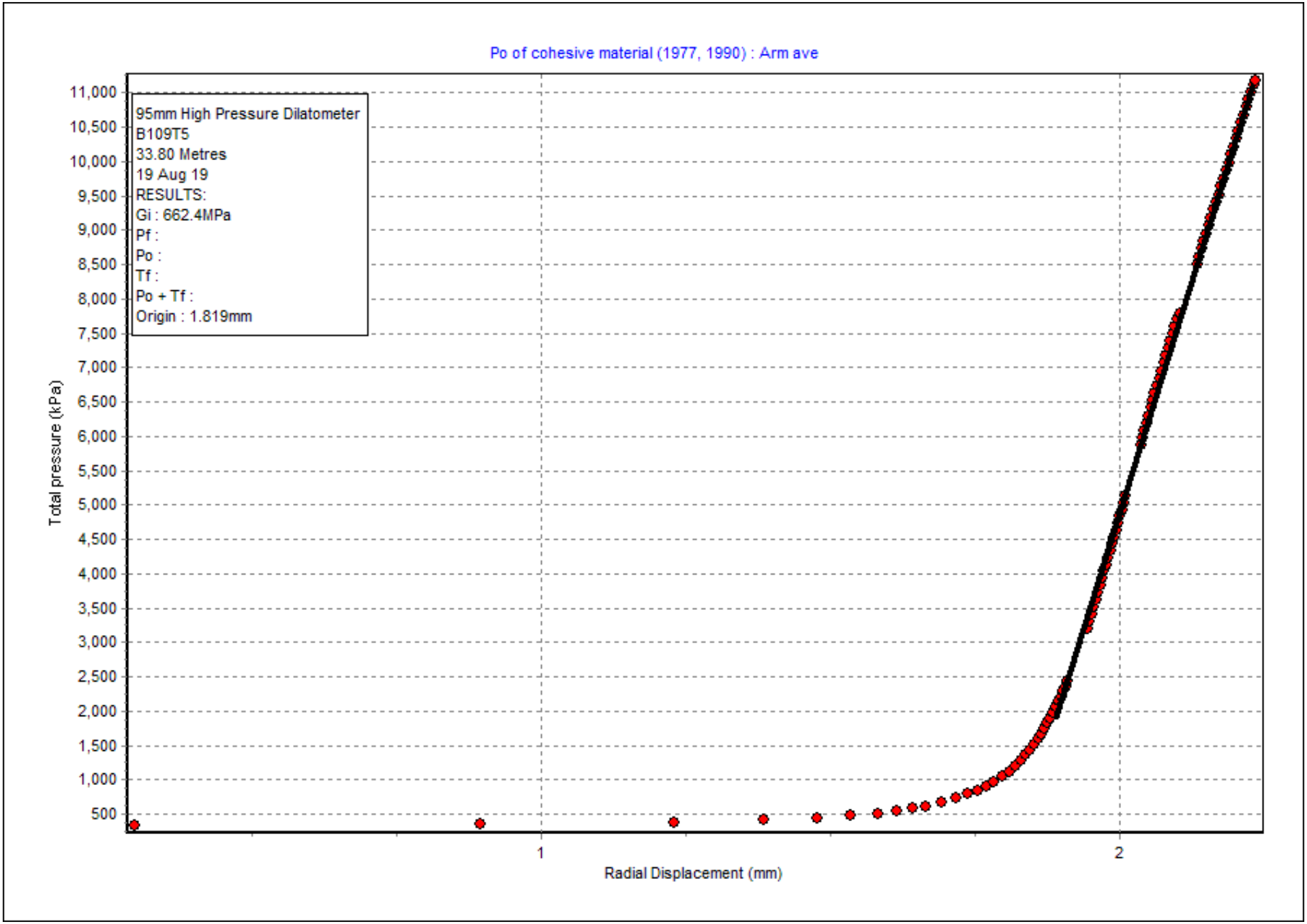
[UNDRAINED STRENGTH PARAMETERS]
Gibson & Anderson 1961 - Cu (kPa) : "Arm ave=7489.4"
Limit pressure (kPa) : "Arm ave=43475"
Jefferies 1988 - Cu (kPa) : "Arm ave=2485.4"

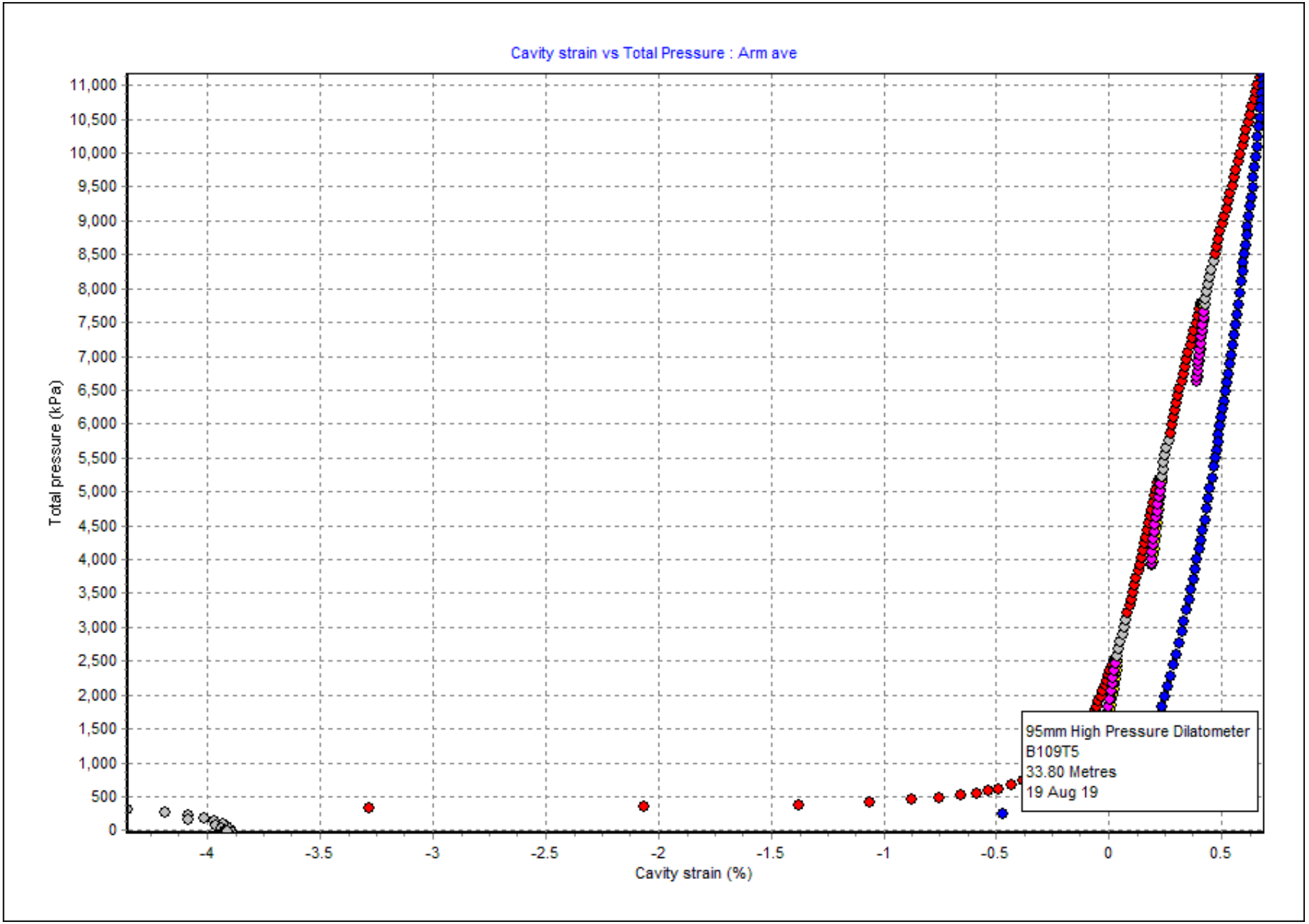
[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=662.4"

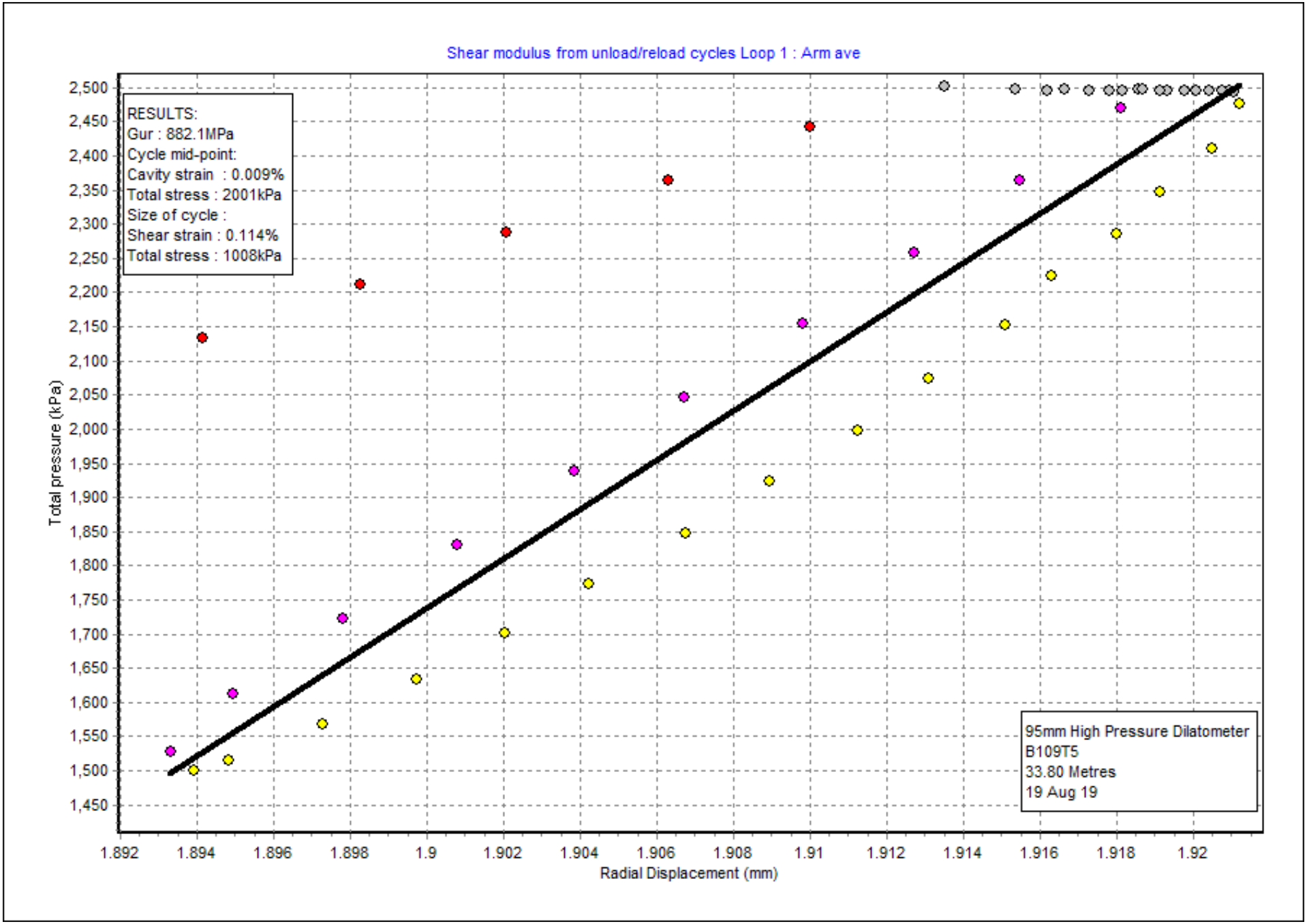
Axis	Loop No	Value (MPa)	Mean Strain (%)	Mean Pc (kPa)	dE (%)	dPc (kPa)
Arm ave	1	882.1	0.009	2001	0.114	1008
Arm ave	2	1453.3	0.211	4546	0.087	1267
Arm ave	3	1617.3	0.407	7162	0.067	1079

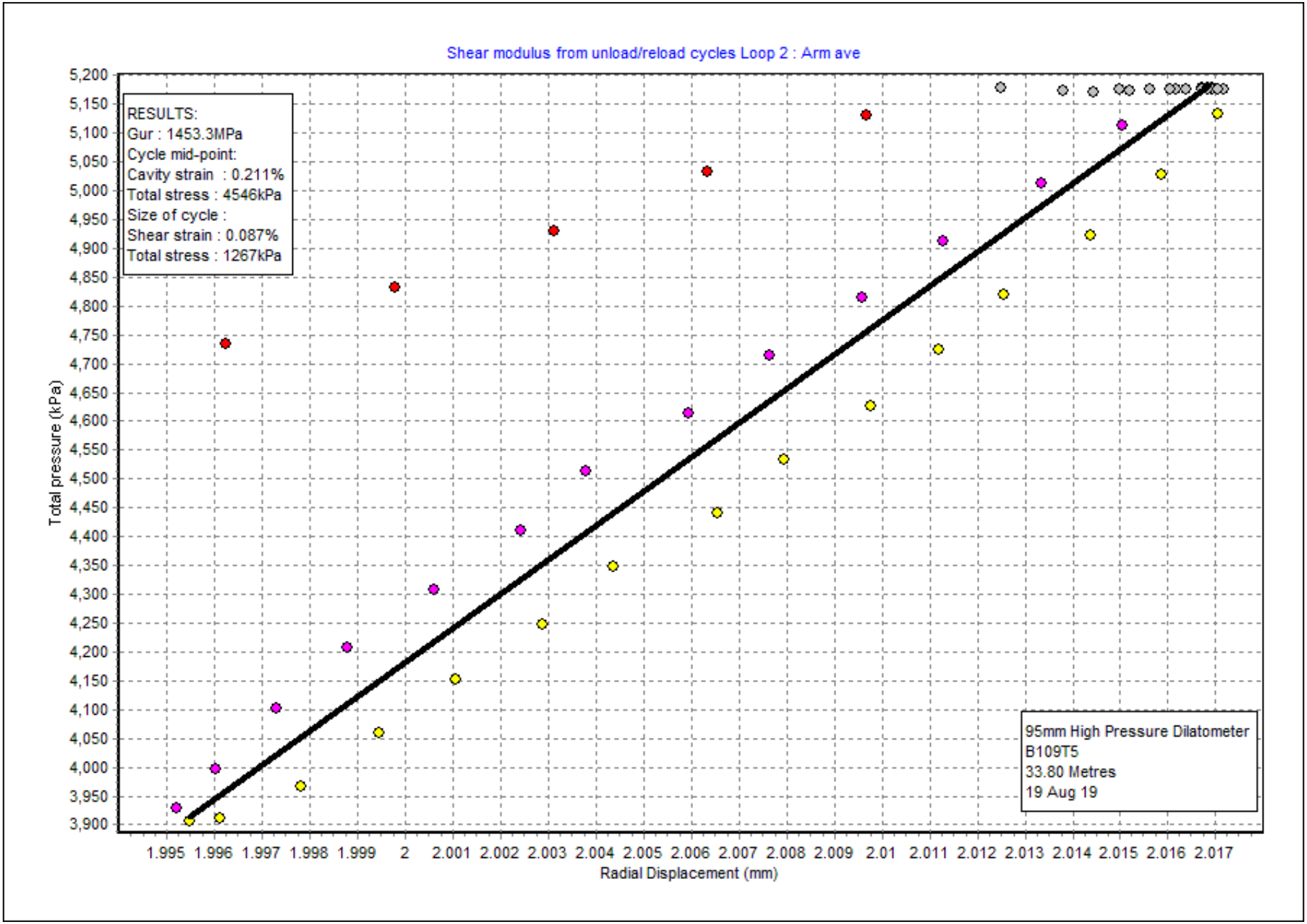
[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]

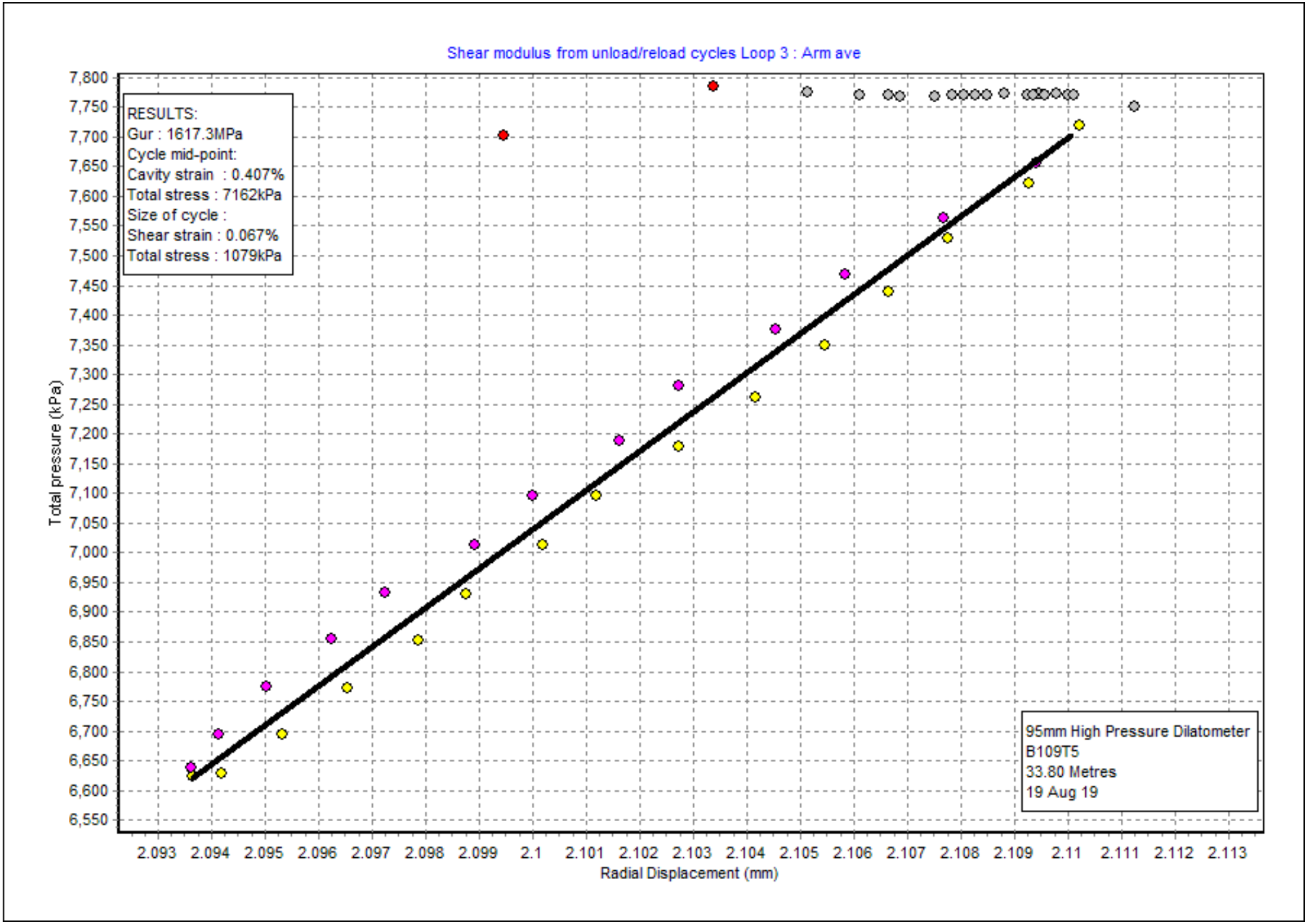
Axis	Loop No	Intercept (MPa)	Alpha (MPa)	Gradient
Arm ave	1	379.927	330.241	0.869
Arm ave	2	369.166	298.037	0.807
Arm ave	3	607.931	526.414	0.866

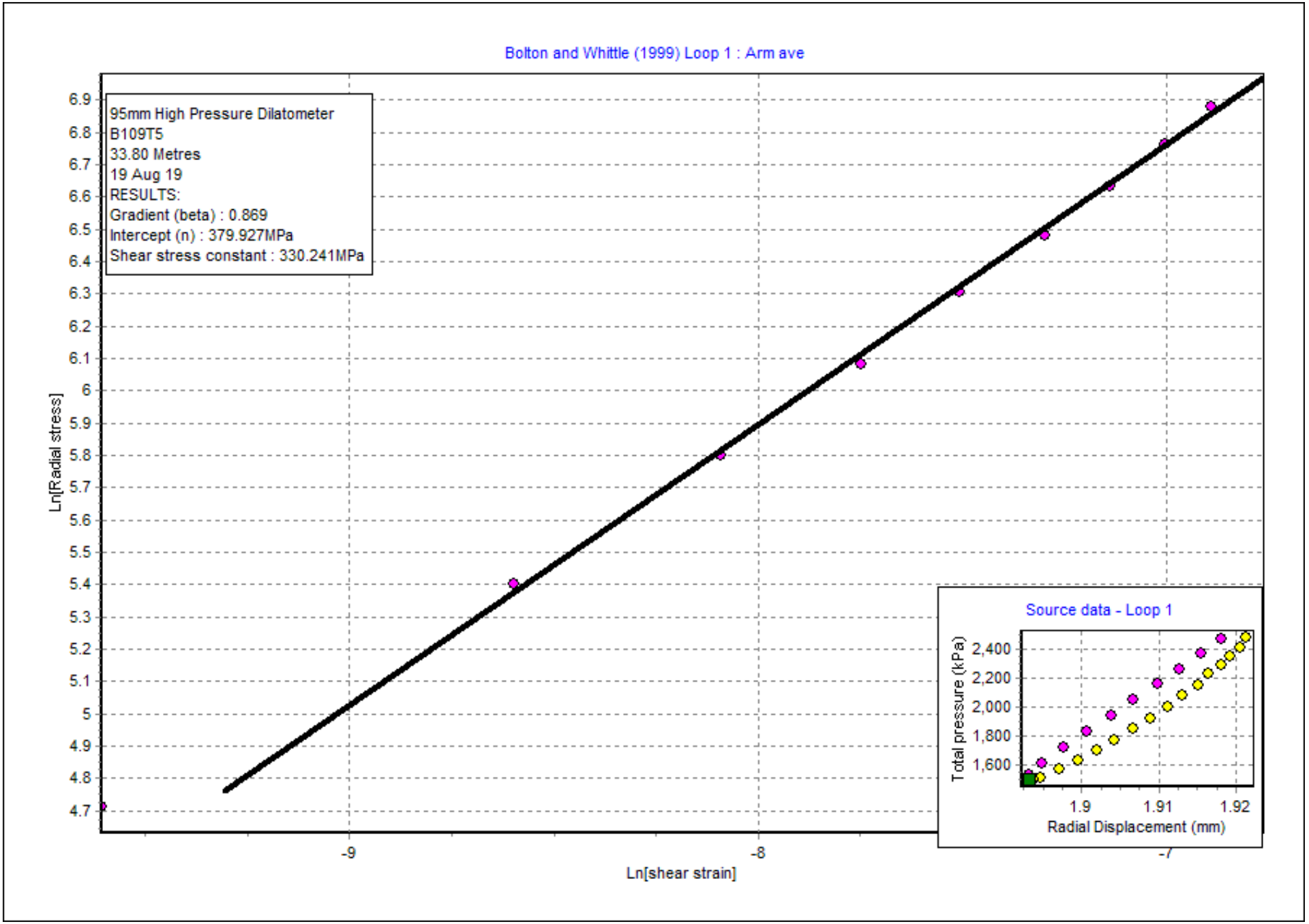

Po of cohesive material (1977, 1990) : Arm ave
95mm High Pressure Dilatometer
B109T5
33.80 Metres
19 Aug 19
RESULTS:
Gi : 662.4MPa
Pf :
Po :
Tf :
Po + Tf :
Origin : 1.819mm
Total pressure (kPa)
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
1
2
Radial Displacement (mm)

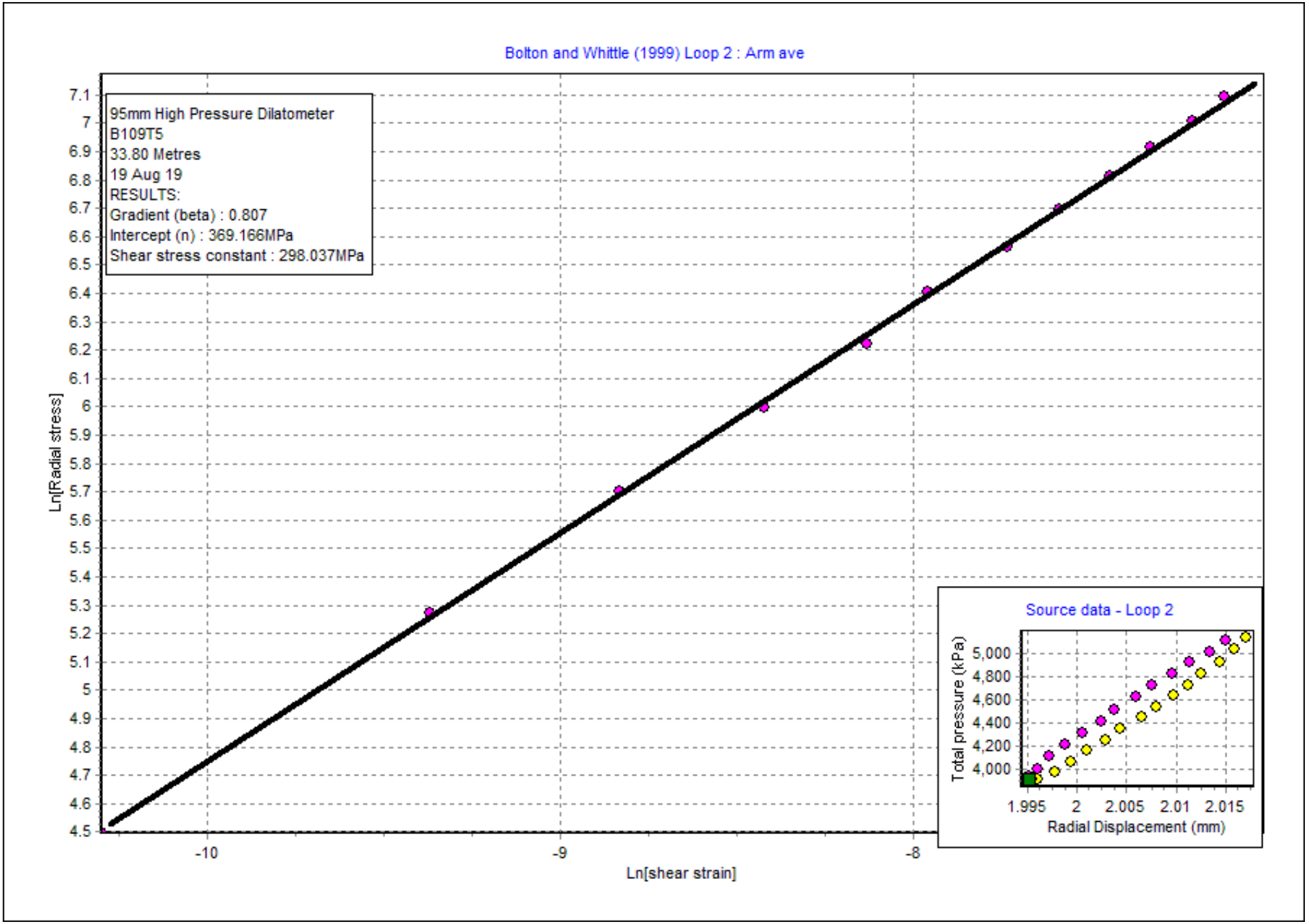

Cavity strain vs Total Pressure : Arm ave
Total pressure (kPa)
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
-4
-3.5
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
Cavity strain (%)
95mm High Pressure Dilatometer
B109T5
33.80 Metres
19 Aug 19

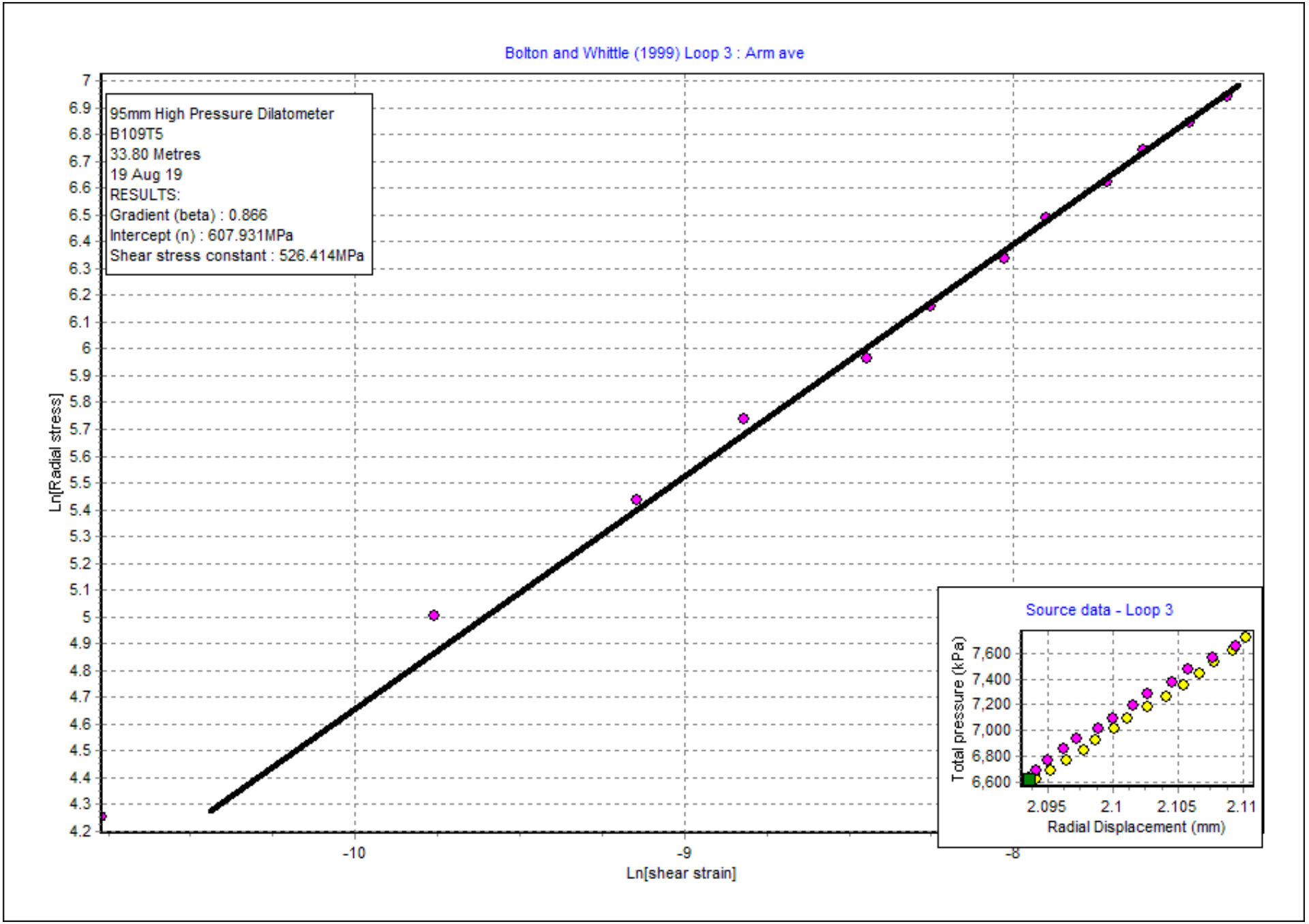

Shear modulus from unload/reload cycles Loop 1 : Arm ave
RESULTS:
Gur : 882.1MPa
Cycle mid-point:
Cavity strain : 0.009%
Total stress : 2001kPa
Size of cycle :
Shear strain : 0.114%
Total stress : 1008kPa
95mm High Pressure Dilatometer
B109T5
33.80 Metres
19 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
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
1,750
1,700
1,650
1,600
1,550
1,500
1,450
1.892
1.894
1.896
1.898
1.9
1.902
1.904
1.906
1.908
1.91
1.912
1.914
1.916
1.918
1.92

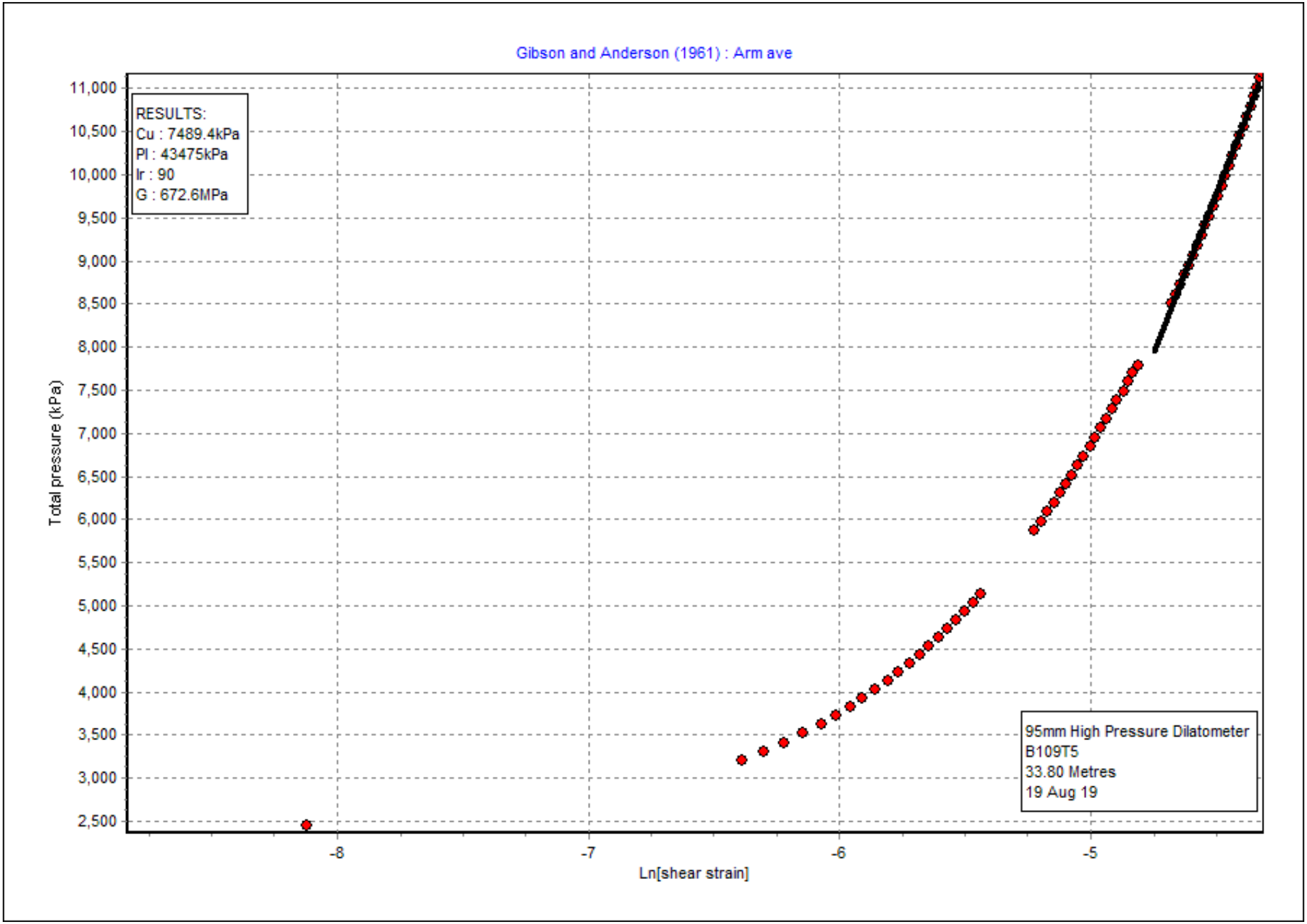

Shear modulus from unload/reload cycles Loop 2 : Arm ave
RESULTS:
Gur : 1453.3MPa
Cycle mid-point:
Cavity strain : 0.211%
Total stress : 4546kPa
Size of cycle :
Shear strain : 0.087%
Total stress : 1267kPa
95mm High Pressure Dilatometer
B109T5
33.80 Metres
19 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
5,200
5,150
5,100
5,050
5,000
4,950
4,900
4,850
4,800
4,750
4,700
4,650
4,600
4,550
4,500
4,450
4,400
4,350
4,300
4,250
4,200
4,150
4,100
4,050
4,000
3,950
3,900
1.995 1.996 1.997 1.998 1.999 2 2.001 2.002 2.003 2.004 2.005 2.006 2.007 2.008 2.009 2.01 2.011 2.012 2.013 2.014 2.015 2.016 2.017

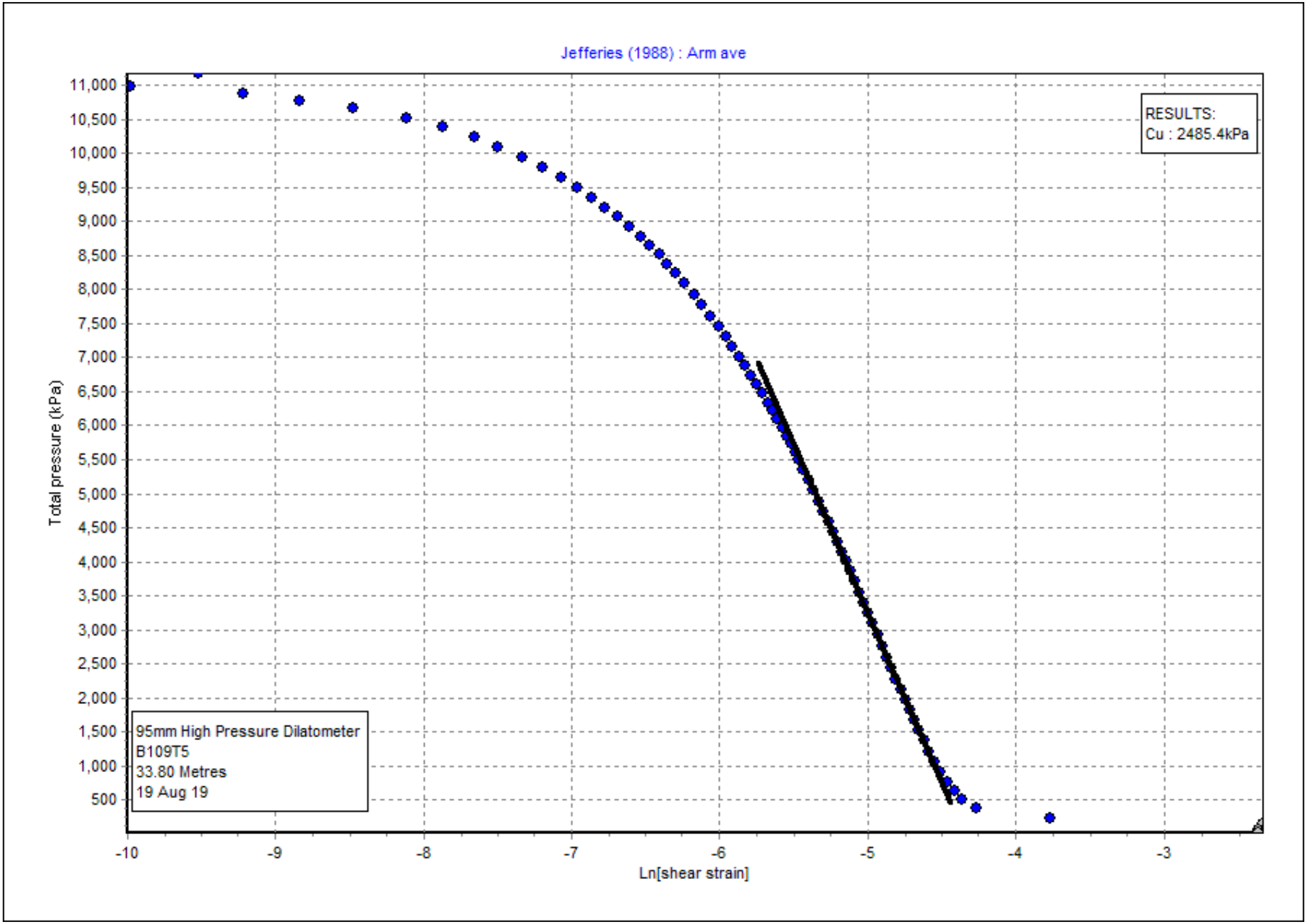

Shear modulus from unload/reload cycles Loop 3 : Arm ave
RESULTS:
Gur : 1617.3MPa
Cycle mid-point:
Cavity strain : 0.407%
Total stress : 7162kPa
Size of cycle :
Shear strain : 0.067%
Total stress : 1079kPa
95mm High Pressure Dilatometer
B109T5
33.80 Metres
19 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
7,800
7,750
7,700
7,650
7,600
7,550
7,500
7,450
7,400
7,350
7,300
7,250
7,200
7,150
7,100
7,050
7,000
6,950
6,900
6,850
6,800
6,750
6,700
6,650
6,600
6,550
2.093
2.094
2.095
2.096
2.097
2.098
2.099
2.1
2.101
2.102
2.103
2.104
2.105
2.106
2.107
2.108
2.109
2.11
2.111
2.112
2.113


Bolton and Whittle (1999) Loop 1 : Arm ave
95mm High Pressure Dilatometer
B109T5
33.80 Metres
19 Aug 19
RESULTS:
Gradient (beta) : 0.869
Intercept (n) : 379.927MPa
Shear stress constant : 330.241MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 1
Total pressure (kPa)
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 2 : Arm ave
95mm High Pressure Dilatometer
B109T5
33.80 Metres
19 Aug 19
RESULTS:
Gradient (beta) : 0.807
Intercept (n) : 369.166MPa
Shear stress constant : 298.037MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 2
Total pressure (kPa)
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 3 : Arm ave
95mm High Pressure Dilatometer
B109T5
33.80 Metres
19 Aug 19
RESULTS:
Gradient (beta) : 0.866
Intercept (n) : 607.931MPa
Shear stress constant : 526.414MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 3
Total pressure (kPa)
Radial Displacement (mm)


Gibson and Anderson (1961) : Arm ave
RESULTS:
Cu : 7489.4kPa
PI : 43475kPa
Ir : 90
G : 672.6MPa
95mm High Pressure Dilatometer
B109T5
33.80 Metres
19 Aug 19
Total pressure (kPa)
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
-8
-7
-6
-5
Ln[shear strain]


Jefferies (1988) : Arm ave
RESULTS:
Cu : 2485.4kPa
95mm High Pressure Dilatometer
B109T5
33.80 Metres
19 Aug 19
Total pressure (kPa)
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
-10
-9
-8
-7
-6
-5
-4
-3
Ln[shear strain]

B109T6 - SUMMARY OF RESULTS
[File made with WinSitu Version 3.9.1.1]

[DETAILS OF TEST]
Project : Crown Street, Manchester
Site : M9019
Borehole : BH109
Test name : B109T6
Test date : 20 Aug 19
Test depth : 38.30 Metres
Water table : 3.00 Metres
Ambient PWP : 346.3 kPa
Material : Sandstone
Probe : 95mm High Pressure Dilatometer
Diameter : 94.0 mm
Data analysed using average arm displacement curve
A non-linear analysis of the rebound cycles has been carried out

Analysed by IRC on 22 Aug 19

Remarks: Pocket 37.5-39. probe at base

[RESULTS FOR CAVITY REFERENCE PRESSURE]
Strain Origin (mm) : "Arm ave=1.97"
Best estimate of Po (kPa) : "Arm ave=3000.0"

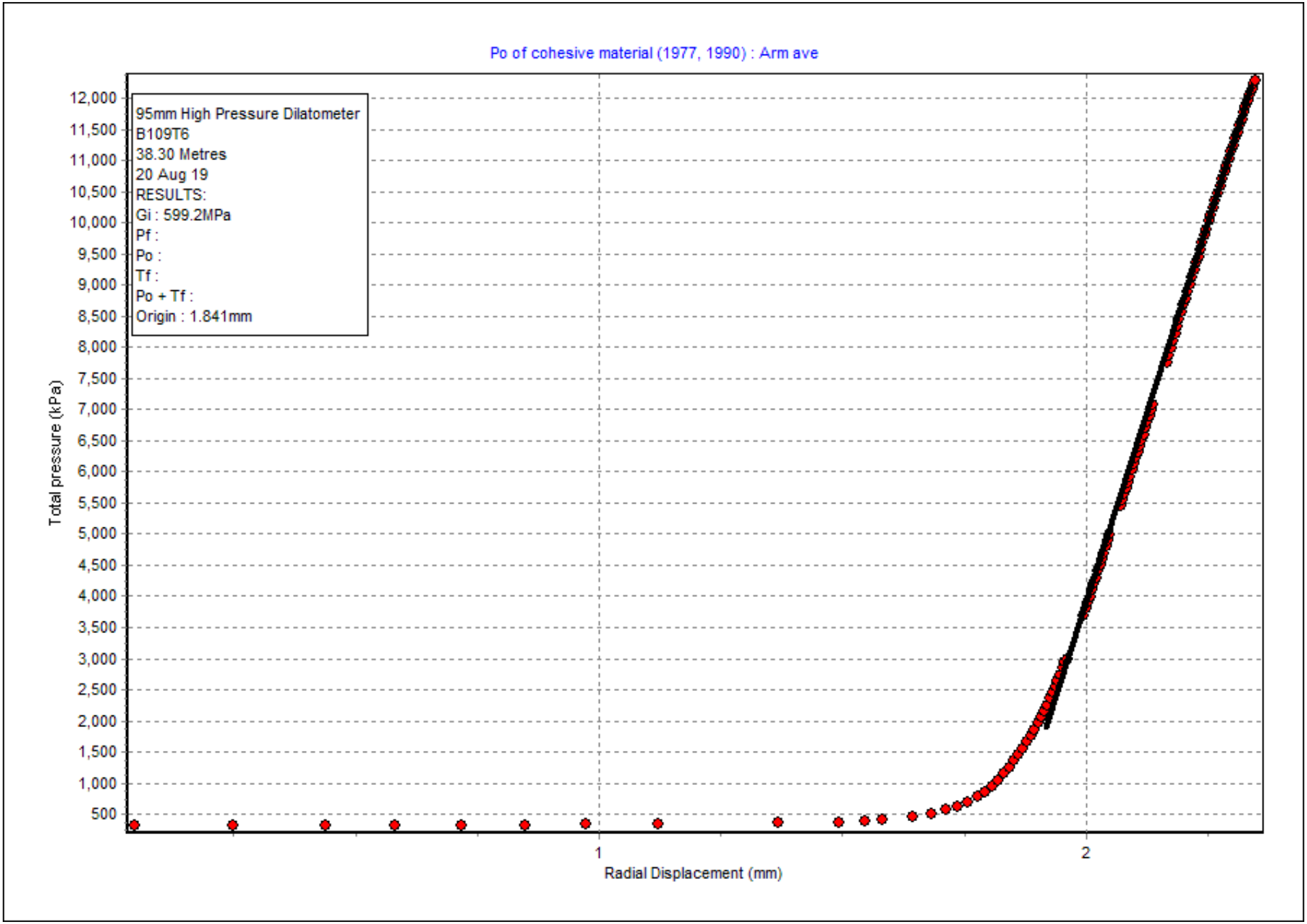
[UNDRAINED STRENGTH PARAMETERS]
Gibson & Anderson 1961 - Cu (kPa) : "Arm ave=7906.4"
Limit pressure (kPa) : "Arm ave=45326"
Jefferies 1988 - Cu (kPa) : "Arm ave=2663.9"

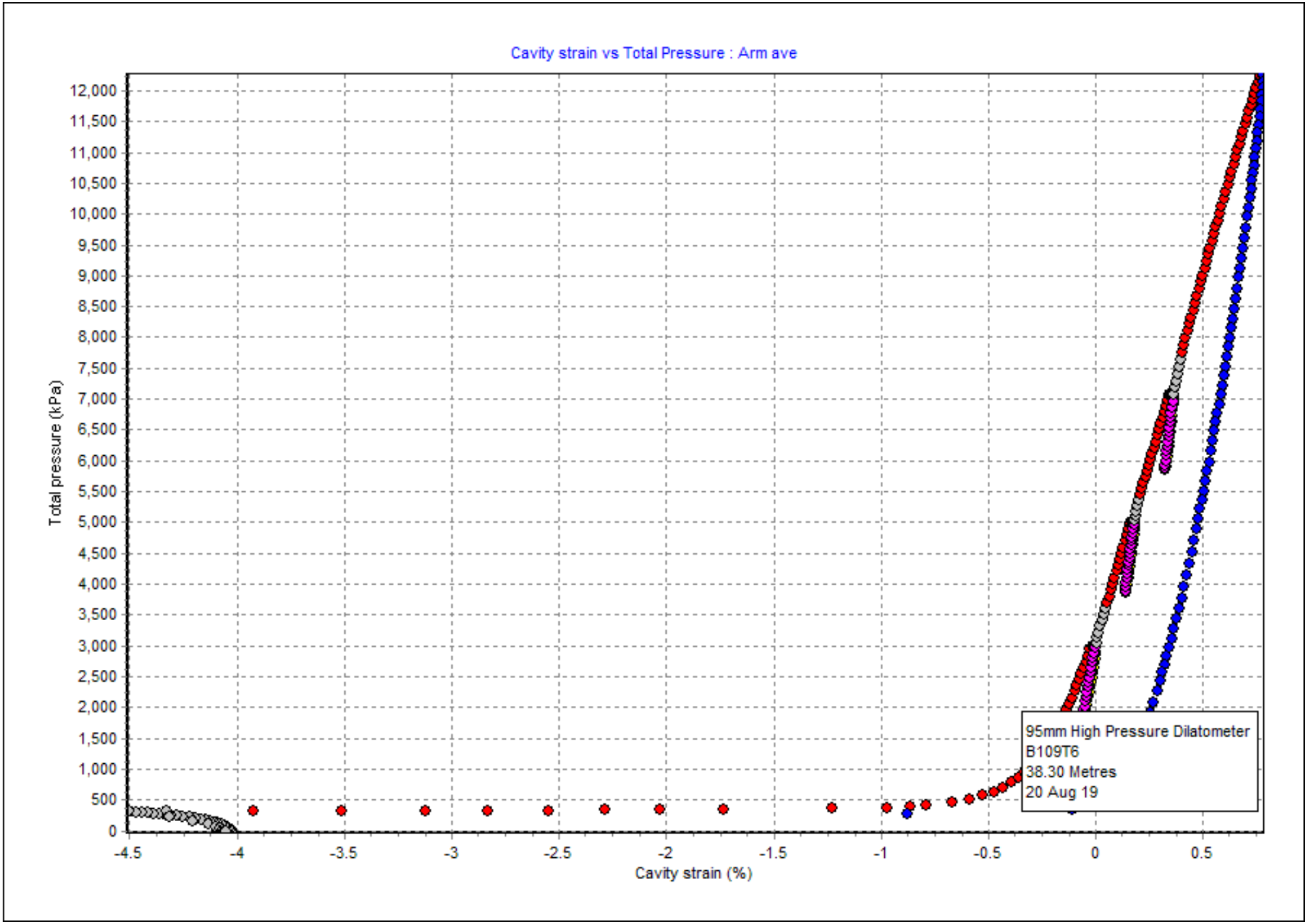
[LINEAR INTERPRETATION OF SHEAR MODULUS G]
Initial slope shear modulus (MPa) :"Arm ave=599.2"

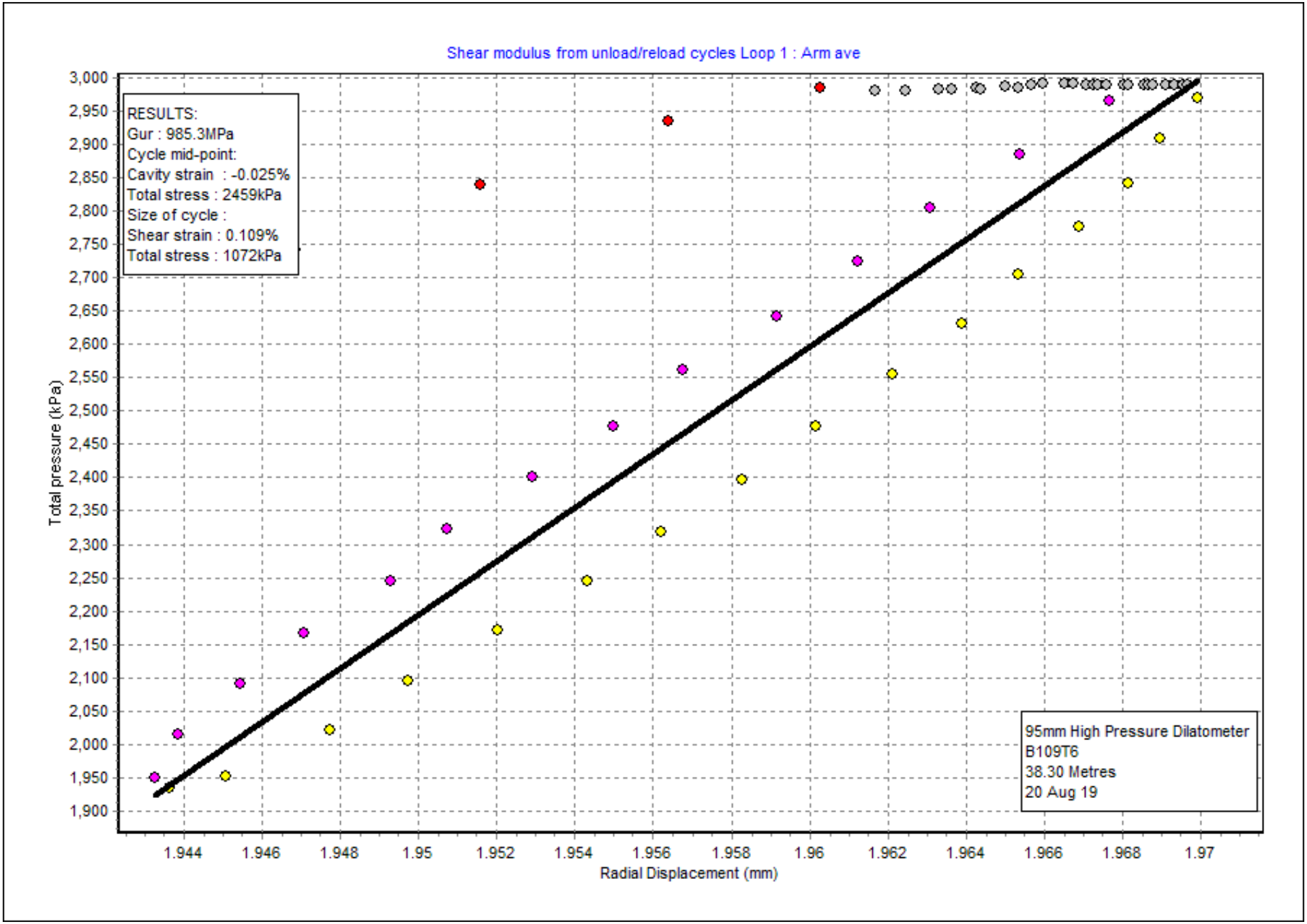
Axis	Loop No	Value (MPa)	Mean Strain (%)	Mean Pc (kPa)	dE (%)	dPc (kPa)
Arm ave	1	985.3	-0.025	2459	0.109	1072
Arm ave	2	1302.0	0.161	4440	0.086	1118
Arm ave	3	1495.5	0.344	6454	0.081	1209

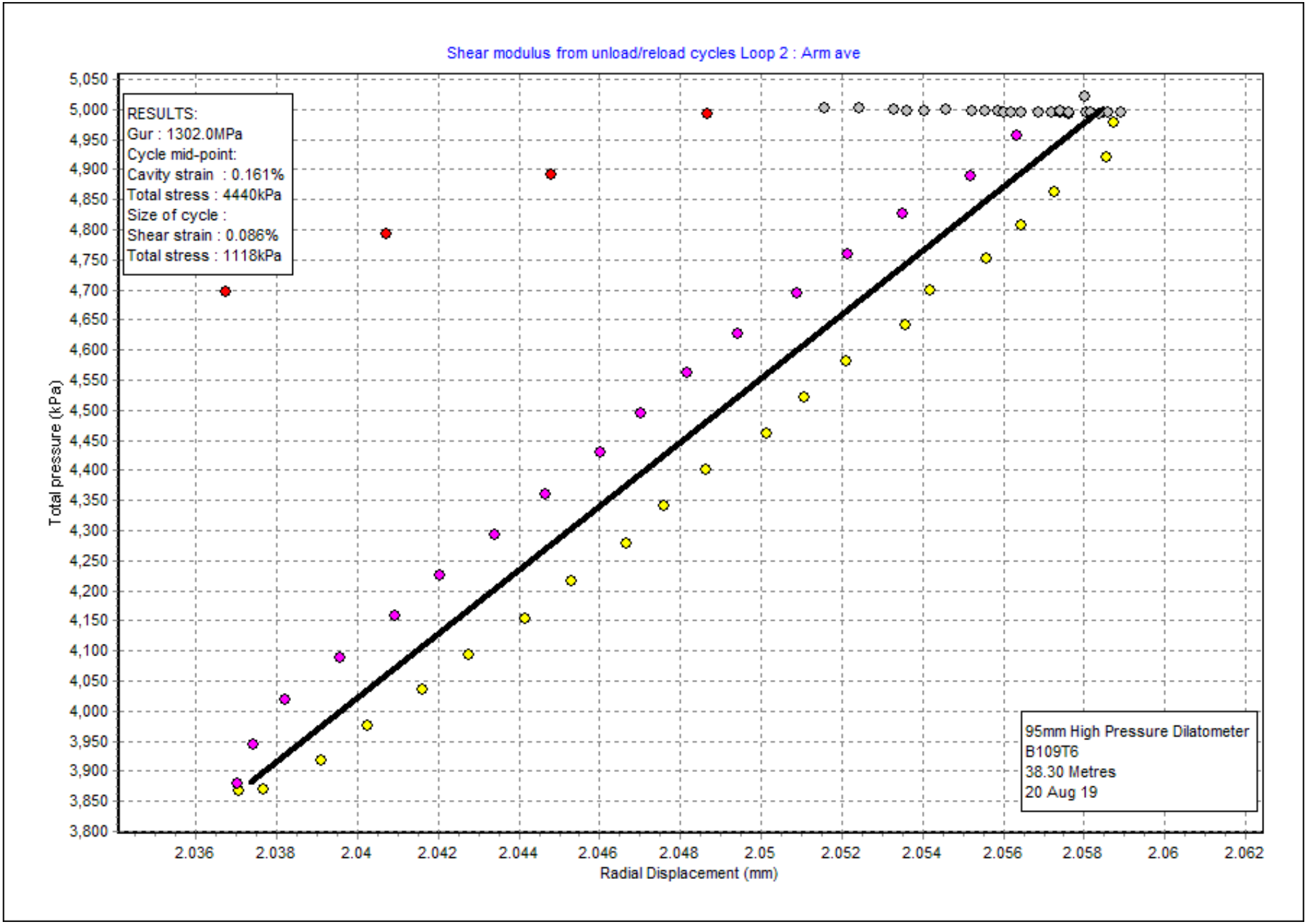
[UNDRAINED NON LINEAR INTERPRETATION OF SECANT SHEAR MODULUS]

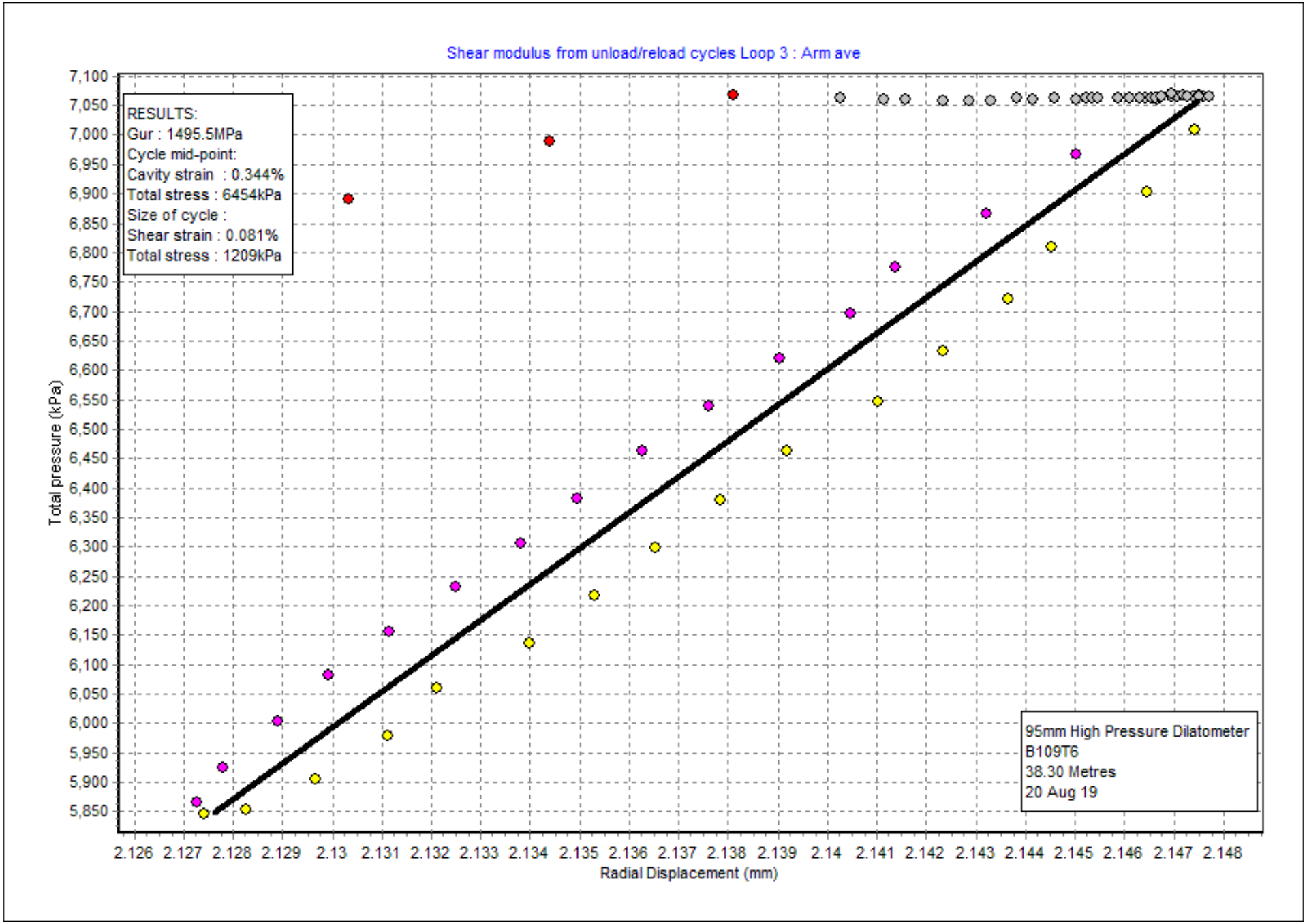
Axis	Loop No	Intercept (MPa)	Alpha (MPa)	Gradient
Arm ave	1	359.286	303.953	0.846
Arm ave	2	398.534	329.405	0.827
Arm ave	3	642.302	563.576	0.877

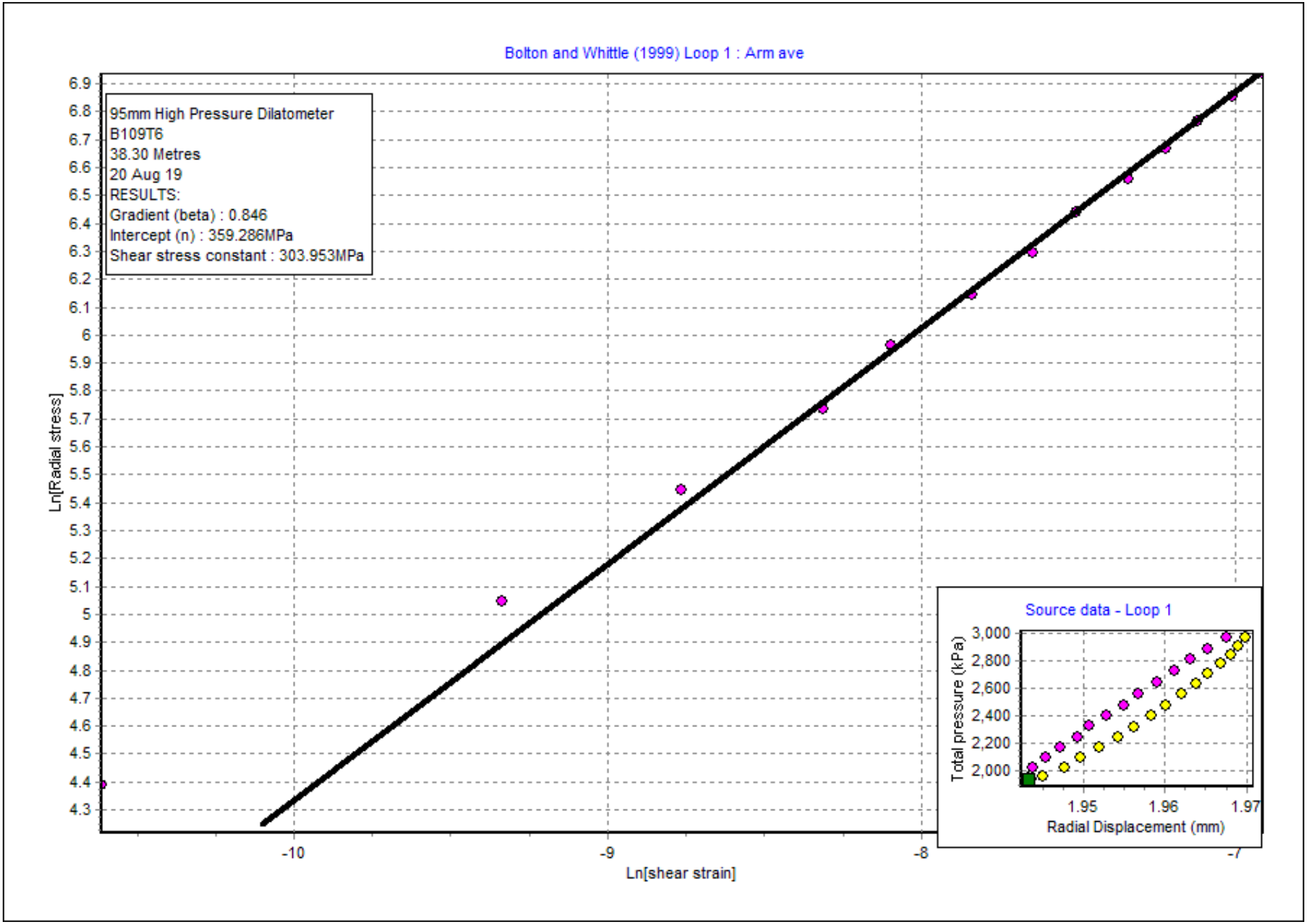

Po of cohesive material (1977, 1990) : Arm ave
95mm High Pressure Dilatometer
B109T6
38.30 Metres
20 Aug 19
RESULTS:
Gi : 599.2MPa
Pf :
Po :
Tf :
Po + Tf :
Origin : 1.841mm
Total pressure (kPa)
12,000
11,500
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
1
2
Radial Displacement (mm)

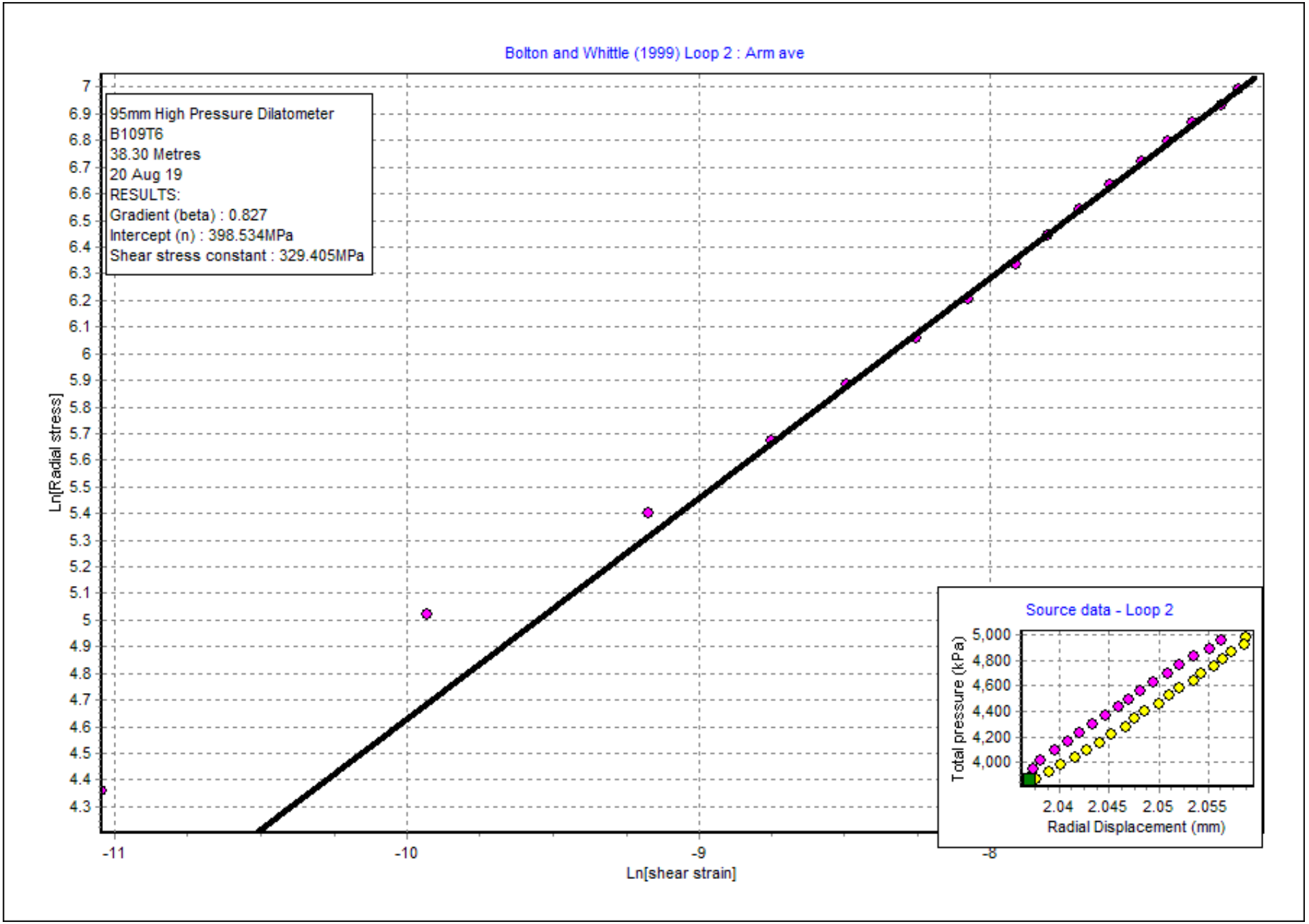

Cavity strain vs Total Pressure : Arm ave
Total pressure (kPa)
12,000
11,500
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
-4.5
-4
-3.5
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
Cavity strain (%)
95mm High Pressure Dilatometer
B109T6
38.30 Metres
20 Aug 19

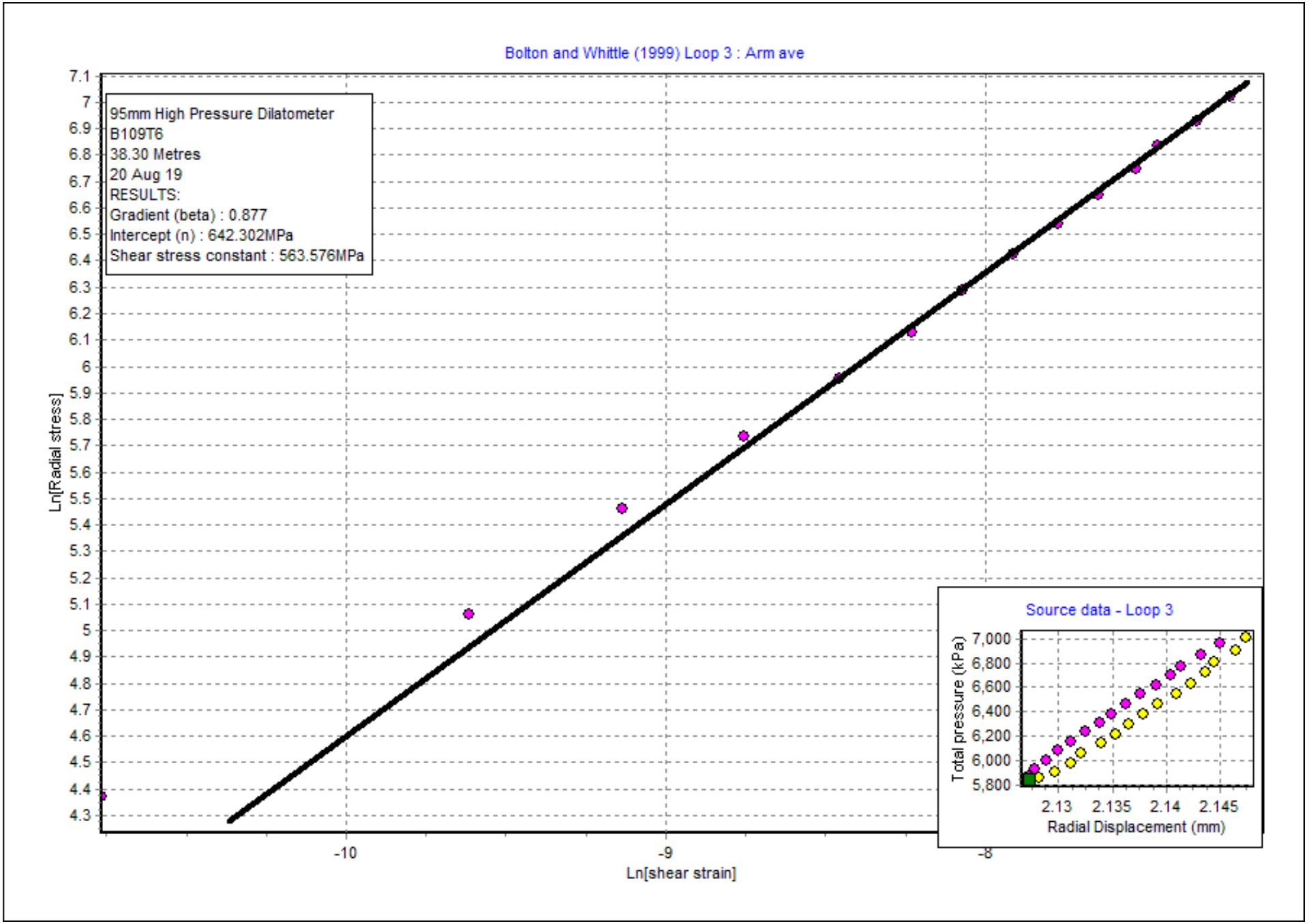

Shear modulus from unload/reload cycles Loop 1 : Arm ave
RESULTS:
Gur : 985.3MPa
Cycle mid-point:
Cavity strain : -0.025%
Total stress : 2459kPa
Size of cycle :
Shear strain : 0.109%
Total stress : 1072kPa
95mm High Pressure Dilatometer
B109T6
38.30 Metres
20 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
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
2,000
1,950
1,900
1.944
1.946
1.948
1.95
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1.954
1.956
1.958
1.96
1.962
1.964
1.966
1.968
1.97

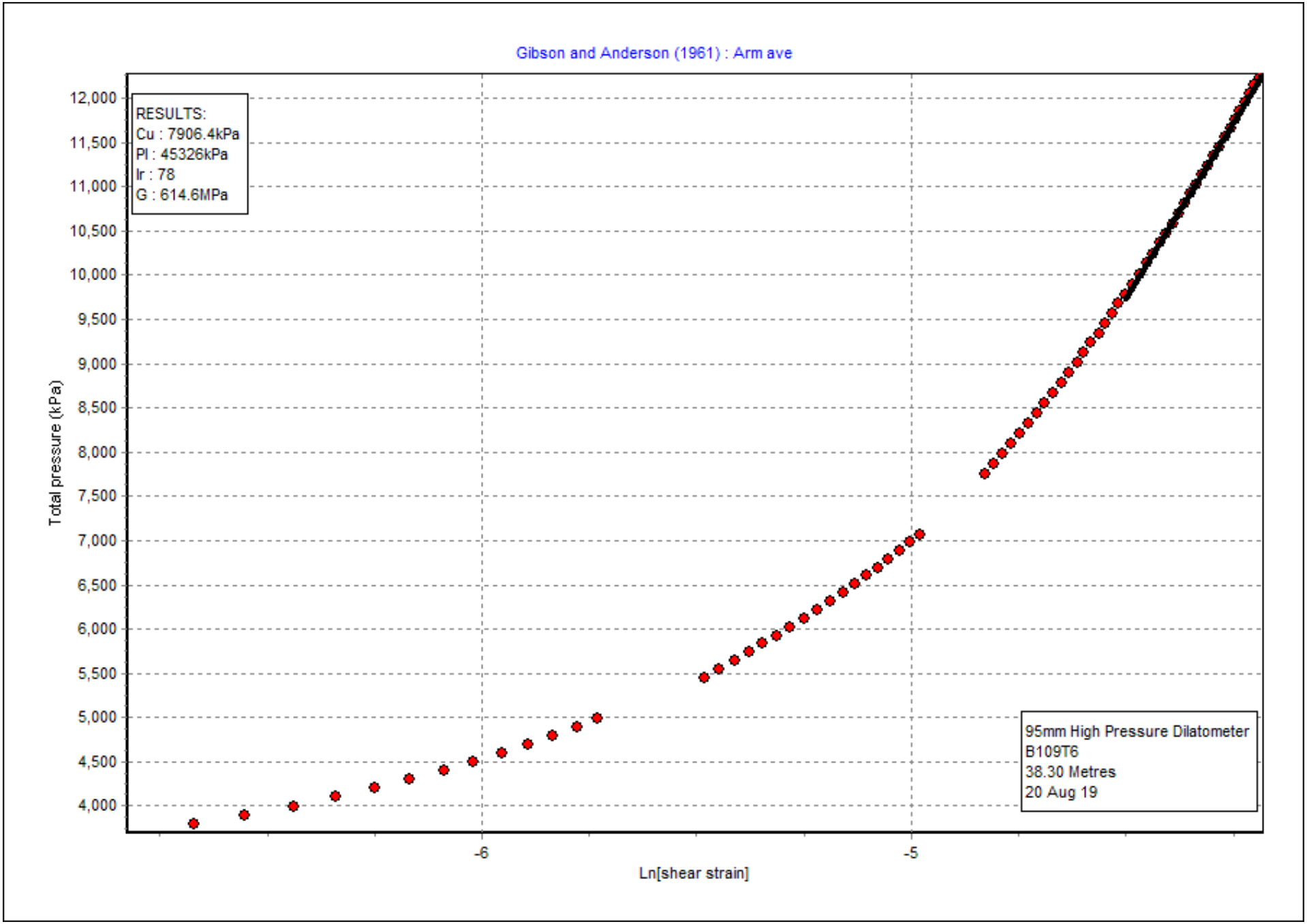

Shear modulus from unload/reload cycles Loop 2 : Arm ave
RESULTS:
Gur : 1302.0MPa
Cycle mid-point:
Cavity strain : 0.161%
Total stress : 4440kPa
Size of cycle :
Shear strain : 0.086%
Total stress : 1118kPa
95mm High Pressure Dilatometer
B109T6
38.30 Metres
20 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
5,050
5,000
4,950
4,900
4,850
4,800
4,750
4,700
4,650
4,600
4,550
4,500
4,450
4,400
4,350
4,300
4,250
4,200
4,150
4,100
4,050
4,000
3,950
3,900
3,850
3,800
2.036
2.038
2.04
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2.058
2.06
2.062

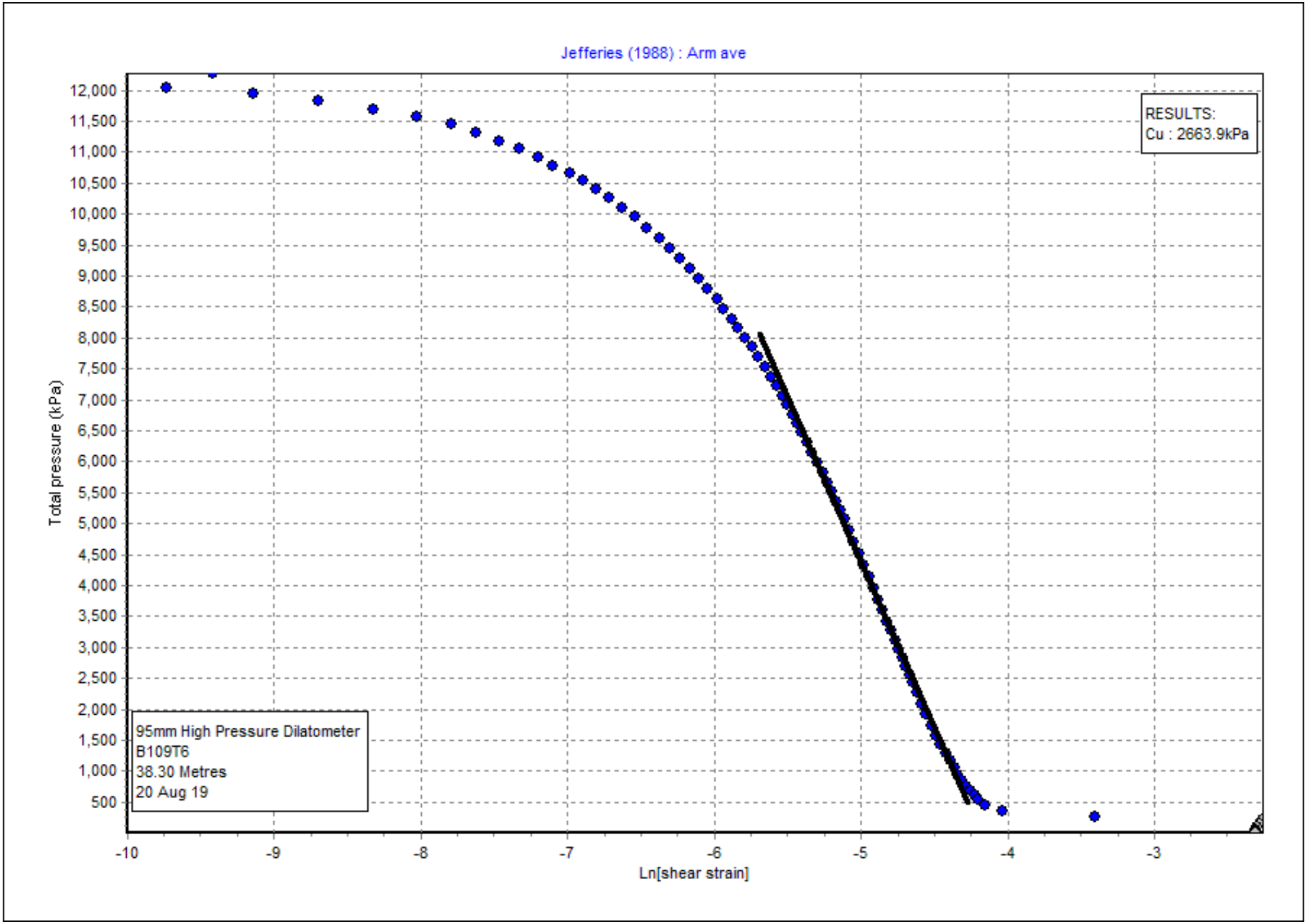

Shear modulus from unload/reload cycles Loop 3 : Arm ave
RESULTS:
Gur : 1495.5MPa
Cycle mid-point:
Cavity strain : 0.344%
Total stress : 6454kPa
Size of cycle :
Shear strain : 0.081%
Total stress : 1209kPa
95mm High Pressure Dilatometer
B109T6
38.30 Metres
20 Aug 19
Total pressure (kPa)
Radial Displacement (mm)
7,100
7,050
7,000
6,950
6,900
6,850
6,800
6,750
6,700
6,650
6,600
6,550
6,500
6,450
6,400
6,350
6,300
6,250
6,200
6,150
6,100
6,050
6,000
5,950
5,900
5,850
2.126 2.127 2.128 2.129 2.13 2.131 2.132 2.133 2.134 2.135 2.136 2.137 2.138 2.139 2.14 2.141 2.142 2.143 2.144 2.145 2.146 2.147 2.148


Bolton and Whittle (1999) Loop 1 : Arm ave
95mm High Pressure Dilatometer
B109T6
38.30 Metres
20 Aug 19
RESULTS:
Gradient (beta) : 0.846
Intercept (n) : 359.286MPa
Shear stress constant : 303.953MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 1
Total pressure (kPa)
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 2 : Arm ave
95mm High Pressure Dilatometer
B109T6
38.30 Metres
20 Aug 19
RESULTS:
Gradient (beta) : 0.827
Intercept (n) : 398.534MPa
Shear stress constant : 329.405MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 2
Total pressure (kPa)
Radial Displacement (mm)


Bolton and Whittle (1999) Loop 3 : Arm ave
95mm High Pressure Dilatometer
B109T6
38.30 Metres
20 Aug 19
RESULTS:
Gradient (beta) : 0.877
Intercept (n) : 642.302MPa
Shear stress constant : 563.576MPa
Ln[Radial stress]
Ln[shear strain]
Source data - Loop 3
Total pressure (kPa)
Radial Displacement (mm)


Gibson and Anderson (1961) : Arm ave
RESULTS:
Cu : 7906.4kPa
PI : 45326kPa
Ir : 78
G : 614.6MPa
95mm High Pressure Dilatometer
B109T6
38.30 Metres
20 Aug 19
Total pressure (kPa)
12,000
11,500
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
-6
-5
Ln[shear strain]


Jefferies (1988) : Arm ave
RESULTS:
Cu : 2663.9kPa
95mm High Pressure Dilatometer
B109T6
38.30 Metres
20 Aug 19
Total pressure (kPa)
12,000
11,500
11,000
10,500
10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
-10
-9
-8
-7
-6
-5
-4
-3
Ln[shear strain]

Summary of Pressuremeter Tests

SOCOTEC

Borehole Reference	Test reference	Depth (m)	Date	Instrument Reference	Groundwater level (mbgl)	Arms Analysed	M+R horizontal pressure (kPa)	In situ horizontal stress, Po (kPa)	Coefficient of lateral earth pressure, K_o based on in situ horizontal stress	Undrained strength		Initial modulus, Gi (MPa)	Loop ref	Shear modulus, Gur (MPa)	Strain amplitude, ec (%)	Non linear stiffness analysis		Remarks
										Limit pressure, pL (kPa)	Shear strength (loading), cu (kPa)					Stiffness exponent, β	Shear stress constant, α (MPa)	
BH103	B103T1	11.30	22-Aug-19	180126	0.00	Arm ave	NA	2200	18.5	40168	7839	360	1	689	0.134	0.835	196.780	
													2	787	0.150	0.836	232.685	
													3	897	0.141	0.826	235.986	
BH103	B103T2	15.80	22-Aug-19	180126	0.00	Arm ave	NA	1200	6.6	46297	10148	305	1	669	0.149	0.884	283.632	
													2	876	0.126	0.834	243.712	
													3	908	0.116	0.785	166.236	
BH103	B103T3	21.80	23-Aug-19	180126	0.00	Arm ave	NA	2000	8.2	46360	8820	484	1	991	0.106	0.860	332.669	
													2	1234	0.105	0.833	326.064	
													3	1468	0.080	0.867	483.451	
BH103	B103T4	26.30	23-Aug-19	180126	0.00	Arm ave	NA	2250	7.6	47956	8618	634	1	987	0.121	0.865	357.657	
													2	1450	0.086	0.803	284.278	
													3	1509	0.091	0.822	359.558	
BH103	B103T5	30.80	27-Aug-19	180126	0.00	Arm ave	NA	2200	6.1	41508	7118	644	1	970	0.094	0.878	371.798	
													2	1438	0.102	0.828	352.820	
													3	1540	0.078	0.797	282.655	
BH103	B103T6	39.80	28-Aug-19	180126	0.00	Arm ave	NA	2300	4.8	49261	9227	557	1	986	0.115	0.828	262.617	
													2	1418	0.087	0.885	572.358	
													3	1451	0.090	0.839	398.628	
BH109	B109T1	14.30	15-Aug-19	180126	0.00	Arm ave	NA	4400	29.8	31514	5086	382	1	701	0.159	0.819	180.603	
													2	937	0.157	0.851	303.273	
BH109	B109T2	18.80	15-Aug-19	180126	0.00	Arm ave	NA	4400	22.4	41483	7314	426	1	889	0.106	0.786	163.950	
													2	1169	0.109	0.820	276.534	
BH109	B109T3	24.70	16-Aug-19	180126	0.00	Arm ave	NA	4500	17.2	41606	7311	428	1	975	0.105	0.829	258.422	
													2	1153	0.111	0.798	240.720	
													3	1151	0.114	0.814	272.748	

Notes: Reference should be made to Section 3 of the report for explanation of the methods of test interpretation and assessment of material parameters.

Project Crown Street, Manchester

Project No. M9019-19

Carried out for Geotechnics

Table

1-1

Summary of Pressuremeter Tests

SOCOTEC

Borehole Reference	Test reference	Depth (m)	Date	Instrument Reference	Groundwater level (mbgl)	Arms Analysed	M+R horizontal pressure (kPa)	In situ horizontal stress, Po (kPa)	Coefficient of lateral earth pressure, K_o based on in situ horizontal stress	Undrained strength: Limit pressure, pL (kPa)	Undrained strength: Shear strength (loading), cu (kPa)	Initial modulus, Gi (MPa)	Loop ref	Shear modulus, Gur (MPa)	Strain amplitude, ec (%)	Non linear stiffness analysis: Stiffness exponent, β	Non linear stiffness analysis: Shear stress constant, α (MPa)	Remarks
BH109	B109T4	29.10	19-Aug-19	180126	0.00	Arm ave	NA	3000	9.3	38707	7338	345	1	770	0.144	0.873	293.947	
													2	973	0.108	0.789	181.391	
													3	1131	0.120	0.809	249.989	
BH109	B109T5	33.80	19-Aug-19	180126	0.00	Arm ave	NA	2300	5.8	43475	7489	662	1	882	0.114	0.869	330.241	
													2	1453	0.087	0.807	298.037	
													3	1617	0.067	0.866	526.414	
BH109	B109T6	38.30	20-Aug-19	180126	0.00	Arm ave	NA	3000	6.8	45326	7906	599	1	985	0.109	0.846	303.953	
													2	1302	0.086	0.827	329.405	
													3	1496	0.081	0.877	563.576	

Notes: Reference should be made to Section 3 of the report for explanation of the methods of test interpretation and assessment of material parameters.

Project Crown Street, Manchester

Project No. M9019-19

Carried out for Geotechnics

Table

1-2

APPENDIX 5

Downhole Geophysical Logging Reports

ROBERTSON GEO SERVICES
Unlocking Your GeoData

CO Geotechnics
WELL BH101
FLD Crown Street
CTY Manchester
STE
FILING No

COMPANY Geotechnics
WELL ID BH101
FIELD Crown Street
COUNTRY UK STATE

LOCATION
Crown Street, Manchester

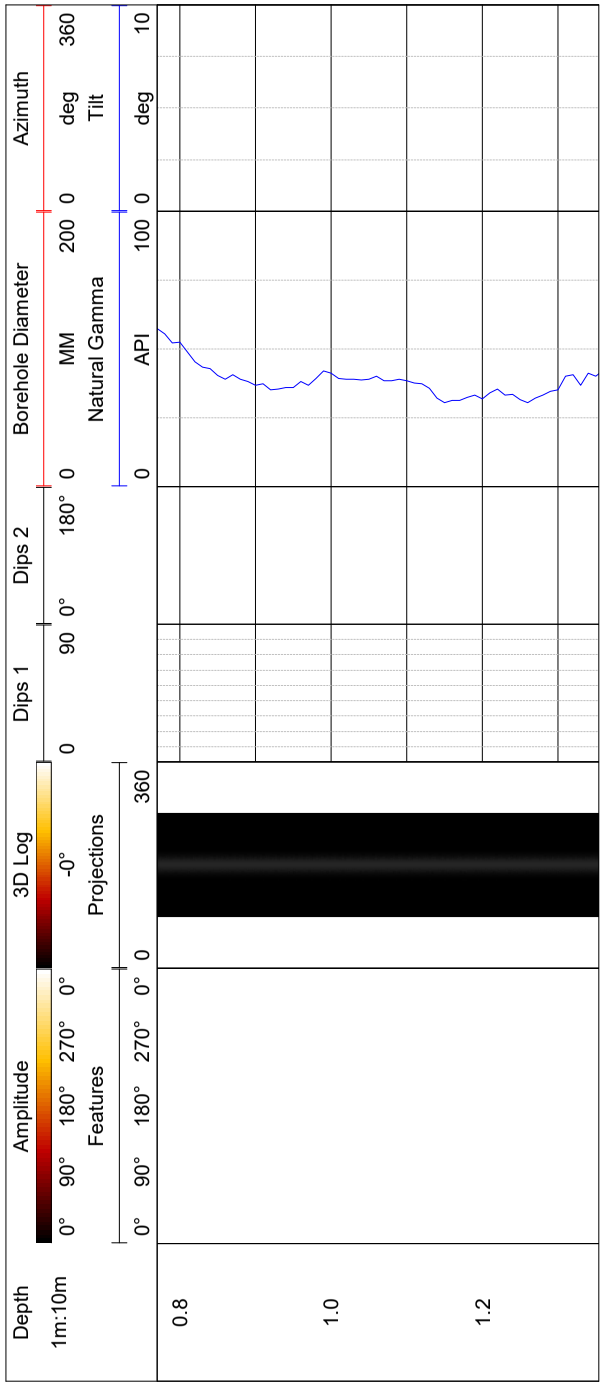
SEC TWP RGE

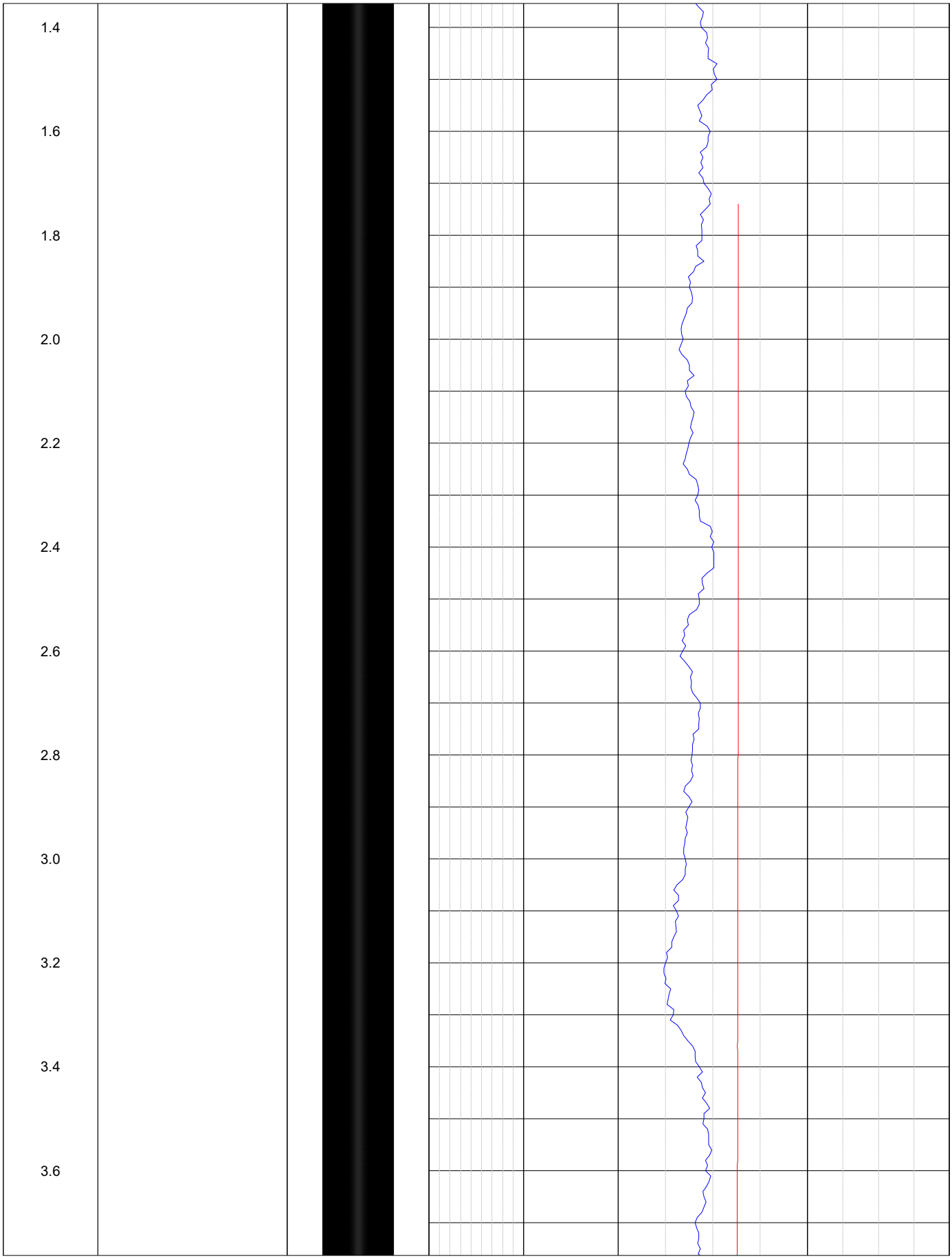
OTHER SERVICES

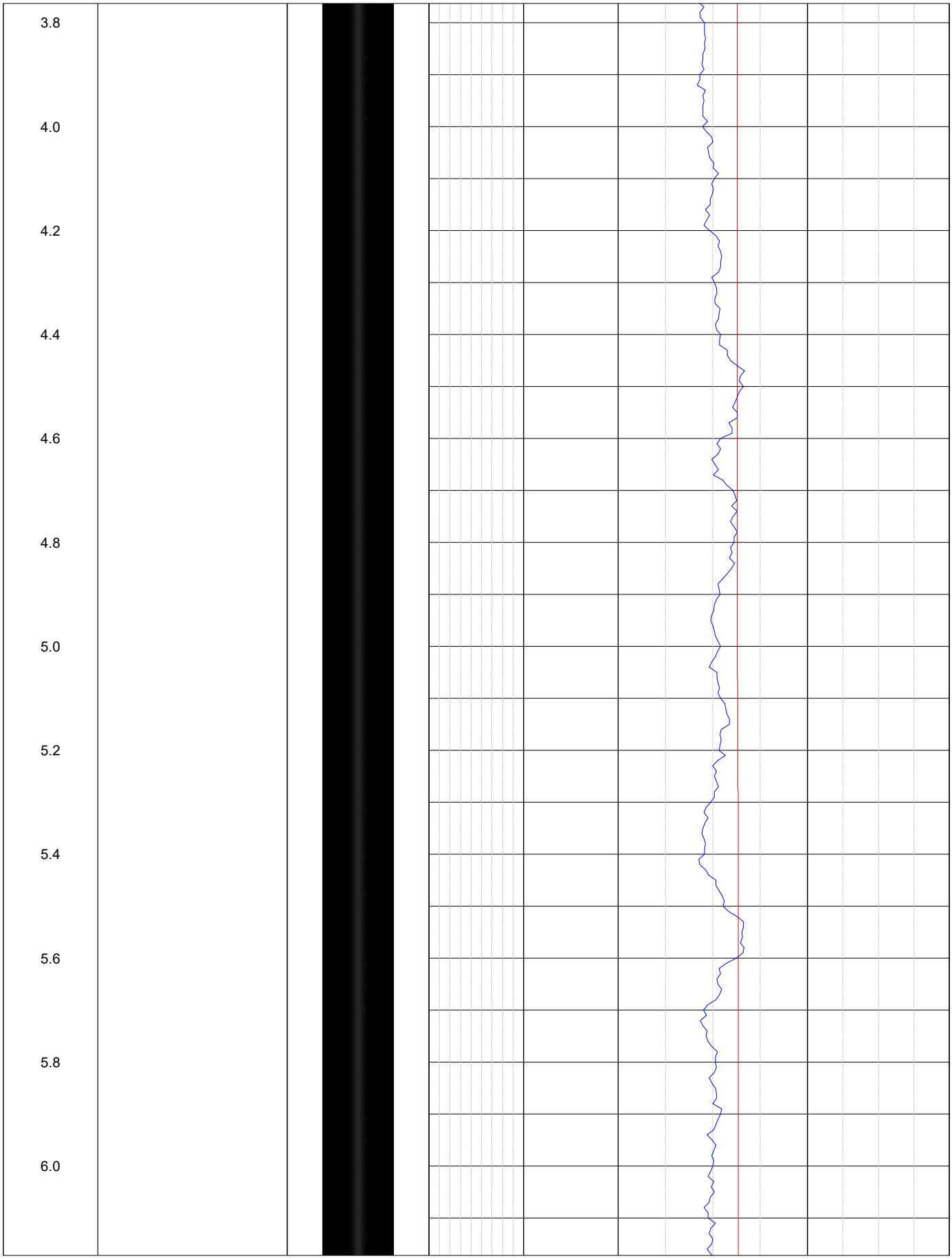
PERMANENT DATUM	GL	ELEVATION	K.B.
LOG MEAS. FROM	GL	ABOVE PERM. DATUM	D.F.
DRILLING MEAS. FROM	GL		G.L.

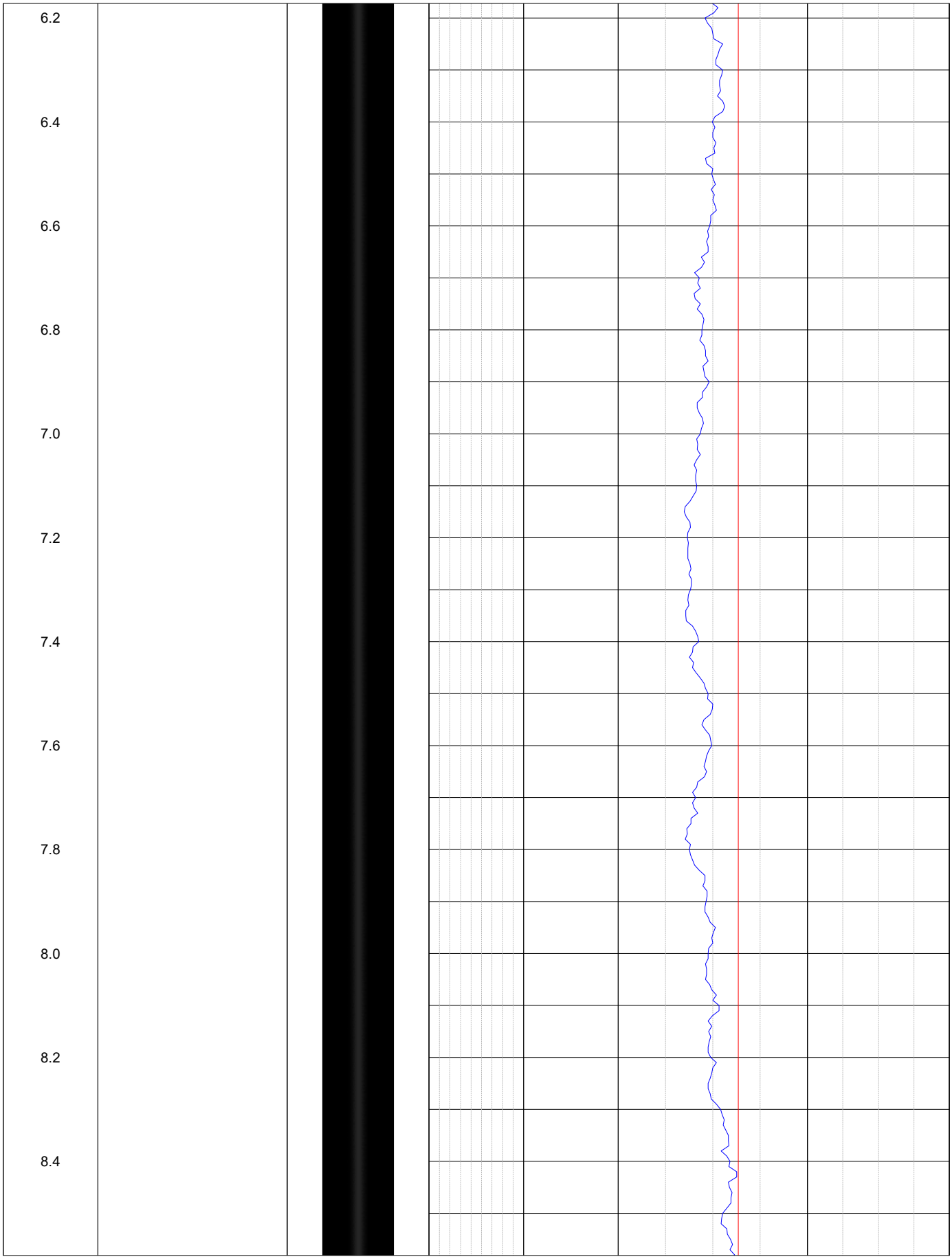
DATE	29/8/19	TYPE FLUID IN HOLE	
RUN No		SALINITY	
TYPE LOG		DENSITY	
DEPTH-DRILLER	25	LEVEL	
DEPTH-LOGGER	25.4	MAX. REC. TEMP.	
BTM LOGGED INTERVAL			
TOP LOGGED INTERVAL		CASING SHOE	
OPERATING RIG TIME			
RECORDED BY	RW		
WITNESSED BY			

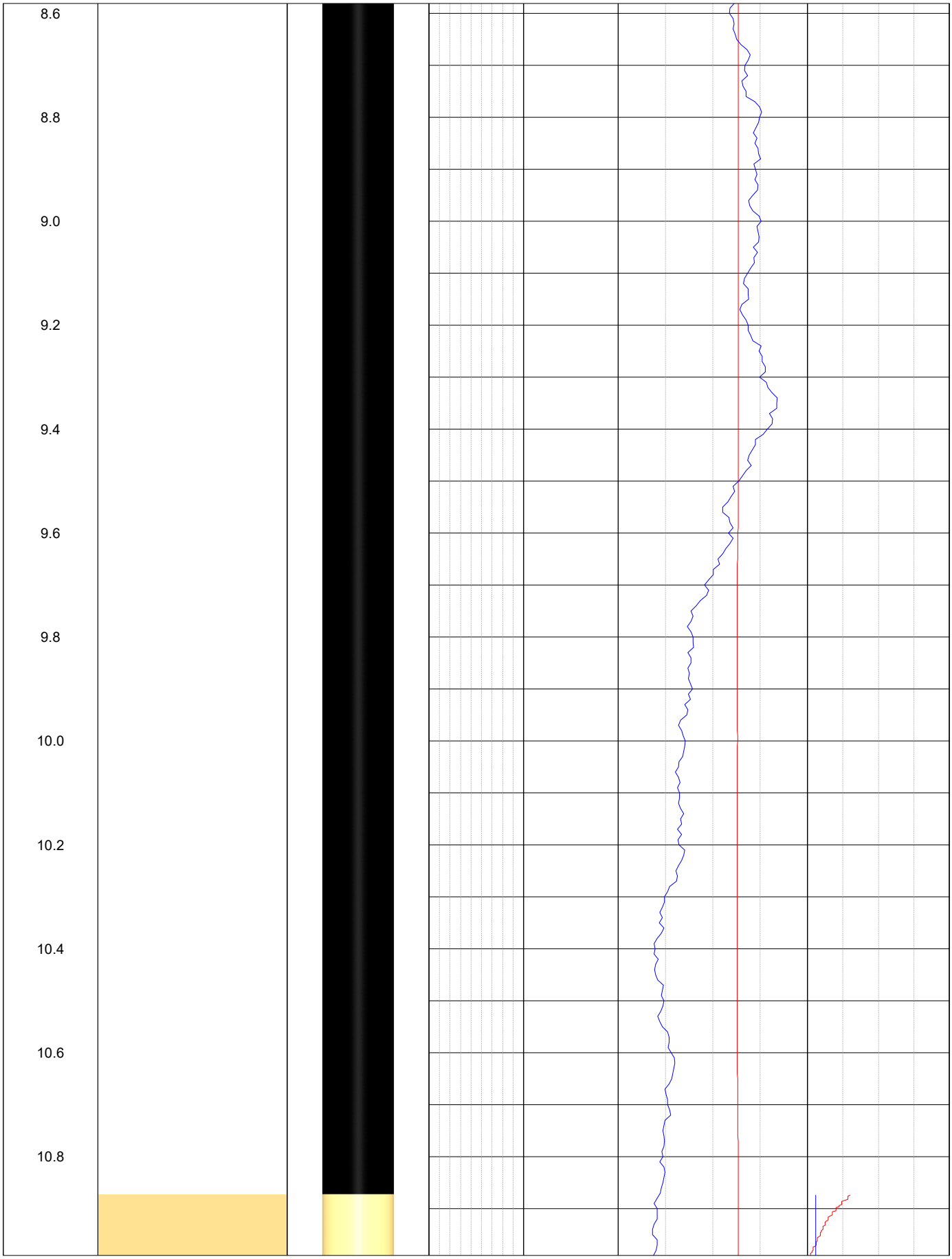
RUN	BOREHOLE RECORD			CASING RECORD			
NO.	BIT	FROM	TO	SIZE	WGT.	FROM	TO

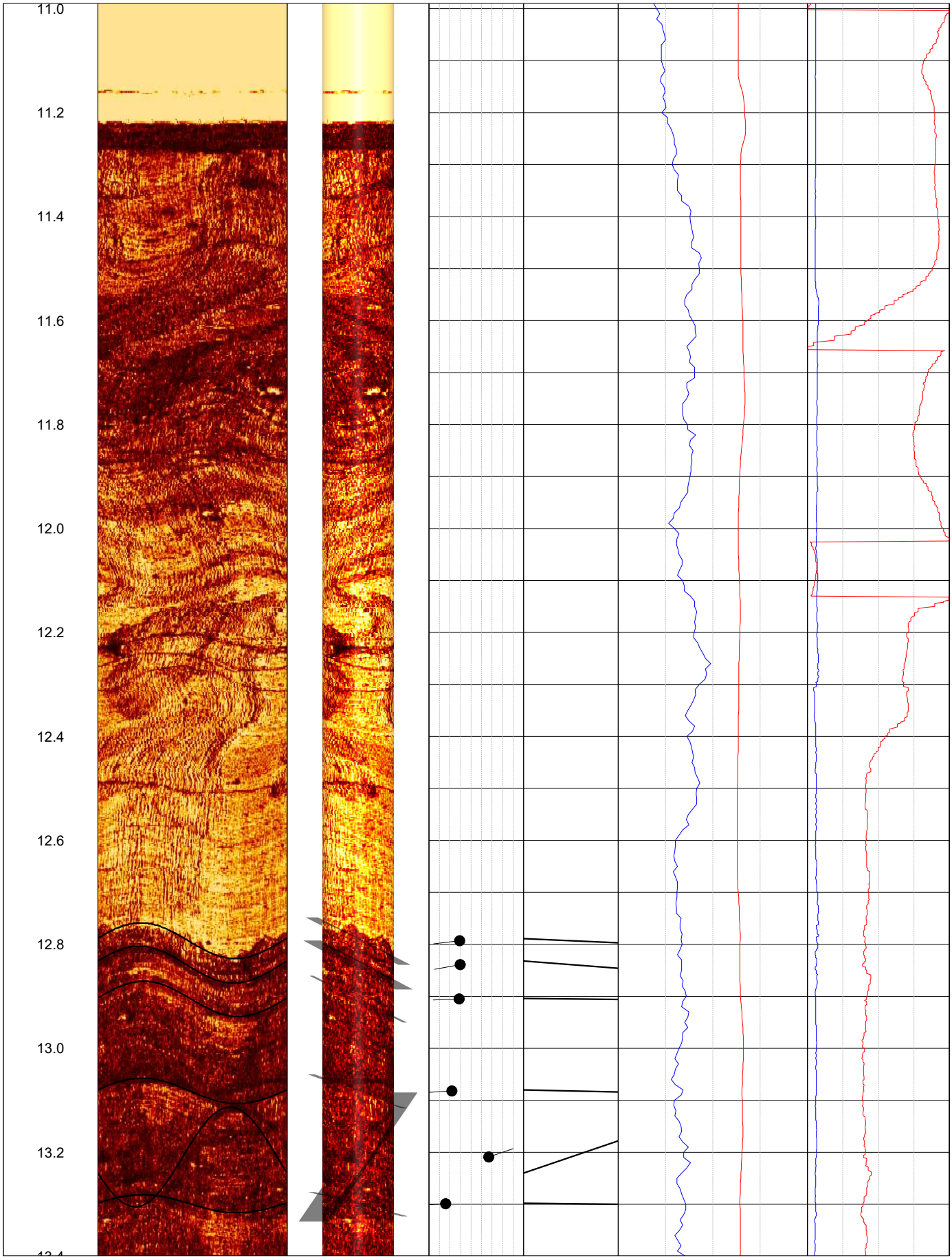


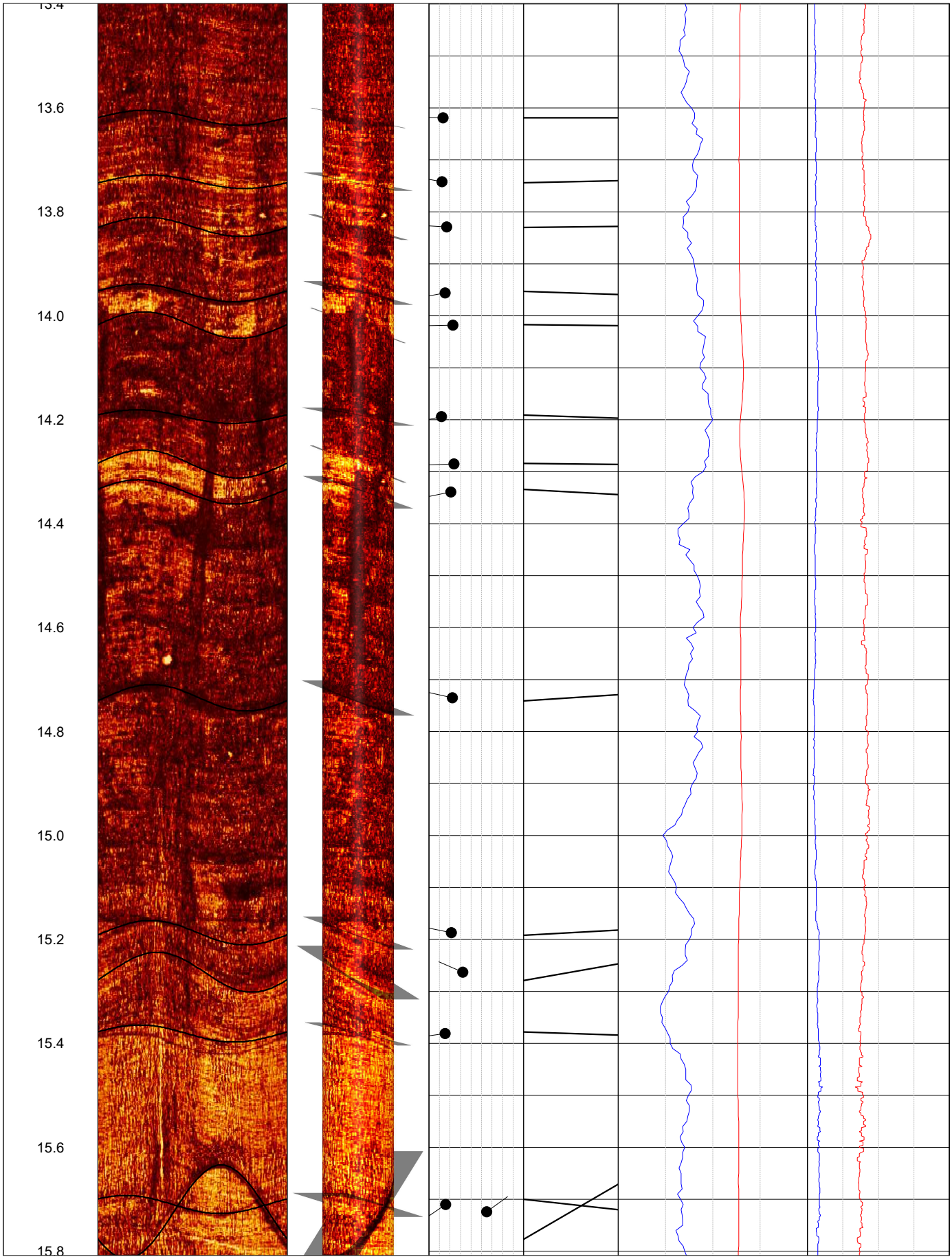

1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
3.2
3.4
3.6

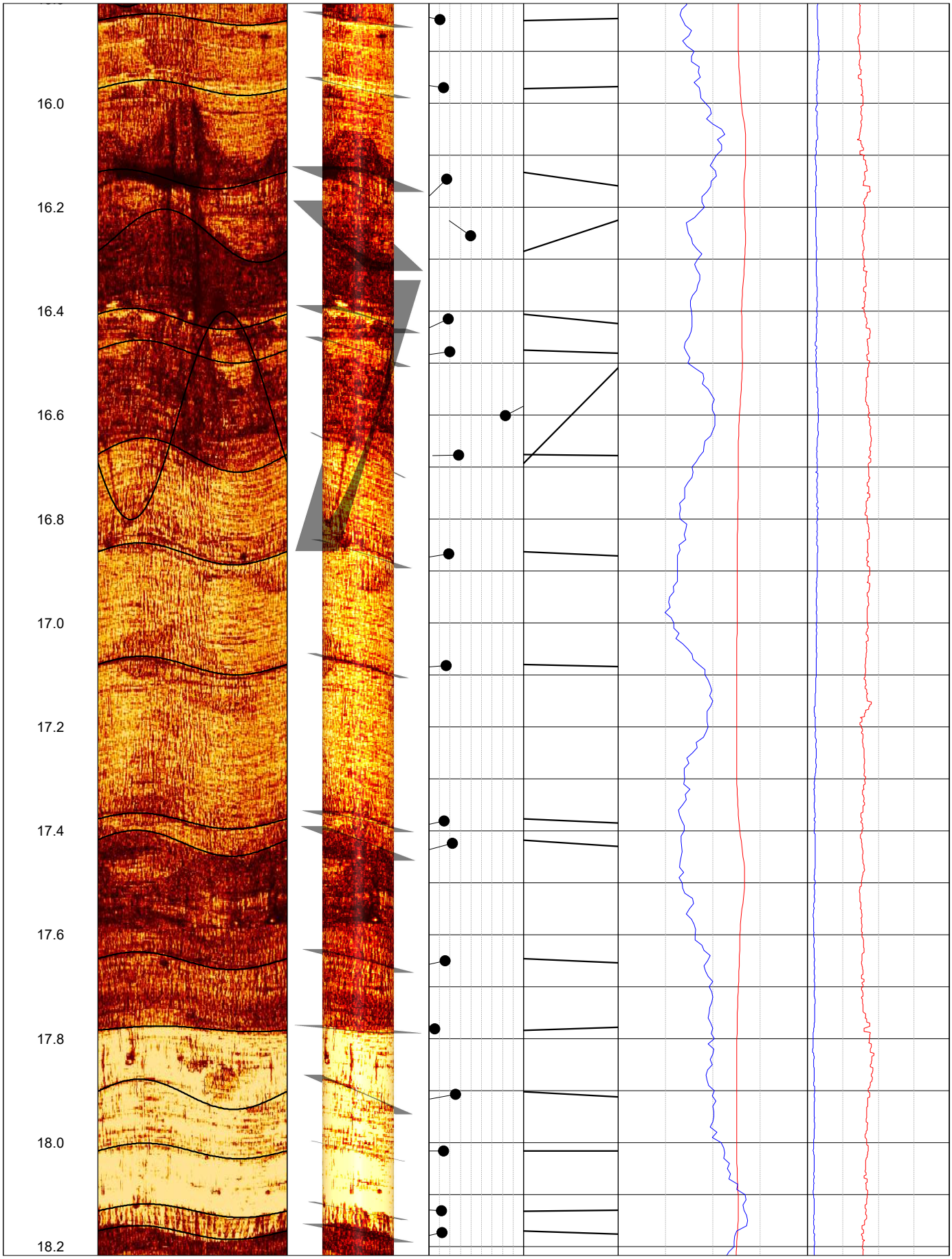

3.8
4.0
4.2
4.4
4.6
4.8
5.0
5.2
5.4
5.6
5.8
6.0

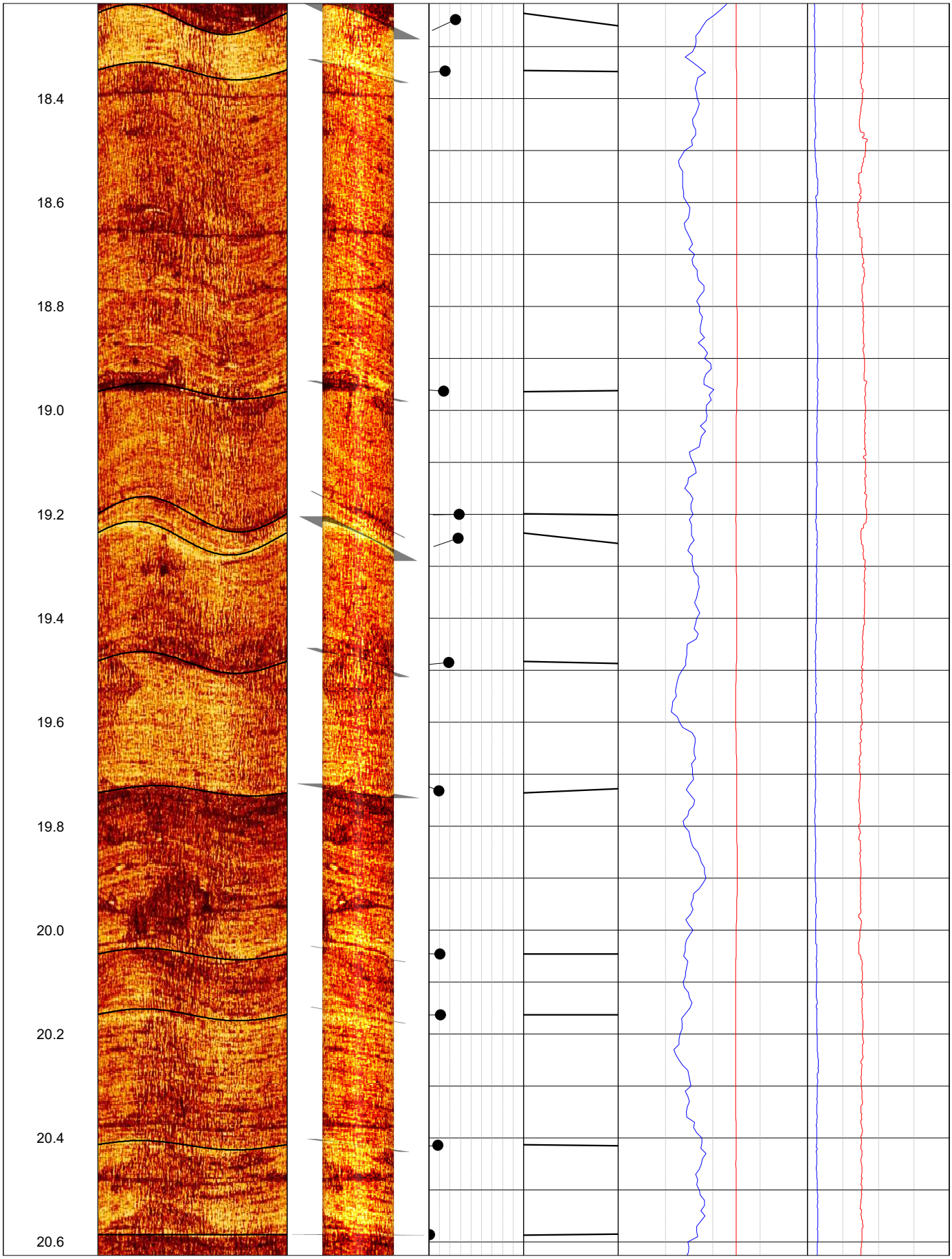

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8.4

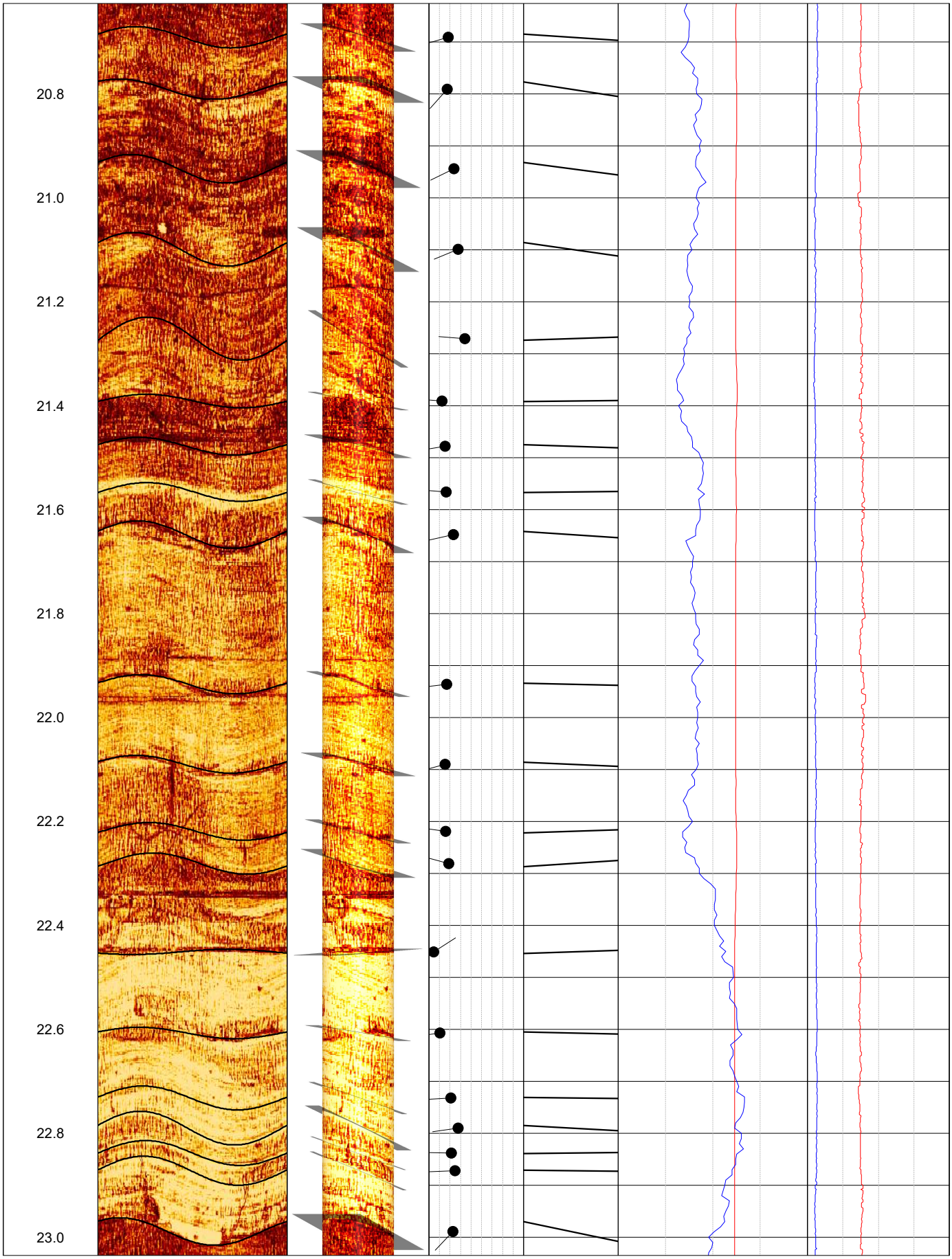

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10.6
10.8

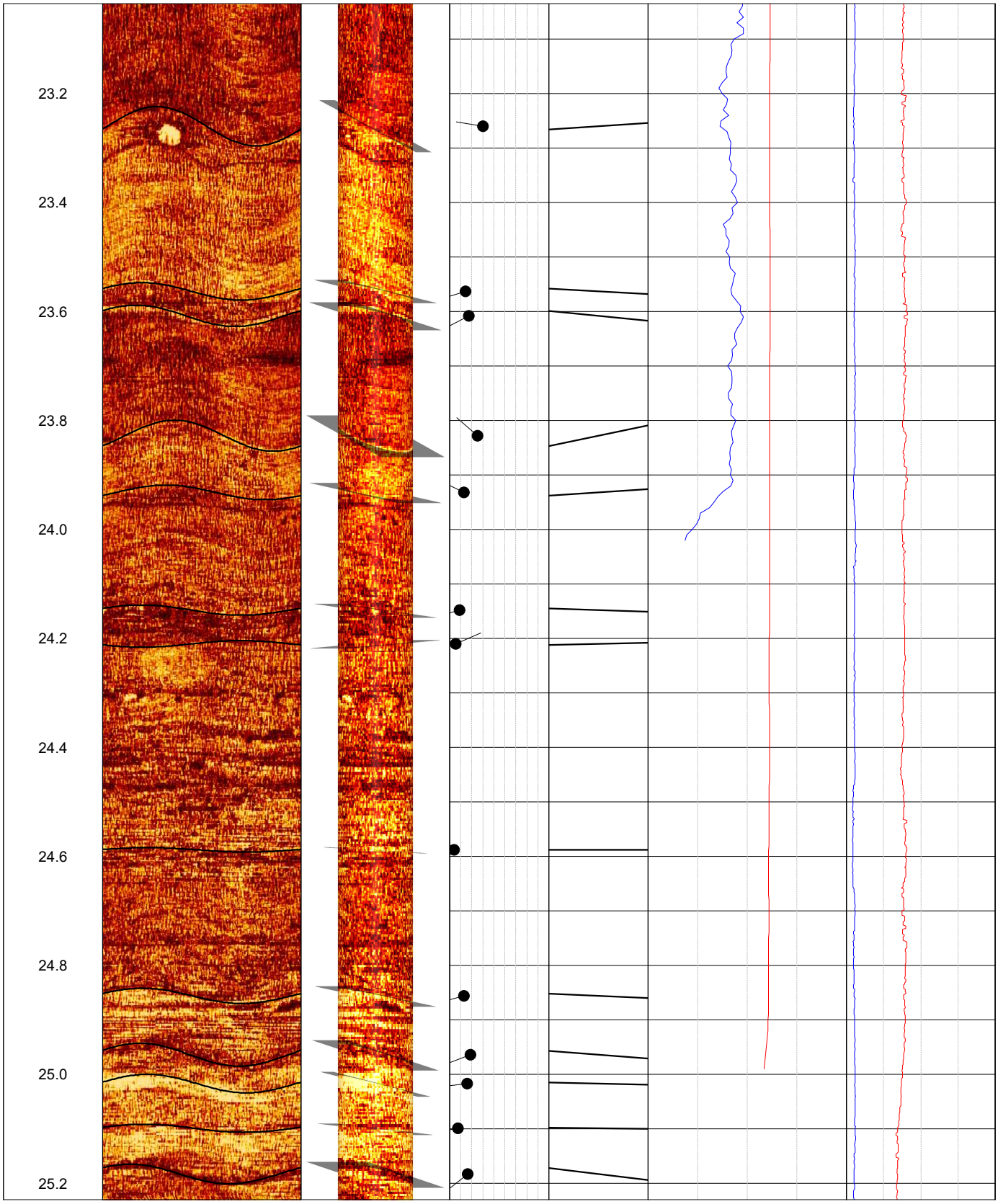

11.0
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12.4
12.6
12.8
13.0
13.2


13.6
13.8
14.0
14.2
14.4
14.6
14.8
15.0
15.2
15.4
15.6


16.0
16.2
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16.8
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17.6
17.8
18.0
18.2


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20.4
20.6


20.8
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22.2
22.4
22.6
22.8
23.0


23.2
23.4
23.6
23.8
24.0
24.2
24.4
24.6
24.8
25.0
25.2

CERTIFICATE OF CONFORMITY

Certificate of Conformity

This is to certify that the following equipment conforms to the specification detailed below

ROBERTSON GEO
Unlocking Your GeoData

Equipment type: High Resolution Acoustic Televiewer

RG Order No: ORD00000

Serial No: HiRAT 8465

Comm. Type: Standard 4-Core



Quality Management System:
ISO 9001:2015
Certified by TÜV SÜD

Tested by: T Hamflett

Date: 01/08/19

Approved by:

Tim Hamflett | *Test Engineer*

Date: 01/08/19

ISO 9001
Certified
Quality Management System
www.tuv-sud.com/ms-cert

Robertson Geologging Ltd.
Deganwy, Conwy, LL31 9PX,
United Kingdom
T: +44 (0) 1492 582 323
E: support@robertson-geo.com
www.robertson-geo.com

ROBERTSON GEO
Unlocking Your GeoData

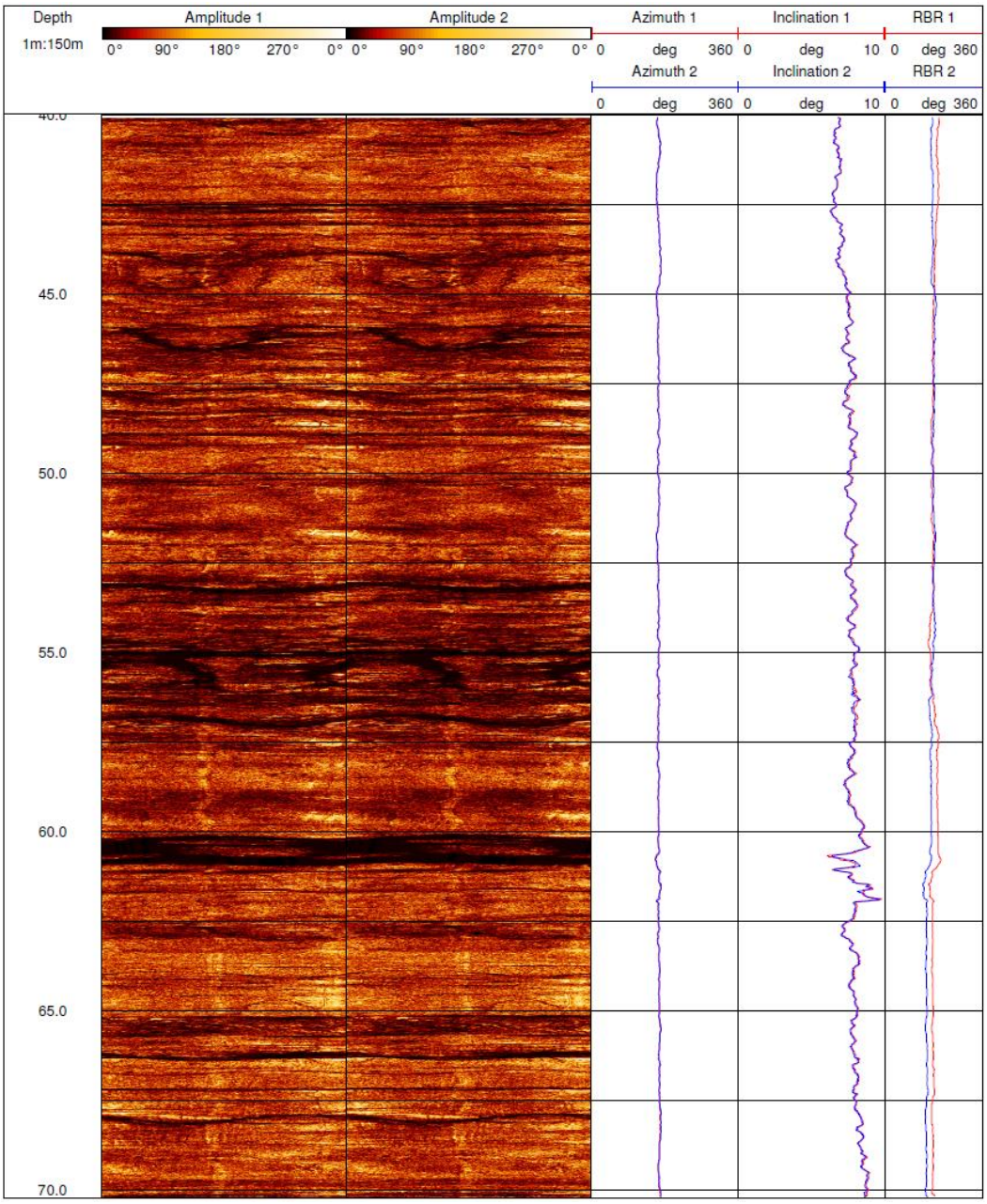
CERTIFICATE OF CONFORMITY

The probe detailed has been calibrated and then logged in the **ROBERTSON** GEO Test Borehole (Deganwy, UK). The resulting data falls within acceptable tolerances and meets all test criteria.

ROBERTSON GEO
Unlocking Your GeoData

Main Pass: 70-40m

Repeat Pass: 70-40m



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ROBERTSON GEO
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CERTIFICATE OF CONFORMITY

Certificate of Conformity

This is to certify that the following equipment conforms to the specification detailed below

ROBERTSON GEO
Unlocking Your GeoData

Equipment type: 3-Arm Caliper Probe (710mm range)

RG Order No: ORD00000

Serial No: 3ACS 001

Comm. Type: Standard 4-Core



Quality Management System:
ISO 9001:2015
Certified by TÜV SÜD

Tested by: T Hamflett

Date: 01/08/19

Approved by:

Tim Hamflett | *Test Engineer*

Date: 01/08/19

TÜV SÜD ISO 9001
ISO 9001
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ROBERTSON GEO
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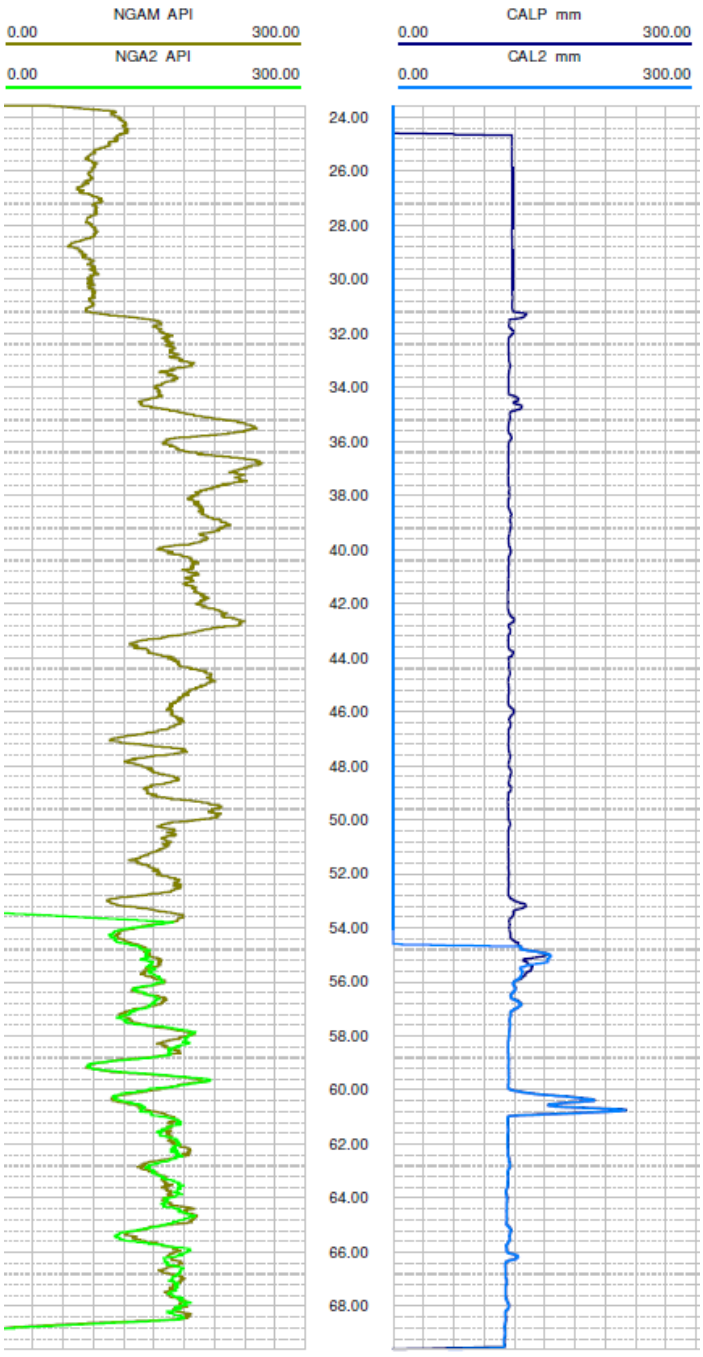
CERTIFICATE OF CONFORMITY

The probe detailed has been calibrated and then logged in the **ROBERTSON** GEO Test Borehole (Deganwy, UK). The resulting data falls within acceptable tolerances and meets all test criteria.

ROBERTSON GEO
Unlocking Your GeoData

Main Pass: 70-25m

Repeat Pass: 70-55m



Channel	x^n	Coefficient
1 NGAM	0	0.0
	1	1.16216
	2	0.0
	3	0.0
2 CALP	0	-193.713
	1	0.132413
	2	-4.43972E-6
	3	0.0
3	0	0.0
	1	1.0
	2	0.0
	3	0.0
4	0	0.0
	1	1.0
	2	0.0
	3	0.0
5	0	0.0
	1	1.0
	2	0.0
	3	0.0
6	0	0.0
	1	1.0
	2	0.0
	3	0.0
7	0	0.0
	1	1.0
	2	0.0
	3	0.0
8	0	0.0
	1	1.0
	2	0.0
	3	0.0
9	0	0.0
	1	1.0
	2	0.0
	3	0.0
10	0	0.0
	1	1.0
	2	0.0
	3	0.0
11	0	0.0
	1	1.0
	2	0.0
	3	0.0
12	0	0.0
	1	1.0
	2	0.0
	3	0.0

Calibrated Value=$ax^0+bx^1+cx^2+dx^3$

TÜV SÜD ISO 9001
ISO 9001
Certified Quality Management System
www.tuv-sud.com/ms-cert

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ROBERTSON GEO SERVICES
Unlocking Your GeoData

CO Geotechnics
WELL BH102
FLD Crown Street
CTY Manchester
STE
FILING No

COMPANY Geotechnics
WELL ID BH102
FIELD Crown Street, Manchester
COUNTRY UK STATE

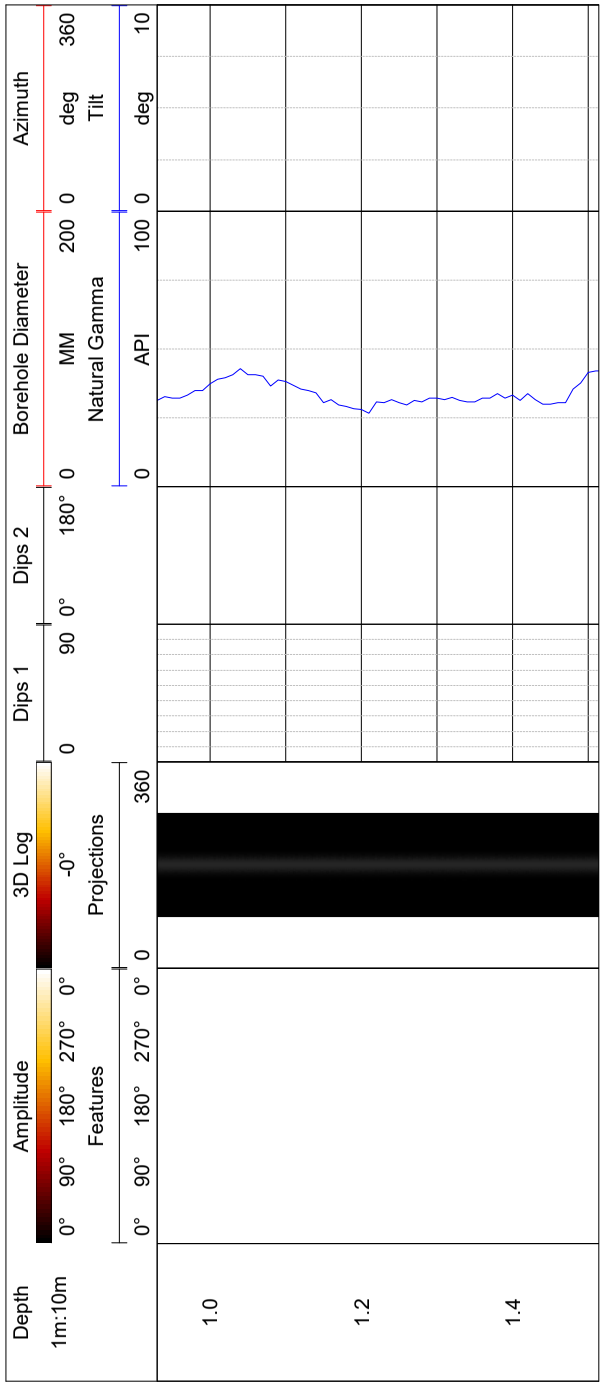
LOCATION
SEC TWP RGE

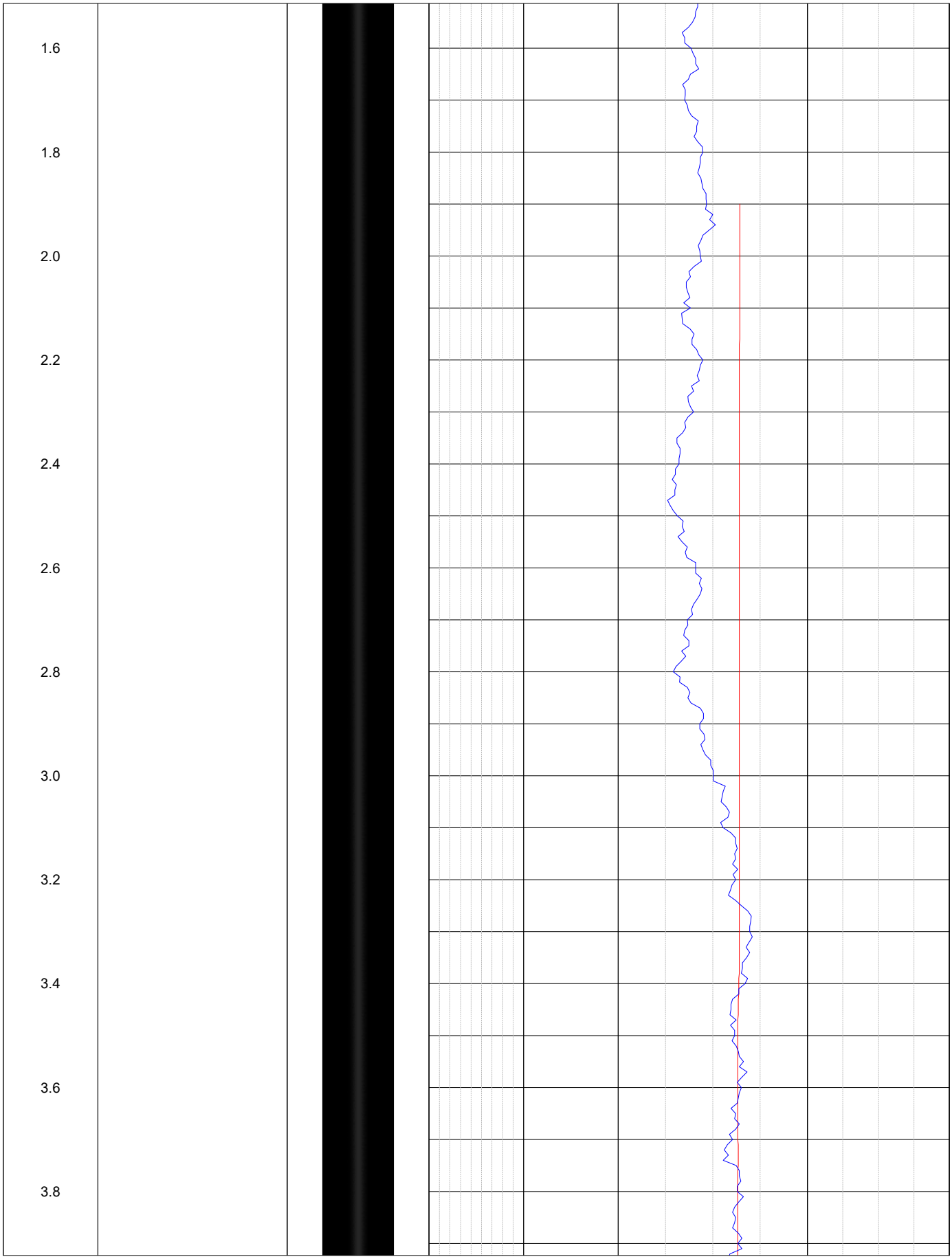
OTHER SERVICES

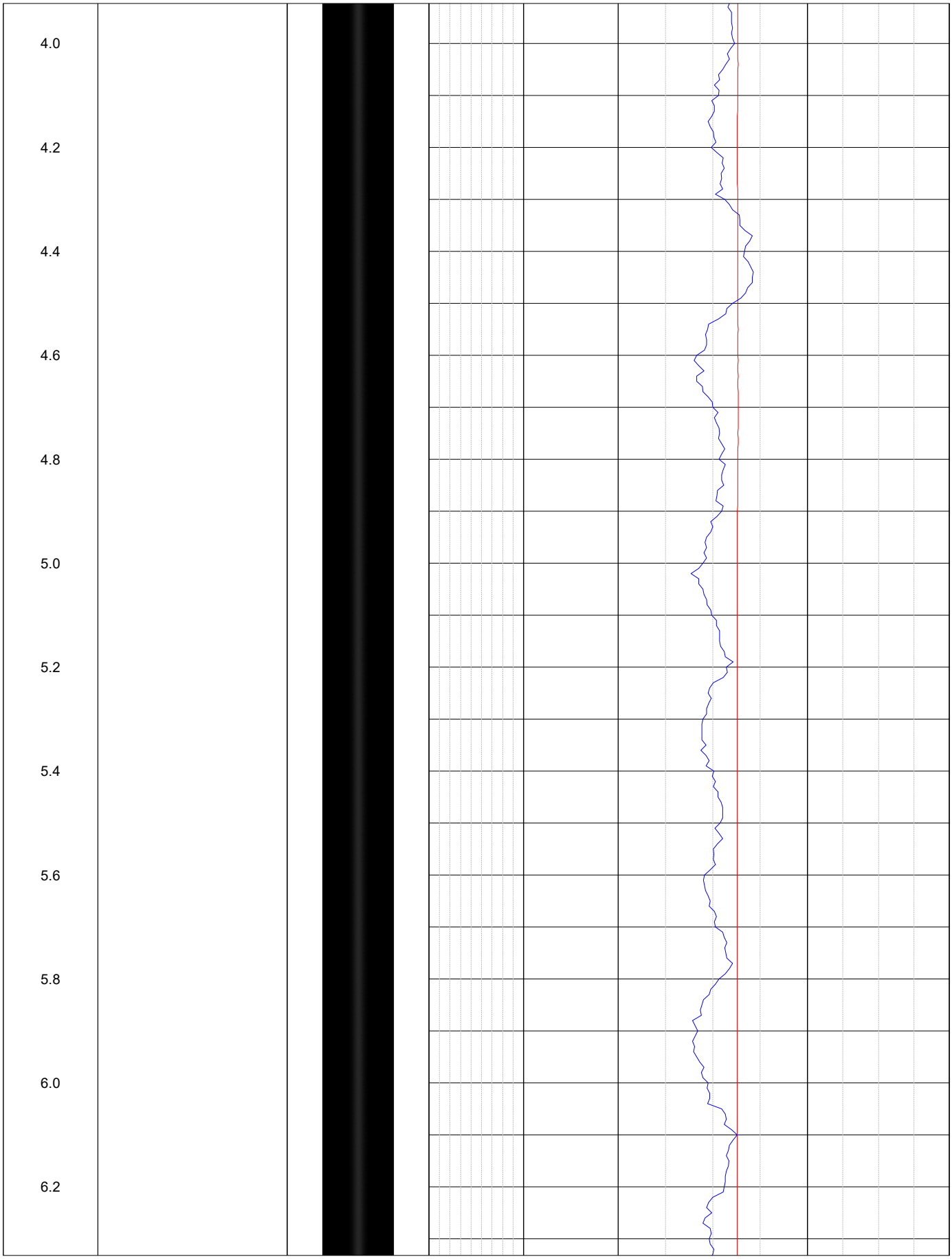
PERMANENT DATUM	GL	ELEVATION	K.B.
LOG MEAS. FROM	GL	ABOVE PERM. DATUM	D.F.
DRILLING MEAS. FROM	GL		G.L.

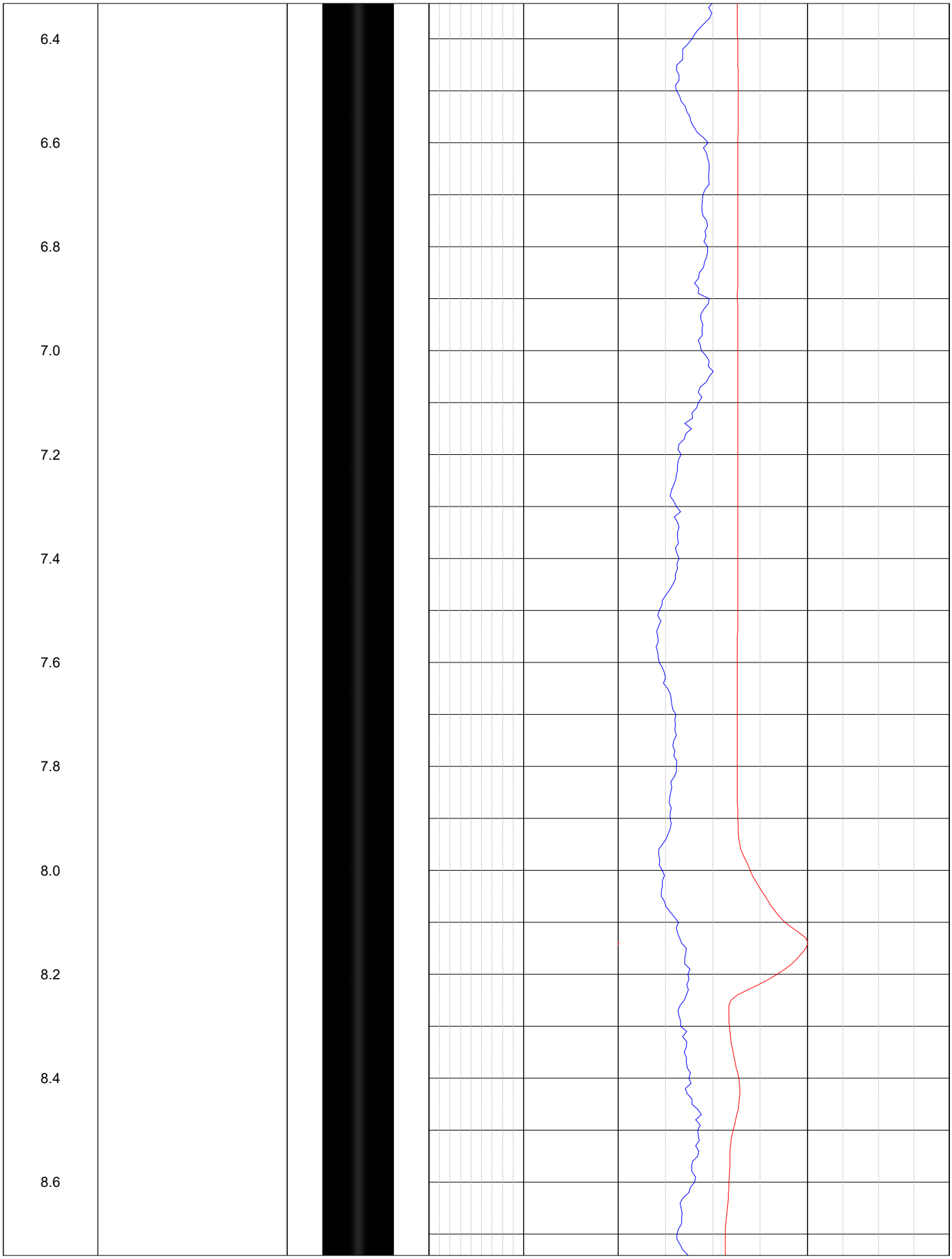
DATE	29/8/19	TYPE FLUID IN HOLE	Water
RUN No		SALINITY	
TYPE LOG		DENSITY	
DEPTH-DRILLER	35	LEVEL	9.57
DEPTH-LOGGER	35.2	MAX. REC. TEMP.	
BTM LOGGED INTERVAL			
TOP LOGGED INTERVAL		CASING SHOE	7.95
OPERATING RIG TIME			
RECORDED BY	RW		
WITNESSED BY			

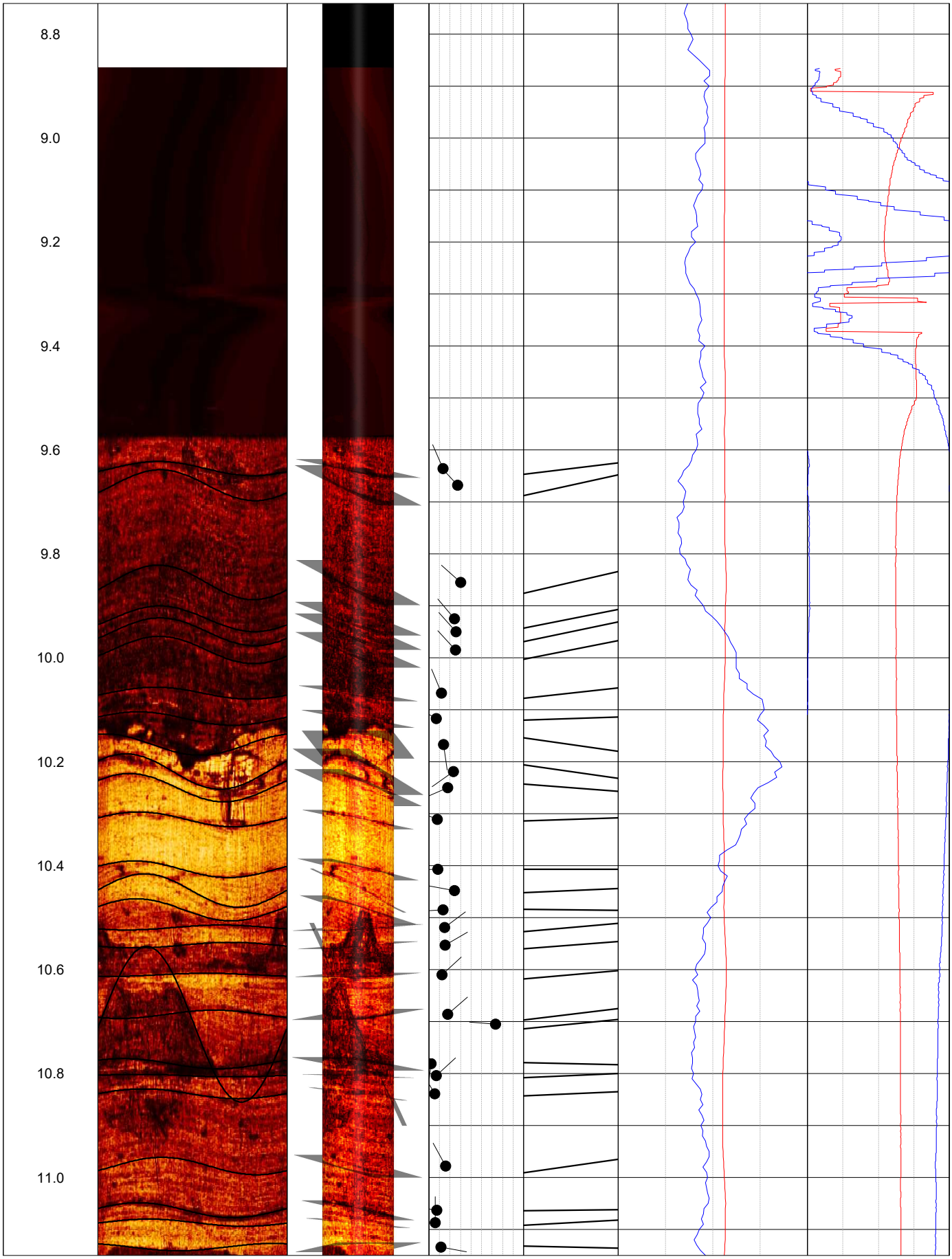
RUN	BOREHOLE RECORD			CASING RECORD			
NO.	BIT	FROM	TO	SIZE	WGT.	FROM	TO

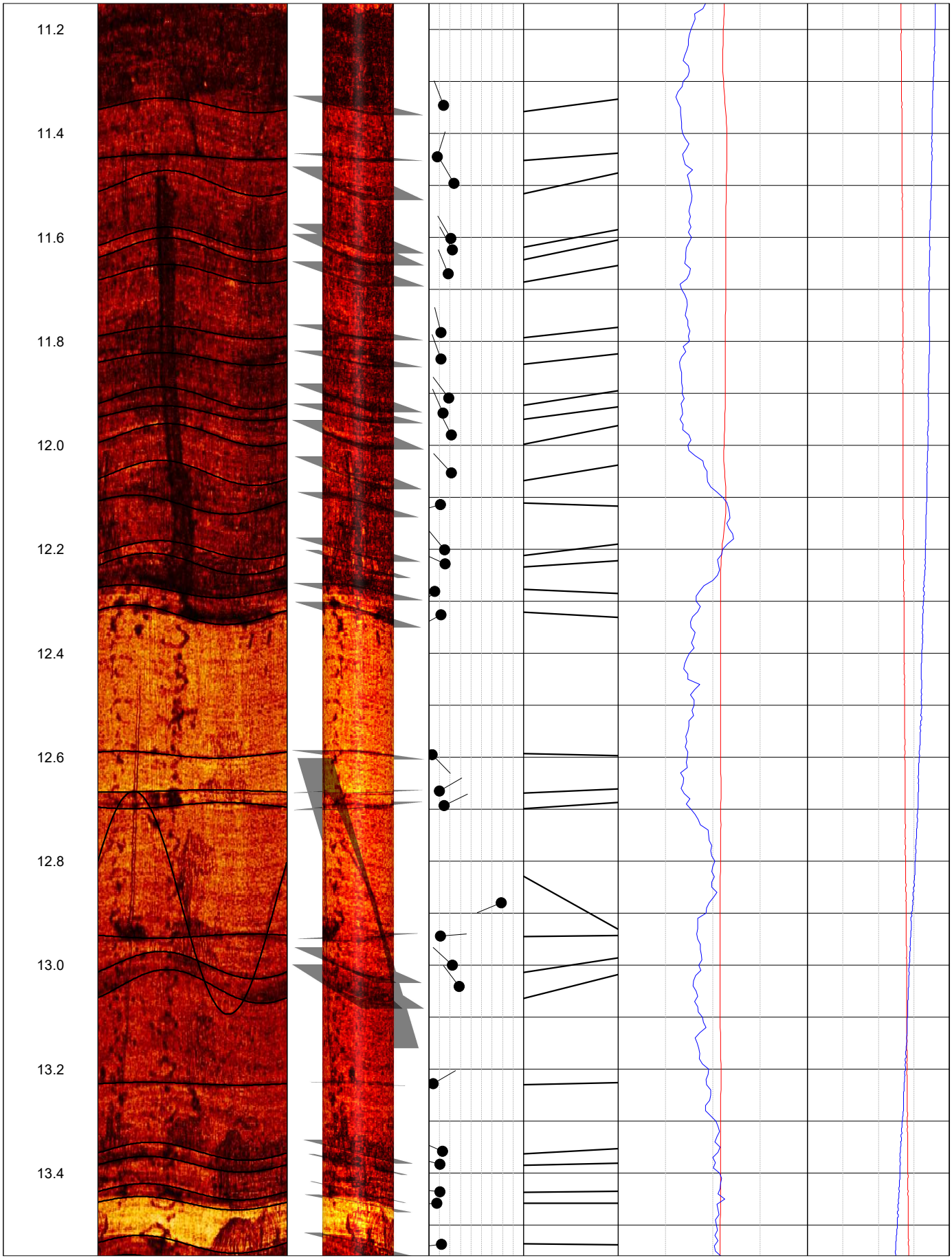


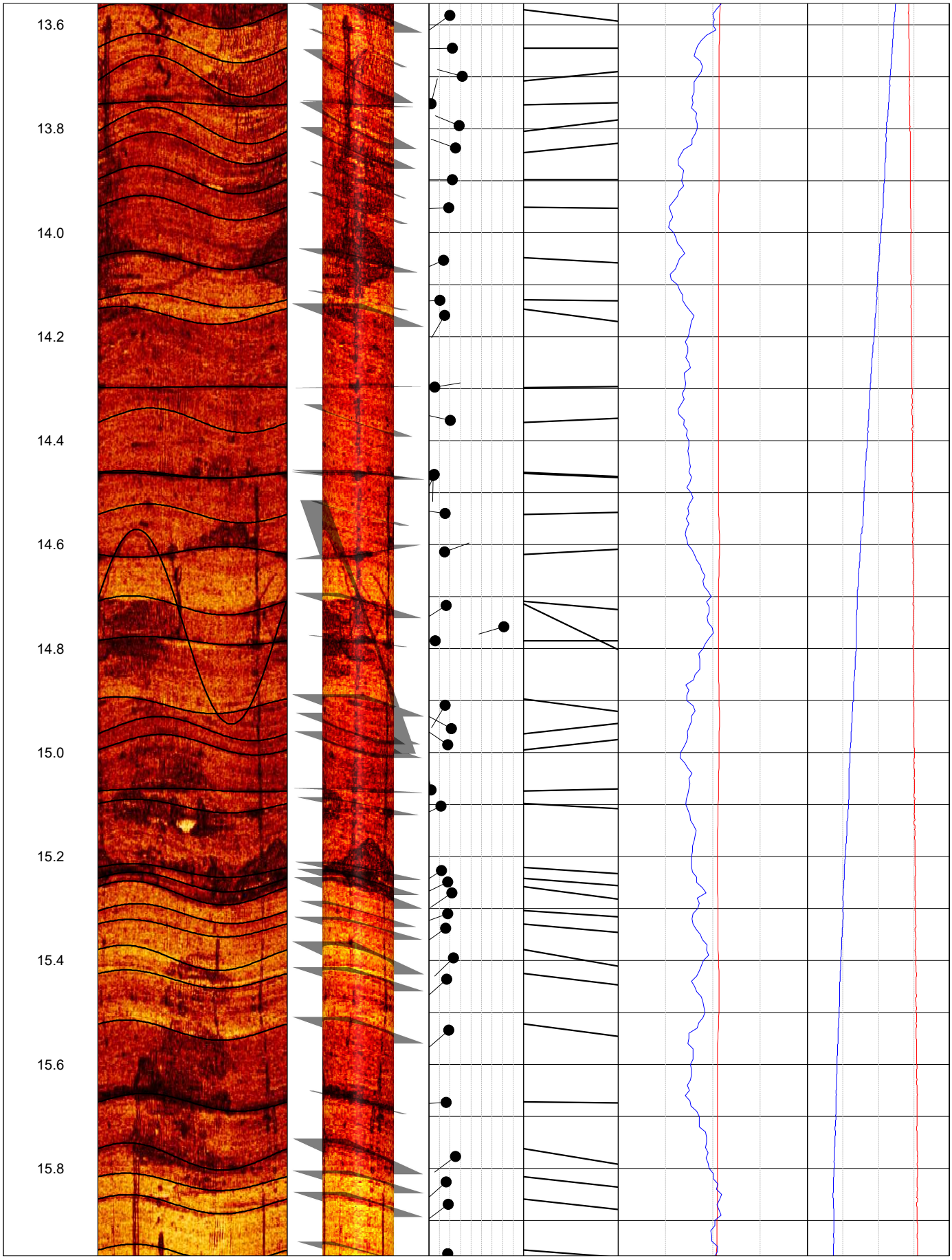

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3.0
3.2
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3.6
3.8

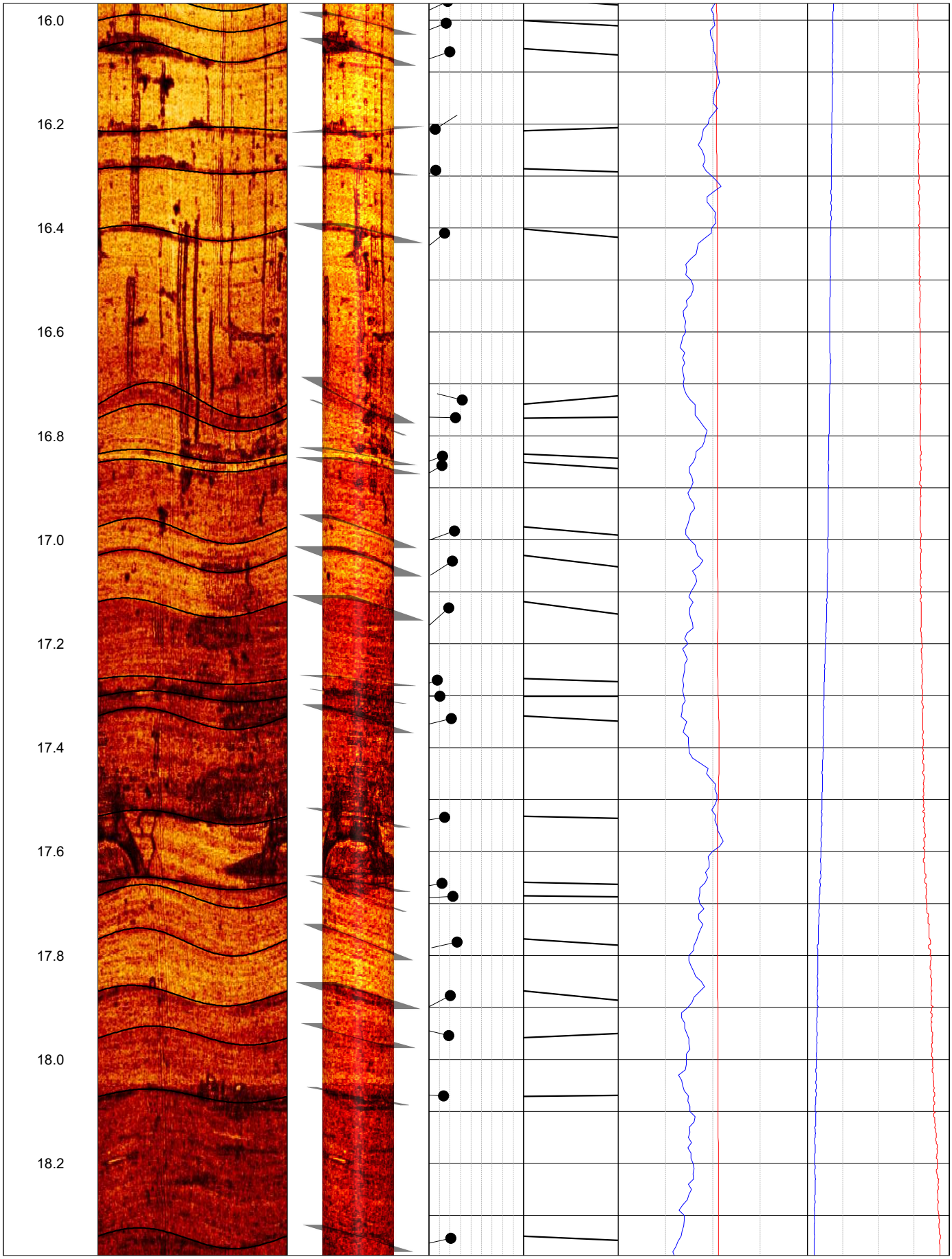

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6.2

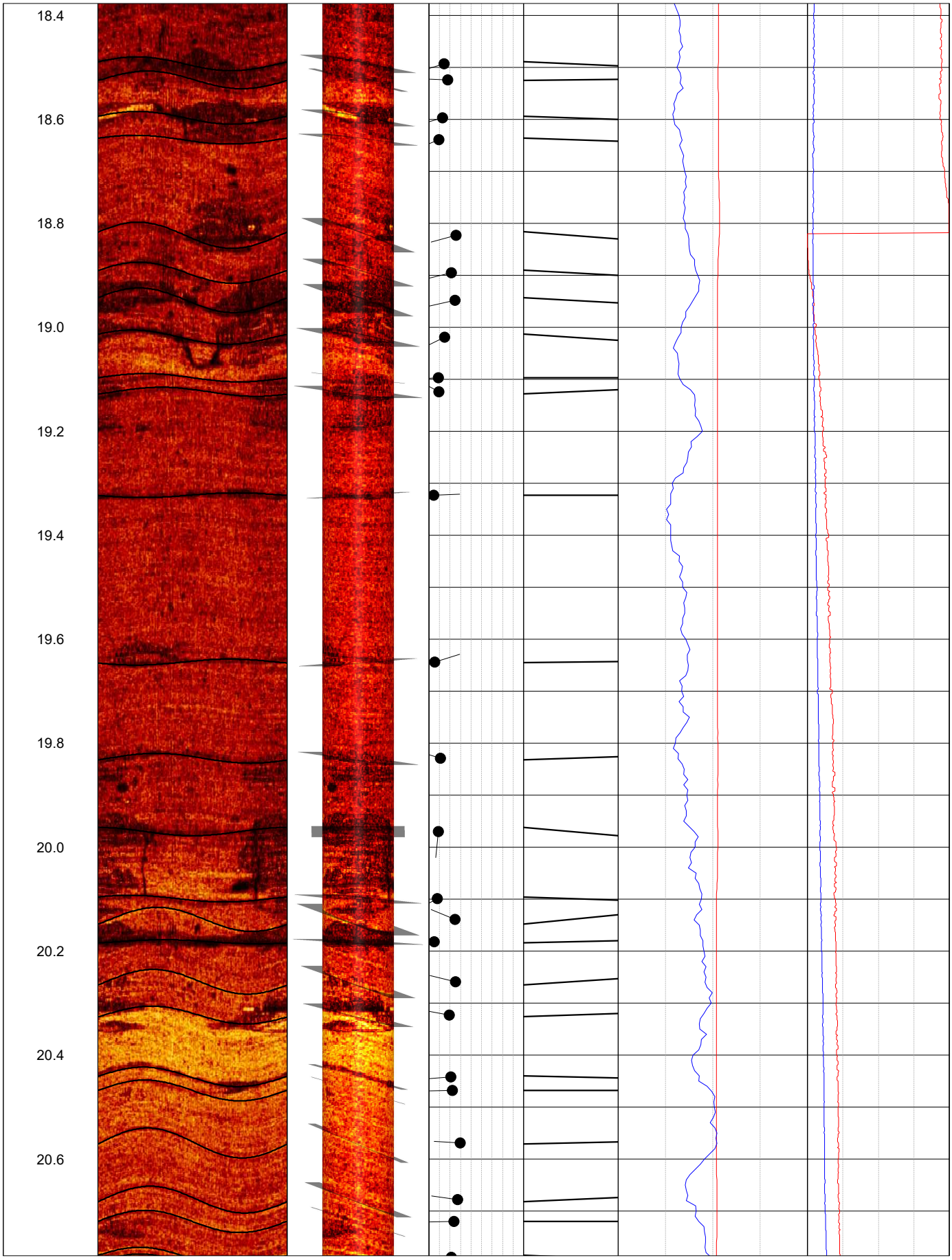

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7.8
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8.4
8.6

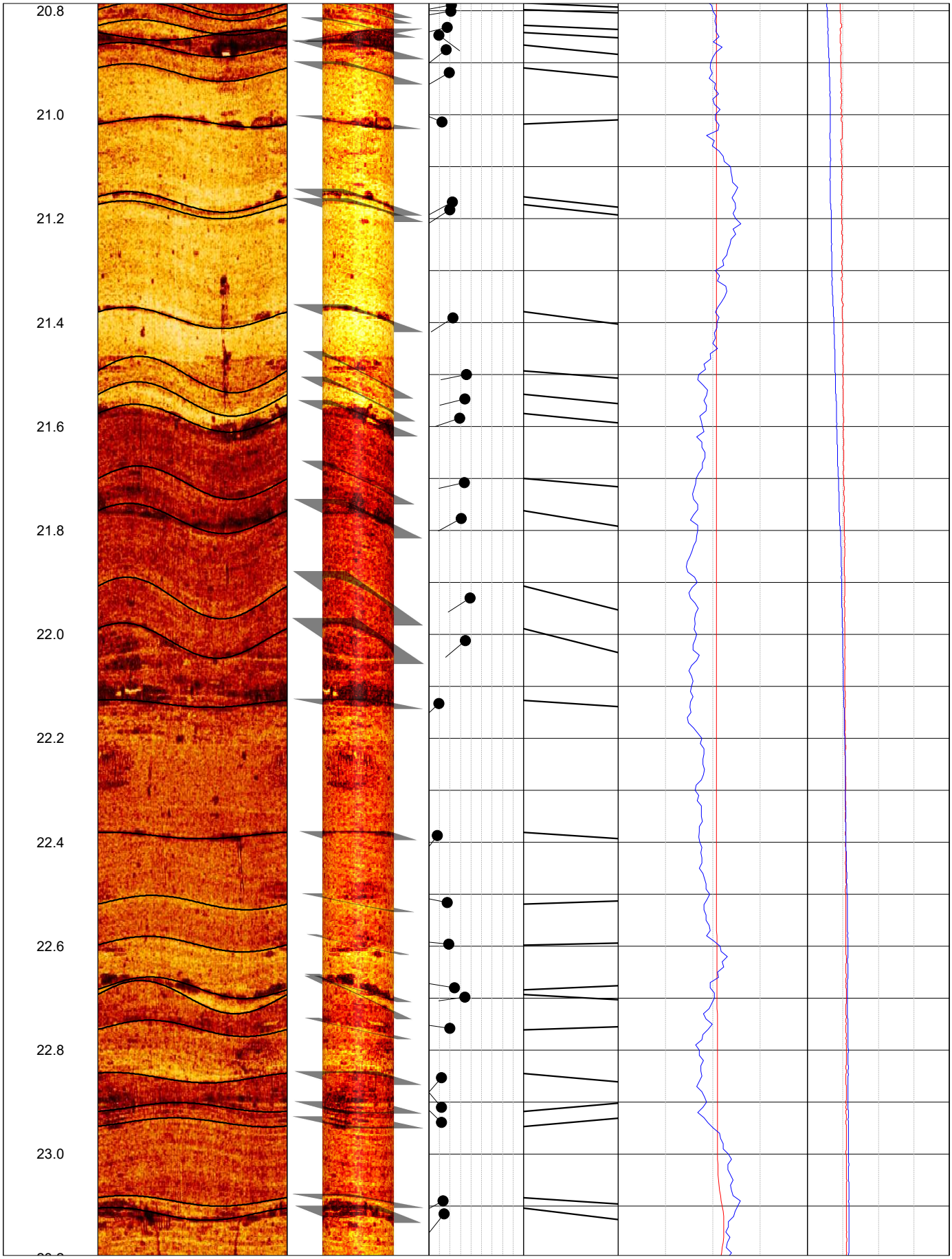

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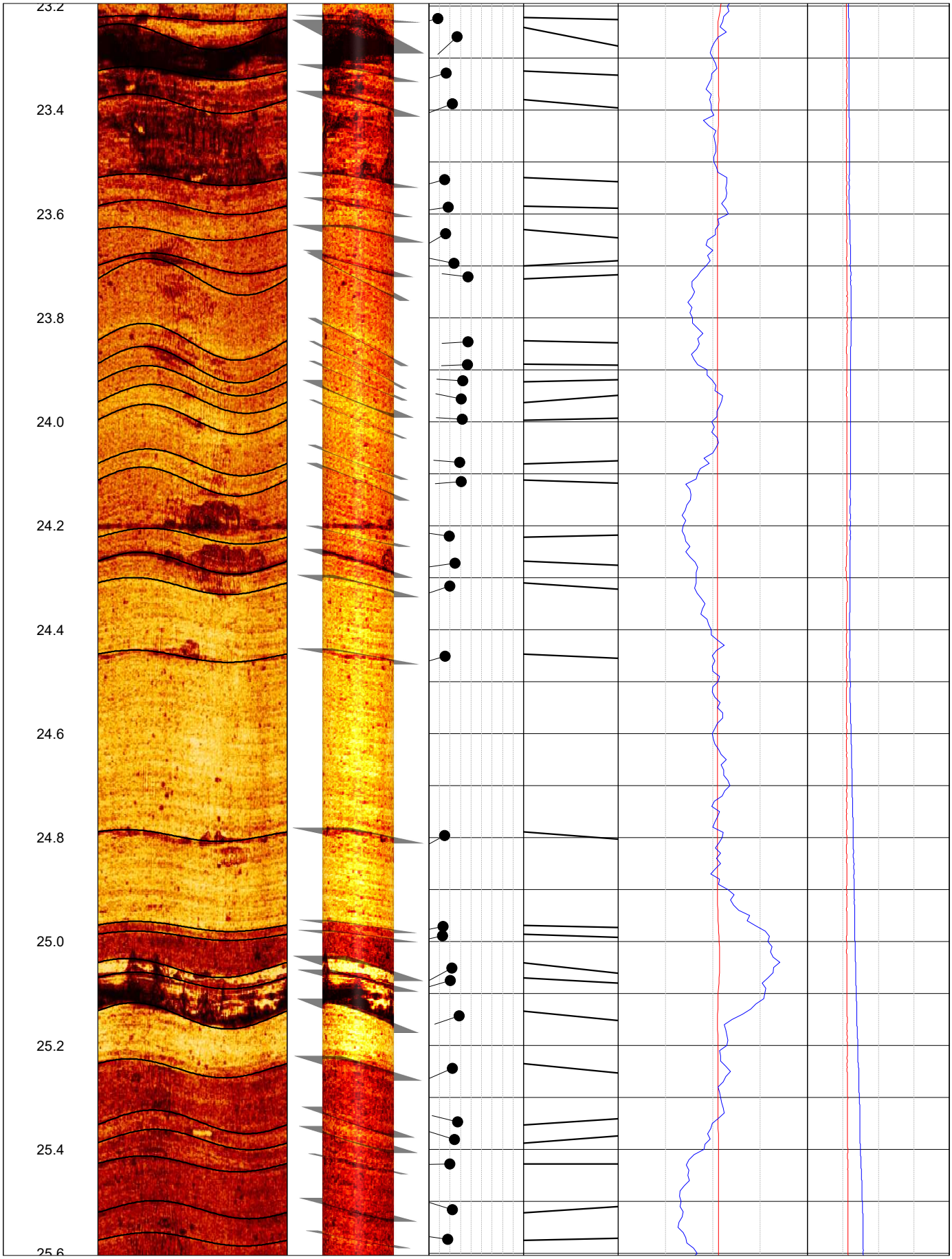

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13.2
13.4

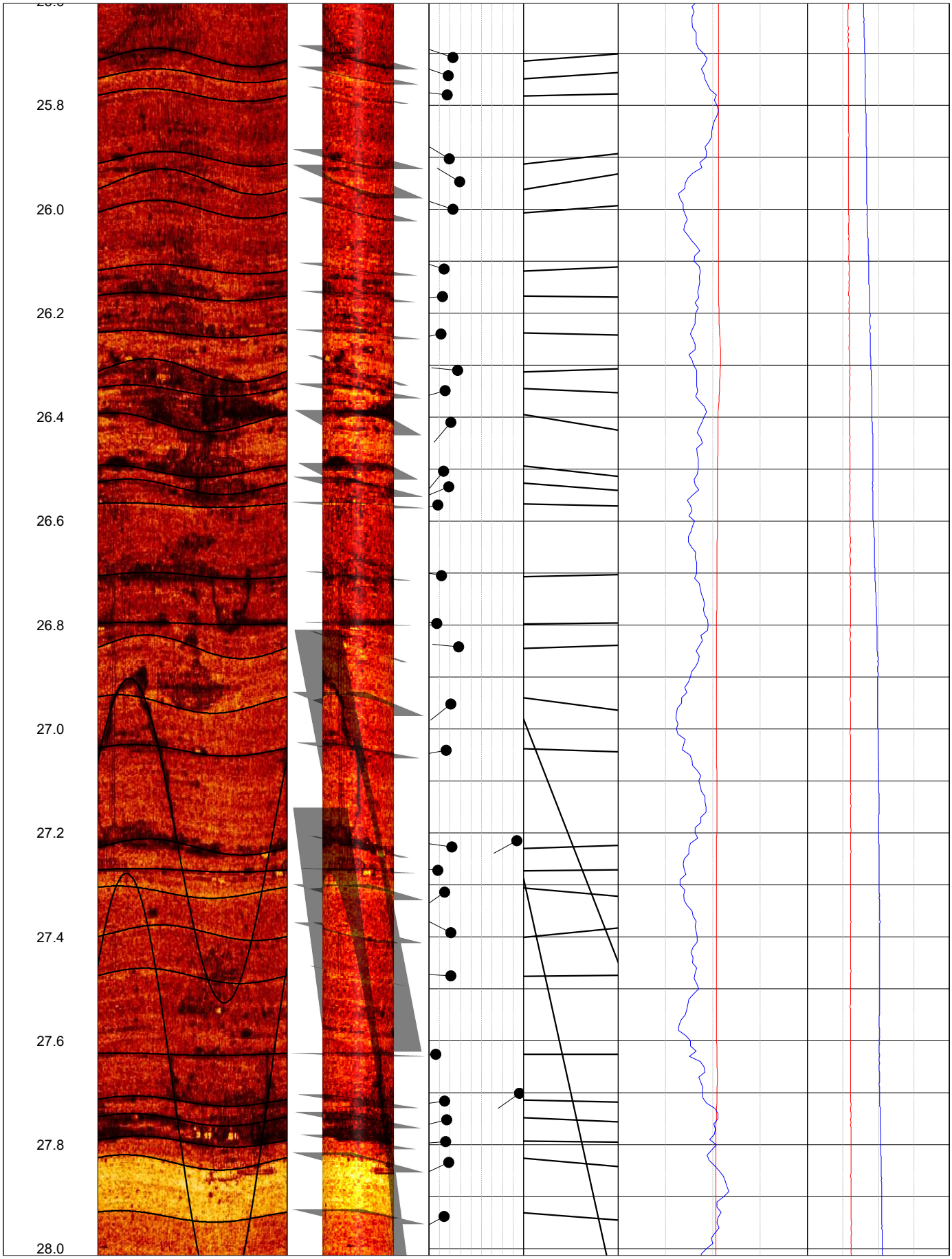

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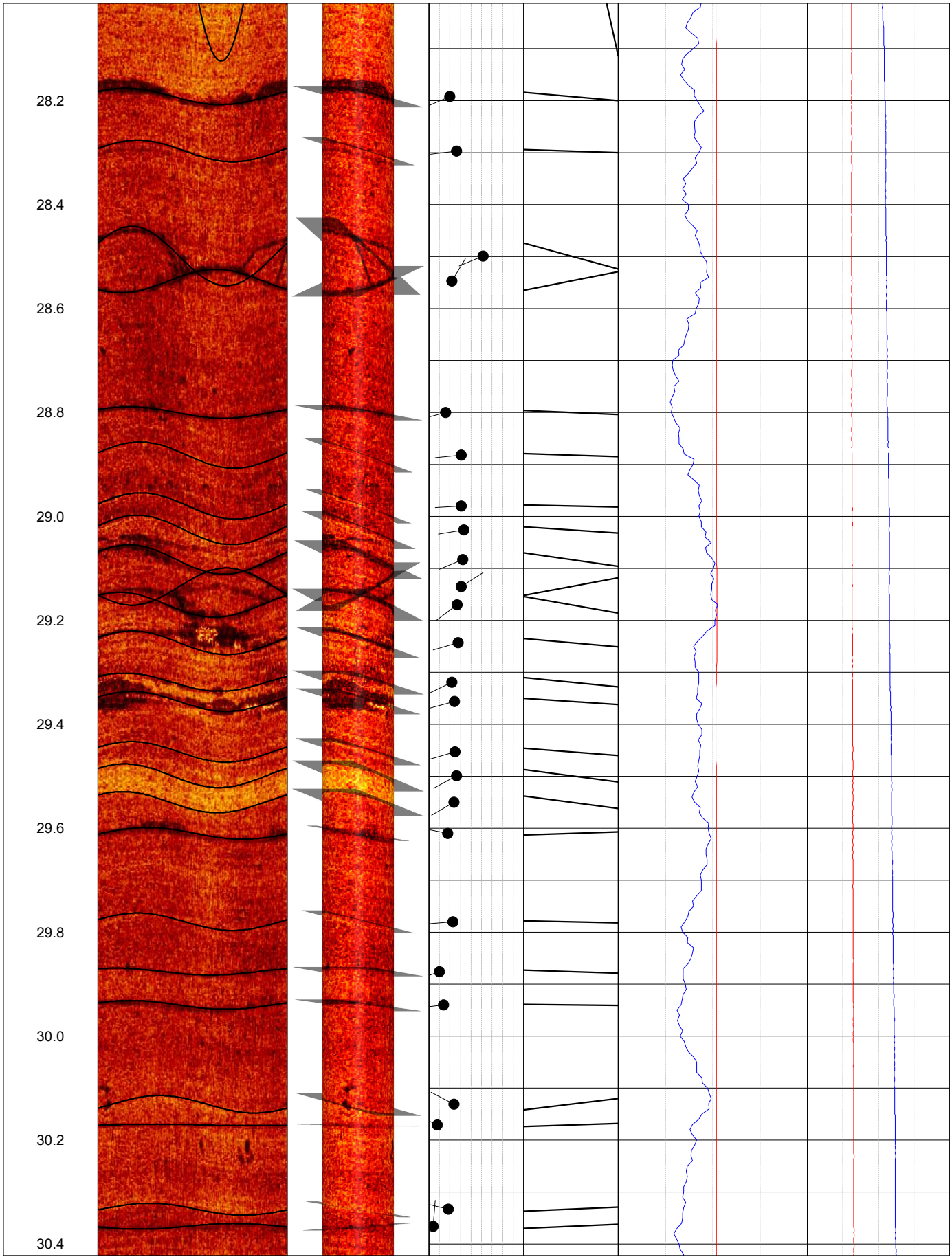

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18.2

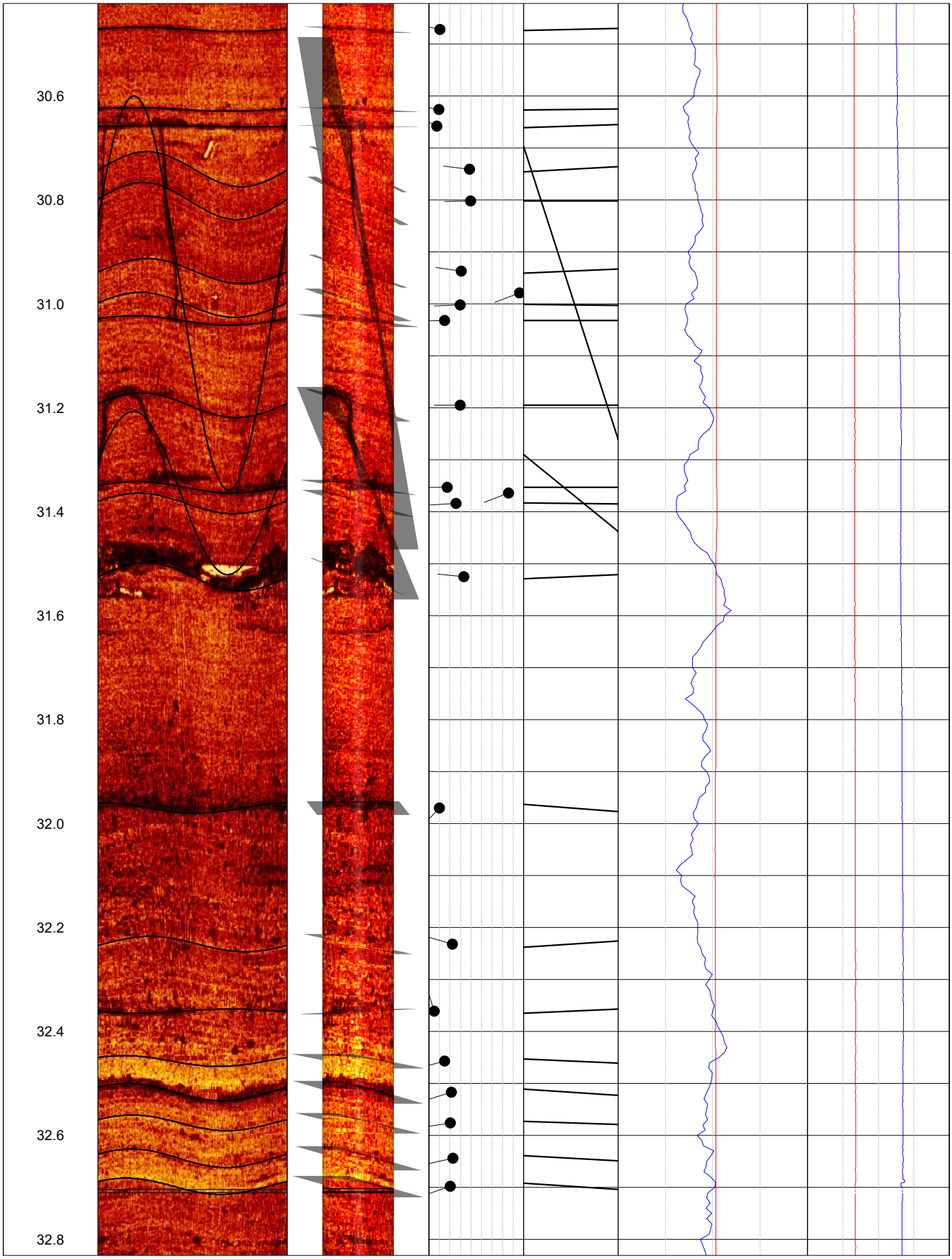

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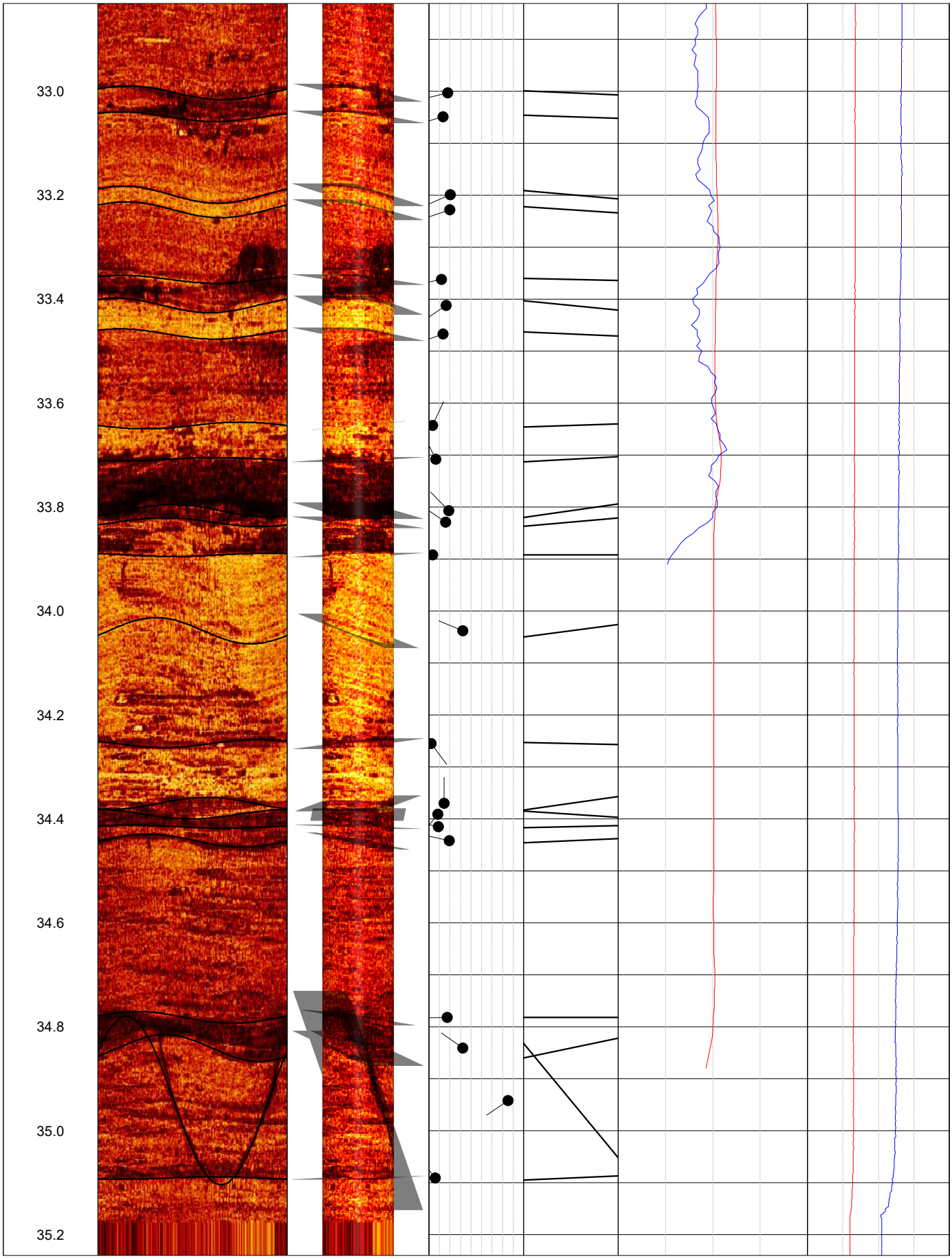

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23.0

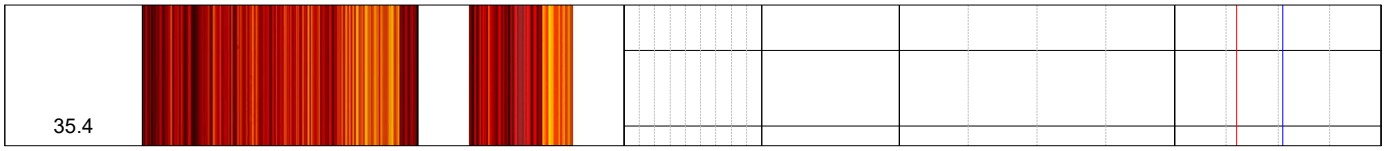

23.2
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25.4
25.6


25.8
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30.4


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32.6
32.8


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33.6
33.8
34.0
34.2
34.4
34.6
34.8
35.0
35.2


35.4

CERTIFICATE OF CONFORMITY

Certificate of Conformity

This is to certify that the following equipment conforms to the specification detailed below

ROBERTSON GEO
Unlocking Your GeoData

Equipment type: High Resolution Acoustic Televiewer

RG Order No: ORD00000

Serial No: HiRAT 8465

Comm. Type: Standard 4-Core



Quality Management System:
ISO 9001:2015
Certified by TÜV SÜD

Tested by: T Hamflett

Date: 01/08/19

Approved by:

Tim Hamflett | *Test Engineer*

Date: 01/08/19

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ROBERTSON GEO
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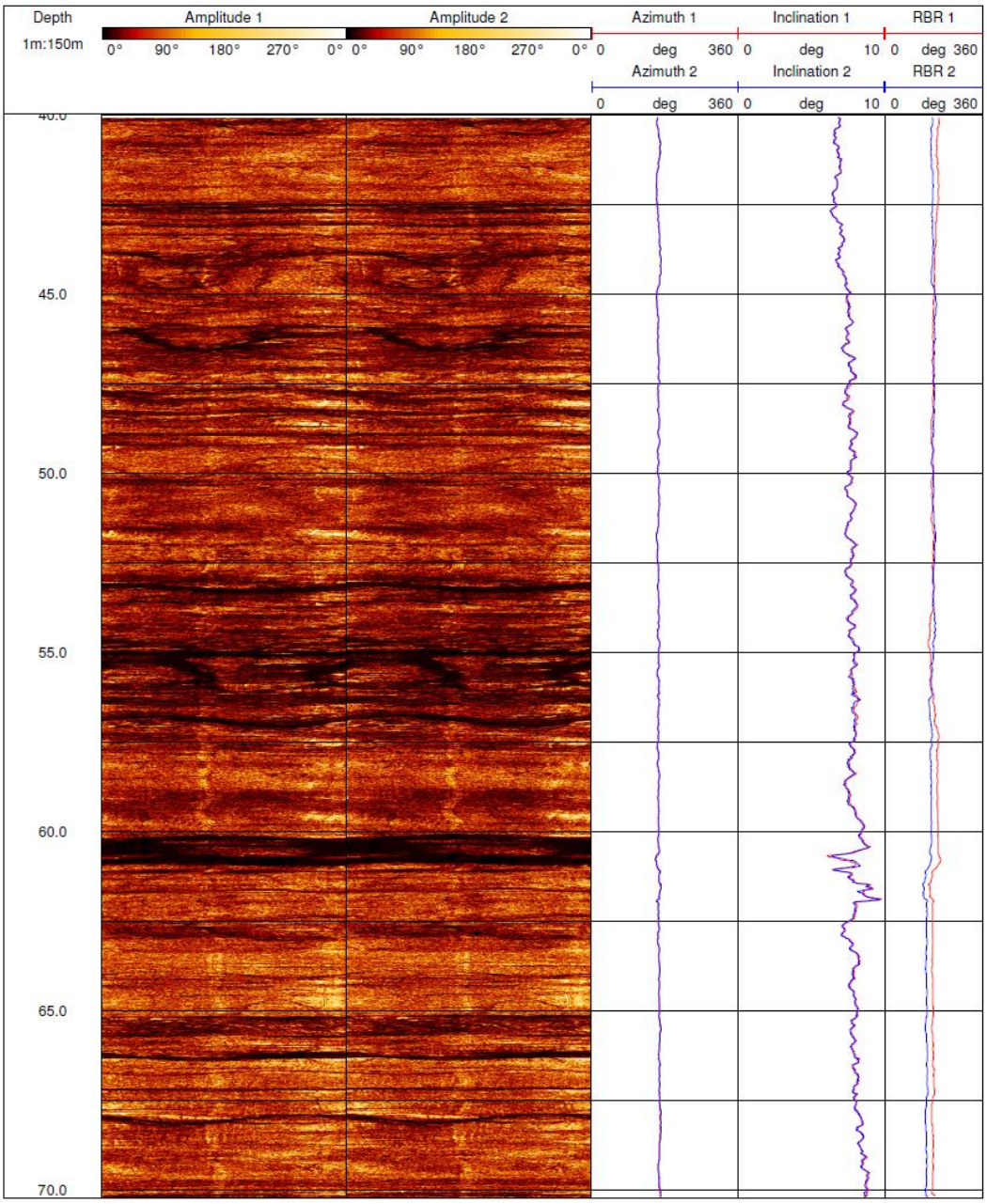
CERTIFICATE OF CONFORMITY

The probe detailed has been calibrated and then logged in the **ROBERTSON** GEO Test Borehole (Deganwy, UK). The resulting data falls within acceptable tolerances and meets all test criteria.

ROBERTSON GEO
Unlocking Your GeoData

Main Pass: 70-40m

Repeat Pass: 70-40m



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CERTIFICATE OF CONFORMITY

Certificate of Conformity

This is to certify that the following equipment conforms to the specification detailed below

ROBERTSON GEO
Unlocking Your GeoData

Equipment type: 3-Arm Caliper Probe (710mm range)

RG Order No: ORD00000

Serial No: 3ACS 001

Comm. Type: Standard 4-Core



Quality Management System:
ISO 9001:2015
Certified by TÜV SÜD

Tested by: T Hamflett

Date: 01/08/19

Approved by:

Tim Hamflett | *Test Engineer*

Date: 01/08/19

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ISO 9001
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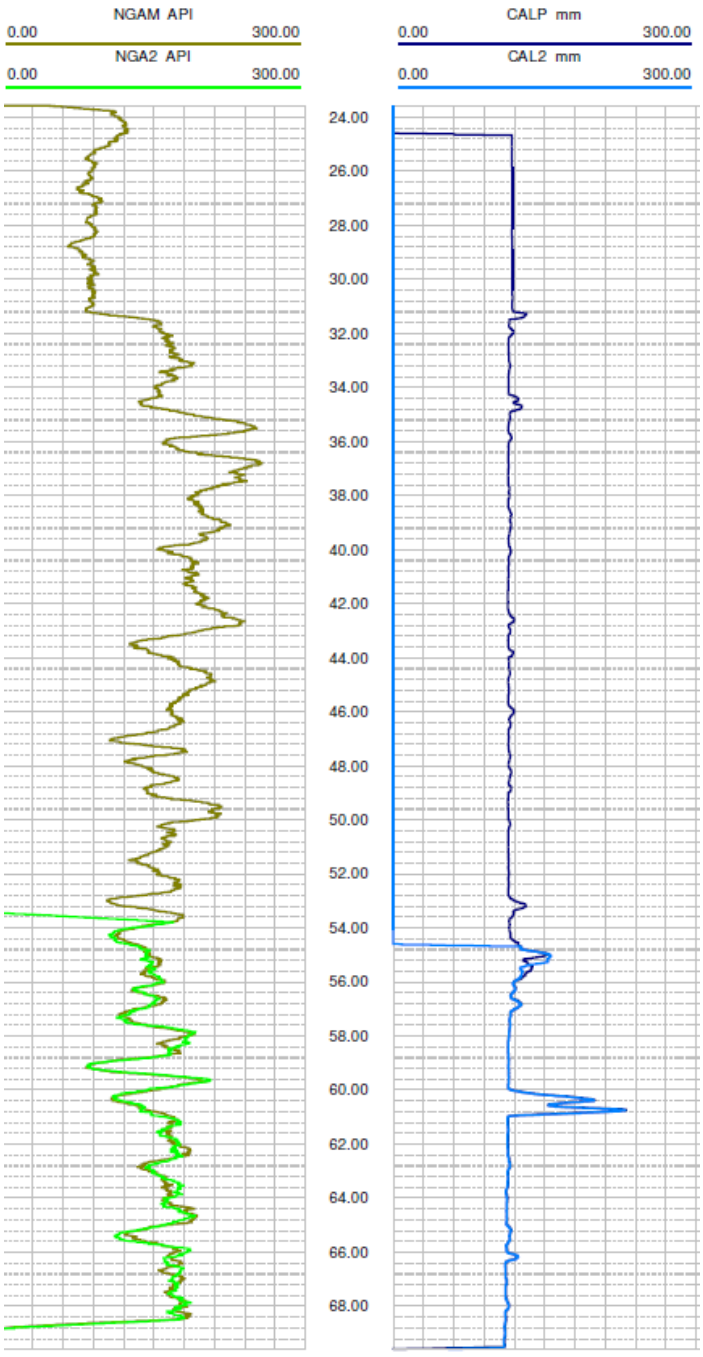
CERTIFICATE OF CONFORMITY

The probe detailed has been calibrated and then logged in the **ROBERTSON** GEO Test Borehole (Deganwy, UK). The resulting data falls within acceptable tolerances and meets all test criteria.

ROBERTSON GEO
Unlocking Your GeoData

Main Pass: 70-25m

Repeat Pass: 70-55m



Channel	x^n	Coefficient
1 NGAM	0	0.0
	1	1.16216
	2	0.0
	3	0.0
2 CALP	0	-193.713
	1	0.132413
	2	-4.43972E-6
	3	0.0
3	0	0.0
	1	1.0
	2	0.0
	3	0.0
4	0	0.0
	1	1.0
	2	0.0
	3	0.0
5	0	0.0
	1	1.0
	2	0.0
	3	0.0
6	0	0.0
	1	1.0
	2	0.0
	3	0.0
7	0	0.0
	1	1.0
	2	0.0
	3	0.0
8	0	0.0
	1	1.0
	2	0.0
	3	0.0
9	0	0.0
	1	1.0
	2	0.0
	3	0.0
10	0	0.0
	1	1.0
	2	0.0
	3	0.0
11	0	0.0
	1	1.0
	2	0.0
	3	0.0
12	0	0.0
	1	1.0
	2	0.0
	3	0.0

Calibrated Value=$ax^0+bx^1+cx^2+dx^3$

TÜV SÜD ISO 9001
ISO 9001
Certified Quality Management System
www.tuv-sud.com/ms-cert

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ROBERTSON GEO
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ROBERTSON GEO SERVICES
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CO Geotechnics
WELL BH108
FLD Crown Street
CTY Manchester
STE
FILING No

COMPANY Geotechnics
WELL ID BH108
FIELD Crown Street, Manchester
COUNTRY UK STATE

LOCATION
Crown Street, Manchester

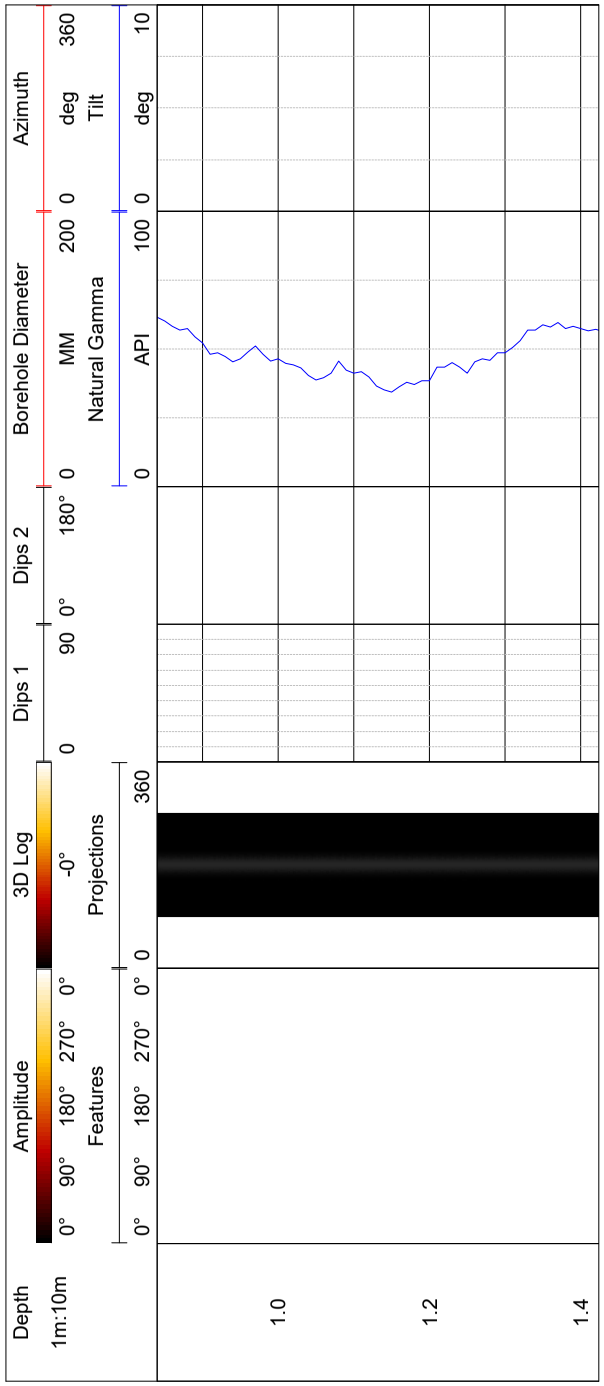
OTHER SERVICES

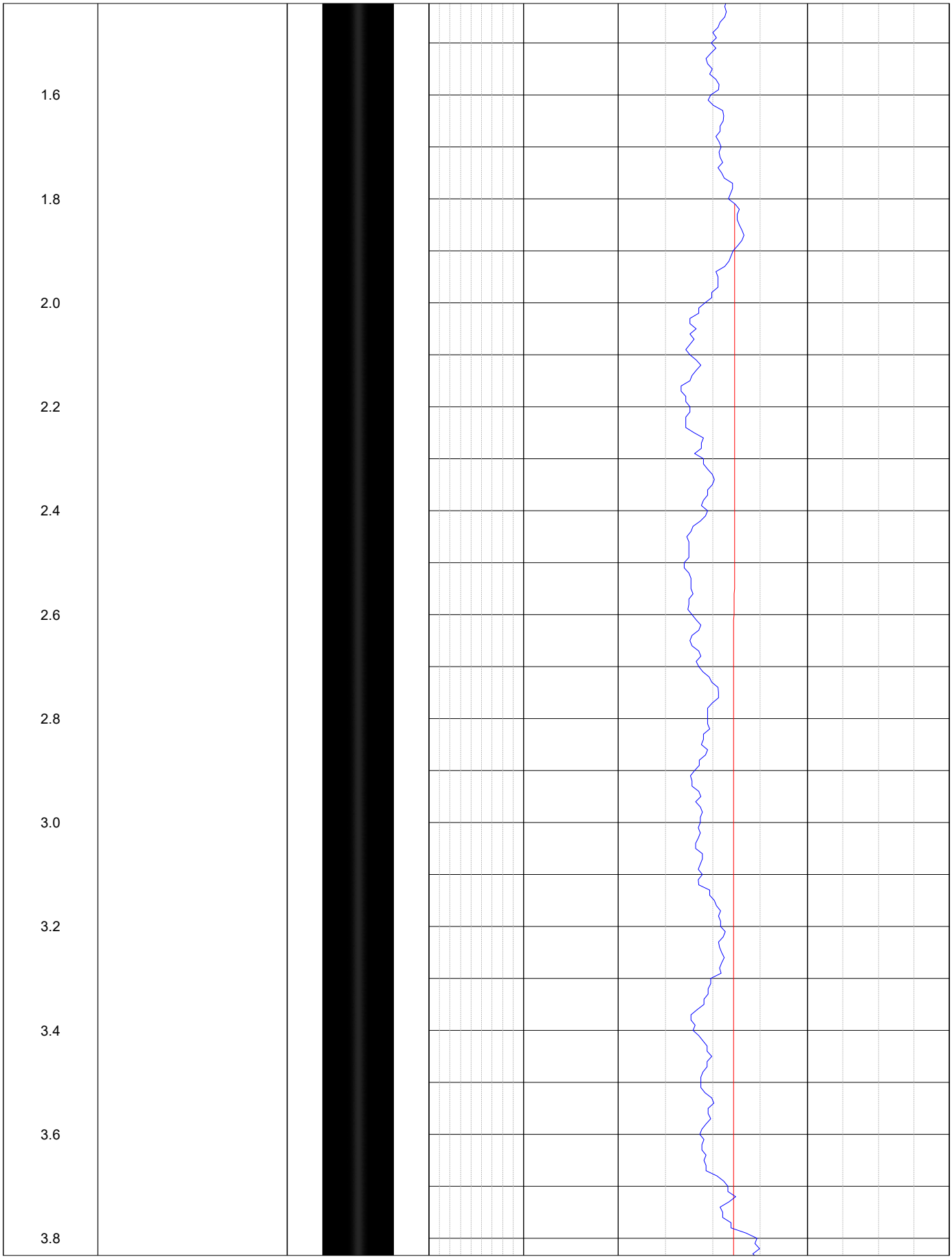
SEC TWP RGE

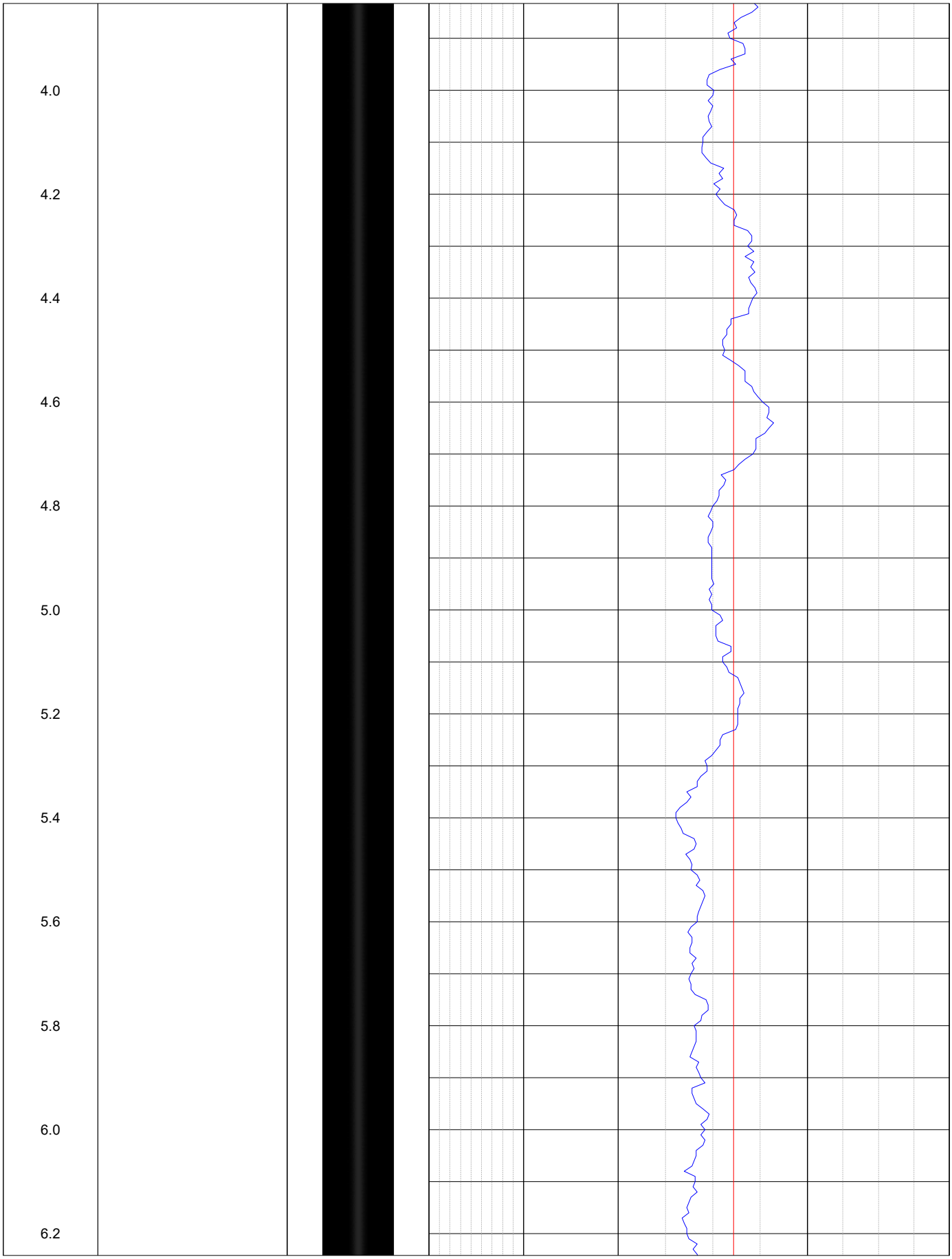
PERMANENT DATUM	GL	ELEVATION	K.B.
LOG MEAS. FROM	GL	ABOVE PERM. DATUM	D.F.
DRILLING MEAS. FROM	GL		G.L.

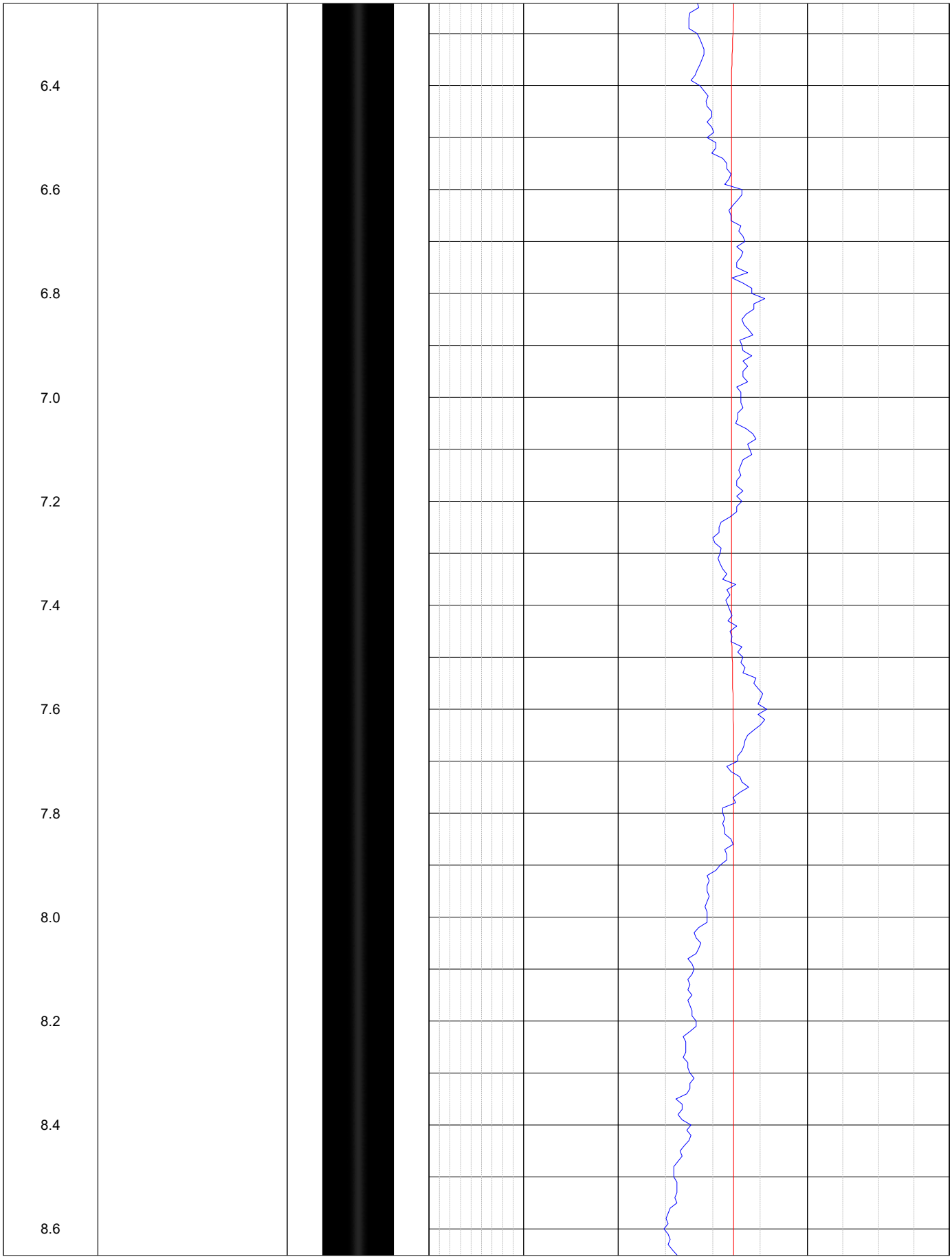
DATE	29/8/19	TYPE FLUID IN HOLE	
RUN No		SALINITY	
TYPE LOG		DENSITY	
DEPTH-DRILLER	35	LEVEL	
DEPTH-LOGGER	34.88	MAX. REC. TEMP.	
BTM LOGGED INTERVAL			
TOP LOGGED INTERVAL		CASING SHOE	
OPERATING RIG TIME			
RECORDED BY	RW		
WITNESSED BY			

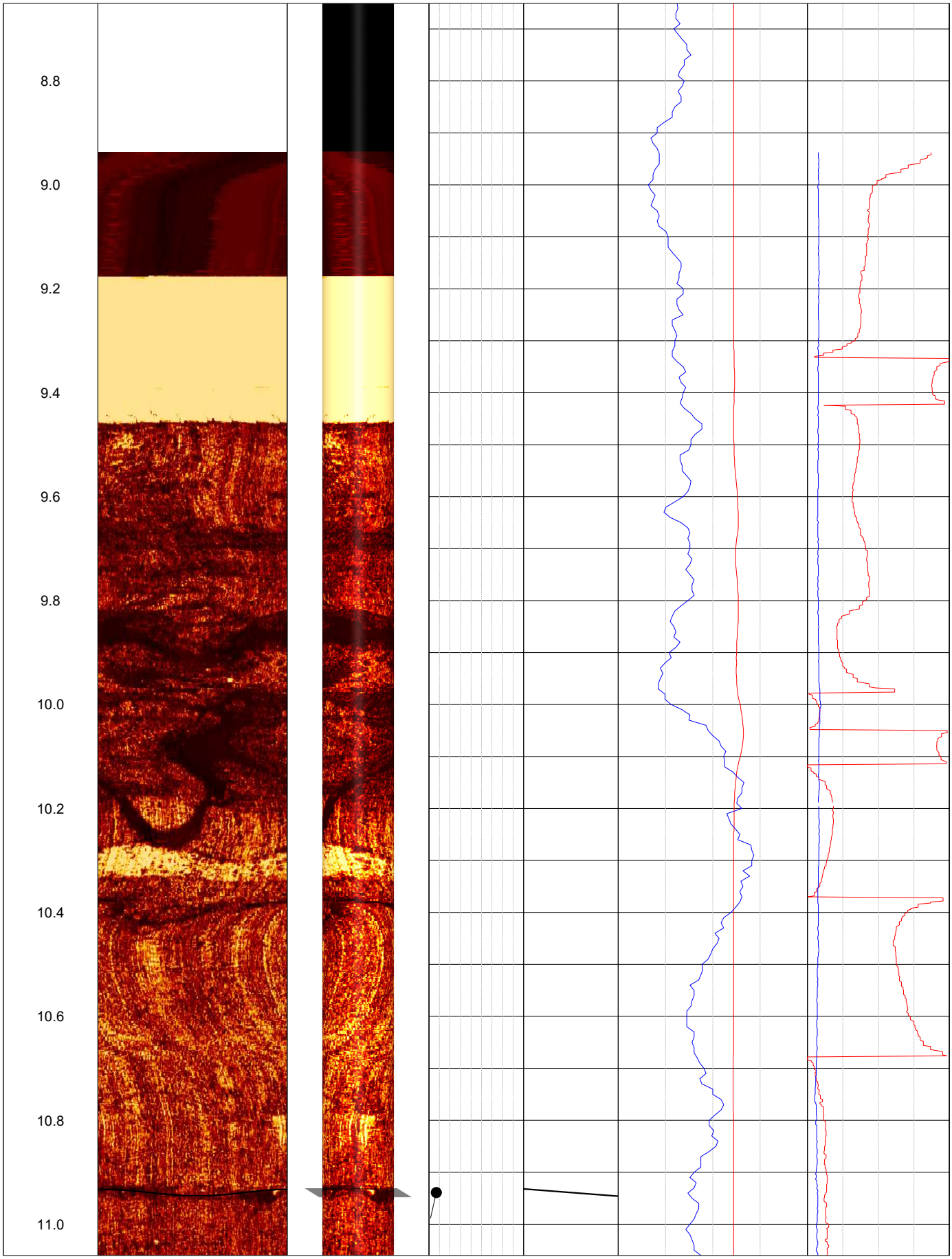
RUN	BOREHOLE RECORD			CASING RECORD			
NO.	BIT	FROM	TO	SIZE	WGT.	FROM	TO

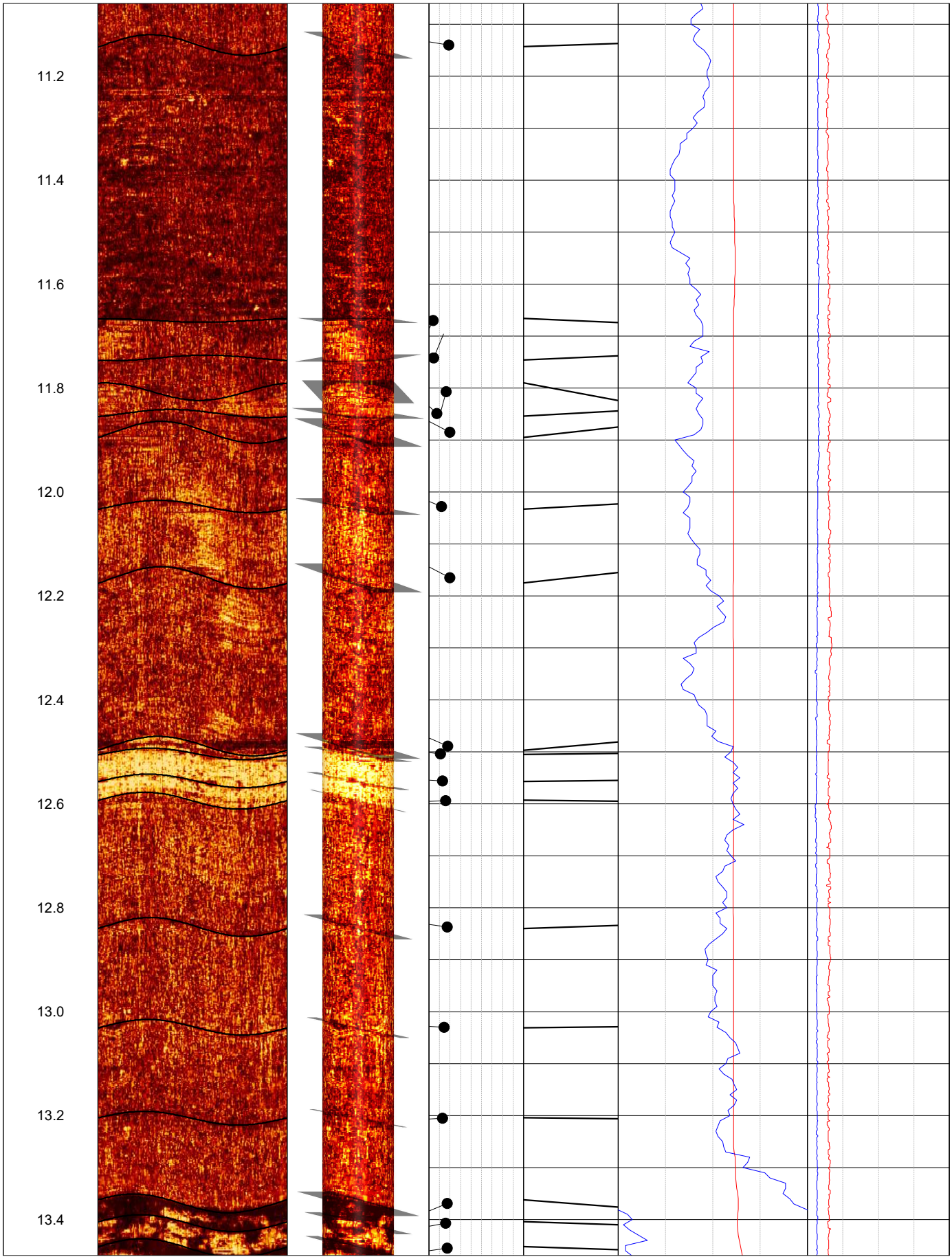


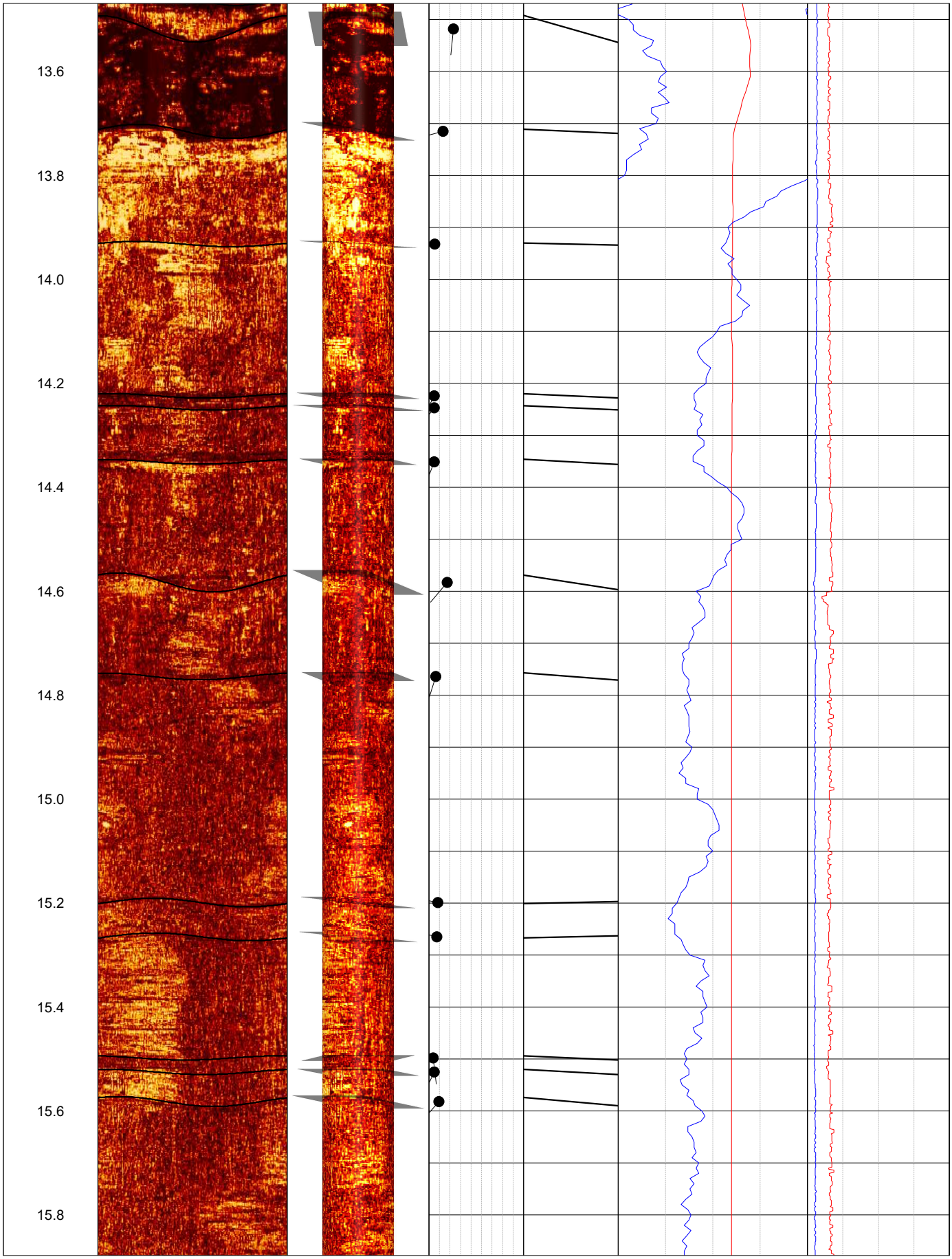

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3.8

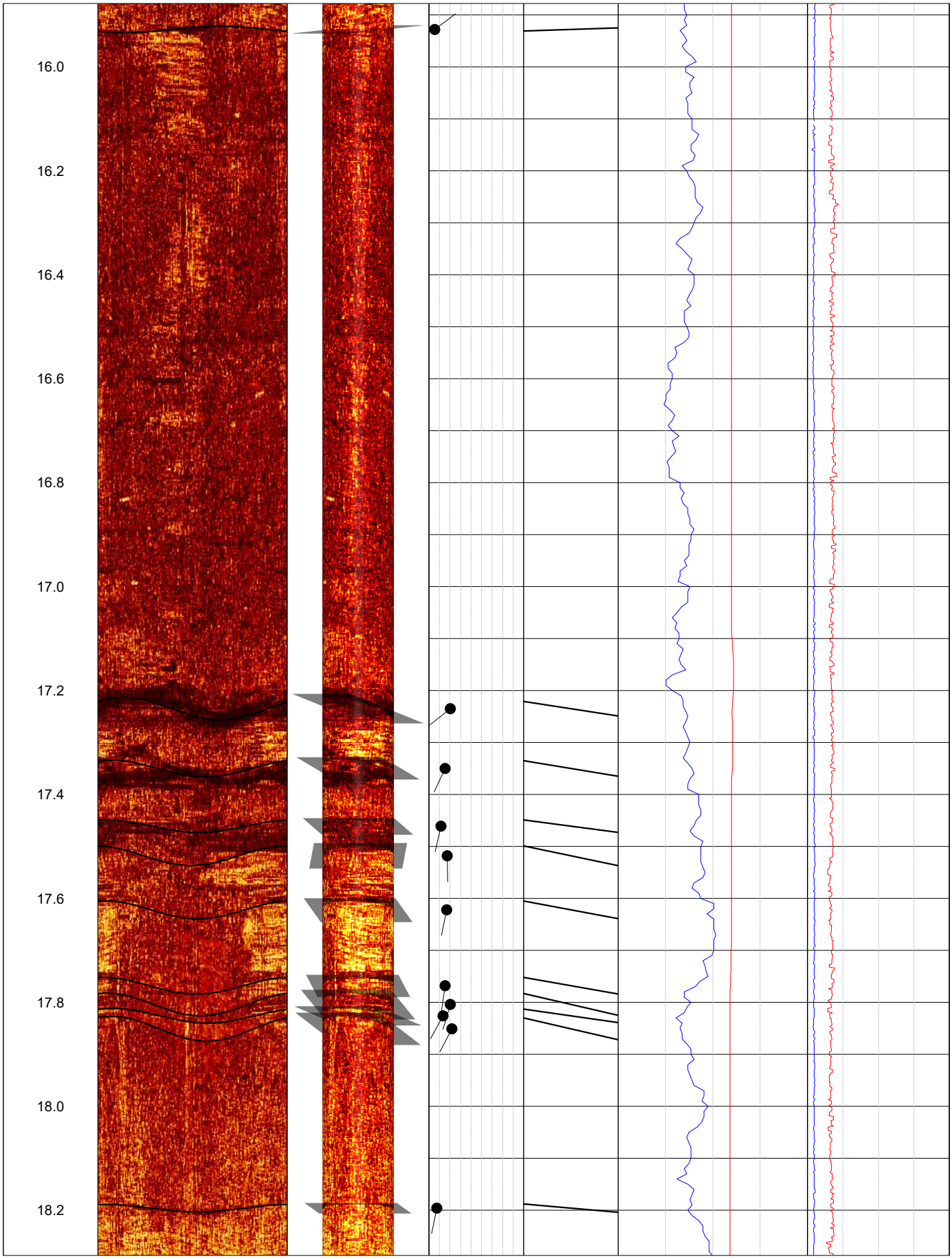

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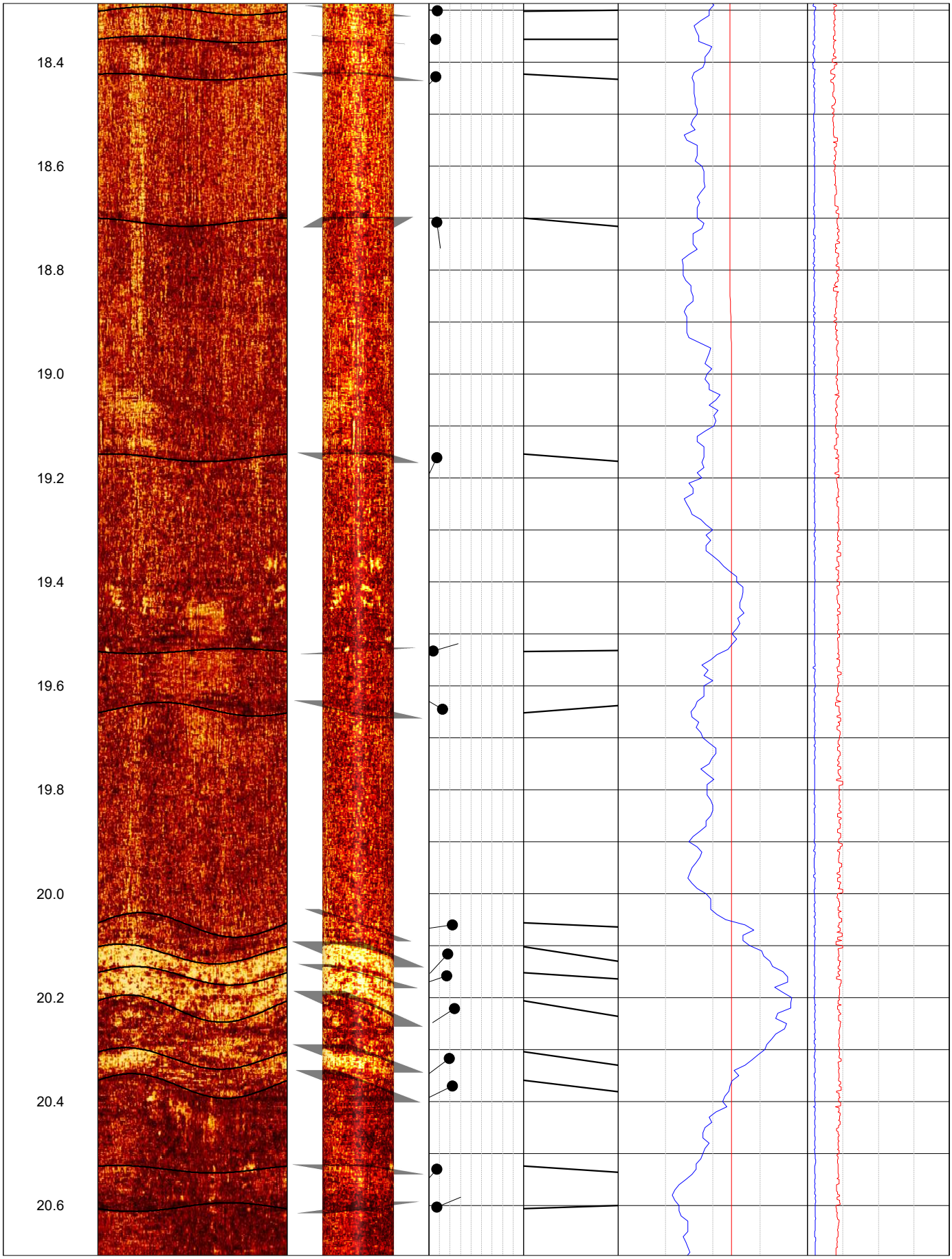

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8.6

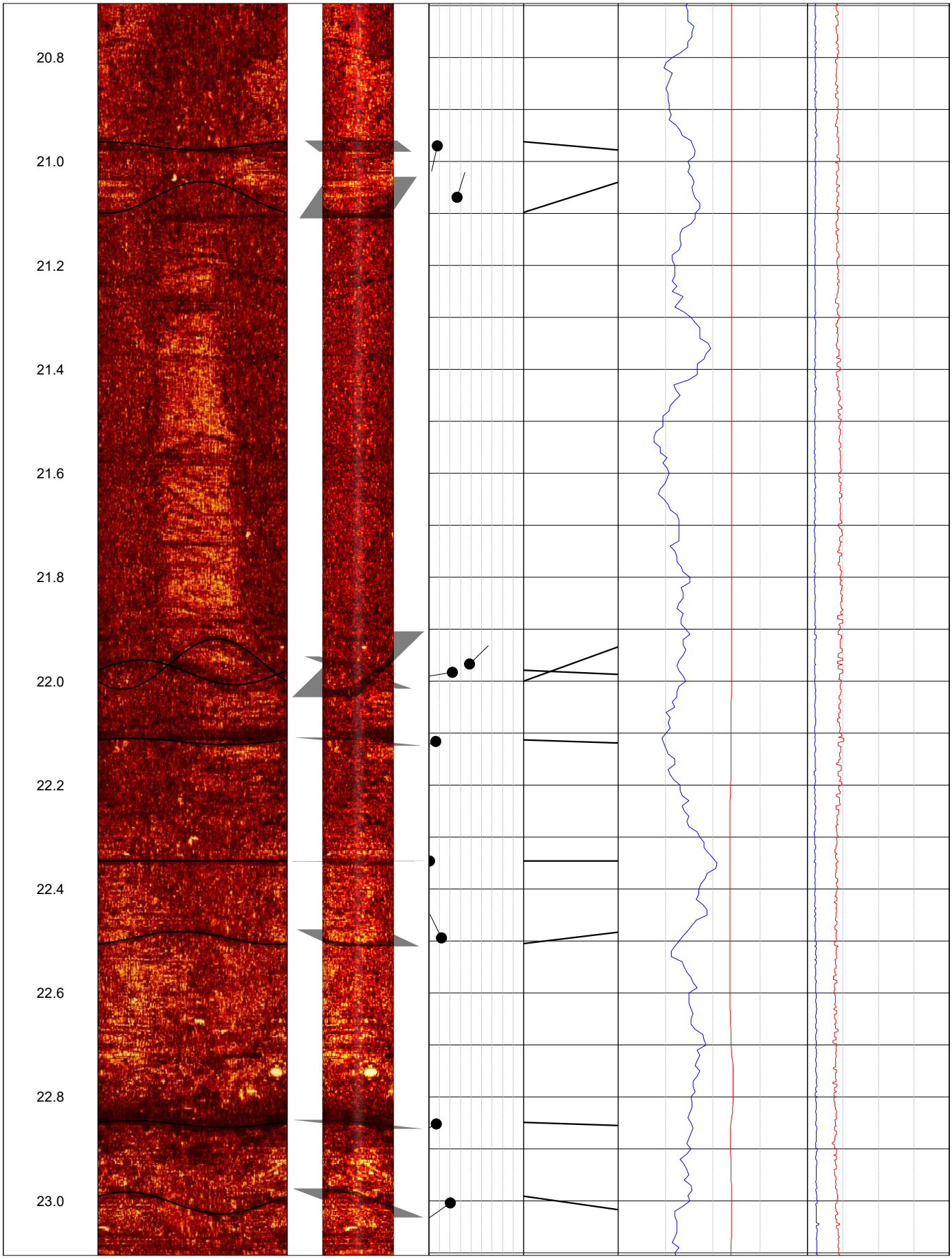

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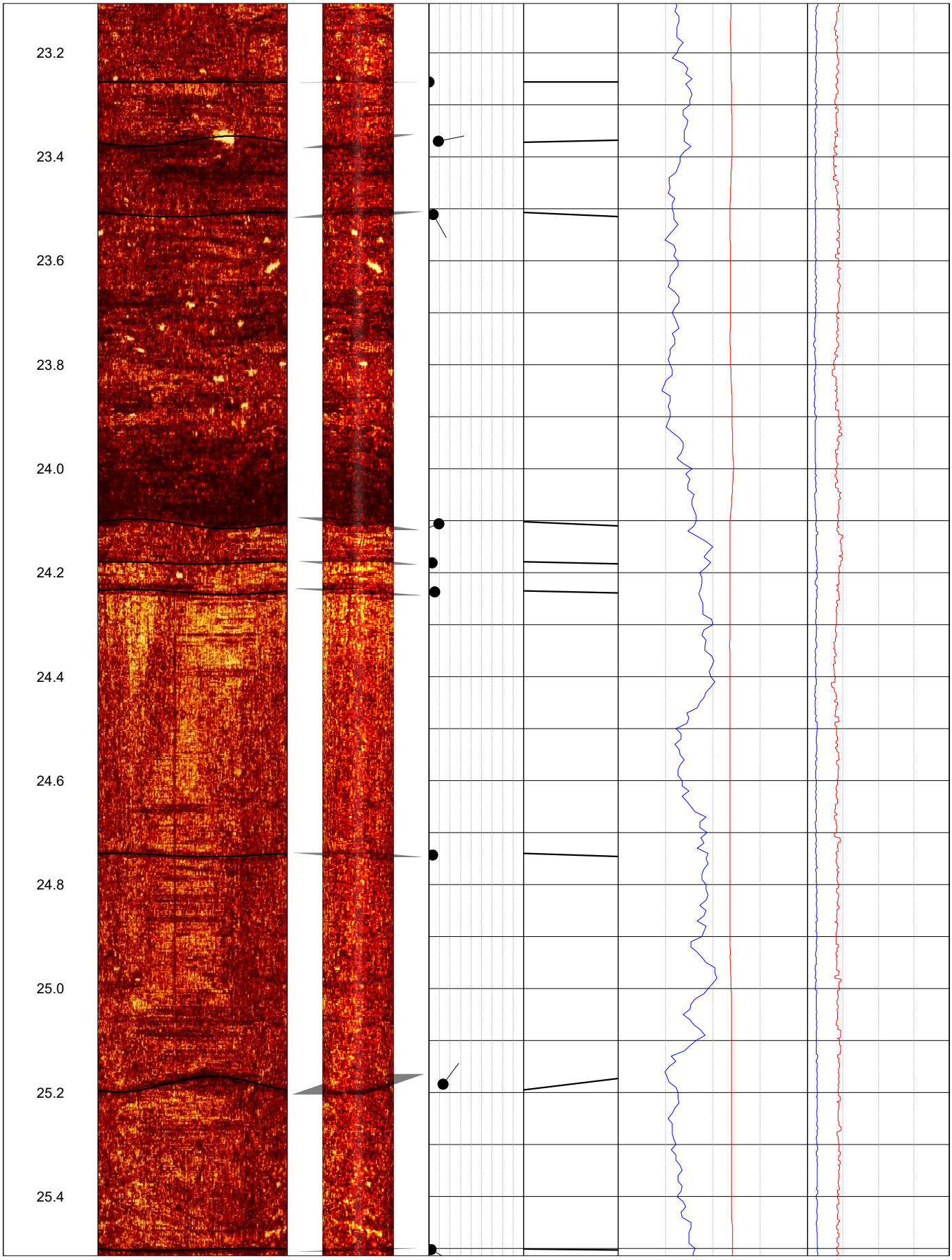

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13.4

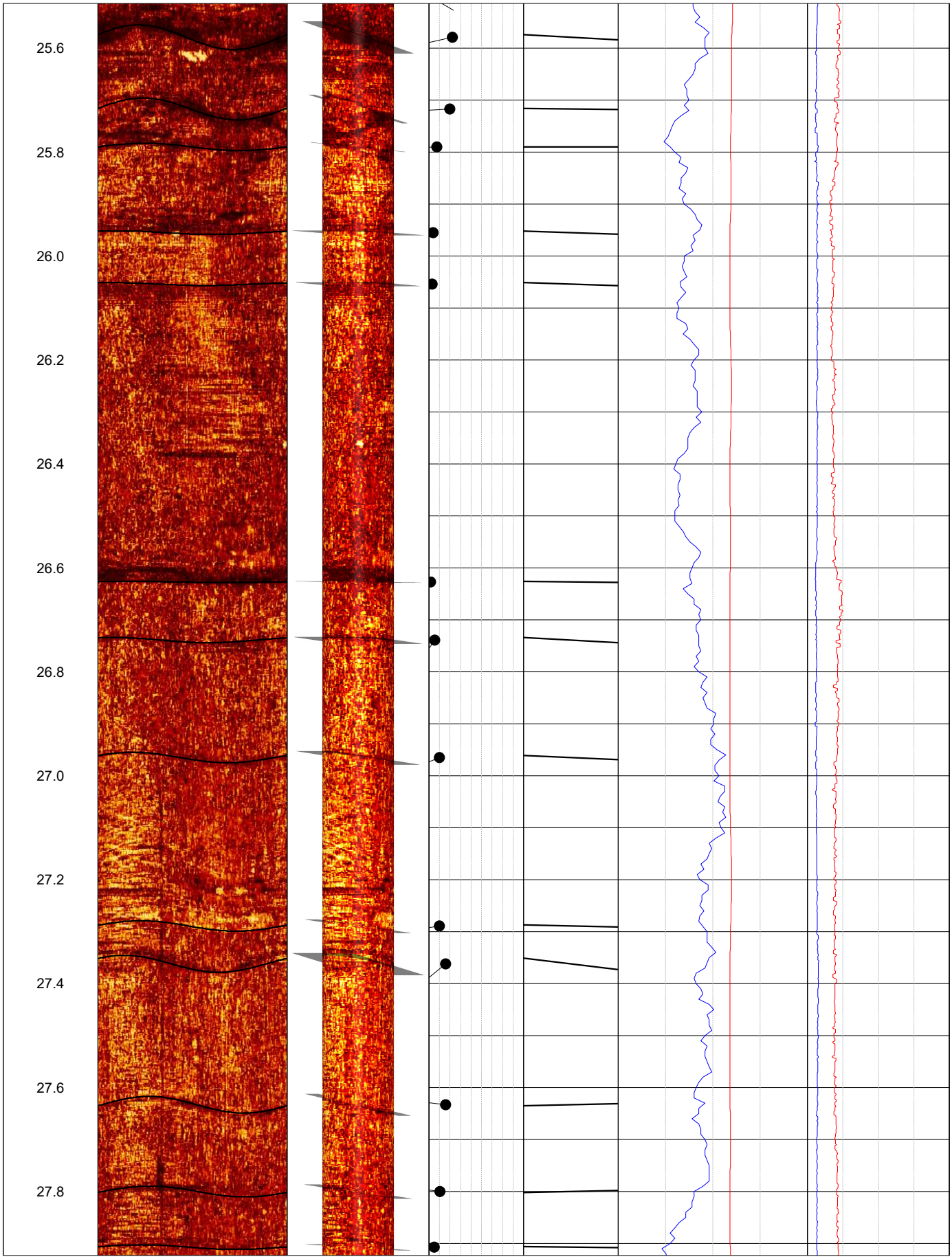

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15.8

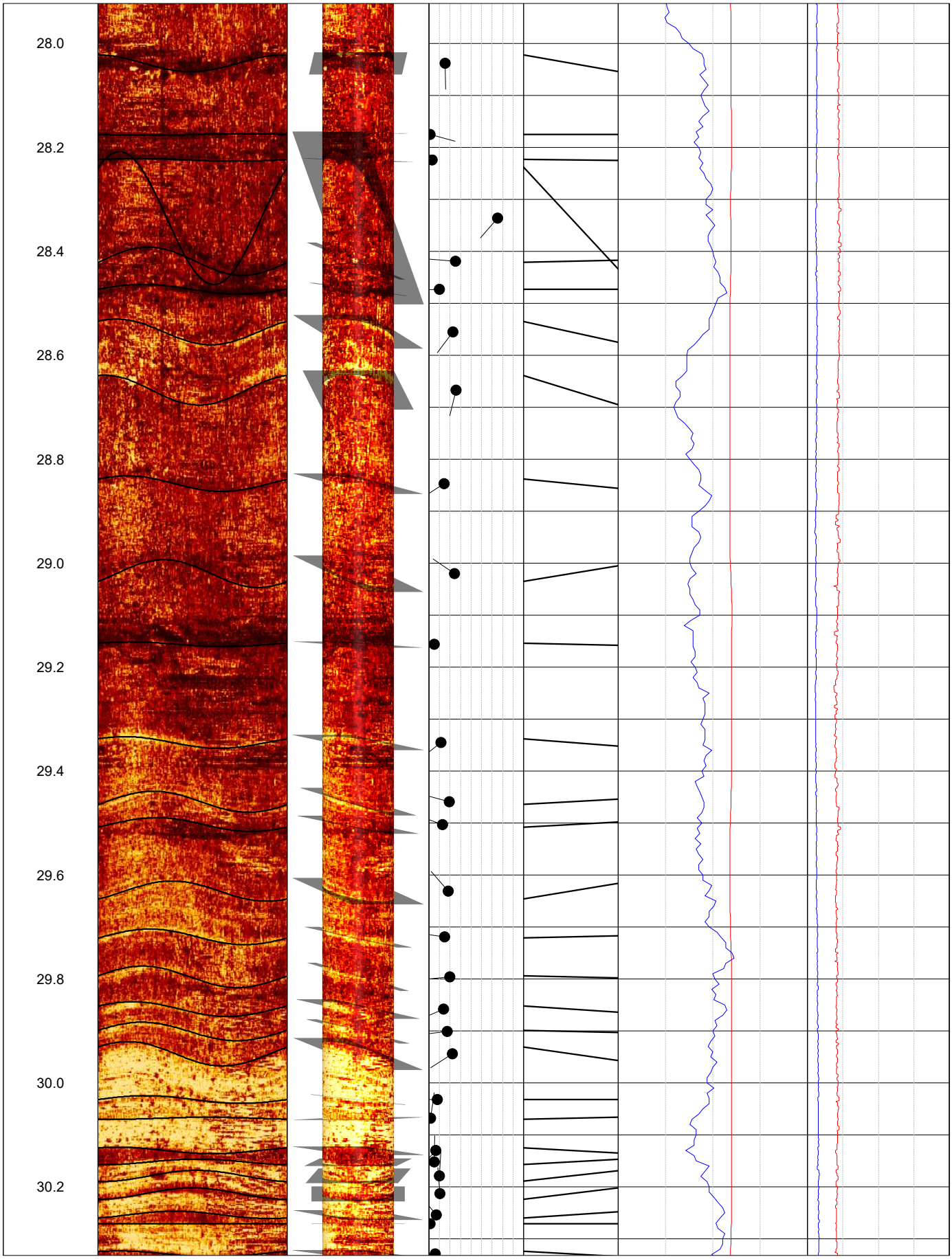

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18.2

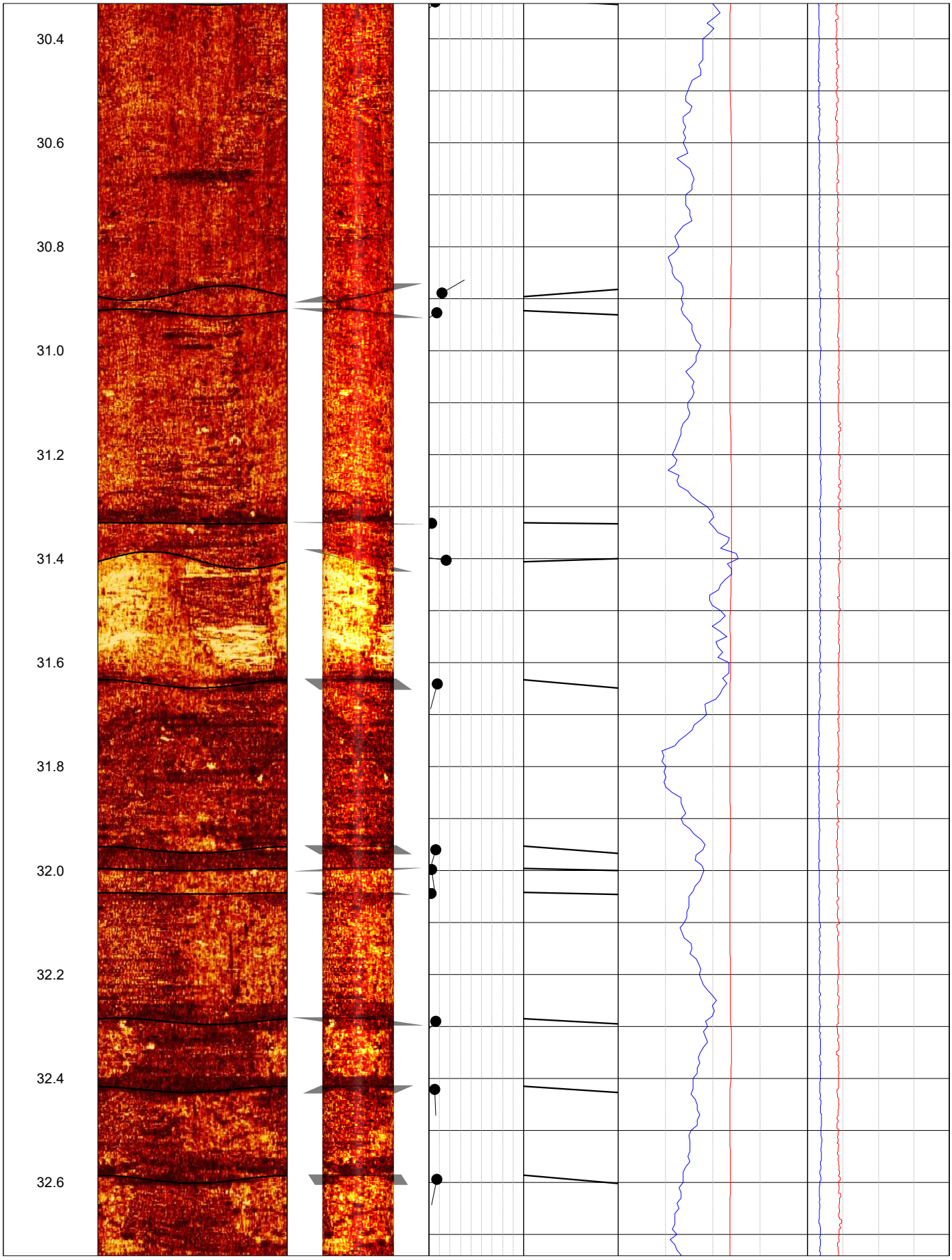

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20.2
20.4
20.6

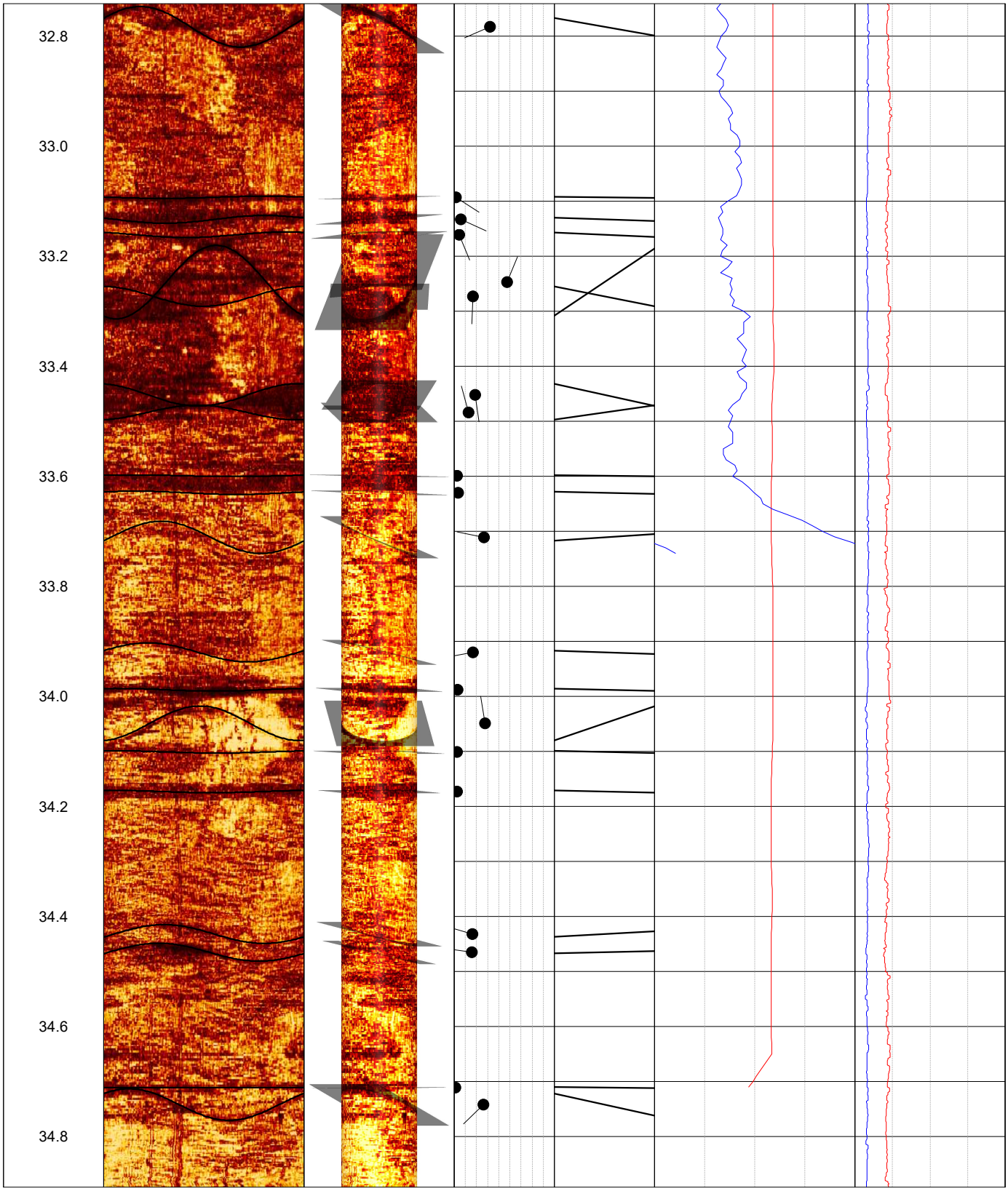

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23.2
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23.6
23.8
24.0
24.2
24.4
24.6
24.8
25.0
25.2
25.4


25.6
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27.8


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30.2


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31.4
31.6
31.8
32.0
32.2
32.4
32.6


32.8
33.0
33.2
33.4
33.6
33.8
34.0
34.2
34.4
34.6
34.8

CERTIFICATE OF CONFORMITY

Certificate of Conformity

This is to certify that the following equipment conforms to the specification detailed below

ROBERTSON GEO
Unlocking Your GeoData

Equipment type: High Resolution Acoustic Televiewer

RG Order No: ORD00000

Serial No: HiRAT 8465

Comm. Type: Standard 4-Core



Quality Management System:
ISO 9001:2015
Certified by TÜV SÜD

Tested by: T Hamflett

Date: 01/08/19

Approved by:

Tim Hamflett | *Test Engineer*

Date: 01/08/19

ISO 9001
Certified
Quality Management System
www.tuv-sud.com/ms-cert

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www.robertson-geo.com

ROBERTSON GEO
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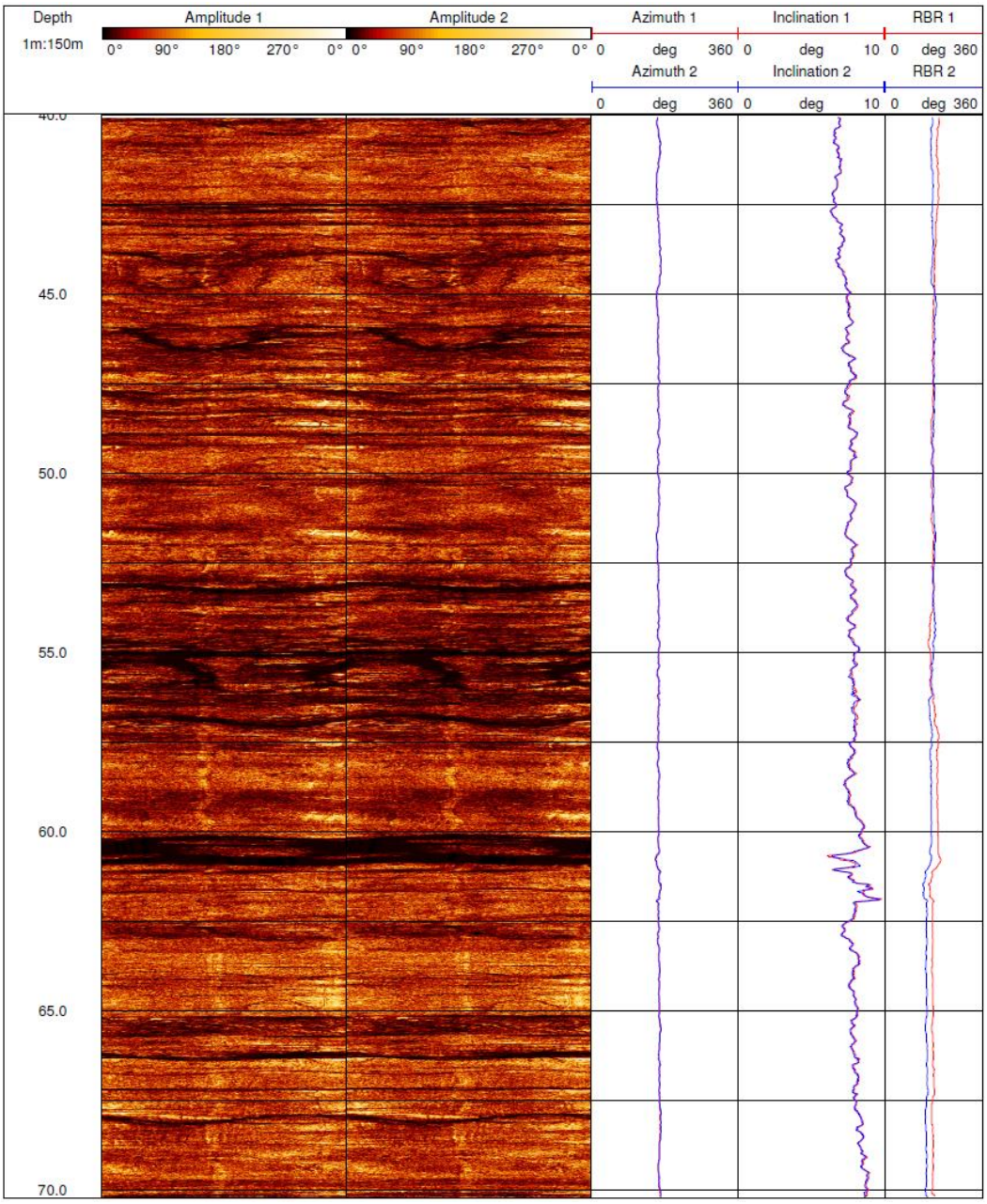
CERTIFICATE OF CONFORMITY

The probe detailed has been calibrated and then logged in the **ROBERTSON** GEO Test Borehole (Deganwy, UK). The resulting data falls within acceptable tolerances and meets all test criteria.

ROBERTSON GEO
Unlocking Your GeoData

Main Pass: 70-40m

Repeat Pass: 70-40m



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ROBERTSON GEO
Unlocking Your GeoData

CERTIFICATE OF CONFORMITY

Certificate of Conformity

This is to certify that the following equipment conforms to the specification detailed below

ROBERTSON GEO
Unlocking Your GeoData

Equipment type: 3-Arm Caliper Probe (710mm range)

RG Order No: ORD00000

Serial No: 3ACS 001

Comm. Type: Standard 4-Core



Quality Management System:
ISO 9001:2015
Certified by TÜV SÜD

Tested by: T Hamflett

Date: 01/08/19

Approved by:

Tim Hamflett | *Test Engineer*

Date: 01/08/19

TÜV SÜD ISO 9001
ISO 9001
Certified
Quality Management System
www.tuv-sud.com/ms-cert

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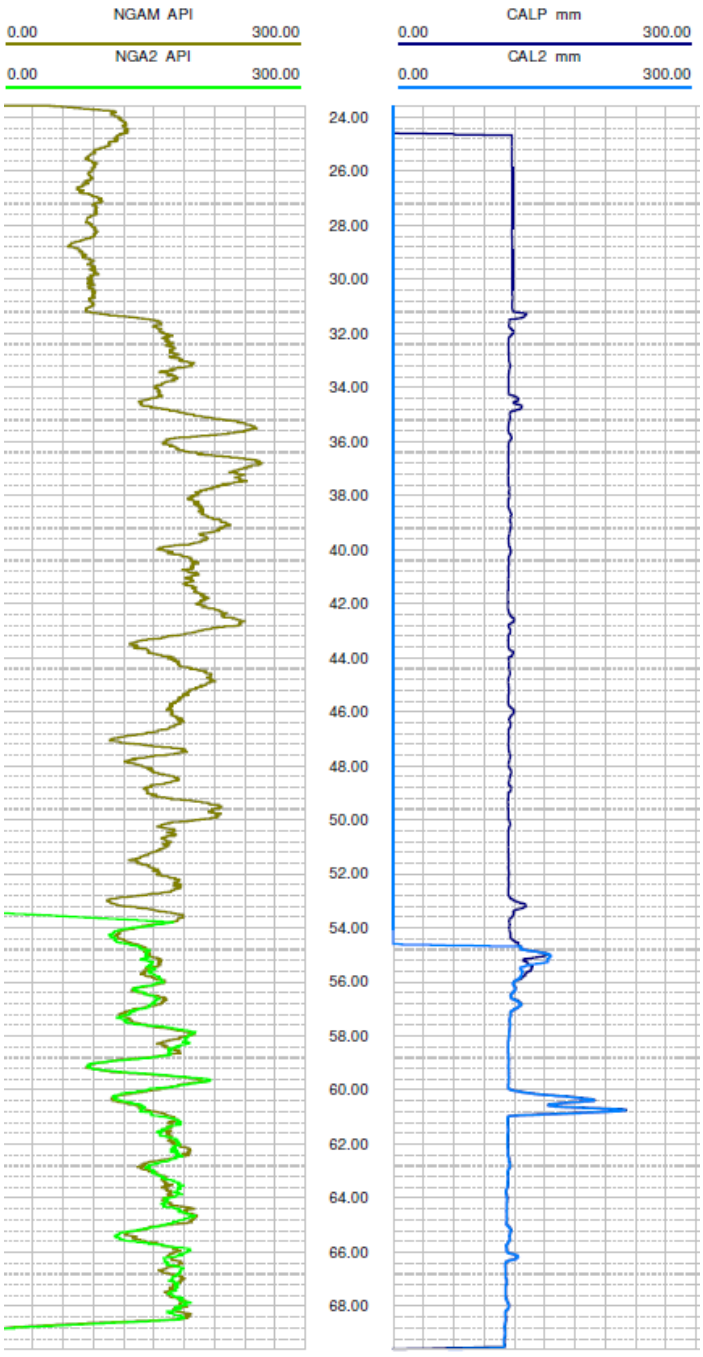
CERTIFICATE OF CONFORMITY

The probe detailed has been calibrated and then logged in the **ROBERTSON** GEO Test Borehole (Deganwy, UK). The resulting data falls within acceptable tolerances and meets all test criteria.

ROBERTSON GEO
Unlocking Your GeoData

Main Pass: 70-25m

Repeat Pass: 70-55m



Channel	x^n	Coefficient
1 NGAM	0	0.0
	1	1.16216
	2	0.0
	3	0.0
2 CALP	0	-193.713
	1	0.132413
	2	-4.43972E-6
	3	0.0
3	0	0.0
	1	1.0
	2	0.0
	3	0.0
4	0	0.0
	1	1.0
	2	0.0
	3	0.0
5	0	0.0
	1	1.0
	2	0.0
	3	0.0
6	0	0.0
	1	1.0
	2	0.0
	3	0.0
7	0	0.0
	1	1.0
	2	0.0
	3	0.0
8	0	0.0
	1	1.0
	2	0.0
	3	0.0
9	0	0.0
	1	1.0
	2	0.0
	3	0.0
10	0	0.0
	1	1.0
	2	0.0
	3	0.0
11	0	0.0
	1	1.0
	2	0.0
	3	0.0
12	0	0.0
	1	1.0
	2	0.0
	3	0.0

Calibrated Value=$ax^0+bx^1+cx^2+dx^3$

TÜV SÜD ISO 9001
ISO 9001
Certified Quality Management System
www.tuv-sud.com/ms-cert

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ROBERTSON GEO
Unlocking Your GeoData

APPENDIX 6

Monitoring Results

FIELDWORK – *Water Level Monitoring*

Project CROWN STREET ZONE 2

Project No PN194002

Client WSP UK LIMITED

Sheet No 1

Borehole		BH101		BH103		BH104		BH107		BH108		BH109	
Instrument (dia. mm)		G (50mm)		G (50mm)		G (50mm)		G (50mm)		G (50mm)		G (50mm)	
Depth to Base (m)		20.00		3.00		3.00		15.00		20.00		3.00	
Filter Zone (m)		9.00-20.00		0.50-3.00		0.50-3.00		10.00-15.00		8.50-20.00		0.50-3.00	
Level		33.42 m OD		33.23 m OD		33.22 m OD		33.20 m OD		32.77 m OD		33.20 m OD	
Date	Time	Depth (m)	Level	Depth (m)	Level	Depth (m)	Level	Depth (m)	Level	Depth (m)	Level	Depth (m)	Level
27 Sep 2019		N/A		1.50	*31.73*	N/A		N/A		8.75	*24.02*	N/A	
16 Oct 2019		N/A		N/A		N/A		N/A		N/A		N/A	
29 Oct 2019		9.93	*23.49*	2.48	*30.75*	DRY		N/A		N/A		2.72	*30.48*
12 Nov 2019		N/A		N/A		2.12	*31.10*	N/A		8.60	*24.17*	N/A	
25 Nov 2019		9.60	*23.82*	2.54	*30.69*	1.60	*31.62*	9.40	*23.80*	8.50	*24.27*	0.40	*32.80*
9 Dec 2019		9.82	*23.60*	2.62	*30.61*	2.52	*30.70*	6.60	*26.60*	5.88	*26.89*	2.71	*30.49*
16 Dec 2019		9.54	*23.88*	2.65	*30.58*	2.63	*30.59*	9.50	*23.70*	8.92	*23.85*	N/A	

Remarks

Symbols and abbreviations are explained on the accompanying key sheet.

All dimensions are in metres.

GEOTECHNICS
geotechnical and geoenvironmental specialists

FIELDWORK - *Insitu Gas Monitoring - Daily Record*

Project **CROWN STREET ZONE 2**

Project No **PN194002**
Date **27/09/2019**

Client **WSP UK LIMITED**

Sheet No. **1 (1 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other **Gas Data LMSxi gas analyser;**

Weather / Site Conditions

Wind	Still ☐	Light ☐	Moderate ☐	Strong ☐
Cloud Cover	None ☐	Slight ☐	Cloudy ☐	Overcast ☐
Precipitation	Dry ☐	Slight ☐	Moderate ☐	Heavy ☐

Borehole	Depth to Base (m)	Depth to Water (m bgl)	Water Sample Taken (Yes/No)	Methane (Peak) CH4 (% VOL)	Methane (Steady) CH4 (% VOL)	Methane (Peak) CH4 (% LEL)	Methane (Steady) CH4 (% LEL)	Carbon Dioxide (Peak) (% VOL)	Remarks
BH101	20.00	N/A							No access to location.
BH103	3.00	1.50	No	0.0	0.0	0.0	0.0	1.3	
BH104	3.00	N/A							No access to location.
BH107	15.00	N/A							No access to location.
BH108	20.00	8.75	No	0.0	0.0	0.0	0.0	0.4	
BH109	3.00	N/A							No access to location.

Remarks

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FIELDWORK - *Insitu Gas Monitoring - Daily Record*

Project **CROWN STREET ZONE 2**

Client **WSP UK LIMITED**

Project No **PN194002**
Date **27/09/2019**
Sheet No. **1 (2 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other **Gas Data LMSxi gas analyser;**

Weather / Site Conditions

Wind Still ☐ Light ☐ Moderate ☐ Strong ☐

Cloud Cover None ☐ Slight ☐ Cloudy ☐ Overcast ☐

Precipitation Dry ☐ Slight ☐ Moderate ☐ Heavy ☐

Borehole	Depth to Base (m)	Carbon Dioxide (Steady) (% VOL)	Oxygen (Peak) (% VOL)	Oxygen (Steady) (% VOL)	Nitrogen (Peak) N2 (% VOL)	Nitrogen (Steady) N2 (% VOL)	Hydrogen Sulphide (Peak) (ppm)	Hydrogen Sulphide (Steady) (ppm)	Remarks
BH101	**20.00**								**No access to location.**
BH103	**3.00**	**0.1**	**11.3**	**19.7**	**87.4**	**80.2**	**0**	**0**	
BH104	**3.00**								**No access to location.**
BH107	**15.00**								**No access to location.**
BH108	**20.00**	**1.3**	**19.7**	**21.2**	**79.9**	**77.5**	**0**	**0**	
BH109	**3.00**								**No access to location.**

Remarks

geotechnics

FIELDWORK - *Insitu Gas Monitoring - Daily Record*

Project **CROWN STREET ZONE 2**

Client **WSP UK LIMITED**

Project No **PN194002**
Date **27/09/2019**
Sheet No. **1 (3 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other **Gas Data LMSxi gas analyser;**

Weather / Site Conditions

Wind	Still ☐	Light ☐	Moderate ☐	Strong ☐
Cloud Cover	None ☐	Slight ☐	Cloudy ☐	Overcast ☐
Precipitation	Dry ☐	Slight ☐	Moderate ☐	Heavy ☐

Borehole	Depth to Base (m)	Carbon Monoxide (Peak) (ppm)	Carbon Monoxide (Steady) (ppm)	Flow Rate (Peak) (l/hr)	Flow Rate (Steady) (l/hr)	Barometric Pressure (mBars)	Wind ()	Cloud ()	Remarks
BH101	**20.00**								**No access to location.**
BH103	**3.00**	**0**	**0**	**0.0**	**0.0**	**997**	**Light**	**Cloudy**	
BH104	**3.00**								**No access to location.**
BH107	**15.00**								**No access to location.**
BH108	**20.00**	**0**	**0**	**0.0**	**0.0**	**997**	**Light**	**Cloudy**	
BH109	**3.00**								**No access to location.**

Remarks

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FIELDWORK - *Insitu Gas Monitoring - Daily Record*

Project **CROWN STREET ZONE 2**

Client **WSP UK LIMITED**

Project No **PN194002**
Date **27/09/2019**
Sheet No. **1 (4 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other **Gas Data LMSxi gas analyser;**

Weather / Site Conditions

Wind	Still ☐	Light ☐	Moderate ☐	Strong ☐
Cloud Cover	None ☐	Slight ☐	Cloudy ☐	Overcast ☐
Precipitation	Dry ☐	Slight ☐	Moderate ☐	Heavy ☐

Borehole	Depth to Base (m)	Rain ()	Equipment Used ()	Monitored by ()	Remarks
BH101	**20.00**				**No access to location.**
BH103	**3.00**	**Heavy**	**Gas Data LMSxi**	**AL**	
BH104	**3.00**				**No access to location.**
BH107	**15.00**				**No access to location.**
BH108	**20.00**	**Heavy**	**Gas Data LMSxi**	**AL**	
BH109	**3.00**				**No access to location.**

Remarks

geotechnics

FIELDWORK - *Insitu Gas Monitoring - Daily Record*

Project **CROWN STREET ZONE 2**

Client **WSP UK LIMITED**

Project No **PN194002**

Date **16/10/2019**

Sheet No. **1 (1 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other

Weather / Site Conditions

Wind Still ☐ Light ☐ Moderate ☐ Strong ☐

Cloud Cover None ☐ Slight ☐ Cloudy ☐ Overcast ☐

Precipitation Dry ☐ Slight ☐ Moderate ☐ Heavy ☐

Borehole	Depth to Base (m)	Depth to Water (m bgl)	Water Sample Taken (Yes/No)	Methane (Peak) CH4 (% VOL)	Methane (Steady) CH4 (% VOL)	Methane (Peak) CH4 (% LEL)	Methane (Steady) CH4 (% LEL)	Carbon Dioxide (Peak) (% VOL)	Remarks
BH101	**20.00**	**N/A**							**No access to location.**
BH103	**3.00**	**N/A**							**No access to location.**
BH104	**3.00**	**N/A**							**No access to location.**
BH107	**15.00**	**N/A**							**No access to location.**
BH108	**20.00**	**N/A**							**No access to location.**
BH109	**3.00**	**N/A**							**No access to location.**

Remarks

geotechnics

FIELDWORK - *Insitu Gas Monitoring - Daily Record*

Project **CROWN STREET ZONE 2**

Client **WSP UK LIMITED**

Project No **PN194002**

Date **16/10/2019**

Sheet No. **1 (2 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other

Weather / Site Conditions

Wind	Still ☐	Light ☐	Moderate ☐	Strong ☐
Cloud Cover	None ☐	Slight ☐	Cloudy ☐	Overcast ☐
Precipitation	Dry ☐	Slight ☐	Moderate ☐	Heavy ☐

Borehole	Depth to Base (m)	Carbon Dioxide (Steady) (% VOL)	Oxygen (Peak) (% VOL)	Oxygen (Steady) (% VOL)	Nitrogen (Peak) N2 (% VOL)	Nitrogen (Steady) N2 (% VOL)	Hydrogen Sulphide (Peak) (ppm)	Hydrogen Sulphide (Steady) (ppm)	Remarks
BH101	**20.00**								**No access to location.**
BH103	**3.00**								**No access to location.**
BH104	**3.00**								**No access to location.**
BH107	**15.00**								**No access to location.**
BH108	**20.00**								**No access to location.**
BH109	**3.00**								**No access to location.**

Remarks

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FIELDWORK - *Insitu Gas Monitoring - Daily Record*

Project **CROWN STREET ZONE 2**

Client **WSP UK LIMITED**

Project No **PN194002**

Date **16/10/2019**

Sheet No. **1 (3 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other

Weather / Site Conditions

Wind Still ☐ Light ☐ Moderate ☐ Strong ☐

Cloud Cover None ☐ Slight ☐ Cloudy ☐ Overcast ☐

Precipitation Dry ☐ Slight ☐ Moderate ☐ Heavy ☐

Borehole	Depth to Base (m)	Carbon Monoxide (Peak) (ppm)	Carbon Monoxide (Steady) (ppm)	Flow Rate (Peak) (l/hr)	Flow Rate (Steady) (l/hr)	Barometric Pressure (mBars)	Wind ()	Cloud ()	Remarks
BH101	**20.00**								**No access to location.**
BH103	**3.00**								**No access to location.**
BH104	**3.00**								**No access to location.**
BH107	**15.00**								**No access to location.**
BH108	**20.00**								**No access to location.**
BH109	**3.00**								**No access to location.**

Remarks

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FIELDWORK - *Insitu Gas Monitoring - Daily Record*

Project **CROWN STREET ZONE 2**

Client **WSP UK LIMITED**

Project No **PN194002**
Date **16/10/2019**
Sheet No. **1 (4 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other

Weather / Site Conditions

Wind	Still ☐	Light ☐	Moderate ☐	Strong ☐
Cloud Cover	None ☐	Slight ☐	Cloudy ☐	Overcast ☐
Precipitation	Dry ☐	Slight ☐	Moderate ☐	Heavy ☐

Borehole	Depth to Base (m)	Rain ()	Equipment Used ()	Monitored by ()	Remarks
BH101	**20.00**				**No access to location.**
BH103	**3.00**				**No access to location.**
BH104	**3.00**				**No access to location.**
BH107	**15.00**				**No access to location.**
BH108	**20.00**				**No access to location.**
BH109	**3.00**				**No access to location.**

Remarks

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FIELDWORK - Insitu Gas Monitoring - Daily Record

Project **CROWN STREET ZONE 2**

Project No **PN194002**
Date **29/10/2019**

Client **WSP UK LIMITED**

Sheet No. **1 (1 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other **GA5000;**

Weather / Site Conditions

Wind	Still	☐	Light	x	Moderate	☐	Strong ☐
Cloud Cover	None	☐	Slight	x	Cloudy	☐	Overcast ☐
Precipitation	Dry	x	Slight	☐	Moderate	☐	Heavy ☐

Borehole	Depth to Base (m)	Depth to Water (m bgl)	Water Sample Taken (Yes/No)	Methane (Peak) CH4 (% VOL)	Methane (Steady) CH4 (% VOL)	Methane (Peak) CH4 (% LEL)	Methane (Steady) CH4 (% LEL)	Carbon Dioxide (Peak) (% VOL)	Remarks
BH101	20.00	9.93	No	0.0	0.0	0.0	0.0	4.9	
BH103	3.00	2.48	No	0.0	0.0	0.0	0.0	2.6	
BH104	3.00	DRY	No	0.0	0.0	0.0	0.0	8.4	
BH107	15.00	N/A							No access to location.
BH108	20.00	N/A							No access to location.
BH109	3.00	2.72	No	0.0	0.0	0.0	0.0	4.6	

Remarks

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Form 002/3

FIELDWORK - Insitu Gas Monitoring - Daily Record

Project **CROWN STREET ZONE 2**

Client **WSP UK LIMITED**

Project No **PN194002**
Date **29/10/2019**
Sheet No. **1 (2 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other **GA5000;**

Weather / Site Conditions

Wind	Still	☐	Light	x	Moderate	☐	Strong ☐
Cloud Cover	None	☐	Slight	x	Cloudy	☐	Overcast ☐
Precipitation	Dry	x	Slight	☐	Moderate	☐	Heavy ☐

Borehole	Depth to Base (m)	Carbon Dioxide (Steady) (% VOL)	Oxygen (Peak) (% VOL)	Oxygen (Steady) (% VOL)	Nitrogen (Peak) N2 (% VOL)	Nitrogen (Steady) N2 (% VOL)	Hydrogen Sulphide (Peak) (ppm)	Hydrogen Sulphide (Steady) (ppm)	Remarks
BH101	20.00	4.9	4.2	4.2	91.0	91.0	0	0	
BH103	3.00	2.6	12.1	12.1	85.4	85.4	0	0	
BH104	3.00	8.4	8.7	8.7	82.9	82.9	0	0	
BH107	15.00								No access to location.
BH108	20.00								No access to location.
BH109	3.00	4.6	1.3	1.3	94.6	94.6	0	0	

Remarks

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FIELDWORK - *Insitu Gas Monitoring - Daily Record*

Project **CROWN STREET ZONE 2**

Client **WSP UK LIMITED**

Project No **PN194002**
Date **29/10/2019**
Sheet No. **1 (3 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other **GA5000;**

Weather / Site Conditions

Wind	Still	☐	Light	x	Moderate ☐	Strong	☐
Cloud Cover	None	☐	Slight	x	Cloudy ☐	Overcast	☐
Precipitation	Dry	x	Slight	☐	Moderate ☐	Heavy	☐

Borehole	Depth to Base (m)	Carbon Monoxide (Peak) (ppm)	Carbon Monoxide (Steady) (ppm)	Flow Rate (Peak) (l/hr)	Flow Rate (Steady) (l/hr)	Barometric Pressure (mBars)	Wind ()	Cloud ()	Remarks
BH101	20.00	0	0	-1.5	-1.5	1022	Light	Slight	
BH103	3.00	0	0	0.9	0.9	1022	Light	Slight	
BH104	3.00	0	0	1.0	1.0	1022	Light	Slight	
BH107	15.00								No access to location.
BH108	20.00								No access to location.
BH109	3.00	1	1	1.1	1.1	1022	Light	Slight	

Remarks

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FIELDWORK - *Insitu Gas Monitoring - Daily Record*

Project **CROWN STREET ZONE 2**

Client **WSP UK LIMITED**

Project No **PN194002**
Date **29/10/2019**
Sheet No. **1 (4 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other **GA5000;**

Weather / Site Conditions

Wind	Still	☐	Light	x	Moderate ☐	Strong	☐
Cloud Cover	None	☐	Slight	x	Cloudy ☐	Overcast	☐
Precipitation	Dry	x	Slight	☐	Moderate ☐	Heavy	☐

Borehole	Depth to Base (m)	Rain ()	Equipment Used ()	Monitored by ()	Remarks
BH101	**20.00**	**Dry**	**GA5000**	**CW**	
BH103	**3.00**	**Dry**	**GA5000**	**CW**	
BH104	**3.00**	**Dry**	**GA5000**	**CW**	
BH107	**15.00**				**No access to location.**
BH108	**20.00**				**No access to location.**
BH109	**3.00**	**Dry**	**GA5000**	**CW**	

Remarks

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FIELDWORK - *Insitu Gas Monitoring - Daily Record*

Project **CROWN STREET ZONE 2**

Client **WSP UK LIMITED**

Project No **PN194002**
Date **12/11/2019**
Sheet No. **1 (1 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other **GA5000;**

Weather / Site Conditions

Wind Still ☐ Light ☐ Moderate ☐ Strong ☐

Cloud Cover None ☐ Slight ☐ Cloudy ☐ Overcast ☐

Precipitation Dry ☐ Slight ☐ Moderate ☐ Heavy ☐

Borehole	Depth to Base (m)	Depth to Water (m bgl)	Water Sample Taken (Yes/No)	Methane (Peak) CH4 (% VOL)	Methane (Steady) CH4 (% VOL)	Methane (Peak) CH4 (% LEL)	Methane (Steady) CH4 (% LEL)	Carbon Dioxide (Peak) (% VOL)	Remarks
BH101	**20.00**	**N/A**							**Location Flooded.**
BH103	**3.00**	**N/A**							**Location Flooded.**
BH104	**3.00**	**2.12**	**No**	**0.0**	**0.0**	**0.0**	**0.0**	**0.3**	
BH107	**15.00**	**N/A**							**Location Flooded.**
BH108	**20.00**	**8.60**	**No**	**0.0**	**0.0**	**0.0**	**0.0**	**1.6**	
BH109	**3.00**	**N/A**							**Location Flooded.**

Remarks

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FIELDWORK - *Insitu Gas Monitoring - Daily Record*

Project **CROWN STREET ZONE 2**

Client **WSP UK LIMITED**

Project No **PN194002**
Date **12/11/2019**
Sheet No. **1 (2 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other **GA5000;**

Weather / Site Conditions

Wind Still ☐ Light ☐ Moderate ☐ Strong ☐

Cloud Cover None ☐ Slight ☐ Cloudy ☐ Overcast ☐

Precipitation Dry ☐ Slight ☐ Moderate ☐ Heavy ☐

Borehole	Depth to Base (m)	Carbon Dioxide (Steady) (% VOL)	Oxygen (Peak) (% VOL)	Oxygen (Steady) (% VOL)	Nitrogen (Peak) N2 (% VOL)	Nitrogen (Steady) N2 (% VOL)	Hydrogen Sulphide (Peak) (ppm)	Hydrogen Sulphide (Steady) (ppm)	Remarks
BH101	**20.00**								**Location Flooded.**
BH103	**3.00**								**Location Flooded.**
BH104	**3.00**	**0.3**	**20.5**	**20.5**	**79.2**	**79.2**	**0**	**0**	
BH107	**15.00**								**Location Flooded.**
BH108	**20.00**	**1.6**	**12.4**	**12.4**	**86.1**	**86.1**	**0**	**0**	
BH109	**3.00**								**Location Flooded.**

Remarks

geotechnics

FIELDWORK - *Insitu Gas Monitoring - Daily Record*

Project **CROWN STREET ZONE 2**

Client **WSP UK LIMITED**

Project No **PN194002**
Date **12/11/2019**
Sheet No. **1 (3 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other **GA5000;**

Weather / Site Conditions

Wind Still ☐ Light ☐ Moderate ☐ Strong ☐

Cloud Cover None ☐ Slight ☐ Cloudy ☐ Overcast ☐

Precipitation Dry ☐ Slight ☐ Moderate ☐ Heavy ☐

Borehole	Depth to Base (m)	Carbon Monoxide (Peak) (ppm)	Carbon Monoxide (Steady) (ppm)	Flow Rate (Peak) (l/hr)	Flow Rate (Steady) (l/hr)	Barometric Pressure (mBars)	Wind ()	Cloud ()	Remarks
BH101	**20.00**								**Location Flooded.**
BH103	**3.00**								**Location Flooded.**
BH104	**3.00**	**0**	**0**	**0.0**	**0.0**	**989**	**Light**	**Cloudy**	
BH107	**15.00**								**Location Flooded.**
BH108	**20.00**	**0**	**0**	**0.3**	**0.2**	**989**	**Light**	**Cloudy**	
BH109	**3.00**								**Location Flooded.**

Remarks

geotechnics

FIELDWORK - *Insitu Gas Monitoring - Daily Record*

Project **CROWN STREET ZONE 2**

Client **WSP UK LIMITED**

Project No **PN194002**
Date **12/11/2019**
Sheet No. **1 (4 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other **GA5000;**

Weather / Site Conditions

Wind	Still ☐	Light ☐	Moderate ☐	Strong ☐
Cloud Cover	None ☐	Slight ☐	Cloudy ☐	Overcast ☐
Precipitation	Dry ☐	Slight ☐	Moderate ☐	Heavy ☐

Borehole	Depth to Base (m)	Rain ()	Equipment Used ()	Monitored by ()	Remarks
BH101	**20.00**				**Location Flooded.**
BH103	**3.00**				**Location Flooded.**
BH104	**3.00**	**Slight**	**GA5000**	**AJ**	
BH107	**15.00**				**Location Flooded.**
BH108	**20.00**	**Slight**	**GA5000**	**AJ**	
BH109	**3.00**				**Location Flooded.**

Remarks

geotechnics

FIELDWORK - *Insitu Gas Monitoring - Daily Record*

Project **CROWN STREET ZONE 2**

Client **WSP UK LIMITED**

Project No **PN194002**

Date **25/11/2019**

Sheet No. **1 (1 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other **GA5000;**

Weather / Site Conditions

Wind	Still ☐	Light ☐	Moderate ☐	Strong ☒
Cloud Cover	None ☐	Slight ☐	Cloudy ☐	Overcast ☒
Precipitation	Dry ☐	Slight ☐	Moderate ☐	Heavy ☒

Borehole	Depth to Base (m)	Depth to Water (m bgl)	Water Sample Taken (Yes/No)	Methane (Peak) CH4 (% VOL)	Methane (Steady) CH4 (% VOL)	Methane (Peak) CH4 (% LEL)	Methane (Steady) CH4 (% LEL)	Carbon Dioxide (Peak) (% VOL)	Remarks
BH101	**20.00**	**9.60**	**No**	**0.1**	**0.1**	**2.0**	**2.0**	**0.2**	
BH103	**3.00**	**2.54**	**No**	**0.1**	**0.1**	**2.0**	**2.0**	**0.1**	
BH104	**3.00**	**1.60**	**No**	**0.5**	**0.5**	**10.0**	**10.0**	**0.1**	
BH107	**15.00**	**9.40**	**No**	**0.4**	**0.4**	**8.0**	**8.0**	**0.2**	
BH108	**20.00**	**8.50**	**No**	**0.3**	**0.3**	**6.0**	**6.0**	**0.1**	
BH109	**3.00**	**0.40**	**No**	**0.2**	**0.2**	**0.4**	**0.4**	**0.1**	

Remarks

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FIELDWORK - *Insitu Gas Monitoring - Daily Record*

Project **CROWN STREET ZONE 2**

Client **WSP UK LIMITED**

Project No **PN194002**
Date **25/11/2019**
Sheet No. **1 (2 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other **GA5000;**

Weather / Site Conditions

Wind	Still ☐	Light ☐	Moderate ☐	Strong ☒
Cloud Cover	None ☐	Slight ☐	Cloudy ☐	Overcast ☒
Precipitation	Dry ☐	Slight ☐	Moderate ☐	Heavy ☒

Borehole	Depth to Base (m)	Carbon Dioxide (Steady) (% VOL)	Oxygen (Peak) (% VOL)	Oxygen (Steady) (% VOL)	Nitrogen (Peak) N2 (% VOL)	Nitrogen (Steady) N2 (% VOL)	Hydrogen Sulphide (Peak) (ppm)	Hydrogen Sulphide (Steady) (ppm)	Remarks
BH101	**20.00**	**0.2**	**21.2**	**21.2**	**78.5**	**78.5**	**0**	**0**	
BH103	**3.00**	**0.1**	**21.0**	**21.0**	**78.0**	**78.0**	**0**	**0**	
BH104	**3.00**	**0.1**	**17.3**	**17.3**	**81.0**	**81.0**	**0**	**0**	
BH107	**15.00**	**0.2**	**21.3**	**21.3**	**78.5**	**78.5**	**0**	**0**	
BH108	**20.00**	**0.1**	**20.4**	**20.4**	**79.5**	**79.5**	**0**	**0**	
BH109	**3.00**	**0.1**	**21.4**	**21.4**	**78.3**	**78.3**	**0**	**0**	

Remarks

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FIELDWORK - Insitu Gas Monitoring - Daily Record

Project **CROWN STREET ZONE 2**

Client **WSP UK LIMITED**

Project No **PN194002**
Date **25/11/2019**
Sheet No. **1 (3 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other **GA5000;**

Weather / Site Conditions

Wind	Still ☐	Light ☐	Moderate ☐	Strong ☒
Cloud Cover	None ☐	Slight ☐	Cloudy ☐	Overcast ☒
Precipitation	Dry ☐	Slight ☐	Moderate ☐	Heavy ☒

Borehole	Depth to Base (m)	Carbon Monoxide (Peak) (ppm)	Carbon Monoxide (Steady) (ppm)	Flow Rate (Peak) (l/hr)	Flow Rate (Steady) (l/hr)	Barometric Pressure (mBars)	Wind ()	Cloud ()	Remarks
BH101	20.00	0	0	0.3	0.3	996	Strong	Overcast	
BH103	3.00	0	0	0.0	0.0	996	Strong	Overcast	
BH104	3.00	0	0	0.4	0.1	996	Strong	Overcast	
BH107	15.00	0	0	0.1	0.1	996	Strong	Overcast	
BH108	20.00	0	0	0.2	0.2	996	Strong	Overcast	
BH109	3.00	0	0	0.0	0.0	996	Strong	Overcast	

Remarks

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FIELDWORK - *Insitu Gas Monitoring - Daily Record*

Project **CROWN STREET ZONE 2**

Client **WSP UK LIMITED**

Project No **PN194002**
Date **25/11/2019**
Sheet No. **1 (4 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other **GA5000;**

Weather / Site Conditions

Wind	Still ☐	Light ☐	Moderate ☐	Strong ☒
Cloud Cover	None ☐	Slight ☐	Cloudy ☐	Overcast ☒
Precipitation	Dry ☐	Slight ☐	Moderate ☐	Heavy ☒

Borehole	Depth to Base (m)	Rain ()	Equipment Used ()	Monitored by ()	Remarks
BH101	**20.00**	**Heavy**	**GA5000**	**GM**	
BH103	**3.00**	**Heavy**	**GA5000**	**GM**	
BH104	**3.00**	**Heavy**	**GA5000**	**GM**	
BH107	**15.00**	**Heavy**	**GA5000**	**GM**	
BH108	**20.00**	**Heavy**	**GA5000**	**GM**	
BH109	**3.00**	**Heavy**	**GA5000**	**GM**	

Remarks

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FIELDWORK - Insitu Gas Monitoring - Daily Record

Project **CROWN STREET ZONE 2**

Client **WSP UK LIMITED**

Project No **PN194002**

Date **09/12/2019**

Sheet No. **1 (1 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other **GFM436 Gas Analyser;**

Weather / Site Conditions

Wind	Still	☐	Light	x	Moderate	☐	Strong ☐
Cloud Cover	None	☐	Slight	x	Cloudy	☐	Overcast ☐
Precipitation	Dry	x	Slight	☐	Moderate	☐	Heavy ☐

Borehole	Depth to Base (m)	Depth to Water (m bgl)	Water Sample Taken (Yes/No)	Methane (Peak) CH4 (% VOL)	Methane (Steady) CH4 (% VOL)	Methane (Peak) CH4 (% LEL)	Methane (Steady) CH4 (% LEL)	Carbon Dioxide (Peak) (% VOL)	Remarks
BH101	20.00	9.82	No	0.0	0.0	0.0	0.0	3.2	
BH103	3.00	2.62	No	0.0	0.0	0.0	0.0	3.0	
BH104	3.00	2.52	No	0.0	0.0	0.0	0.0	0.1	
BH107	15.00	6.60	No	0.0	0.0	0.0	0.0	0.2	
BH108	20.00	5.88	No	0.0	0.0	0.0	0.0	0.1	
BH109	3.00	2.71	No	0.0	0.0	0.0	0.0	3.3	

Remarks

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FIELDWORK - *Insitu Gas Monitoring - Daily Record*

Project **CROWN STREET ZONE 2**

Client **WSP UK LIMITED**

Project No **PN194002**

Date **09/12/2019**

Sheet No. **1 (2 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other **GFM436 Gas Analyser;**

Weather / Site Conditions

Wind	Still	☐	Light	x	Moderate	☐	Strong ☐
Cloud Cover	None	☐	Slight	x	Cloudy	☐	Overcast ☐
Precipitation	Dry	x	Slight	☐	Moderate	☐	Heavy ☐

Borehole	Depth to Base (m)	Carbon Dioxide (Steady) (% VOL)	Oxygen (Peak) (% VOL)	Oxygen (Steady) (% VOL)	Nitrogen (Peak) N2 (% VOL)	Nitrogen (Steady) N2 (% VOL)	Hydrogen Sulphide (Peak) (ppm)	Hydrogen Sulphide (Steady) (ppm)	Remarks
BH101	**20.00**	**3.2**	**9.4**	**9.4**	**87.4**	**87.4**	**0**	**0**	
BH103	**3.00**	**3.0**	**13.7**	**13.7**	**83.3**	**83.3**	**0**	**0**	
BH104	**3.00**	**0.1**	**19.1**	**19.1**	**80.8**	**80.8**	**0**	**0**	
BH107	**15.00**	**0.2**	**18.9**	**18.9**	**80.9**	**80.9**	**0**	**0**	
BH108	**20.00**	**0.1**	**19.3**	**19.3**	**80.6**	**80.6**	**0**	**0**	
BH109	**3.00**	**3.3**	**7.8**	**7.8**	**88.9**	**88.9**	**0**	**0**	

Remarks

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FIELDWORK - *Insitu Gas Monitoring - Daily Record*

Project **CROWN STREET ZONE 2**

Client **WSP UK LIMITED**

Project No **PN194002**

Date **09/12/2019**

Sheet No. **1 (3 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other **GFM436 Gas Analyser;**

Weather / Site Conditions

Wind	Still	☐	Light	x	Moderate	☐	Strong ☐
Cloud Cover	None	☐	Slight	x	Cloudy	☐	Overcast ☐
Precipitation	Dry	x	Slight	☐	Moderate	☐	Heavy ☐

Borehole	Depth to Base (m)	Carbon Monoxide (Peak) (ppm)	Carbon Monoxide (Steady) (ppm)	Flow Rate (Peak) (l/hr)	Flow Rate (Steady) (l/hr)	Barometric Pressure (mBars)	Wind ()	Cloud ()	Remarks
BH101	20.00	0	0	3.3	0.0	1009	Light	Slight	
BH103	3.00	0	0	2.7	1.6	1009	Light	Slight	
BH104	3.00	0	0	2.4	1.5	1009	Light	Slight	
BH107	15.00	0	0	-3.3	-3.3	1010	Light	Slight	
BH108	20.00	0	0	2.5	1.2	1011	Light	Slight	
BH109	3.00	0	0	2.5	1.9	1010	Light	Slight	

Remarks

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FIELDWORK - *Insitu Gas Monitoring - Daily Record*

Project **CROWN STREET ZONE 2**

Client **WSP UK LIMITED**

Project No **PN194002**
Date **09/12/2019**
Sheet No. **1 (4 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 [ ] MK2 [ ] GA2000 [ ]

Other **GFM436 Gas Analyser;**

Weather / Site Conditions

Wind	Still	[ ]	Light	[x]	Moderate [ ]	Strong	[ ]
Cloud Cover	None	[ ]	Slight	[x]	Cloudy [ ]	Overcast	[ ]
Precipitation	Dry	[x]	Slight	[ ]	Moderate [ ]	Heavy	[ ]

Borehole	Depth to Base (m)	Rain ()	Equipment Used ()	Monitored by ()	Remarks
BH101	**20.00**	**Dry**	**GFM436 Gas Anal**	**AV**	
BH103	**3.00**	**Dry**	**GFM436 Gas Anal**	**AV**	
BH104	**3.00**	**Dry**	**GFM436 Gas Anal**	**AV**	
BH107	**15.00**	**Dry**	**GFM436 Gas Anal**	**AV**	
BH108	**20.00**	**Dry**	**GFM436 Gas Anal**	**AV**	
BH109	**3.00**	**Dry**	**GFM436 Gas Anal**	**AV**	

Remarks

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FIELDWORK - *Insitu Gas Monitoring - Daily Record*

Project **CROWN STREET ZONE 2**

Client **WSP UK LIMITED**

Project No **PN194002**
Date **16/12/2019**
Sheet No. **1 (1 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other **GFM436 Gas Analyser;**

Weather / Site Conditions

Wind	Still	x	Light	☐	Moderate	☐	Strong ☐
Cloud Cover	None	x	Slight	☐	Cloudy	☐	Overcast ☐
Precipitation	Dry	x	Slight	☐	Moderate	☐	Heavy ☐

Borehole	Depth to Base (m)	Depth to Water (m bgl)	Water Sample Taken (Yes/No)	Methane (Peak) CH4 (% VOL)	Methane (Steady) CH4 (% VOL)	Methane (Peak) CH4 (% LEL)	Methane (Steady) CH4 (% LEL)	Carbon Dioxide (Peak) (% VOL)	Remarks
BH101	20.00	9.54	No	0.0	0.0	0.0	0.0	3.2	
BH103	3.00	2.65	No	0.0	0.0	0.0	0.0	2.2	
BH104	3.00	2.63	No	0.0	0.0	0.0	0.0	0.1	
BH107	15.00	9.50	No	0.0	0.0	0.0	0.0	0.4	
BH108	20.00	8.92	No	0.0	0.0	0.0	0.0	0.4	
BH109	3.00	N/A							No access to location.

Remarks

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FIELDWORK - *Insitu Gas Monitoring - Daily Record*

Project **CROWN STREET ZONE 2**

Client **WSP UK LIMITED**

Project No **PN194002**
Date **16/12/2019**
Sheet No. **1 (2 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other **GFM436 Gas Analyser;**

Weather / Site Conditions

Wind	Still	x	Light	☐	Moderate	☐	Strong ☐
Cloud Cover	None	x	Slight	☐	Cloudy	☐	Overcast ☐
Precipitation	Dry	x	Slight	☐	Moderate	☐	Heavy ☐

Borehole	Depth to Base (m)	Carbon Dioxide (Steady) (% VOL)	Oxygen (Peak) (% VOL)	Oxygen (Steady) (% VOL)	Nitrogen (Peak) N2 (% VOL)	Nitrogen (Steady) N2 (% VOL)	Hydrogen Sulphide (Peak) (ppm)	Hydrogen Sulphide (Steady) (ppm)	Remarks
BH101	**20.00**	**3.2**	**9.6**	**9.6**	**87.2**	**87.2**	**0**	**0**	
BH103	**3.00**	**2.2**	**15.6**	**15.6**	**82.2**	**82.2**	**0**	**0**	
BH104	**3.00**	**0.1**	**17.1**	**17.1**	**82.2**	**82.2**	**0**	**0**	
BH107	**15.00**	**0.4**	**18.9**	**18.9**	**80.7**	**80.7**	**0**	**0**	
BH108	**20.00**	**0.4**	**18.0**	**18.0**	**81.6**	**81.6**	**0**	**0**	
BH109	**3.00**								**No access to location.**

Remarks

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FIELDWORK - *Insitu Gas Monitoring - Daily Record*

Project **CROWN STREET ZONE 2**

Client **WSP UK LIMITED**

Project No **PN194002**

Date **16/12/2019**

Sheet No. **1 (3 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other **GFM436 Gas Analyser;**

Weather / Site Conditions

Wind	Still	x	Light	☐	Moderate	☐	Strong ☐
Cloud Cover	None	x	Slight	☐	Cloudy	☐	Overcast ☐
Precipitation	Dry	x	Slight	☐	Moderate	☐	Heavy ☐

Borehole	Depth to Base (m)	Carbon Monoxide (Peak) (ppm)	Carbon Monoxide (Steady) (ppm)	Flow Rate (Peak) (l/hr)	Flow Rate (Steady) (l/hr)	Barometric Pressure (mBars)	Wind ()	Cloud ()	Remarks
BH101	20.00	0	0	1.9	0.0	993	Still	None	
BH103	3.00	0	0	2.1	0.0	993	Still	None	
BH104	3.00	0	0	1.9	0.0	994	Still	None	
BH107	15.00	0	0	-3.8	0.0	994	Still	None	
BH108	20.00	0	0	3.5	1.2	993	Still	None	
BH109	3.00								No access to location.

Remarks

geotechnics

FIELDWORK - *Insitu Gas Monitoring - Daily Record*

Project **CROWN STREET ZONE 2**

Client **WSP UK LIMITED**

Project No **PN194002**
Date **16/12/2019**
Sheet No. **1 (4 of 4)**

Equipment Used

GI Infra Red Gas Analyser MK1 ☐ MK2 ☐ GA2000 ☐

Other **GFM436 Gas Analyser;**

Weather / Site Conditions

Wind	Still	x	Light	☐	Moderate	☐	Strong ☐
Cloud Cover	None	x	Slight	☐	Cloudy	☐	Overcast ☐
Precipitation	Dry	x	Slight	☐	Moderate	☐	Heavy ☐

Borehole	Depth to Base (m)	Rain ()	Equipment Used ()	Monitored by ()	Remarks
BH101	**20.00**	**Dry**	**GFM436 Gas Anal**	**AVM**	
BH103	**3.00**	**Dry**	**GFM436 Gas Anal**	**AVM**	
BH104	**3.00**	**Dry**	**GFM436 Gas Anal**	**AVM**	
BH107	**15.00**	**Dry**	**GFM436 Gas Anal**	**AVM**	
BH108	**20.00**	**Dry**	**GFM436 Gas Anal**	**AVM**	
BH109	**3.00**				**No access to location.**

Remarks

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APPENDIX 7

Laboratory Test Results - Geotechnical (Soil)

Laboratory Test Certificate

Form REP008 Rev 3

Issued To	Geotechnics Ltd The Geotechnical Centre Unit 1B, Borders Industrial Estate River Lane, Saltney Chester CH4 8RJ	**Date of issue**	30/10/2019
		Issue No.	1
		Client Ref. No.	-
		Samples / Material Source	
		Samples Recv'd	23/09/19 & 21/10/19
Testing Start Date	25/09/2019	Sample State	As received
Testing Complete	30/10/2019	Sampled by	Geotechnics Limited
Comments	Rock Moisture Content performed according In-House procedure, not to IRSM accredited Method		
Project No	PN194002		
Project Name	CROWN STREET ZONE 2		

Summary of Tests

Standard	Test Description	Test Quantity	UKAS
BS EN ISO 17892-1:2014	Water Content	23	Yes
BS EN ISO 17892-2:2014 Cl. 5.1	Bulk Density by Linear Measurement	2	Yes
BS EN ISO 17892-12:2018 Cl. 5.3 & 5.5	Liquid Limit and Plastic Limit	15	Yes
BS EN ISO 17892-4:2016 Cl. 5.2	Particle Size Distribution by Sieving Method	3	Yes
ISRM Suggested Method (1985)	Point Load Strength of Rock	149	Yes
BS EN ISO 17892-8:2018	Shear Strength by Unconsolidated Undrained Triaxial Test - Single Stage	18	Yes

Note: Any descriptions, opinions or interpretations are outside the scope of UKAS accreditation.
The results within this report relate only to the samples tested and received from the client.

UKAS TESTING
1365

Test Results checked and approved for issue.
Signed for and on behalf of Geotechnics Limited

Schiano

Stephane Schiano (Laboratory Testing Manager)

GEOTECHNICS
geotechnical and geoenvironmental specialists
203 Torrington Avenue, Tile Hill,
Coventry, CV4 9UT

DATA SHEET - Laboratory Test Symbols

Classification and Strength

Symbol	**C - Clay**	**M - Silt**
	(0 - containing organic matter)	
	Plasticity	L - Low
		I - Intermediate
		H - High
		V - Very High
		E - Extremely High
Ip	Plasticity Index	
%	% retained on 425 µm sieve, shown under Ip value	
w_L	Liquid Limit	
w_P	Plastic Limit	
NP	Non-Plastic	
NAT	Sample tested in natural state	
w	Water Content	
P_d	Particle Density	
Test	**Quick undrained triaxial tests**	
	SS	Single stage - 102mm diameter.
	S3	Single stage - set of 3 38mm diameter.
	MS	Multistage - 102mm diameter.
	D	Drained Test
	HV	Hand Vane
	PP	Pocket Penetrometer (kg/cm²)
	NST	Not suitable for test
γ_b	Bulk Density	
σ_3	Triaxial Cell Pressure	
$\sigma_1 - \sigma_3$	Deviator Stress	
##	Excessive Strain	
c_u	Undrained Cohesion	
c	Cohesion Intercept	
ϕ	Angle of Shearing Resistance	
Linear Shrink	Linear Shrinkage	
Stab add-	Stabiliser which is added	

Consolidation

m_v	Coefficient of Volume Compressibility
c_{v50}	Coefficient of Consolidation - Log t
c_{v90}	Coefficient of Consolidation - $\sqrt{t}$

Rock

UF	Unacceptable Failure

Chemical Analysis

Acid Soluble	Total sulphate in specimen, expressed as SO_3 %, value in brackets expressed as SO_4 %
Water Soluble	Soluble sulphate in 2:1 water : soil extract, expressed as SO_3 g/l, value in brackets expressed as SO_4 g/l
In Water	Sulphate content of groundwater, expressed as SO_3 g/l, value in brackets expressed as SO_4 g/l
pH	pH value
Organic content	Organic content expressed as a percentage of dry weight
Chloride	Chloride Ion content expressed as a percentage of dry weight

MCV, Compaction, CBR

MCV	Moisture Condition Value at natural water content
MCC	Moisture Condition Calibration
CCV	Chalk Crushing Value

Compaction

Type	2.5	= 2.5 kg Rammer
	4.5	= 4.5 kg Rammer
	V	= Vibrating Hammer
γ_b	Bulk Density	
γ_d	Dry Density	

CBR California Bearing Ratio

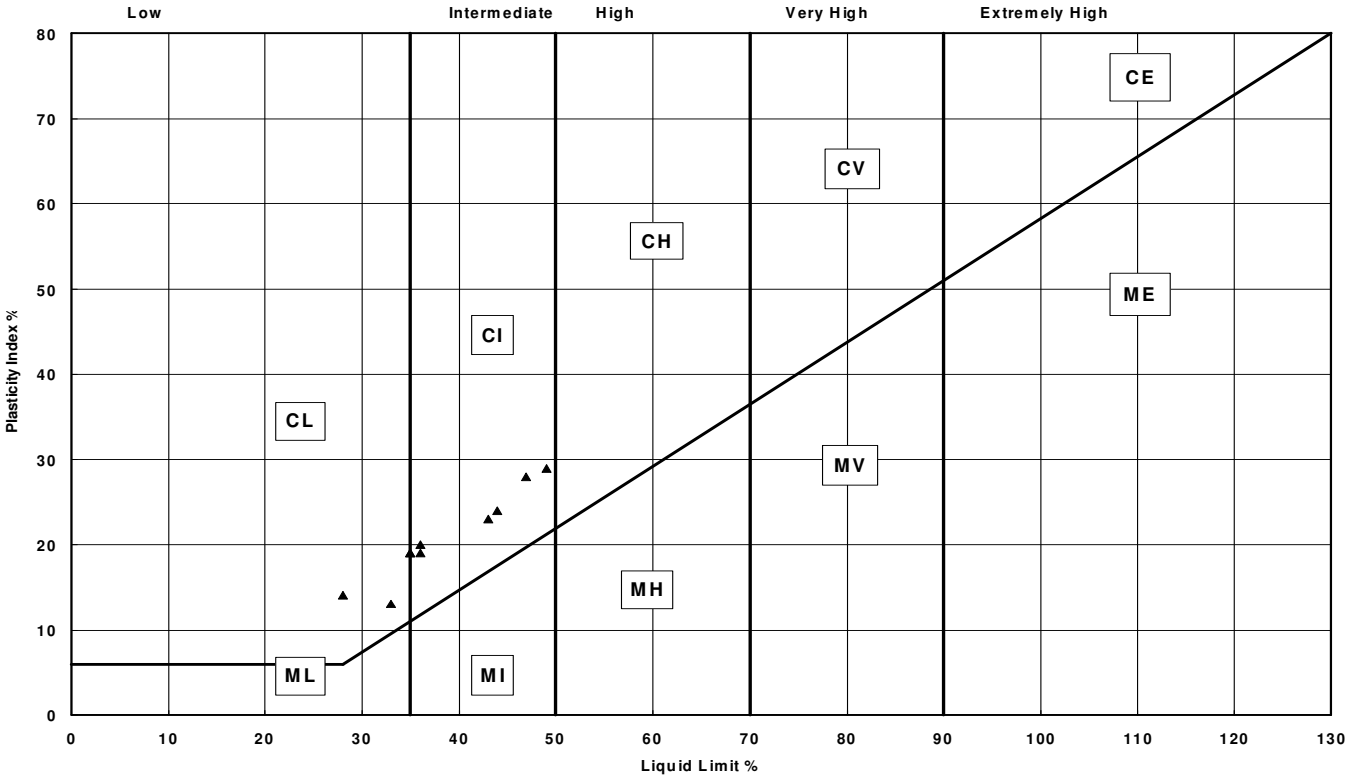
Type	2.5	= Test on Specimen Recompacted using 2.5 kg Rammer
	4.5	= As above but using 4.5 kg Rammer
	V	= As above but using Vibrating Hammer
	M	= Test on open drive mould specimen cut in field
	S	= Soaked Specimen
Top	CBR at top of mould	
Bottom	CBR at bottom of mould	
ND	None Detected	
*	In the Sample Description denotes a laboratory only description	

LABORATORY RESULTS - *Classification Chart*

Project: CROWN STREET ZONE 2

Project No: PN194002

PLOT OF PLASTICITY INDEX AGAINST LIQUID LIMIT
for all items tested



Soil Type	Plasticity Characterisics
C Clay	L Low
	I Intermediate
M Silt	H High
	V Very High
	E Extremely High

Table of Soil Types and Plasticity Characteristics from BS 5930 : 1999

Remarks

31/10/2019

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LABORATORY RESULTS - Classification and Strength

Project CROWN STREET ZONE 2 **Project No:** PN194002

Sample					Classification					Strength					
Hole	Depth (Specimen Depth) m	Type	Sample Ref	Description	Symbol	I_p (>425) %	w_L %	w_p %	w (p_d) %	Test	γ_b (γ_d) Mg/m^3	σ_3 kN/m^2	$\sigma_1-\sigma_3$ kN/m^2	c_u kN/m^2	c_{Avg} kN/m^2
BH101	4.20-4.65 (4.20-4.30)	U	N77161	Stiff high strength greyish brown mottled reddish brown slightly sandy slightly gravelly CLAY.	CI	24 (3%)	44	20	14.8 <13.5>	SS	2.25	80	249	124	124
BH101	6.20-6.65 (6.20-6.50)	U	N77162	Stiff high strength greyish brown mottled reddish brown slightly sandy slightly gravelly CLAY.	CI	23 (3%)	43	20	19.6 [16.1]	SS	2.25	120	184	92 ##	92
BH101	8.20-8.65 (8.40)	U	N77163	Very stiff extremely high strength greyish brown mottled reddish brown slightly sandy slightly gravelly CLAY.					8.5 <7.9>	SS	2.36	160	1384	692	692
BH102	5.20-5.65 (5.20-5.30)	U	N77190	Stiff high strength brown slightly sandy slightly gravelly CLAY.	CI	19 (7%)	35	16	17.9 <17.6>	SS	2.17	100	195	98	98
BH102	7.20-7.65 (7.40)	U	N77191	Very stiff extremely high strength brown slightly sandy slightly gravelly CLAY.					7.7 <8.7>	SS	2.23	140	611	305	305
BH103	3.20-3.65 (3.20-3.45)	U	N77193	Very stiff very high strength greyish brown slightly sandy slightly gravelly CLAY.	CI	19 (8%)	35	16	14.9 <14.5>	SS	2.20	60	437	219	219
BH103	5.20-5.65 (5.20-5.40)	U	N77196	Very stiff very high strength greyish brown slightly sandy slightly gravelly CLAY.	CL	14 (12%)	28	14	11.6 <11.5>	SS	2.27	100	445	222	222
BH103	7.20-7.65 (7.20)	U	N77596	Soft to firm low to medium strength reddish brown slightly gravelly sandy CLAY.					11.4 [11.8]	SS	2.26	140	79	40 ##	40
BH104	3.20-3.65 (3.20-3.25)	UT	N77167	Stiff high strength greyish brown slightly sandy slightly gravelly CLAY with occasional thin laminae of sand.	CI	20 (8%)	36	16	17.9 [15.5]	SS	2.21	60	278	139 ##	139
BH104	7.20-7.65 (7.20)	UT	N77169	Stiff greyish brown slightly sandy slightly gravelly SILT with occasional thin laminae of sand. (See Test Remarks Sheet for further information)		(12%)	21	NP	8.6	SS	2.16		NST		
BH105	3.20-3.65 (3.20-3.45)	U	N77197	Stiff high strength greyish brown slightly sandy slightly gravelly CLAY.	CI	19 (6%)	36	17	17.5 [12.2]	SS	2.18	60	199	99 ##	99
BH105	5.65-5.75 (5.65)	D	N77199	Stiff greyish brown slightly sandy slightly gravelly CLAY with some bands of sand and gravel.					10.6						

Remarks AGS

NST - Not suitable for Test
For Standards followed see Laboratory Test Certficate
^ Rock water content test
QUT Water Contents: <Failure Zone>, [After test]

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LABORATORY RESULTS - Classification and Strength

Project CROWN STREET ZONE 2 **Project No:** PN194002

Sample					Classification					Strength					
Hole	Depth (Specimen Depth) m	Type	Sample Ref	Description	Symbol	I_p (>425) %	w_L %	w_p %	w (p_d) %	Test	γ_b (γ_d) Mg/m^3	σ_3 kN/m^2	$\sigma_1-\sigma_3$ kN/m^2	c_u kN/m^2	c_{Avg} kN/m^2
BH106	4.20-4.65 (4.20)	D	N77202	Stiff greyish brown slightly sandy slightly gravelly CLAY.					15.3						
BH106	5.20-5.65 (5.20-5.40)	U	N77203	Firm medium strength greyish brown slightly sandy slightly gravelly SILT.		(37%)	26	NP	15.7 [15.7]	SS	2.13	100	109	54 ##	54
BH107	5.20-5.65 (5.20)	UT	N77174	Stiff high strength brown slightly sandy slightly gravelly CLAY.					11.9 <14.9>	SS	2.14	100	212	106	106
BH107	7.20-7.65 (7.20)	UT	N77175	Very stiff extremely high strength brown slightly sandy slightly gravelly SILT.		(9%)	23	NP	12.9 <10.0>	SS	2.34	140	803	402	402
BH108	3.20-3.65 (3.20)	U	N77177	Very stiff very high strength brown slightly sandy slightly gravelly SILT.		(20%)	24	NP	14.0 [15.6]	SS	2.21	60	304	152 ##	152
BH108	5.20-5.65 (5.25)	U	N77178	Very stiff very high strength brown slightly gravelly sandy CLAY.					12.4 [11.8]	SS	2.28	100	393	196 ##	196
BH108	7.20-7.65 (7.20)	U	N77179	Stiff high strength brown slightly gravelly sandy CLAY.	CI	29 (1%)	49	20	20.1 <19.0>	SS	2.07	140	177	88	88
BH109	3.20-3.65 (3.20)	UT	N77183	Soft low strength greyish brown slightly sandy slightly gravelly CLAY.	CL	13 (12%)	33	20	17.1 <12.7>	SS	2.07	60	52	26	26
BH109	5.65-5.75 (5.65)	D	N77185	Firm greyish brown slightly sandy slightly gravelly CLAY.					16.3						
BH109	7.20-7.65 (7.20)	UT	N77186	Stiff greyish brown slightly sandy slightly gravelly SILT. (See Test Remarks Sheet for further information)		(14%)	21	NP	8.6	SS	1.86		NST		
BH109	9.20-9.65 (9.20)	UT	N77187	Firm medium strength reddish brown slightly sandy slightly gravelly CLAY.	CI	28 (5%)	47	19	19.1 <27.5>	SS	2.01	180	119	60	60

Remarks NST - Not suitable for Test
For Standards followed see Laboratory Test Certficate
^ Rock water content test
QUT Water Contents: <Failure Zone>, [After test]

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LABORATORY RESULTS - Atterberg Limit

Project CROWN STREET ZONE 2 **Project No:** PN194002

Sample					Results								
Hole	Depth (Specimen Depth) m	Type	Sample Ref	Description	Test Type	Point Data: Cone Pene.	Point Data: Water % (Factor)	Symbol	Ip %	>425 sieve µm	w_L %	w_p %
BH101	4.20-4.65 (4.20)	U	N77161	Stiff high strength greyish brown mottled reddish brown slightly sandy slightly gravelly CLAY.	Fall Cone 4pt with increasing water content, cone type: 80g/30, washed over 425um sieve			CI	24	3%	44	20
BH101	6.20-6.65 (6.20)	U	N77162	Stiff high strength greyish brown mottled reddish brown slightly sandy slightly gravelly CLAY.	Fall Cone 4pt with increasing water content, cone type: 80g/30, washed over 425um sieve			CI	23	3%	43	20
BH102	5.20-5.65 (5.20)	U	N77190	Stiff high strength brown slightly sandy slightly gravelly CLAY.	Fall Cone 4pt with increasing water content, cone type: 80g/30, washed over 425um sieve			CI	19	7%	35	16
BH103	3.20-3.65 (3.20)	U	N77193	Very stiff very high strength greyish brown slightly sandy slightly gravelly CLAY.	Fall Cone 4pt with increasing water content, cone type: 80g/30, washed over 425um sieve			CI	19	8%	35	16
BH103	5.20-5.65 (5.20)	U	N77196	Very stiff very high strength greyish brown slightly sandy slightly gravelly CLAY.	Fall Cone 4pt with increasing water content, cone type: 80g/30, washed over 425um sieve			CL	14	12%	28	14
BH104	3.20-3.65 (3.20)	UT	N77167	Stiff high strength greyish brown slightly sandy slightly gravelly CLAY with occasional thin laminae of sand.	Fall Cone 4pt with increasing water content, cone type: 80g/30, washed over 425um sieve			CI	20	8%	36	16
BH104	7.20-7.65 (7.20)	UT	N77169	Stiff greyish brown slightly sandy slightly gravelly SILT with occasional thin laminae of sand.	Fall Cone 4pt with increasing water content, cone type: 80g/30, washed over 425um sieve					12%	21	NP
BH105	3.20-3.65 (3.20)	U	N77197	Stiff high strength greyish brown slightly sandy slightly gravelly CLAY.	Fall Cone 4pt with increasing water content, cone type: 80g/30, washed over 425um sieve			CI	19	6%	36	17
BH106	5.20-5.65 (5.20)	U	N77203	Firm medium strength greyish brown slightly sandy slightly gravelly SILT.	Fall Cone 4pt with increasing water content, cone type: 80g/30, washed over 425um sieve					37%	26	NP
BH107	7.20-7.65 (7.20)	UT	N77175	Very stiff extremely high strength brown slightly sandy slightly gravelly SILT.	Fall Cone 4pt with increasing water content, cone type: 80g/30, washed over 425um sieve					9%	23	NP
BH108	3.20-3.65 (3.20)	U	N77177	Very stiff very high strength brown slightly sandy slightly gravelly SILT.	Fall Cone 4pt with increasing water content, cone type: 80g/30, washed over 425um sieve					20%	24	NP

Remarks

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LABORATORY RESULTS - Atterberg Limit

Project CROWN STREET ZONE 2 **Project No:** PN194002

Sample					Results								
Hole	Depth (Specimen Depth) m	Type	Sample Ref	Description	Test Type	Point Data: Cone Pene.	Point Data: Water % (Factor)	Symbol	ρ %	>425 sieve µm	w_L %	w_p %
BH108	7.20-7.65 (7.20)	U	N77179	Stiff high strength brown slightly gravelly sandy CLAY.	Fall Cone 4pt with increasing water content, cone type: 80g/30, washed over 425um sieve			CI	29	1%	49	20
BH109	3.20-3.65 (3.20)	UT	N77183	Soft low strength greyish brown slightly sandy slightly gravelly CLAY.	Fall Cone 4pt with increasing water content, cone type: 80g/30, washed over 425um sieve			CL	13	12%	33	20
BH109	7.20-7.65 (7.20)	UT	N77186	Stiff greyish brown slightly sandy slightly gravelly SILT.	Fall Cone 4pt with increasing water content, cone type: 80g/30, washed over 425um sieve					14%	21	NP
BH109	9.20-9.65 (9.20)	UT	N77187	Firm medium strength reddish brown slightly sandy slightly gravelly CLAY.	Fall Cone 4pt with increasing water content, cone type: 80g/30, washed over 425um sieve			CI	28	5%	47	19

Remarks

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LABORATORY RESULTS - *Test Remarks*

Project CROWN STREET ZONE 2 **Project No:** PN194002

Sample				Laboratory Remark
Hole	Depth (Specimen Depth) m	Type	Sample Ref	
BH104	7.20-7.65 (7.20-7.65)	UT	N77169	Quick Undrained Triaxial Test - NST= Insufficient sample - samples is dry and broke appart.
BH109	7.20-7.65 (7.20-7.65)	UT	N77186	Quick Undrained Triaxial Test - NST= Sample too short due to breaking at 150mm.

Remarks

LABORATORY RESULTS - Unconsolidated Undrained Triaxial Test

Project: CROWN STREET ZONE 2

Project No: PN194002

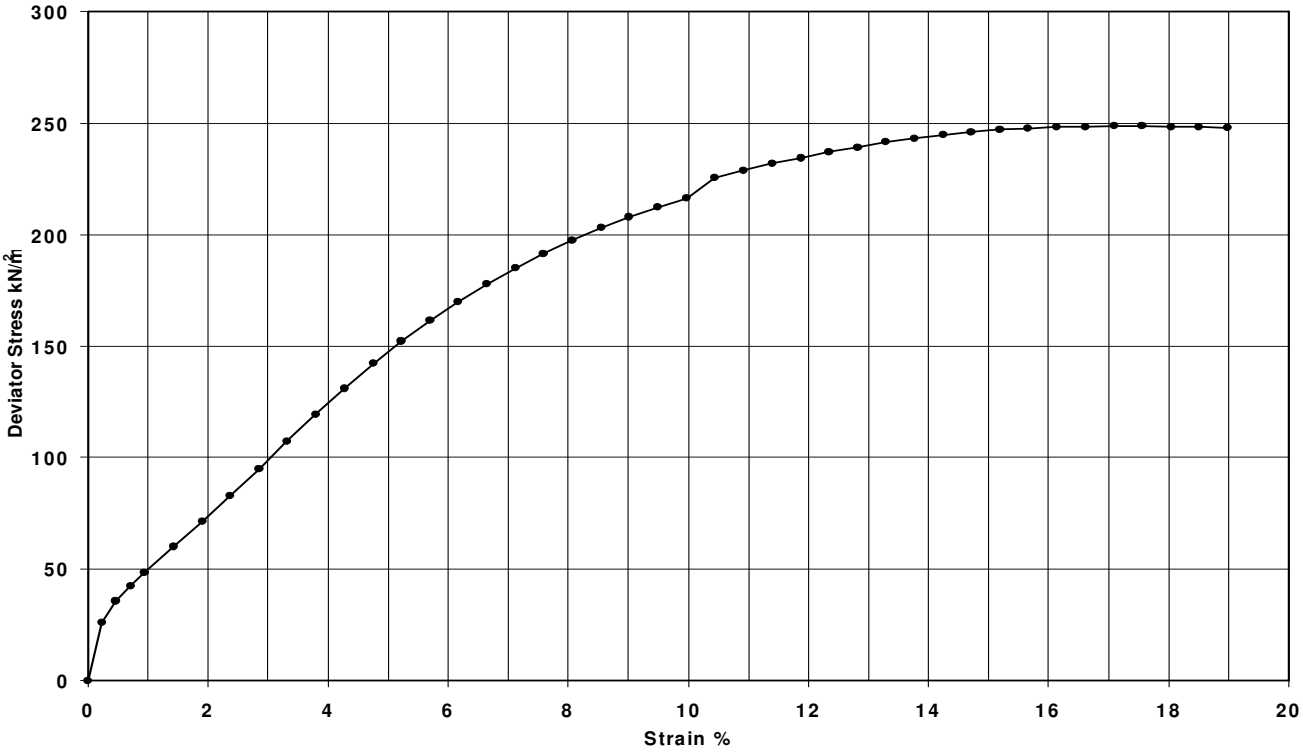
Hole	BH101
Sample Depth	4.20-4.65m
Sample Type	U
Sample Ref	N77161

Sample Description

The following samples were combined to perform this test:

Stiff high strength greyish brown mottled reddish brown slightly sandy slightly gravelly CLAY.

BS EN ISO 17892-8:2018



		Stage 1	Stage 2	Stage 3
Sample Condition		Undisturbed		
Orientation of sample		Vertical		
Initial Diameter	(mm)	101.15		
Initial Length	(mm)	210.68		
Initial Water Content	(%)	14.8		
Initial Bulk Density	(Mg/m³)	2.25		
Initial Dry Density	(Mg/m³)	1.96		
Particle Density	(Mg/m³)	2.65 Assumed		
Cell Pressure	(kPa)	80		
'Specimen Height' at start of Shearing Stage	(mm)	210.55		
Membrane Thickness/Correction	(mm/kPa)			
Rate of Strain	(%/min)	1.3		
Corrected Deviator Stress	(kPa)	249		
Undrained Shear Strength	(kPa)	124		
Strain at Failure	(%)	17.1		
Failure Zone Water Content	(%)	13.5		
Water Content (after test)	(%)			
Mode of Failure		Plastic		

Strain %	Corrected Deviator Stress kN/m²	Strain %	Corrected Deviator Stress kN/m²
0.2	26.1	10.0	216.4
0.5	35.5	10.4	225.6
0.7	42.5	10.9	228.7
0.9	48.4	11.4	231.8
1.4	59.9	11.9	234.5
1.9	71.4	12.3	237.1
2.4	83.1	12.8	239.2
2.8	95.0	13.3	241.3
3.3	107.2	13.8	243.1
3.8	119.3	14.2	244.8
4.3	131.0	14.7	246.1
4.7	142.1	15.2	246.9
5.2	152.4	15.7	247.6
5.7	161.4	16.1	248.2
6.2	169.8	16.6	248.4
6.6	178.0	17.1	248.6
7.1	185.0	17.6	248.6
7.6	191.6	18.0	248.3
8.1	197.5	18.5	248.2
8.5	202.9	19.0	248.1
9.0	207.9		
9.5	212.2		

Remarks

31/10/2019

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LABORATORY RESULTS - *Unconsolidated Undrained Triaxial Test*

Project: CROWN STREET ZONE 2

Project No: PN194002

Hole	BH101
Sample Depth	4.20-4.65m
Sample Type	U
Sample Ref	N77161





Remarks

31/10/2019

GEOTECHNICS

LABORATORY RESULTS - Unconsolidated Undrained Triaxial Test

Project: CROWN STREET ZONE 2

Project No: PN194002

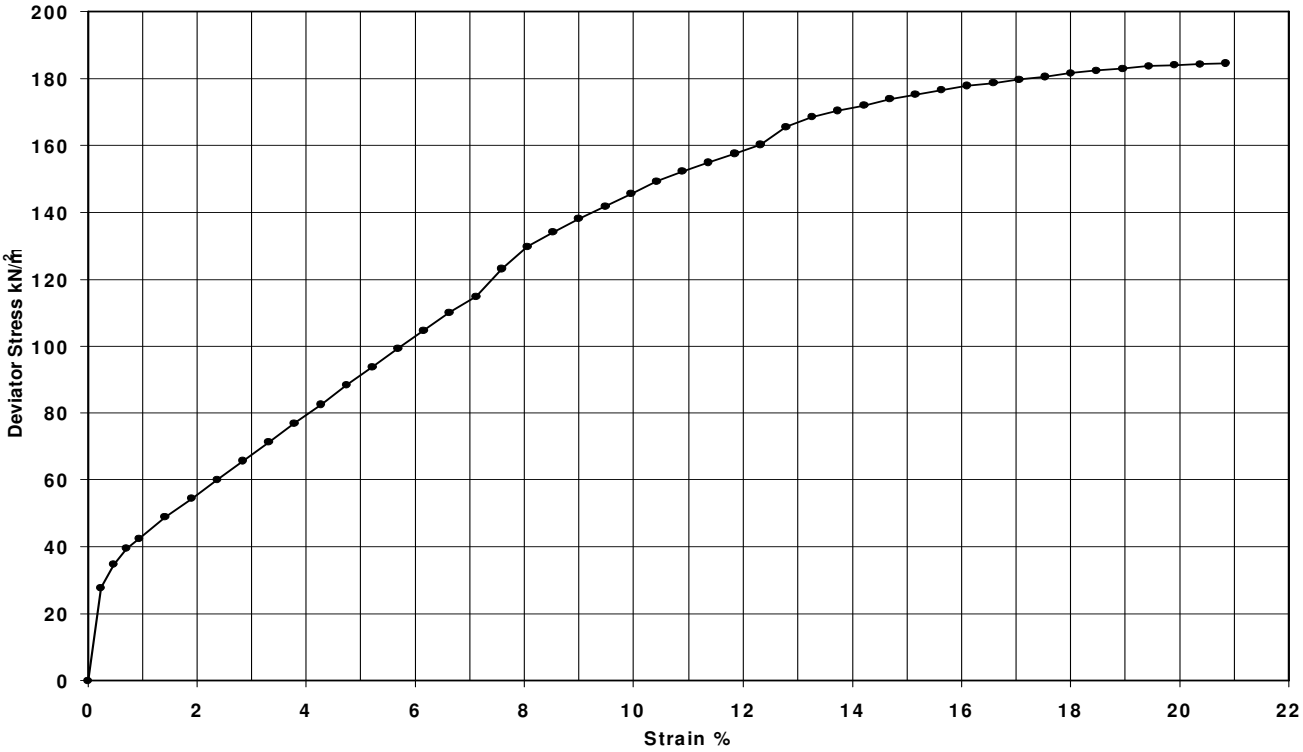
Hole	BH101
Sample Depth	6.20-6.65m
Sample Type	U
Sample Ref	N77162

Sample Description

The following samples were combined to perform this test:

Stiff high strength greyish brown mottled reddish brown slightly sandy slightly gravelly CLAY.

BS EN ISO 17892-8:2018



		Stage 1	Stage 2	Stage 3
Sample Condition		Undisturbed		
Orientation of sample		Vertical		
Initial Diameter	(mm)	100.40		
Initial Length	(mm)	211.01		
Initial Water Content	(%)	19.6		
Initial Bulk Density	(Mg/m³)	2.25		
Initial Dry Density	(Mg/m³)	1.88		
Particle Density	(Mg/m³)	2.65 Assumed		
Cell Pressure	(kPa)	120		
'Specimen Height' at start of Shearing Stage	(mm)	210.79		
Membrane Thickness/Correction	(mm/kPa)			
Rate of Strain	(%/min)	1.3		
Corrected Deviator Stress	(kPa)	184		
Undrained Shear Strength	(kPa)	92		
Strain at Failure	(%)	20 (excess)		
Failure Zone Water Content	(%)			
Water Content (after test)	(%)	16.1		
Mode of Failure		Plastic		

Strain %	Corrected Deviator Stress kN/m²	Strain %	Corrected Deviator Stress kN/m²
0.2	27.8	10.0	145.6
0.5	34.6	10.4	149.2
0.7	39.4	10.9	152.1
0.9	42.4	11.4	154.9
1.4	48.9	11.8	157.6
1.9	54.6	12.3	160.2
2.4	60.1	12.8	165.6
2.8	65.6	13.3	168.6
3.3	71.2	13.7	170.4
3.8	76.8	14.2	172.1
4.3	82.5	14.7	173.8
4.7	88.3	15.2	175.1
5.2	93.8	15.6	176.6
5.7	99.3	16.1	177.7
6.2	104.8	16.6	178.7
6.6	110.0	17.1	179.8
7.1	114.9	17.5	180.6
7.6	123.0	18.0	181.5
8.1	129.9	18.5	182.4
8.5	134.1	19.0	183.0
9.0	138.1	19.4	183.6
9.5	141.7	19.9	184.1

Remarks

31/10/2019

GEOTECHNICS

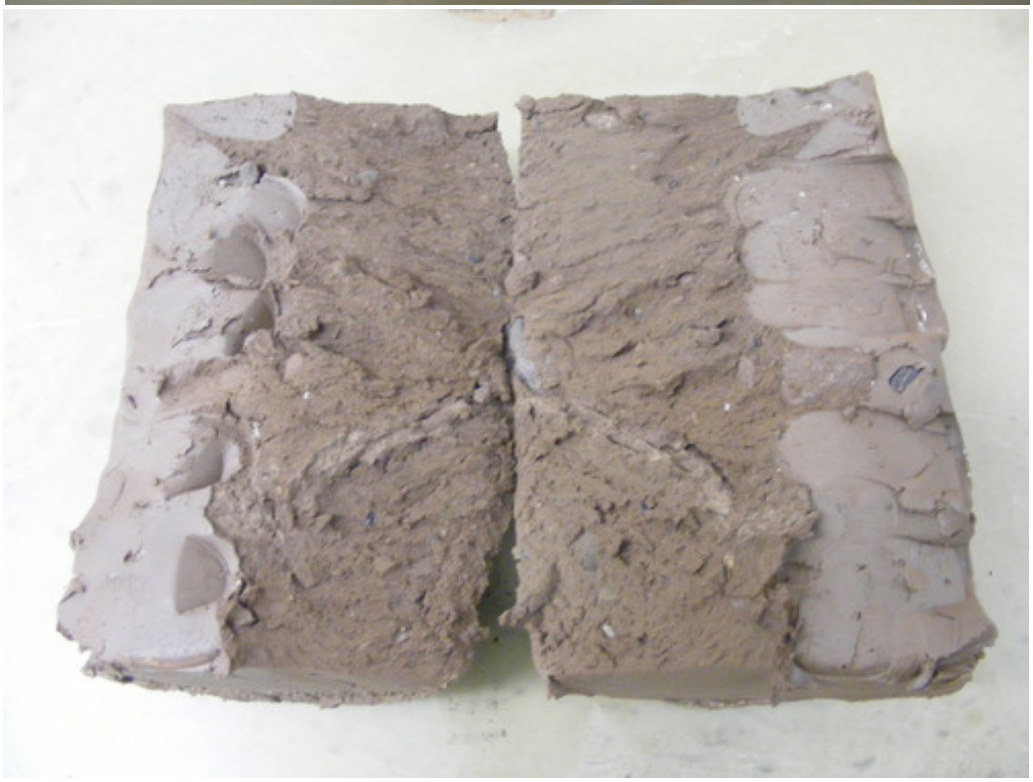
LABORATORY RESULTS - *Unconsolidated Undrained Triaxial Test*

Project: CROWN STREET ZONE 2

Project No: PN194002

Hole	BH101
Sample Depth	6.20-6.65m
Sample Type	U
Sample Ref	N77162





Remarks

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LABORATORY RESULTS - Unconsolidated Undrained Triaxial Test

Project: CROWN STREET ZONE 2

Project No: PN194002

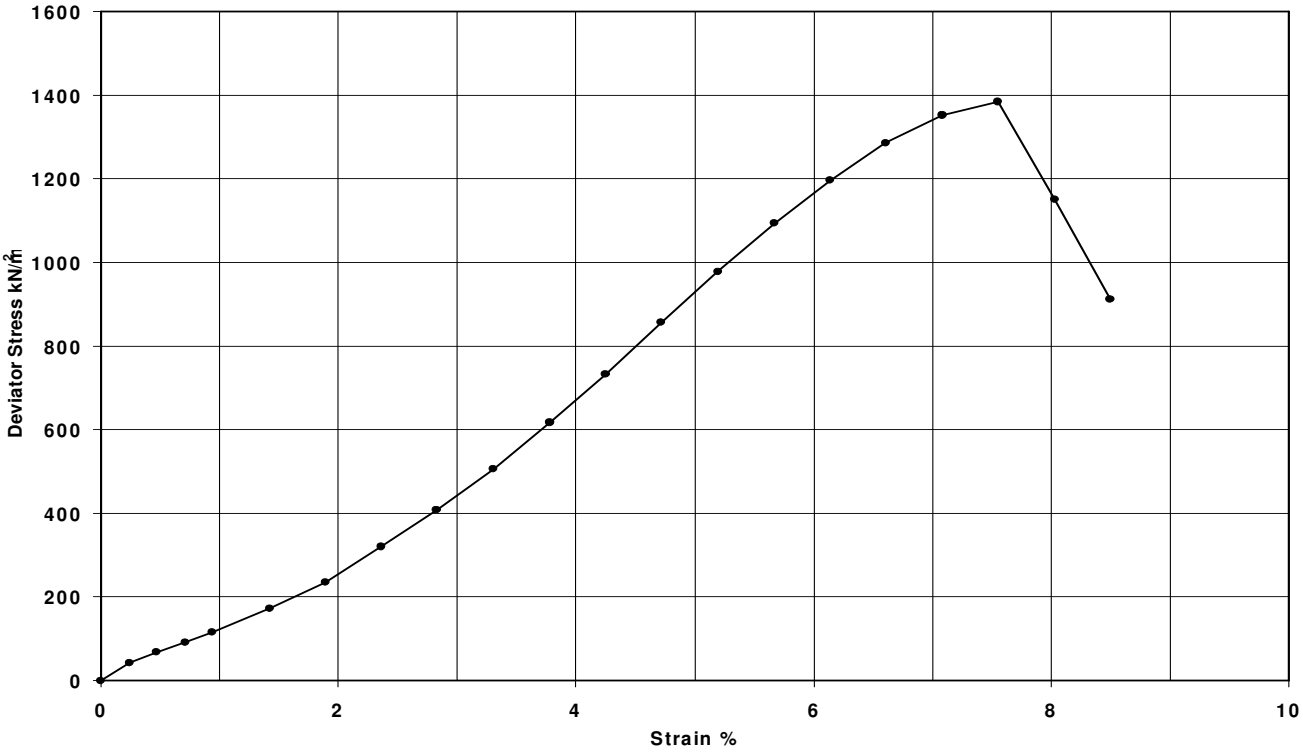
Hole	BH101
Sample Depth	8.20-8.65m
Sample Type	U
Sample Ref	N77163

Sample Description

The following samples were combined to perform this test:

Very stiff extremely high strength greyish brown mottled reddish brown slightly sandy slightly gravelly CLAY.

BS EN ISO 17892-8:2018



		Stage 1	Stage 2	Stage 3
Sample Condition		Undisturbed		
Orientation of sample		Vertical		
Initial Diameter	(mm)	101.91		
Initial Length	(mm)	211.81		
Initial Water Content	(%)	8.5		
Initial Bulk Density	(Mg/m³)	2.36		
Initial Dry Density	(Mg/m³)	2.18		
Particle Density	(Mg/m³)	2.65 Assumed		
Cell Pressure	(kPa)	160		
'Specimen Height' at start of Shearing Stage	(mm)	211.66		
Membrane Thickness/Correction	(mm/kPa)			
Rate of Strain	(%/min)	1.3		
Corrected Deviator Stress	(kPa)	1384		
Undrained Shear Strength	(kPa)	692		
Strain at Failure	(%)	7.6		
Failure Zone Water Content	(%)	7.9		
Water Content (after test)	(%)			
Mode of Failure		Brittle		

Strain %	Corrected Deviator Stress kN/m²	Strain %	Corrected Deviator Stress kN/m²
0.2	42.2		
0.5	69.3		
0.7	92.8		
0.9	115.9		
1.4	174.1		
1.9	234.0		
2.4	321.2		
2.8	408.9		
3.3	506.8		
3.8	616.8		
4.2	732.5		
4.7	856.9		
5.2	978.9		
5.7	1094.7		
6.1	1196.6		
6.6	1286.8		
7.1	1352.4		
7.6	1383.8		
8.0	1151.7		
8.5	912.7		

Remarks

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GEOTECHNICS

LABORATORY RESULTS - *Unconsolidated Undrained Triaxial Test*

Project: CROWN STREET ZONE 2

Project No: PN194002

Hole	BH101
Sample Depth	8.20-8.65m
Sample Type	U
Sample Ref	N77163





Remarks

31/10/2019

GEOTECHNICS

LABORATORY RESULTS - Unconsolidated Undrained Triaxial Test

Project: CROWN STREET ZONE 2

Project No: PN194002

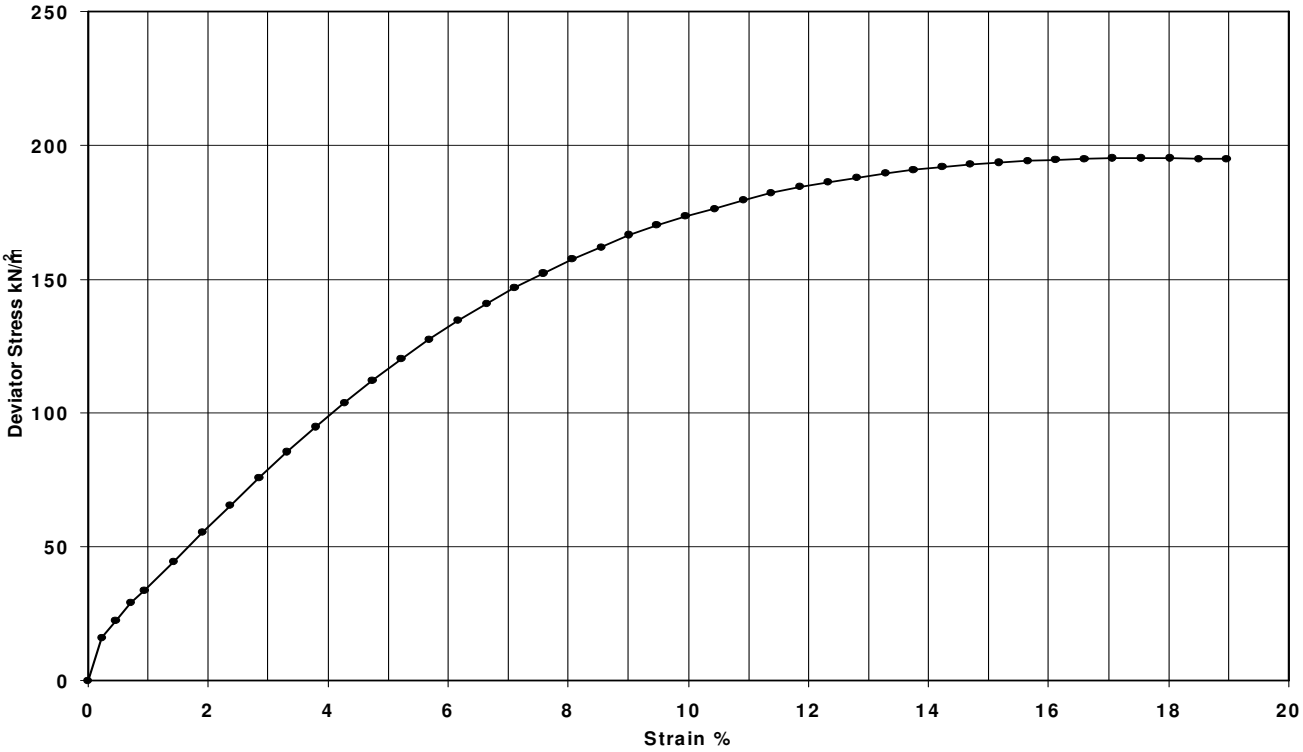
Hole	BH102
Sample Depth	5.20-5.65m
Sample Type	U
Sample Ref	N77190

Sample Description

The following samples were combined to perform this test:

Stiff high strength brown slightly sandy slightly gravelly CLAY.

BS EN ISO 17892-8:2018



		Stage 1	Stage 2	Stage 3
Sample Condition		Undisturbed		
Orientation of sample		Vertical		
Initial Diameter	(mm)	101.81		
Initial Length	(mm)	210.86		
Initial Water Content	(%)	17.9		
Initial Bulk Density	(Mg/m³)	2.17		
Initial Dry Density	(Mg/m³)	1.84		
Particle Density	(Mg/m³)	2.65 Assumed		
Cell Pressure	(kPa)	100		
'Specimen Height' at start of Shearing Stage	(mm)	210.77		
Membrane Thickness/Correction	(mm/kPa)			
Rate of Strain	(%/min)	1.3		
Corrected Deviator Stress	(kPa)	195		
Undrained Shear Strength	(kPa)	98		
Strain at Failure	(%)	17.1		
Failure Zone Water Content	(%)	17.6		
Water Content (after test)	(%)			
Mode of Failure		Plastic		

Strain %	Corrected Deviator Stress kN/m²	Strain %	Corrected Deviator Stress kN/m²
0.2	16.1	10.0	173.5
0.5	22.2	10.4	176.4
0.7	29.1	10.9	179.6
0.9	33.6	11.4	182.2
1.4	44.5	11.9	184.5
1.9	55.3	12.3	186.3
2.4	65.6	12.8	188.0
2.8	75.7	13.3	189.5
3.3	85.5	13.8	190.8
3.8	94.8	14.2	191.9
4.3	103.7	14.7	193.0
4.7	112.1	15.2	193.6
5.2	120.0	15.7	194.3
5.7	127.6	16.1	194.7
6.2	134.5	16.6	195.0
6.6	140.9	17.1	195.3
7.1	146.8	17.5	195.2
7.6	152.4	18.0	195.1
8.1	157.5	18.5	195.1
8.5	162.0	19.0	194.9
9.0	166.4		
9.5	170.2		

Remarks

31/10/2019

GEOTECHNICS

LABORATORY RESULTS - *Unconsolidated Undrained Triaxial Test*

Project: CROWN STREET ZONE 2

Project No: PN194002

Hole	BH102
Sample Depth	5.20-5.65m
Sample Type	U
Sample Ref	N77190





Remarks

31/10/2019

GEOTECHNICS

LABORATORY RESULTS - Unconsolidated Undrained Triaxial Test

Project: CROWN STREET ZONE 2

Project No: PN194002

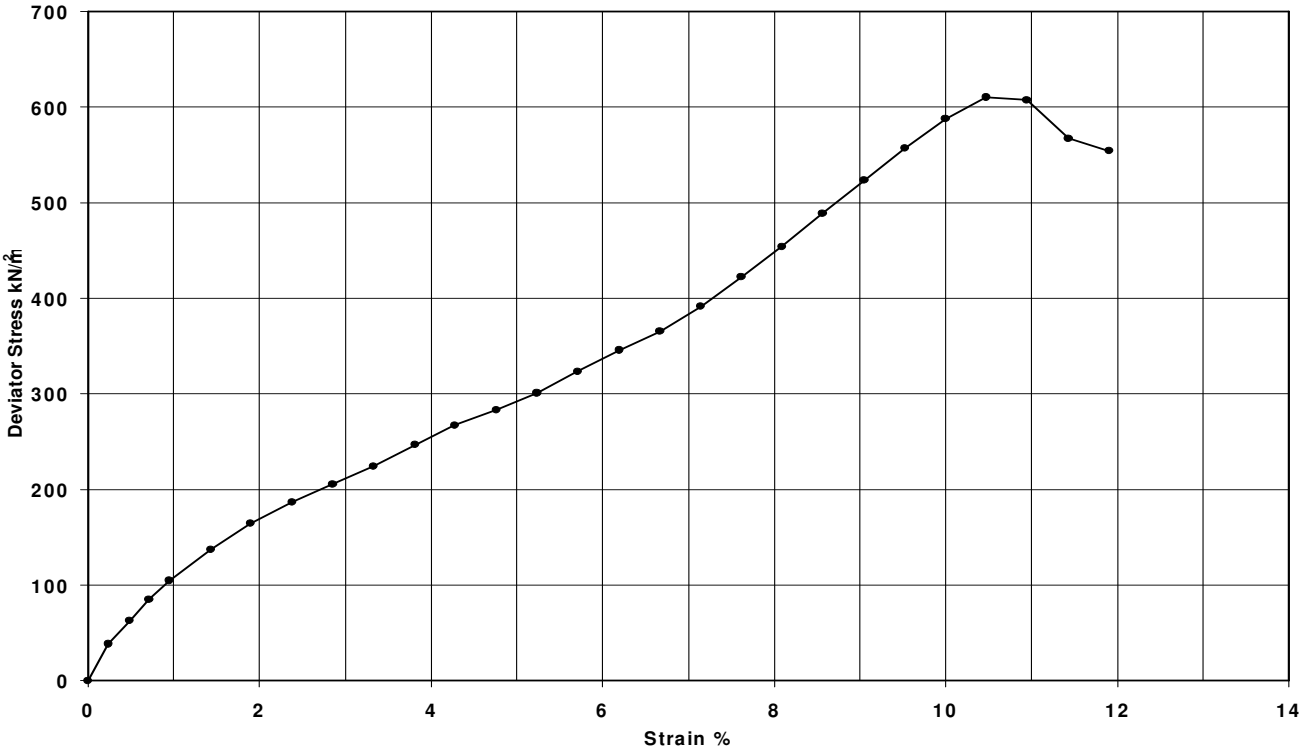
Hole BH102
Sample Depth 7.20-7.65m
Sample Type U
Sample Ref N77191

Sample Description

The following samples were combined to perform this test:

Very stiff extremely high strength brown slightly sandy slightly gravelly CLAY.

BS EN ISO 17892-8:2018



		Stage 1	Stage 2	Stage 3
Sample Condition		Undisturbed		
Orientation of sample		Vertical		
Initial Diameter	(mm)	102.74		
Initial Length	(mm)	210.04		
Initial Water Content	(%)	7.7		
Initial Bulk Density	(Mg/m³)	2.23		
Initial Dry Density	(Mg/m³)	2.07		
Particle Density	(Mg/m³)	2.65 Assumed		
Cell Pressure	(kPa)	140		
'Specimen Height' at start of Shearing Stage	(mm)	209.86		
Membrane Thickness/Correction	(mm/kPa)			
Rate of Strain	(%/min)	1.3		
Corrected Deviator Stress	(kPa)	611		
Undrained Shear Strength	(kPa)	305		
Strain at Failure	(%)	10.5		
Failure Zone Water Content	(%)	8.7		
Water Content (after test)	(%)			
Mode of Failure		Brittle		

Strain %	Corrected Deviator Stress kN/m²	Strain %	Corrected Deviator Stress kN/m²
0.2	38.1	10.0	588.3
0.5	63.0	10.5	610.7
0.7	85.2	11.0	607.8
1.0	104.6	11.4	567.5
1.4	137.0	11.9	554.2
1.9	164.0		
2.4	187.0		
2.9	206.0		
3.3	224.6		
3.8	246.4		
4.3	267.6		
4.8	283.2		
5.2	301.0		
5.7	323.0		
6.2	345.6		
6.7	365.7		
7.1	391.6		
7.6	422.5		
8.1	454.3		
8.6	488.8		
9.0	523.6		
9.5	556.8		

Remarks

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GEOTECHNICS

LABORATORY RESULTS - *Unconsolidated Undrained Triaxial Test*

Project: CROWN STREET ZONE 2

Project No: PN194002

Hole	BH102
Sample Depth	7.20-7.65m
Sample Type	U
Sample Ref	N77191





Remarks

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GEOTECHNICS

LABORATORY RESULTS - Unconsolidated Undrained Triaxial Test

Project: CROWN STREET ZONE 2

Project No: PN194002

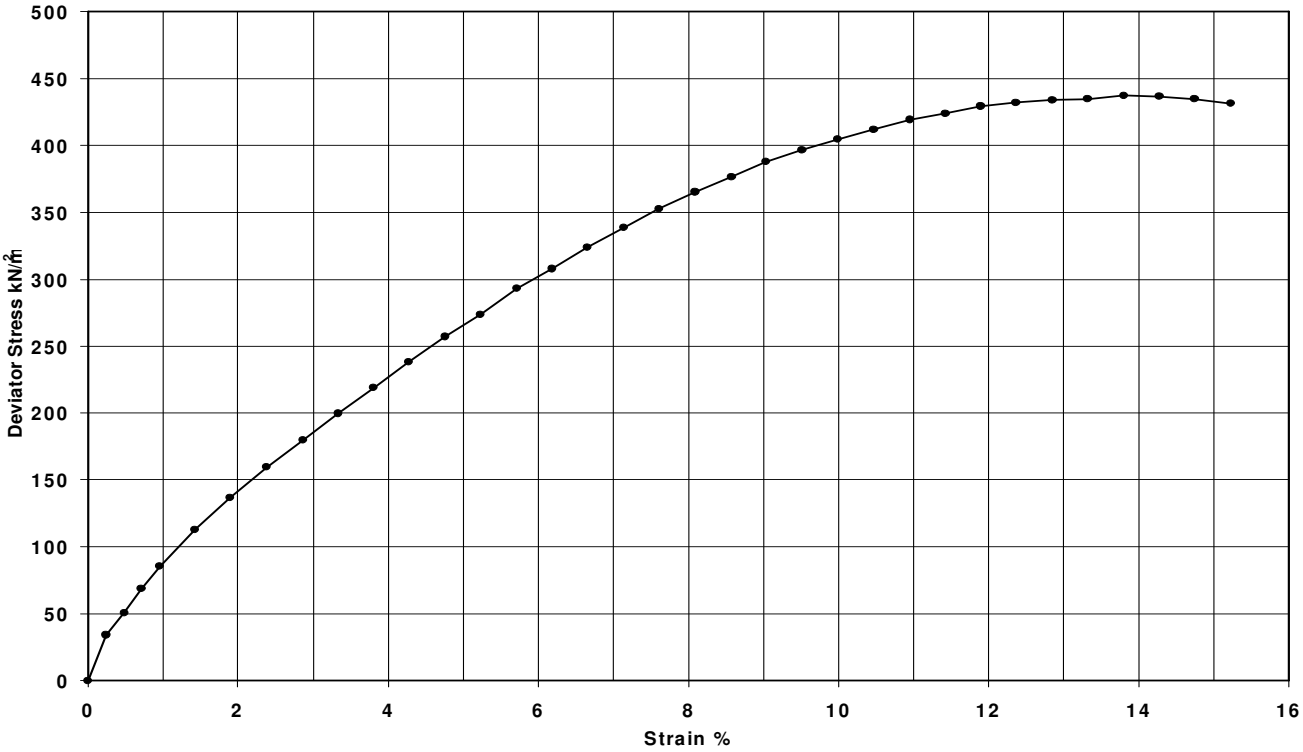
Hole	BH103
Sample Depth	3.20-3.65m
Sample Type	U
Sample Ref	N77193

Sample Description

The following samples were combined to perform this test:

Very stiff very high strength greyish brown slightly sandy slightly gravelly CLAY.

BS EN ISO 17892-8:2018



		Stage 1	Stage 2	Stage 3
Sample Condition		Undisturbed		
Orientation of sample		Vertical		
Initial Diameter	(mm)	102.50		
Initial Length	(mm)	210.14		
Initial Water Content	(%)	14.9		
Initial Bulk Density	(Mg/m³)	2.20		
Initial Dry Density	(Mg/m³)	1.91		
Particle Density	(Mg/m³)	2.65 Assumed		
Cell Pressure	(kPa)	60		
'Specimen Height' at start of Shearing Stage	(mm)	210.11		
Membrane Thickness/Correction	(mm/kPa)			
Rate of Strain	(%/min)	1.3		
Corrected Deviator Stress	(kPa)	437		
Undrained Shear Strength	(kPa)	219		
Strain at Failure	(%)	13.8		
Failure Zone Water Content	(%)	14.5		
Water Content (after test)	(%)			
Mode of Failure		Intermediate		

Strain %	Corrected Deviator Stress kN/m²	Strain %	Corrected Deviator Stress kN/m²
0.2	34.1	10.0	404.7
0.5	50.8	10.5	411.9
0.7	69.1	10.9	419.2
1.0	85.1	11.4	424.1
1.4	112.7	11.9	429.2
1.9	136.8	12.4	432.0
2.4	159.4	12.8	433.8
2.9	179.6	13.3	434.7
3.3	199.4	13.8	437.1
3.8	218.9	14.3	436.5
4.3	238.4	14.8	434.8
4.8	257.3	15.2	431.1
5.2	274.0		
5.7	293.2		
6.2	307.9		
6.7	323.8		
7.1	338.3		
7.6	352.3		
8.1	364.9		
8.6	376.4		
9.0	387.9		
9.5	396.6		

Remarks

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GEOTECHNICS

LABORATORY RESULTS - *Unconsolidated Undrained Triaxial Test*

Project: CROWN STREET ZONE 2

Project No: PN194002

Hole	BH103
Sample Depth	3.20-3.65m
Sample Type	U
Sample Ref	N77193





Remarks

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LABORATORY RESULTS - Unconsolidated Undrained Triaxial Test

Project: CROWN STREET ZONE 2

Project No: PN194002

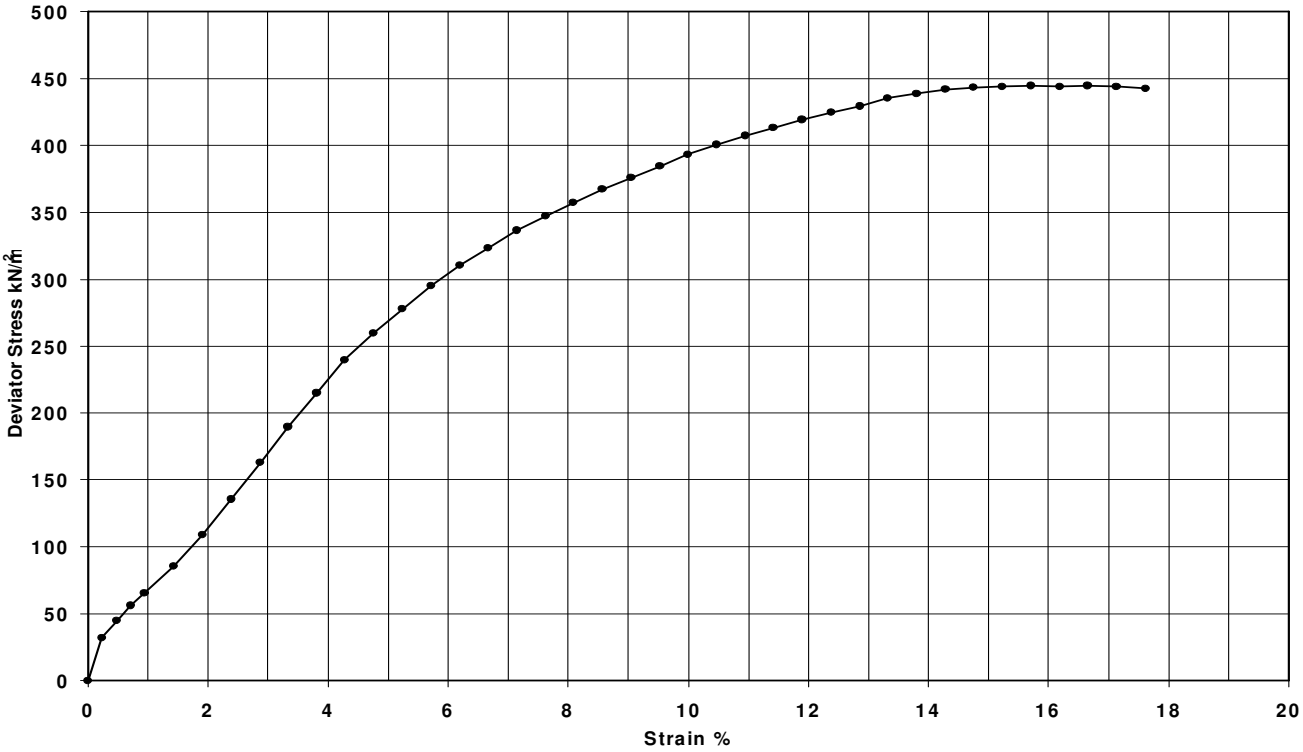
Hole	BH103
Sample Depth	5.20-5.65m
Sample Type	U
Sample Ref	N77196

Sample Description

The following samples were combined to perform this test:

Very stiff very high strength greyish brown slightly sandy slightly gravelly CLAY.

BS EN ISO 17892-8:2018



		Stage 1	Stage 2	Stage 3
Sample Condition		Undisturbed		
Orientation of sample		Vertical		
Initial Diameter	(mm)	102.55		
Initial Length	(mm)	210.11		
Initial Water Content	(%)	11.6		
Initial Bulk Density	(Mg/m³)	2.27		
Initial Dry Density	(Mg/m³)	2.03		
Particle Density	(Mg/m³)	2.65 Assumed		
Cell Pressure	(kPa)	100		
'Specimen Height' at start of Shearing Stage	(mm)	210.07		
Membrane Thickness/Correction	(mm/kPa)			
Rate of Strain	(%/min)	1.3		
Corrected Deviator Stress	(kPa)	445		
Undrained Shear Strength	(kPa)	222		
Strain at Failure	(%)	15.7		
Failure Zone Water Content	(%)	11.5		
Water Content (after test)	(%)			
Mode of Failure		Plastic		

Strain %	Corrected Deviator Stress kN/m²	Strain %	Corrected Deviator Stress kN/m²
0.2	32.0	10.0	393.0
0.5	44.7	10.5	400.3
0.7	55.9	10.9	407.0
1.0	65.3	11.4	413.3
1.4	85.4	11.9	419.1
1.9	108.8	12.4	424.4
2.4	135.6	12.9	429.3
2.9	163.0	13.3	435.1
3.3	189.3	13.8	438.7
3.8	215.3	14.3	442.1
4.3	239.7	14.8	443.3
4.8	259.5	15.2	444.2
5.2	278.0	15.7	444.5
5.7	294.7	16.2	444.2
6.2	310.2	16.7	444.3
6.7	323.4	17.1	443.8
7.1	336.2	17.6	442.5
7.6	347.0		
8.1	357.3		
8.6	367.0		
9.0	376.1		
9.5	384.7		

Remarks

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GEOTECHNICS

LABORATORY RESULTS - Unconsolidated Undrained Triaxial Test

Project: CROWN STREET ZONE 2

Project No: PN194002

Hole	BH103
Sample Depth	5.20-5.65m
Sample Type	U
Sample Ref	N77196





Remarks

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GEOTECHNICS

LABORATORY RESULTS - Unconsolidated Undrained Triaxial Test

Project: CROWN STREET ZONE 2

Project No: PN194002

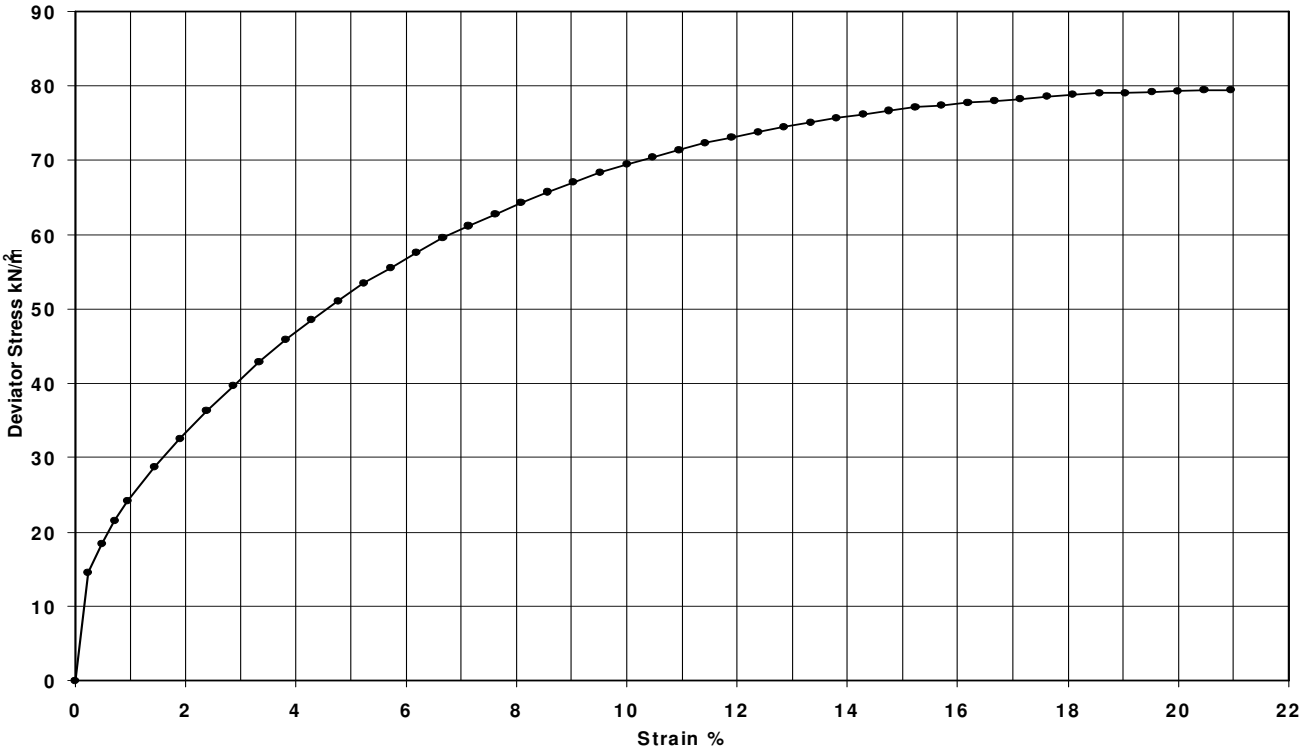
Hole	BH103
Sample Depth	7.20-7.65m
Sample Type	U
Sample Ref	N77596

Sample Description

The following samples were combined to perform this test:

Soft to firm low to medium strength reddish brown slightly gravelly sandy CLAY.

BS EN ISO 17892-8:2018



		Stage 1	Stage 2	Stage 3
Sample Condition		Undisturbed		
Orientation of sample		Vertical		
Initial Diameter	(mm)	102.79		
Initial Length	(mm)	210.07		
Initial Water Content	(%)	11.4		
Initial Bulk Density	(Mg/m³)	2.26		
Initial Dry Density	(Mg/m³)	2.03		
Particle Density	(Mg/m³)	2.65 Assumed		
Cell Pressure	(kPa)	140		
'Specimen Height' at start of Shearing Stage	(mm)	209.87		
Membrane Thickness/Correction	(mm/kPa)			
Rate of Strain	(%/min)	2.0		
Corrected Deviator Stress	(kPa)	79		
Undrained Shear Strength	(kPa)	40		
Strain at Failure	(%)	20 (excess)		
Failure Zone Water Content	(%)			
Water Content (after test)	(%)	11.8		
Mode of Failure		Plastic		

Strain %	Corrected Deviator Stress kN/m²	Strain %	Corrected Deviator Stress kN/m²
0.2	14.6	10.0	69.5
0.5	18.4	10.5	70.5
0.7	21.5	10.9	71.4
1.0	24.1	11.4	72.3
1.4	28.7	11.9	73.1
1.9	32.6	12.4	73.8
2.4	36.3	12.9	74.5
2.9	39.6	13.3	75.1
3.3	42.8	13.8	75.7
3.8	45.9	14.3	76.2
4.3	48.6	14.8	76.7
4.8	51.1	15.2	77.1
5.2	53.4	15.7	77.4
5.7	55.5	16.2	77.7
6.2	57.5	16.7	78.0
6.7	59.5	17.1	78.2
7.1	61.2	17.6	78.6
7.6	62.8	18.1	78.8
8.1	64.3	18.6	79.0
8.6	65.8	19.0	79.1
9.0	67.1	19.5	79.2
9.5	68.3	20.0	79.3

Remarks

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GEOTECHNICS

LABORATORY RESULTS - *Unconsolidated Undrained Triaxial Test*

Project: CROWN STREET ZONE 2

Project No: PN194002

Hole	BH103
Sample Depth	7.20-7.65m
Sample Type	U
Sample Ref	N77596





Remarks

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GEOTECHNICS

LABORATORY RESULTS - Unconsolidated Undrained Triaxial Test

Project: CROWN STREET ZONE 2

Project No: PN194002

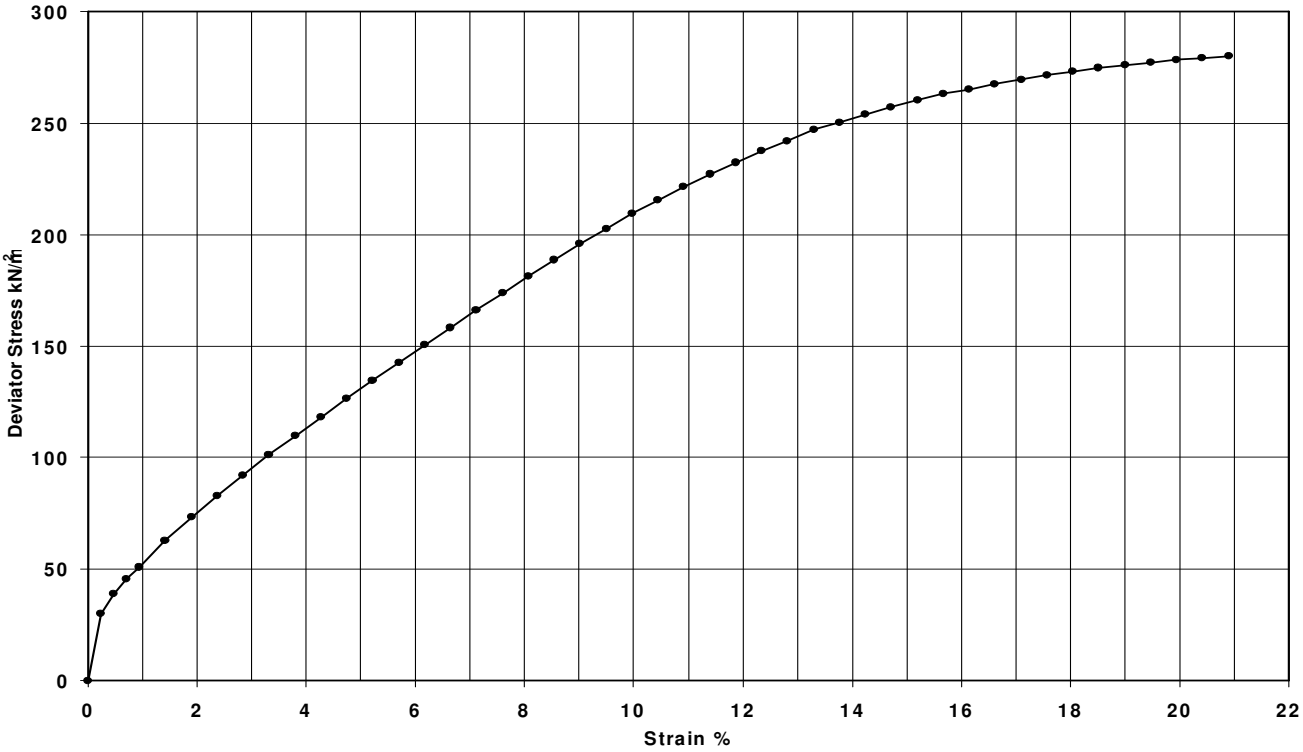
Hole	BH104
Sample Depth	3.20-3.65m
Sample Type	UT
Sample Ref	N77167

Sample Description

The following samples were combined to perform this test:

Stiff high strength greyish brown slightly sandy slightly gravelly CLAY with occasional thin laminae of sand.

BS EN ISO 17892-8:2018



		Stage 1	Stage 2	Stage 3
Sample Condition		Undisturbed		
Orientation of sample		Vertical		
Initial Diameter	(mm)	102.26		
Initial Length	(mm)	210.54		
Initial Water Content	(%)	17.9		
Initial Bulk Density	(Mg/m³)	2.21		
Initial Dry Density	(Mg/m³)	1.88		
Particle Density	(Mg/m³)	2.65 Assumed		
Cell Pressure	(kPa)	60		
'Specimen Height' at start of Shearing Stage	(mm)	210.28		
Membrane Thickness/Correction	(mm/kPa)			
Rate of Strain	(%/min)	1.3		
Corrected Deviator Stress	(kPa)	278		
Undrained Shear Strength	(kPa)	139		
Strain at Failure	(%)	20 (excess)		
Failure Zone Water Content	(%)			
Water Content (after test)	(%)	15.5		
Mode of Failure		Plastic		

Strain %	Corrected Deviator Stress kN/m²	Strain %	Corrected Deviator Stress kN/m²
0.2	29.9	10.0	209.4
0.5	38.7	10.4	215.7
0.7	45.6	10.9	221.5
0.9	51.0	11.4	226.9
1.4	62.9	11.9	232.4
1.9	73.3	12.3	237.3
2.4	82.9	12.8	242.0
2.8	92.2	13.3	247.1
3.3	101.4	13.8	250.2
3.8	109.8	14.2	253.9
4.3	118.3	14.7	257.1
4.7	126.5	15.2	260.3
5.2	134.5	15.7	263.0
5.7	142.4	16.1	265.3
6.2	150.5	16.6	267.4
6.6	158.4	17.1	269.4
7.1	166.2	17.6	271.4
7.6	173.8	18.0	273.0
8.1	181.4	18.5	274.7
8.5	188.7	19.0	276.0
9.0	196.0	19.5	277.3
9.5	202.8	19.9	278.2

Remarks

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GEOTECHNICS

LABORATORY RESULTS - Unconsolidated Undrained Triaxial Test

Project: CROWN STREET ZONE 2

Project No: PN194002

Hole	BH104
Sample Depth	3.20-3.65m
Sample Type	UT
Sample Ref	N77167





Remarks

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GEOTECHNICS

LABORATORY RESULTS - Unconsolidated Undrained Triaxial Test

Project: CROWN STREET ZONE 2

Project No: PN194002

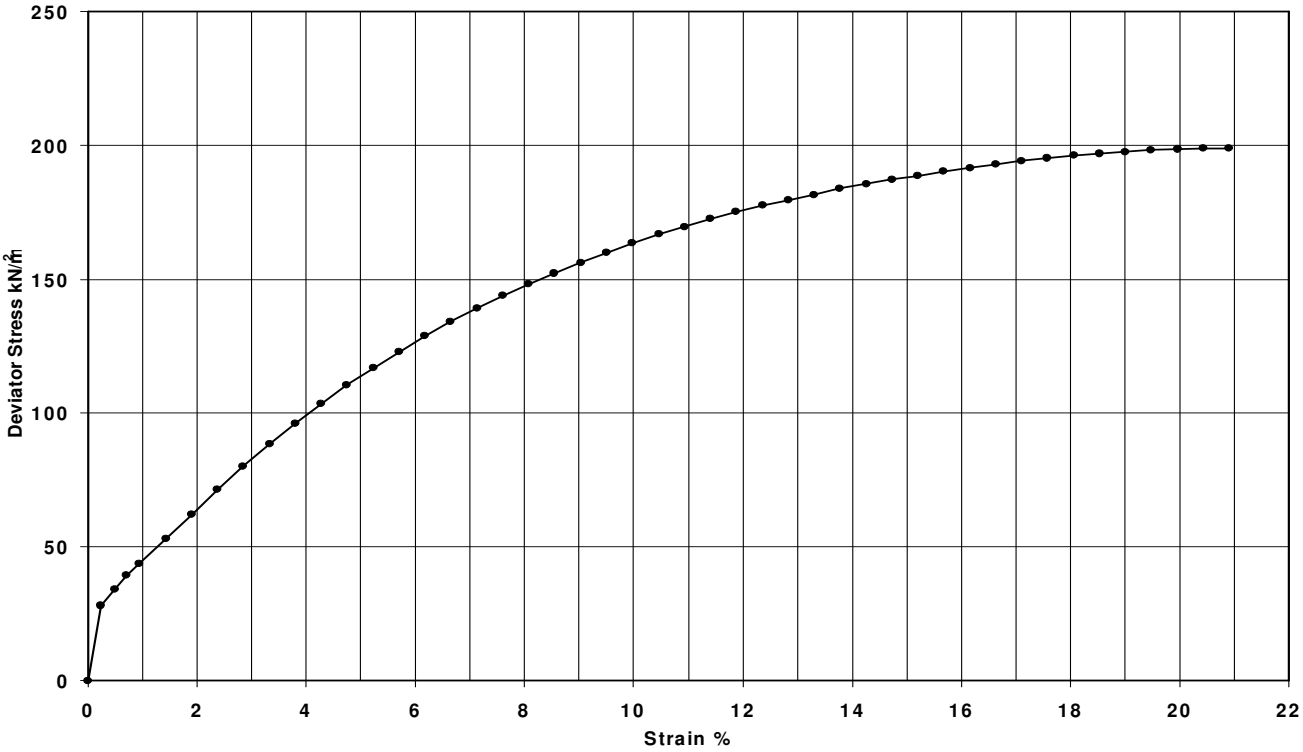
Hole BH105
Sample Depth 3.20-3.65m
Sample Type U
Sample Ref N77197

Sample Description

The following samples were combined to perform this test:

Stiff high strength greyish brown slightly sandy slightly gravelly CLAY.

BS EN ISO 17892-8:2018



		Stage 1	Stage 2	Stage 3
Sample Condition		Undisturbed		
Orientation of sample		Vertical		
Initial Diameter	(mm)	102.43		
Initial Length	(mm)	210.42		
Initial Water Content	(%)	17.5		
Initial Bulk Density	(Mg/m³)	2.18		
Initial Dry Density	(Mg/m³)	1.86		
Particle Density	(Mg/m³)	2.65 Assumed		
Cell Pressure	(kPa)	60		
'Specimen Height' at start of Shearing Stage	(mm)	210.33		
Membrane Thickness/Correction	(mm/kPa)			
Rate of Strain	(%/min)	1.3		
Corrected Deviator Stress	(kPa)	199		
Undrained Shear Strength	(kPa)	99		
Strain at Failure	(%)	20 (excess)		
Failure Zone Water Content	(%)			
Water Content (after test)	(%)	12.2		
Mode of Failure		Plastic		

Strain %	Corrected Deviator Stress kN/m²	Strain %	Corrected Deviator Stress kN/m²
0.2	28.2	10.0	163.4
0.5	34.2	10.5	166.7
0.7	39.3	10.9	169.7
1.0	43.9	11.4	172.4
1.4	53.0	11.9	175.2
1.9	62.2	12.4	177.4
2.4	71.4	12.8	179.7
2.9	80.0	13.3	181.7
3.3	88.3	13.8	183.8
3.8	96.2	14.3	185.5
4.3	103.5	14.7	187.1
4.8	110.5	15.2	188.6
5.2	116.8	15.7	190.2
5.7	123.0	16.2	191.6
6.2	128.7	16.6	192.8
6.7	134.1	17.1	194.1
7.1	139.0	17.6	195.3
7.6	143.8	18.1	196.3
8.1	148.3	18.5	197.0
8.6	152.3	19.0	197.6
9.0	156.2	19.5	198.2
9.5	160.0	20.0	198.6

Remarks

31/10/2019

GEOTECHNICS

LABORATORY RESULTS - *Unconsolidated Undrained Triaxial Test*

Project: CROWN STREET ZONE 2

Project No: PN194002

Hole	BH105
Sample Depth	3.20-3.65m
Sample Type	U
Sample Ref	N77197





Remarks

31/10/2019

GEOTECHNICS

LABORATORY RESULTS - Unconsolidated Undrained Triaxial Test

Project: CROWN STREET ZONE 2

Project No: PN194002

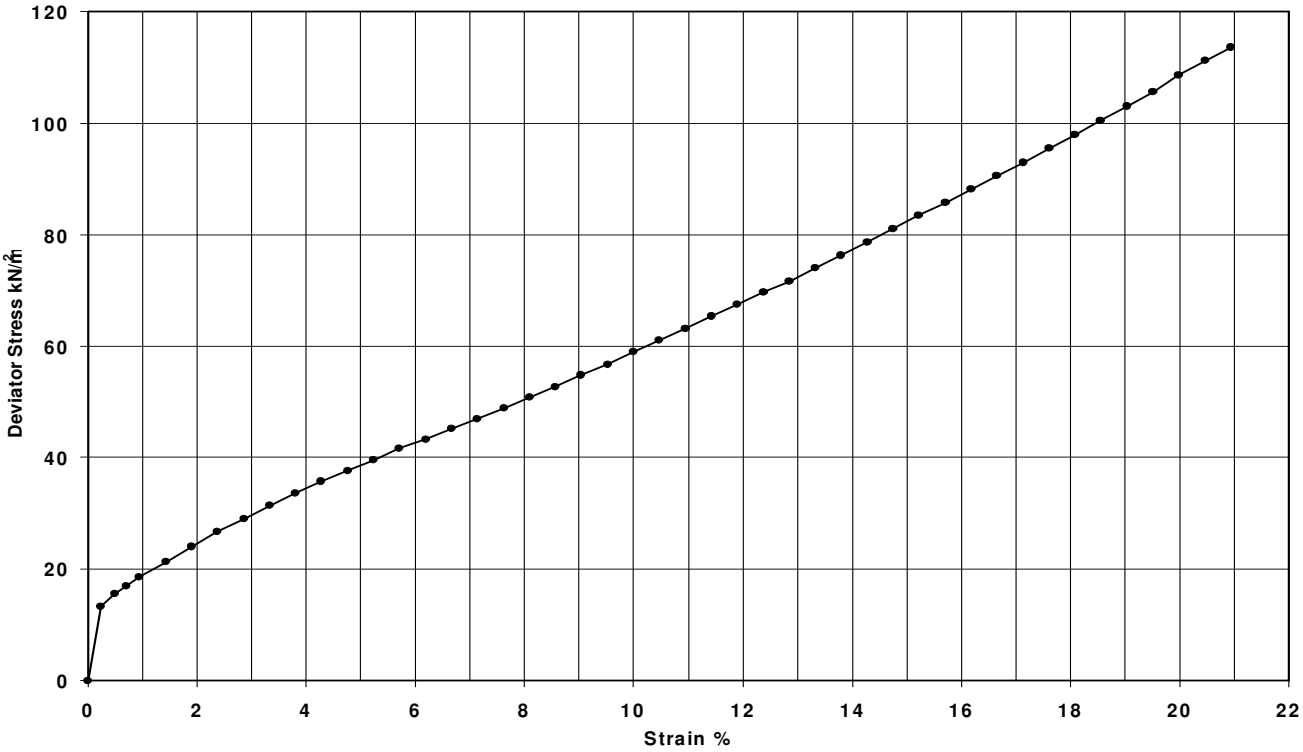
Hole	BH106
Sample Depth	5.20-5.65m
Sample Type	U
Sample Ref	N77203

Sample Description

The following samples were combined to perform this test:

Firm medium strength greyish brown slightly sandy slightly gravelly SILT.

BS EN ISO 17892-8:2018



		Stage 1	Stage 2	Stage 3
Sample Condition		Undisturbed		
Orientation of sample		Vertical		
Initial Diameter	(mm)	103.24		
Initial Length	(mm)	210.09		
Initial Water Content	(%)	15.7		
Initial Bulk Density	(Mg/m³)	2.13		
Initial Dry Density	(Mg/m³)	1.84		
Particle Density	(Mg/m³)	2.65 Assumed		
Cell Pressure	(kPa)	100		
'Specimen Height' at start of Shearing Stage	(mm)	210.07		
Membrane Thickness/Correction	(mm/kPa)			
Rate of Strain	(%/min)	1.3		
Corrected Deviator Stress	(kPa)	109		
Undrained Shear Strength	(kPa)	54		
Strain at Failure	(%)	20 (excess)		
Failure Zone Water Content	(%)			
Water Content (after test)	(%)	15.7		
Mode of Failure		Plastic		

Strain %	Corrected Deviator Stress kN/m²	Strain %	Corrected Deviator Stress kN/m²
0.2	13.2	10.0	59.0
0.5	15.6	10.5	61.0
0.7	17.0	10.9	63.2
1.0	18.6	11.4	65.3
1.4	21.4	11.9	67.4
1.9	24.1	12.4	69.6
2.4	26.7	12.9	71.7
2.9	29.0	13.3	74.0
3.3	31.3	13.8	76.2
3.8	33.6	14.3	78.6
4.3	35.7	14.8	81.0
4.8	37.7	15.2	83.5
5.2	39.6	15.7	85.7
5.7	41.6	16.2	88.1
6.2	43.2	16.7	90.5
6.7	45.1	17.1	92.9
7.1	47.0	17.6	95.4
7.6	48.8	18.1	97.8
8.1	50.8	18.6	100.5
8.6	52.8	19.0	103.0
9.0	54.8	19.5	105.6
9.5	56.8	20.0	108.5

Remarks

31/10/2019

GEOTECHNICS

LABORATORY RESULTS - Unconsolidated Undrained Triaxial Test

Project: CROWN STREET ZONE 2

Project No: PN194002

Hole	BH106
Sample Depth	5.20-5.65m
Sample Type	U
Sample Ref	N77203





Remarks

31/10/2019

GEOTECHNICS

LABORATORY RESULTS - Unconsolidated Undrained Triaxial Test

Project: CROWN STREET ZONE 2

Project No: PN194002

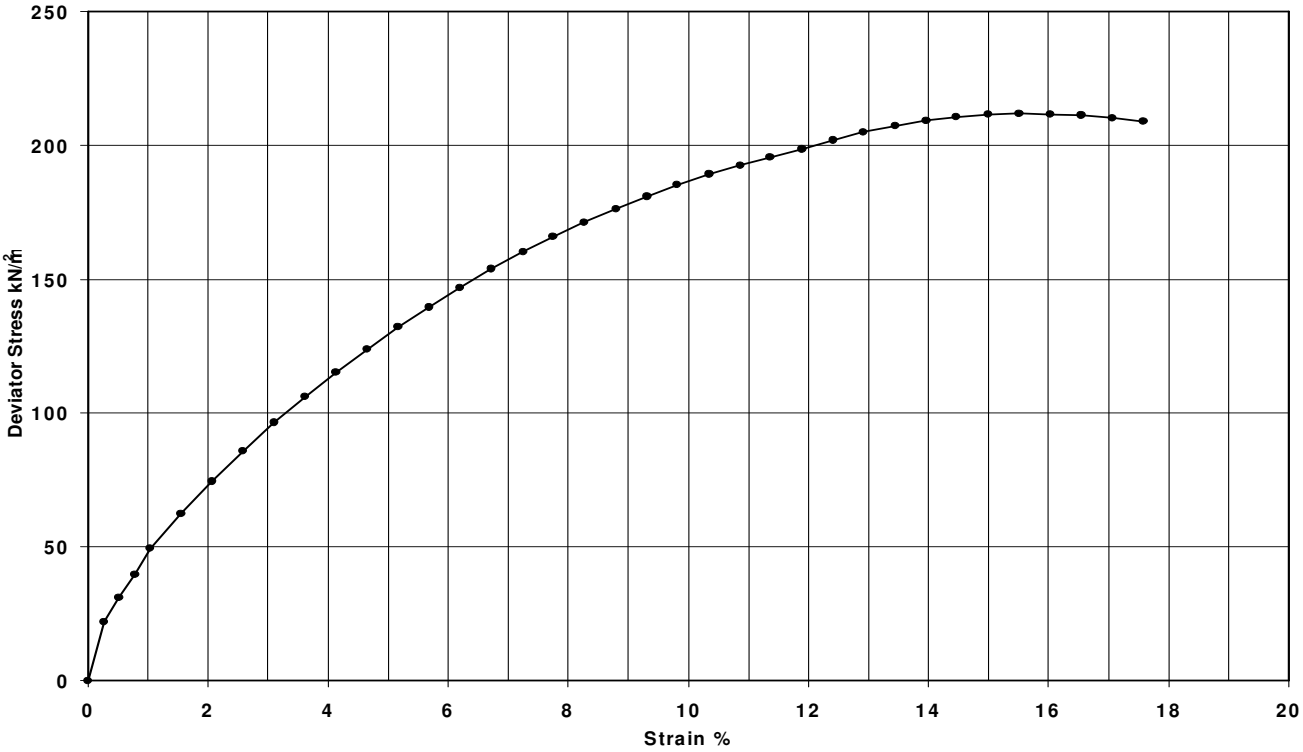
Hole BH107
Sample Depth 5.20-5.65m
Sample Type UT
Sample Ref N77174

Sample Description

The following samples were combined to perform this test:

Stiff high strength brown slightly sandy slightly gravelly CLAY.

BS EN ISO 17892-8:2018



		Stage 1	Stage 2	Stage 3
Sample Condition		Undisturbed		
Orientation of sample		Vertical		
Initial Diameter	(mm)	102.81		
Initial Length	(mm)	193.44		
Initial Water Content	(%)	11.9		
Initial Bulk Density	(Mg/m³)	2.14		
Initial Dry Density	(Mg/m³)	1.91		
Particle Density	(Mg/m³)	2.65 Assumed		
Cell Pressure	(kPa)	100		
'Specimen Height' at start of Shearing Stage	(mm)	193.41		
Membrane Thickness/Correction	(mm/kPa)			
Rate of Strain	(%/min)	1.3		
Corrected Deviator Stress	(kPa)	212		
Undrained Shear Strength	(kPa)	106		
Strain at Failure	(%)	15.5		
Failure Zone Water Content	(%)	14.9		
Water Content (after test)	(%)			
Mode of Failure		Plastic		

Strain %	Corrected Deviator Stress kN/m²	Strain %	Corrected Deviator Stress kN/m²
0.3	22.0	10.9	192.7
0.5	31.1	11.4	195.5
0.8	39.8	11.9	198.6
1.0	49.3	12.4	201.9
1.6	62.3	12.9	204.9
2.1	74.3	13.4	207.4
2.6	85.9	14.0	209.4
3.1	96.4	14.5	210.7
3.6	106.1	15.0	211.6
4.1	115.2	15.5	211.9
4.7	123.8	16.0	211.5
5.2	132.1	16.5	211.2
5.7	139.5	17.1	210.3
6.2	146.9	17.6	208.9
6.7	153.9		
7.2	160.2		
7.8	165.8		
8.3	171.4		
8.8	176.3		
9.3	181.0		
9.8	185.3		
10.3	189.2		

Remarks

31/10/2019

GEOTECHNICS

LABORATORY RESULTS - *Unconsolidated Undrained Triaxial Test*

Project: CROWN STREET ZONE 2

Project No: PN194002

Hole	BH107
Sample Depth	5.20-5.65m
Sample Type	UT
Sample Ref	N77174





Remarks

31/10/2019

GEOTECHNICS

LABORATORY RESULTS - Unconsolidated Undrained Triaxial Test

Project: CROWN STREET ZONE 2

Project No: PN194002

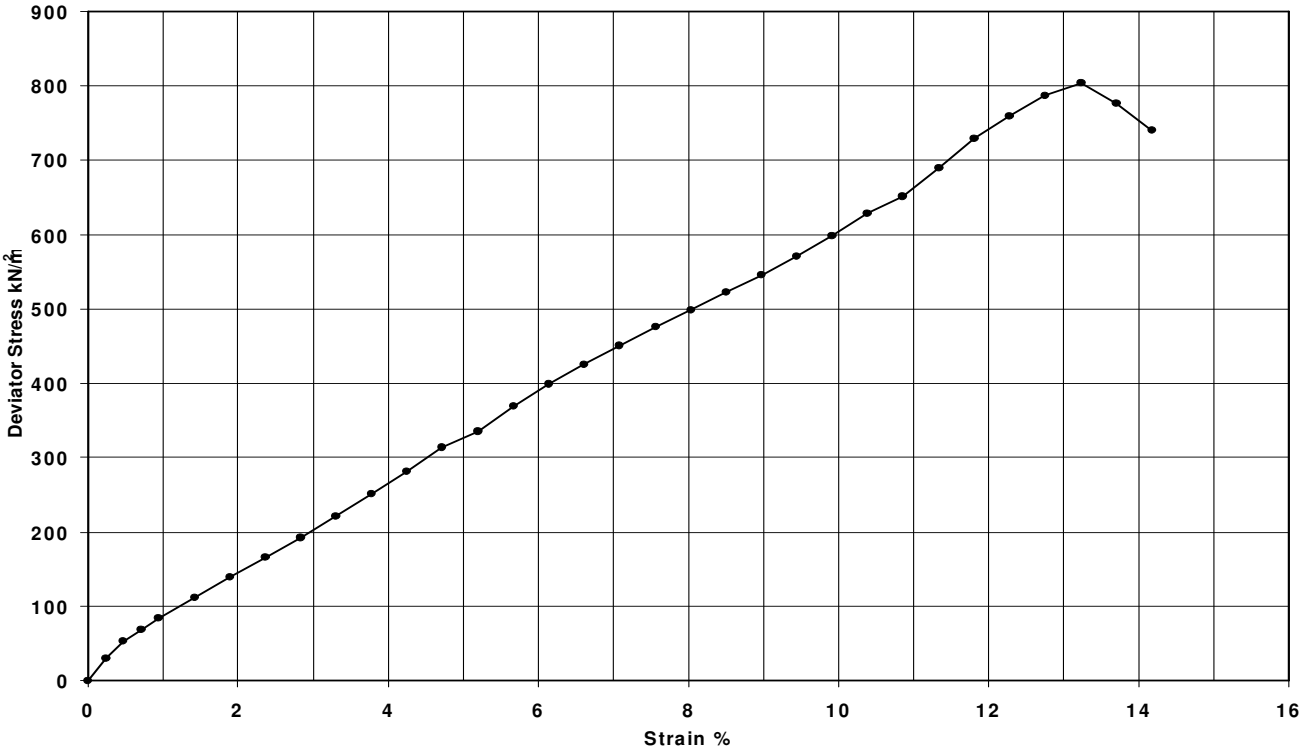
Hole	BH107
Sample Depth	7.20-7.65m
Sample Type	UT
Sample Ref	N77175

Sample Description

The following samples were combined to perform this test:

Very stiff extremely high strength brown slightly sandy slightly gravelly SILT.

BS EN ISO 17892-8:2018



		Stage 1	Stage 2	Stage 3
Sample Condition		Undisturbed		
Orientation of sample		Vertical		
Initial Diameter	(mm)	101.92		
Initial Length	(mm)	211.72		
Initial Water Content	(%)	12.9		
Initial Bulk Density	(Mg/m³)	2.34		
Initial Dry Density	(Mg/m³)	2.07		
Particle Density	(Mg/m³)	2.65 Assumed		
Cell Pressure	(kPa)	140		
'Specimen Height' at start of Shearing Stage	(mm)	211.41		
Membrane Thickness/Correction	(mm/kPa)			
Rate of Strain	(%/min)	1.3		
Corrected Deviator Stress	(kPa)	803		
Undrained Shear Strength	(kPa)	402		
Strain at Failure	(%)	13.2		
Failure Zone Water Content	(%)	10.0		
Water Content (after test)	(%)			
Mode of Failure		Intermediate		

Strain %	Corrected Deviator Stress kN/m²	Strain %	Corrected Deviator Stress kN/m²
0.2	29.6	9.9	598.9
0.5	53.2	10.4	628.2
0.7	69.0	10.9	651.2
0.9	84.2	11.3	689.9
1.4	111.8	11.8	729.0
1.9	139.4	12.3	759.7
2.4	165.7	12.8	786.6
2.8	192.3	13.2	803.5
3.3	220.9	13.7	776.6
3.8	250.5	14.2	740.5
4.3	281.7		
4.7	313.3		
5.2	335.7		
5.7	368.9		
6.1	398.7		
6.6	425.4		
7.1	450.9		
7.6	475.8		
8.0	498.3		
8.5	522.4		
9.0	545.7		
9.4	570.8		

Remarks

31/10/2019

GEOTECHNICS

LABORATORY RESULTS - *Unconsolidated Undrained Triaxial Test*

Project: CROWN STREET ZONE 2

Project No: PN194002

Hole	BH107
Sample Depth	7.20-7.65m
Sample Type	UT
Sample Ref	N77175





Remarks

31/10/2019

GEOTECHNICS

LABORATORY RESULTS - Unconsolidated Undrained Triaxial Test

Project: CROWN STREET ZONE 2

Project No: PN194002

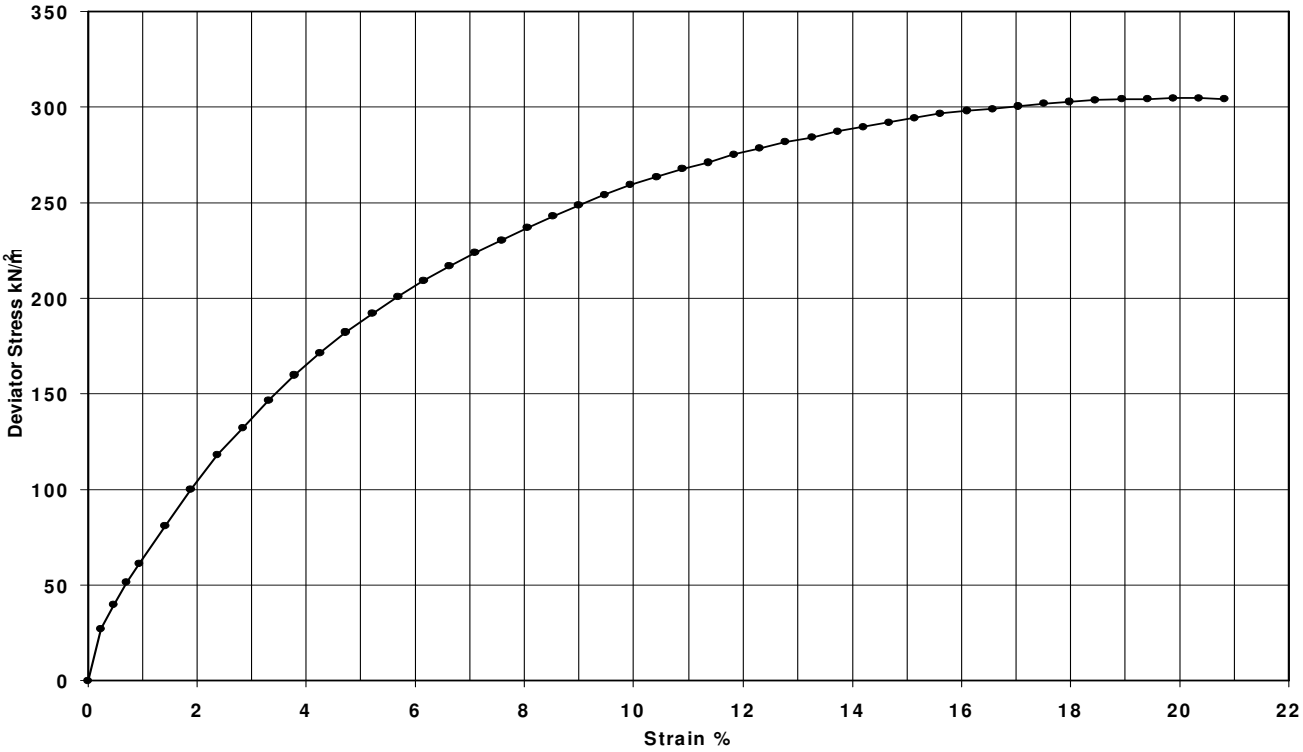
Hole	BH108
Sample Depth	3.20-3.65m
Sample Type	U
Sample Ref	N77177

Sample Description

The following samples were combined to perform this test:

Very stiff very high strength brown slightly sandy slightly gravelly SILT.

BS EN ISO 17892-8:2018



		Stage 1	Stage 2	Stage 3
Sample Condition		Undisturbed		
Orientation of sample		Vertical		
Initial Diameter	(mm)	99.30		
Initial Length	(mm)	211.22		
Initial Water Content	(%)	14.0		
Initial Bulk Density	(Mg/m³)	2.21		
Initial Dry Density	(Mg/m³)	1.94		
Particle Density	(Mg/m³)	2.65 Assumed		
Cell Pressure	(kPa)	60		
'Specimen Height' at start of Shearing Stage	(mm)	211.11		
Membrane Thickness/Correction	(mm/kPa)			
Rate of Strain	(%/min)	1.3		
Corrected Deviator Stress	(kPa)	304		
Undrained Shear Strength	(kPa)	152		
Strain at Failure	(%)	20 (excess)		
Failure Zone Water Content	(%)			
Water Content (after test)	(%)	15.6		
Mode of Failure		Plastic		

Strain %	Corrected Deviator Stress kN/m²	Strain %	Corrected Deviator Stress kN/m²
0.2	27.1	9.9	259.2
0.5	39.6	10.4	263.5
0.7	51.6	10.9	267.5
0.9	61.3	11.4	271.3
1.4	80.8	11.8	275.0
1.9	99.9	12.3	278.6
2.4	118.2	12.8	281.7
2.8	132.1	13.3	284.3
3.3	146.6	13.7	287.2
3.8	159.9	14.2	289.5
4.3	171.4	14.7	292.2
4.7	182.1	15.2	294.4
5.2	191.9	15.6	296.7
5.7	200.8	16.1	298.1
6.2	209.1	16.6	299.3
6.6	216.9	17.0	300.5
7.1	223.9	17.5	301.8
7.6	230.5	18.0	302.7
8.0	236.9	18.5	303.7
8.5	242.9	18.9	304.1
9.0	248.6	19.4	304.4
9.5	254.1	19.9	304.4

Remarks

31/10/2019

GEOTECHNICS

LABORATORY RESULTS - Unconsolidated Undrained Triaxial Test

Project: CROWN STREET ZONE 2

Project No: PN194002

Hole	BH108
Sample Depth	3.20-3.65m
Sample Type	U
Sample Ref	N77177





Remarks

31/10/2019

GEOTECHNICS

LABORATORY RESULTS - Unconsolidated Undrained Triaxial Test

Project: CROWN STREET ZONE 2

Project No: PN194002

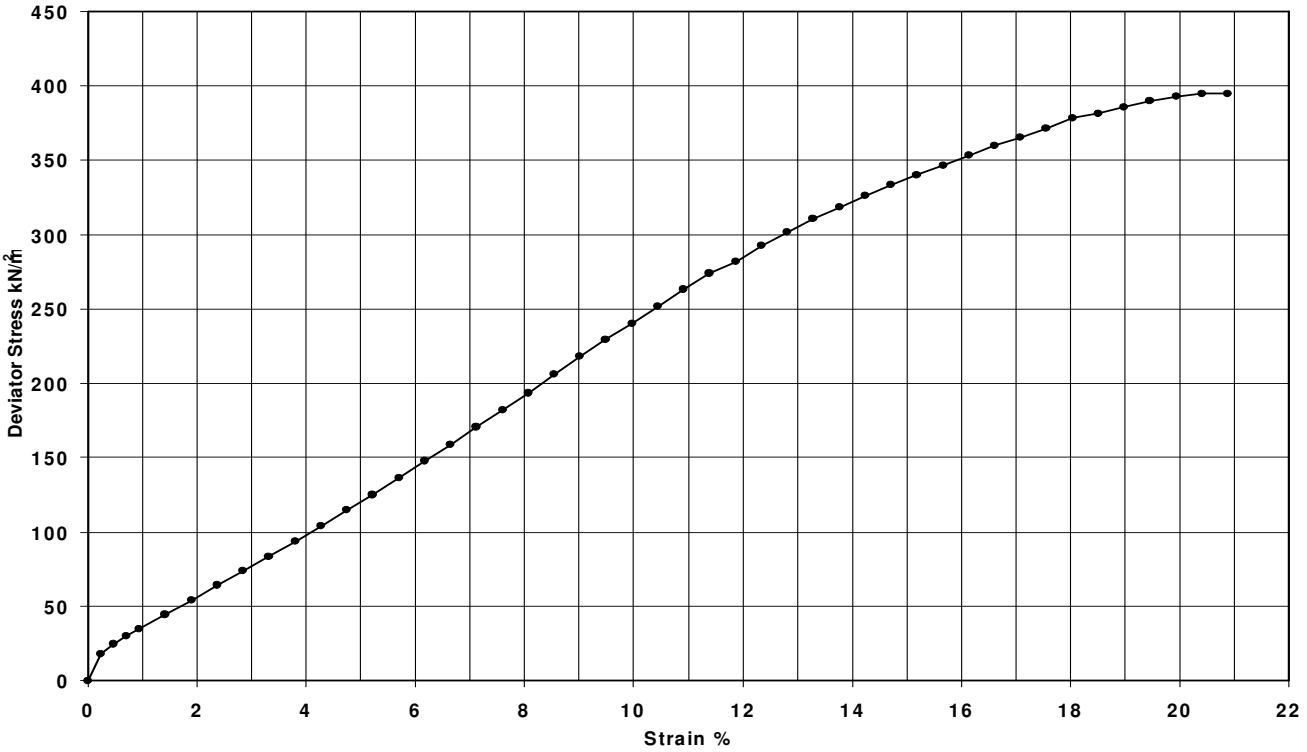
Hole BH108
Sample Depth 5.20-5.65m
Sample Type U
Sample Ref N77178

Sample Description

The following samples were combined to perform this test:

Very stiff very high strength brown slightly gravelly sandy CLAY.

BS EN ISO 17892-8:2018



		Stage 1	Stage 2	Stage 3
Sample Condition		Undisturbed		
Orientation of sample		Vertical		
Initial Diameter	(mm)	102.15		
Initial Length	(mm)	210.65		
Initial Water Content	(%)	12.4		
Initial Bulk Density	(Mg/m³)	2.28		
Initial Dry Density	(Mg/m³)	2.03		
Particle Density	(Mg/m³)	2.65 Assumed		
Cell Pressure	(kPa)	100		
'Specimen Height' at start of Shearing Stage	(mm)	210.44		
Membrane Thickness/Correction	(mm/kPa)			
Rate of Strain	(%/min)	1.3		
Corrected Deviator Stress	(kPa)	393		
Undrained Shear Strength	(kPa)	196		
Strain at Failure	(%)	20 (excess)		
Failure Zone Water Content	(%)			
Water Content (after test)	(%)	11.8		
Mode of Failure		Plastic		

Strain %	Corrected Deviator Stress kN/m²	Strain %	Corrected Deviator Stress kN/m²
0.2	18.2	10.0	240.5
0.5	24.8	10.4	251.8
0.7	30.2	10.9	263.0
0.9	35.1	11.4	273.7
1.4	44.8	11.9	281.7
1.9	54.3	12.3	292.9
2.4	64.1	12.8	301.6
2.8	73.7	13.3	310.6
3.3	83.5	13.8	318.5
3.8	93.7	14.2	326.1
4.3	103.8	14.7	333.2
4.7	114.6	15.2	340.2
5.2	125.2	15.7	346.6
5.7	136.3	16.1	353.5
6.2	147.6	16.6	359.8
6.6	158.9	17.1	365.4
7.1	170.5	17.6	371.1
7.6	182.0	18.0	378.5
8.1	193.6	18.5	381.8
8.5	206.2	19.0	385.7
9.0	218.4	19.5	389.9
9.5	229.7	19.9	392.8

Remarks

31/10/2019

GEOTECHNICS

LABORATORY RESULTS - *Unconsolidated Undrained Triaxial Test*

Project: CROWN STREET ZONE 2

Project No: PN194002

Hole	BH108
Sample Depth	5.20-5.65m
Sample Type	U
Sample Ref	N77178





Remarks

31/10/2019

GEOTECHNICS

LABORATORY RESULTS - Unconsolidated Undrained Triaxial Test

Project: CROWN STREET ZONE 2

Project No: PN194002

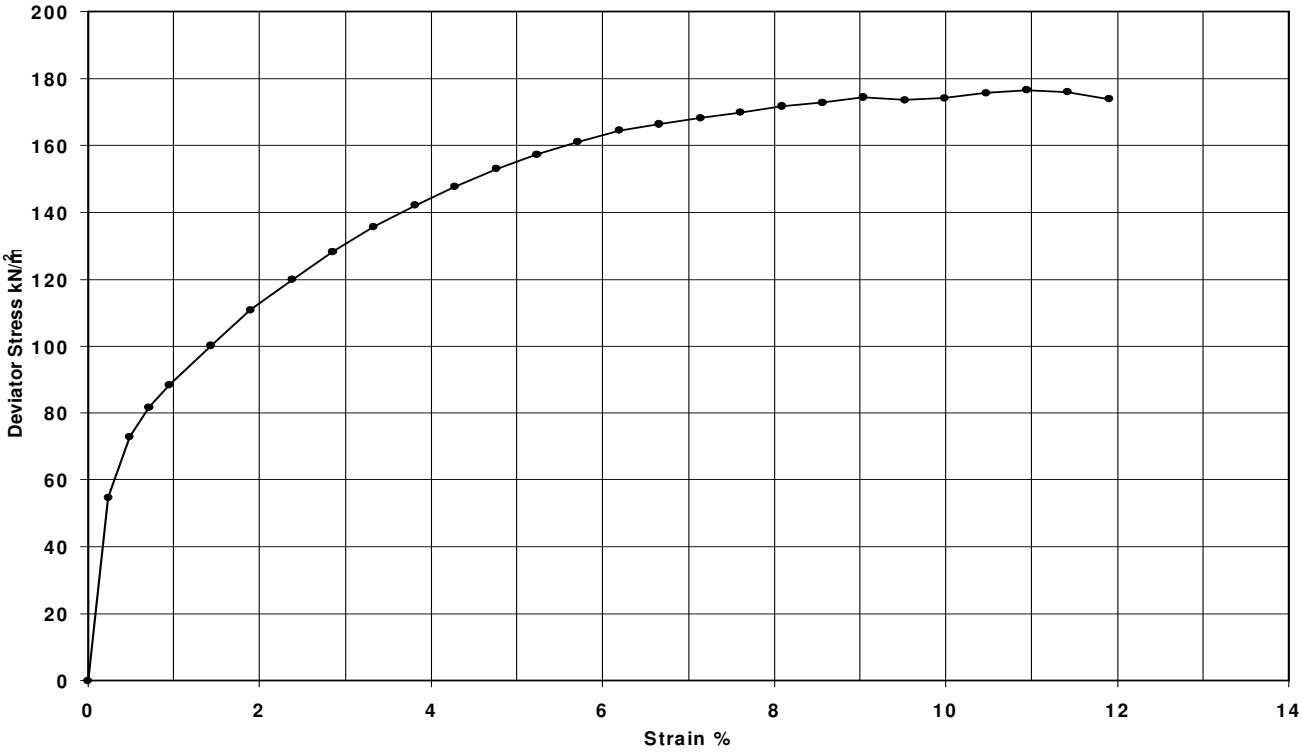
Hole BH108
Sample Depth 7.20-7.65m
Sample Type U
Sample Ref N77179

Sample Description

The following samples were combined to perform this test:

Stiff high strength brown slightly gravelly sandy CLAY.

BS EN ISO 17892-8:2018



		Stage 1	Stage 2	Stage 3
Sample Condition		Undisturbed		
Orientation of sample		Vertical		
Initial Diameter	(mm)	102.98		
Initial Length	(mm)	210.13		
Initial Water Content	(%)	20.1		
Initial Bulk Density	(Mg/m³)	2.07		
Initial Dry Density	(Mg/m³)	1.72		
Particle Density	(Mg/m³)	2.65 Assumed		
Cell Pressure	(kPa)	140		
'Specimen Height' at start of Shearing Stage	(mm)	210.08		
Membrane Thickness/Correction	(mm/kPa)			
Rate of Strain	(%/min)	1.3		
Corrected Deviator Stress	(kPa)	177		
Undrained Shear Strength	(kPa)	88		
Strain at Failure	(%)	11.0		
Failure Zone Water Content	(%)	19.0		
Water Content (after test)	(%)			
Mode of Failure		Intermediate		

Strain %	Corrected Deviator Stress kN/m²	Strain %	Corrected Deviator Stress kN/m²
0.2	54.7	10.0	174.1
0.5	73.0	10.5	175.8
0.7	81.8	10.9	176.6
1.0	88.4	11.4	176.1
1.4	100.1	11.9	173.9
1.9	110.8		
2.4	119.8		
2.9	128.1		
3.3	135.5		
3.8	141.9		
4.3	147.7		
4.8	153.0		
5.2	157.3		
5.7	160.9		
6.2	164.5		
6.7	166.3		
7.1	168.2		
7.6	169.8		
8.1	171.6		
8.6	172.8		
9.0	174.3		
9.5	173.6		

Remarks

31/10/2019

GEOTECHNICS

LABORATORY RESULTS - *Unconsolidated Undrained Triaxial Test*

Project: CROWN STREET ZONE 2

Project No: PN194002

Hole	BH108
Sample Depth	7.20-7.65m
Sample Type	U
Sample Ref	N77179





Remarks

31/10/2019

GEOTECHNICS

LABORATORY RESULTS - Unconsolidated Undrained Triaxial Test

Project: CROWN STREET ZONE 2

Project No: PN194002

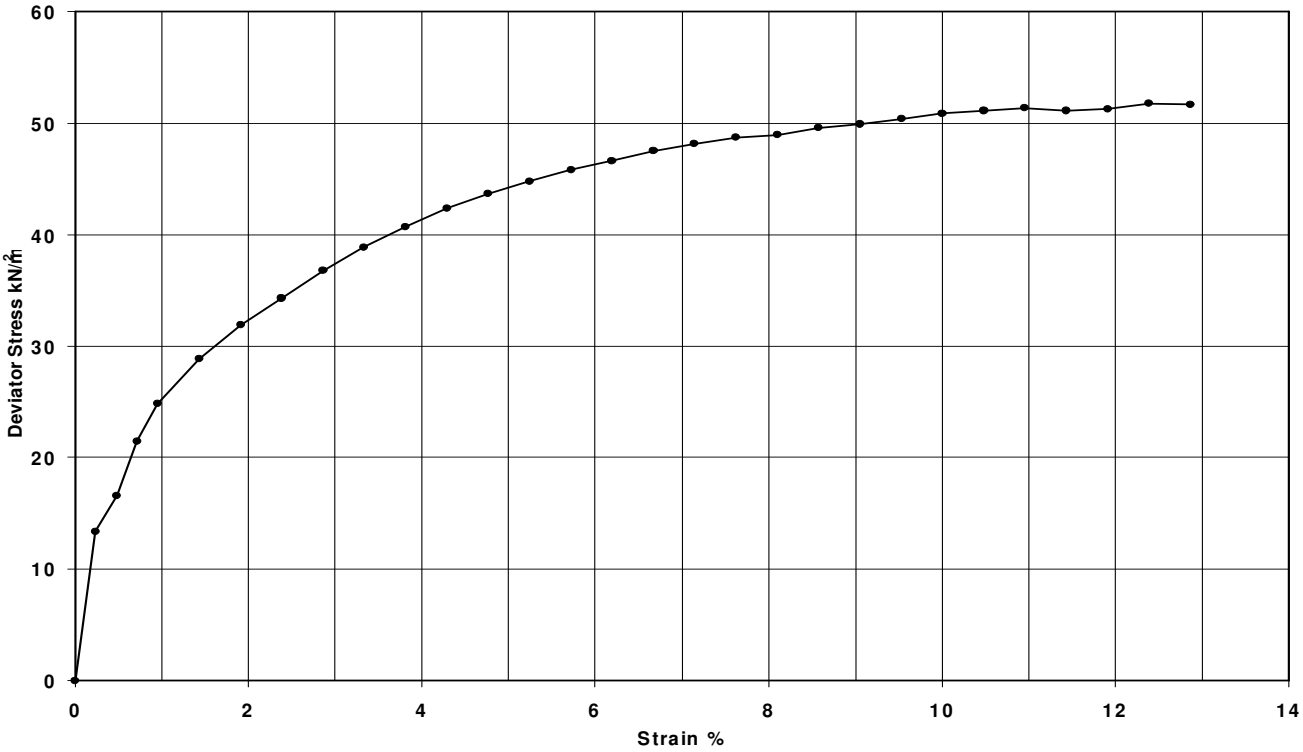
Hole	BH109
Sample Depth	3.20-3.65m
Sample Type	UT
Sample Ref	N77183

Sample Description

The following samples were combined to perform this test:

Soft low strength greyish brown slightly sandy slightly gravelly CLAY.

BS EN ISO 17892-8:2018



		Stage 1	Stage 2	Stage 3
Sample Condition		Undisturbed		
Orientation of sample		Vertical		
Initial Diameter	(mm)	102.88		
Initial Length	(mm)	209.96		
Initial Water Content	(%)	17.1		
Initial Bulk Density	(Mg/m³)	2.07		
Initial Dry Density	(Mg/m³)	1.77		
Particle Density	(Mg/m³)	2.65 Assumed		
Cell Pressure	(kPa)	60		
'Specimen Height' at start of Shearing Stage	(mm)	209.81		
Membrane Thickness/Correction	(mm/kPa)			
Rate of Strain	(%/min)	1.3		
Corrected Deviator Stress	(kPa)	52		
Undrained Shear Strength	(kPa)	26		
Strain at Failure	(%)	12.4		
Failure Zone Water Content	(%)	12.7		
Water Content (after test)	(%)			
Mode of Failure		Intermediate		

Strain %	Corrected Deviator Stress kN/m²	Strain %	Corrected Deviator Stress kN/m²
0.2	13.4	10.0	50.8
0.5	16.6	10.5	51.1
0.7	21.5	11.0	51.3
1.0	24.8	11.4	51.1
1.4	28.9	11.9	51.3
1.9	31.9	12.4	51.7
2.4	34.3	12.9	51.7
2.9	36.7		
3.3	38.8		
3.8	40.7		
4.3	42.4		
4.8	43.7		
5.2	44.8		
5.7	45.8		
6.2	46.6		
6.7	47.5		
7.1	48.1		
7.6	48.7		
8.1	49.0		
8.6	49.6		
9.0	49.9		
9.5	50.4		

Remarks

31/10/2019

GEOTECHNICS

LABORATORY RESULTS - Unconsolidated Undrained Triaxial Test

Project: CROWN STREET ZONE 2

Project No: PN194002

Hole	BH109
Sample Depth	3.20-3.65m
Sample Type	UT
Sample Ref	N77183





Remarks

31/10/2019

GEOTECHNICS

LABORATORY RESULTS - Unconsolidated Undrained Triaxial Test

Project: CROWN STREET ZONE 2

Project No: PN194002

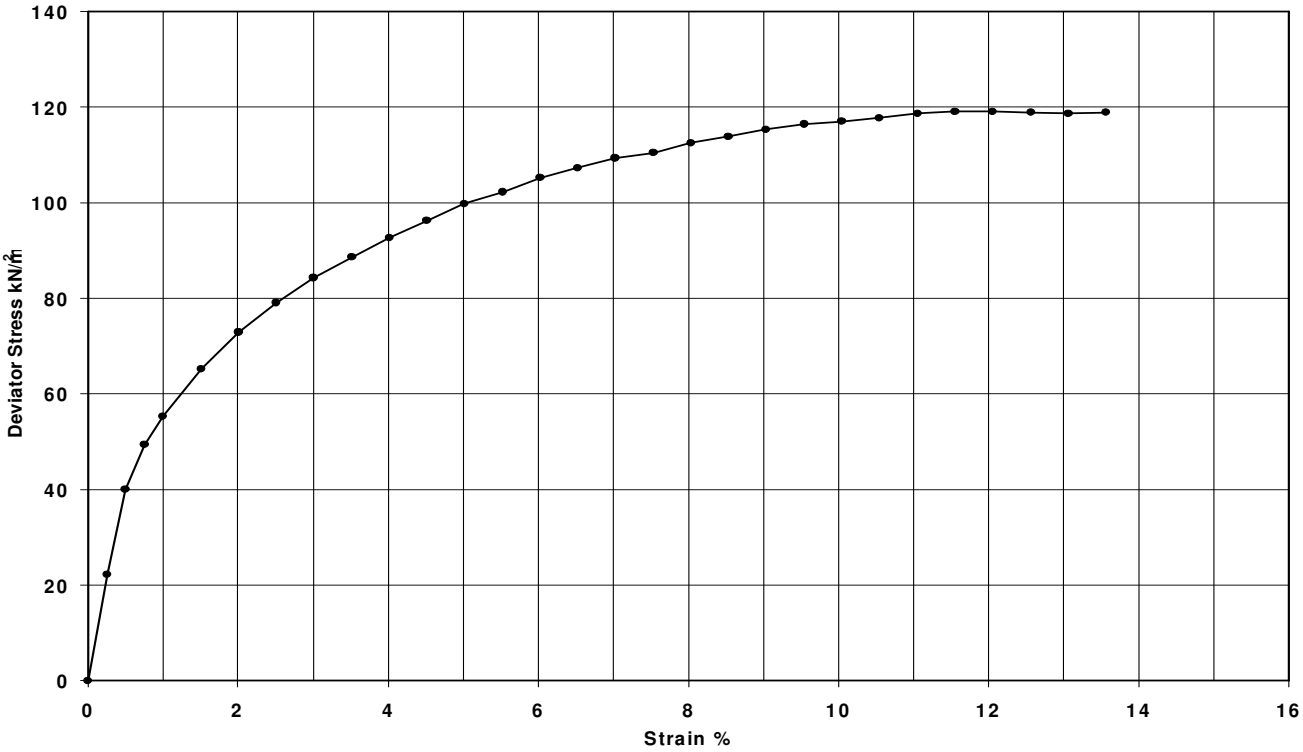
Hole	BH109
Sample Depth	9.20-9.65m
Sample Type	UT
Sample Ref	N77187

Sample Description

The following samples were combined to perform this test:

Firm medium strength reddish brown slightly sandy slightly gravelly CLAY.

BS EN ISO 17892-8:2018



		Stage 1	Stage 2	Stage 3
Sample Condition		Undisturbed		
Orientation of sample		Vertical		
Initial Diameter	(mm)	102.20		
Initial Length	(mm)	199.04		
Initial Water Content	(%)	19.1		
Initial Bulk Density	(Mg/m³)	2.01		
Initial Dry Density	(Mg/m³)	1.69		
Particle Density	(Mg/m³)	2.65 Assumed		
Cell Pressure	(kPa)	180		
'Specimen Height' at start of Shearing Stage	(mm)	198.72		
Membrane Thickness/Correction	(mm/kPa)			
Rate of Strain	(%/min)	1.3		
Corrected Deviator Stress	(kPa)	119		
Undrained Shear Strength	(kPa)	60		
Strain at Failure	(%)	11.6		
Failure Zone Water Content	(%)	27.5		
Water Content (after test)	(%)			
Mode of Failure		Intermediate		

Strain %	Corrected Deviator Stress kN/m²	Strain %	Corrected Deviator Stress kN/m²
0.3	22.3	10.6	117.9
0.5	40.1	11.1	118.7
0.8	49.3	11.6	119.1
1.0	55.4	12.1	119.0
1.5	65.2	12.6	118.9
2.0	72.9	13.1	118.8
2.5	79.1	13.6	119.0
3.0	84.3		
3.5	88.7		
4.0	92.7		
4.5	96.3		
5.0	99.8		
5.5	102.2		
6.0	105.2		
6.5	107.3		
7.0	109.3		
7.5	110.5		
8.0	112.5		
8.5	113.9		
9.0	115.4		
9.5	116.4		
10.0	117.0		

Remarks

31/10/2019

GEOTECHNICS

LABORATORY RESULTS - *Unconsolidated Undrained Triaxial Test*

Project: CROWN STREET ZONE 2

Project No: PN194002

Hole	BH109
Sample Depth	9.20-9.65m
Sample Type	UT
Sample Ref	N77187





Remarks

31/10/2019

GEOTECHNICS

LABORATORY RESULTS - Particle Size Distribution

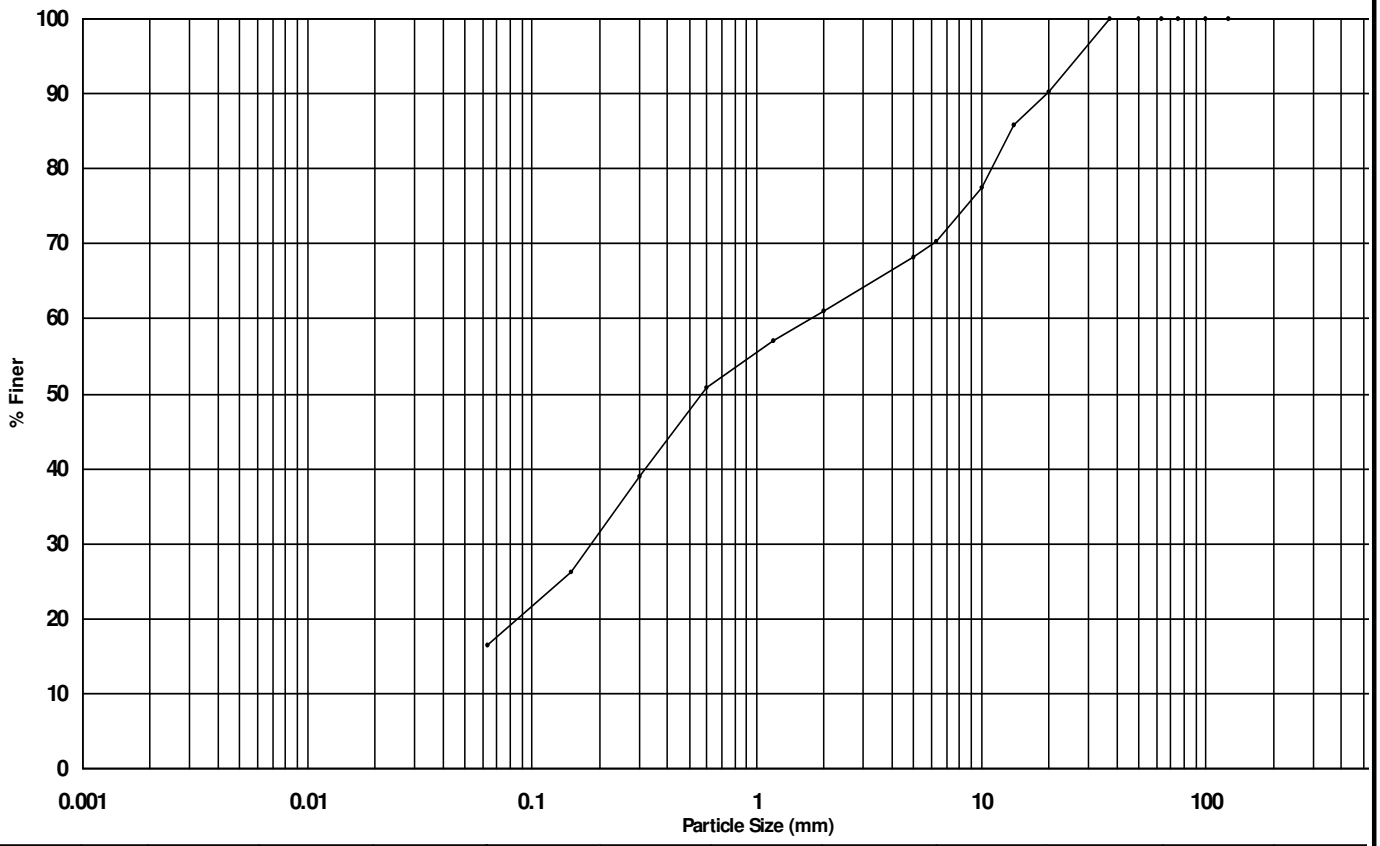
Project: CROWN STREET ZONE 2

Project No: PN194002

Hole	BH101
Sample Depth	3.20-3.65m
Sample Type	B
Sample Ref	N77159

Sample Description

Brown silty fine to coarse SAND and fine to coarse GRAVEL.



Classification												
	CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	Cobbles	Boulde
		SILT			SAND			Gravel				

Classification	% of each
SILT (including CLAY)	16
SAND	45
GRAVEL	39
COBBLES	0
BOULDERS	0

Size	% Finer
125 mm	100
100 mm	100
75 mm	100
63 mm	100
50 mm	100
37.5 mm	100
20 mm	90
14 mm	86
10 mm	78
6.3 mm	70
5 mm	68
2 mm	61
1.18 mm	57
600 µm	51
300 µm	39
150 µm	26

Size	% Finer
63 µm	16

Uniformity Coefficient
Not Available
Sieving Method
Wet sieve
Fine Particle Analysis

Method	
Pre-treated with	
% loss on Pre-treatment	
Particle Density	

Remarks AGS Sieve:-Test performed in accordance with BS EN ISO 17892-4:2016

30/10/2019

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LABORATORY RESULTS - Particle Size Distribution

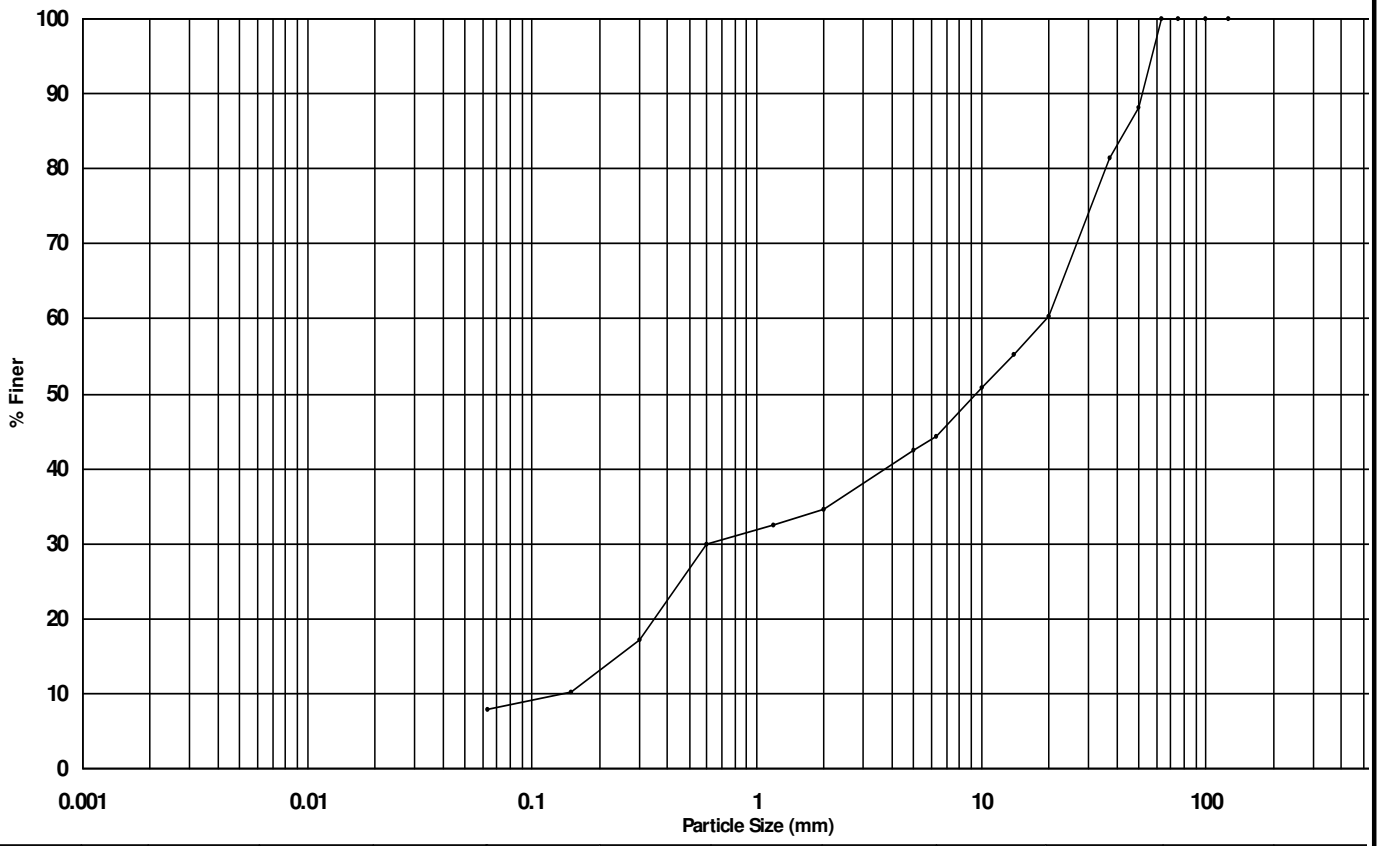
Project: CROWN STREET ZONE 2

Project No: PN194002

Hole	BH101
Sample Depth	10.20-10.32m
Sample Type	B
Sample Ref	N77164

Sample Description

Orangish brown very sandy silty fine to coarse GRAVEL.



Classification												
	CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	Cobbles	Boulde
		SILT			SAND			Gravel				

Classification	% of each
SILT (including CLAY)	8
SAND	27
GRAVEL	65
COBBLES	0
BOULDERS	0

Size	% Finer
125 mm	100
100 mm	100
75 mm	100
63 mm	100
50 mm	88
37.5 mm	81
20 mm	60
14 mm	55
10 mm	51
6.3 mm	44
5 mm	42
2 mm	35
1.18 mm	32
600 µm	30
300 µm	17
150 µm	10

Size	% Finer
63 µm	8

Uniformity Coefficient
135.28

Sieving Method
Wet sieve

Fine Particle Analysis	
Method	
Pre-treated with	
% loss on Pre-treatment	
Particle Density	

Remarks AGS Sieve:-Test performed in accordance with BS EN ISO 17892-4:2016

30/10/2019

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LABORATORY RESULTS - Particle Size Distribution

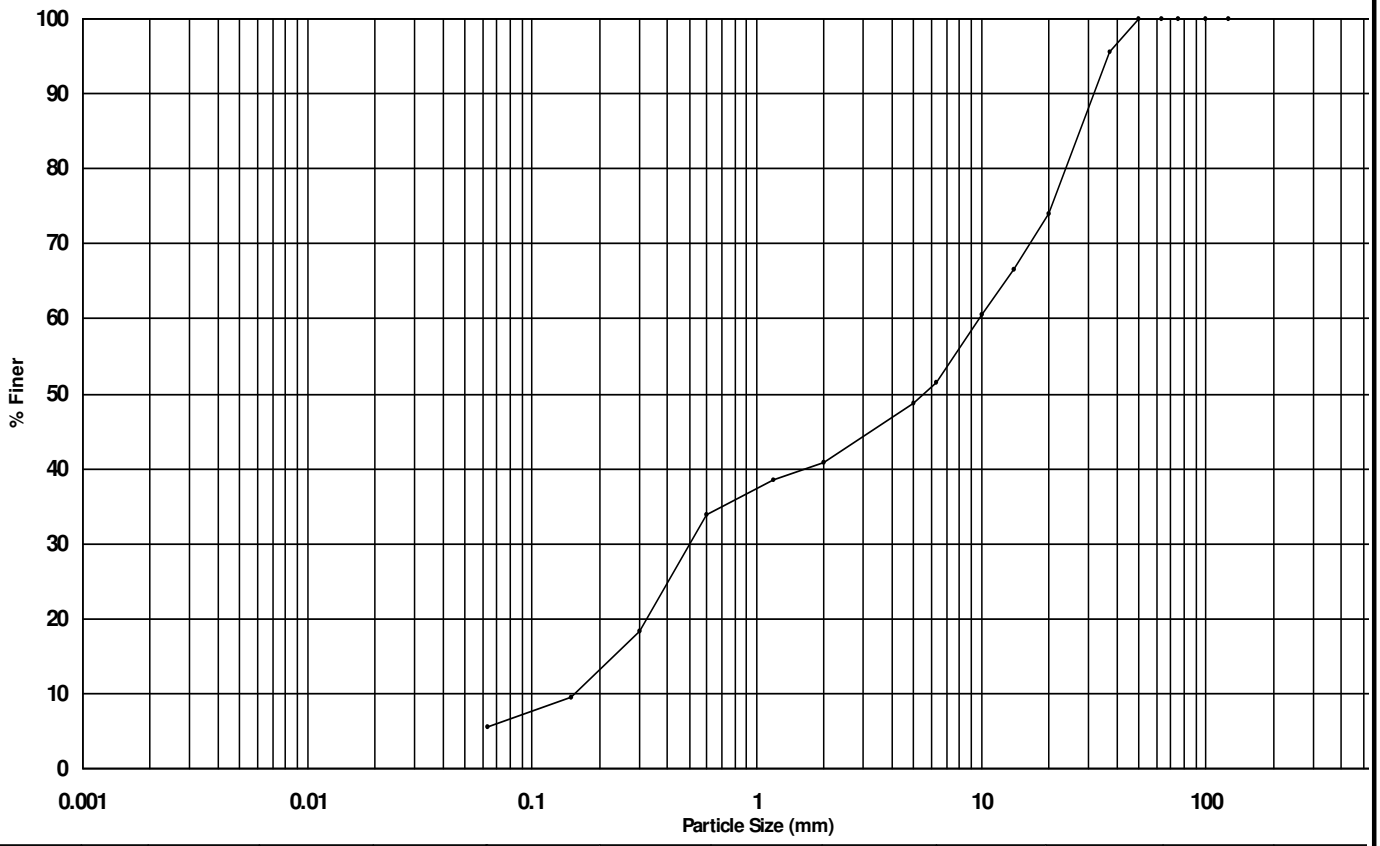
Project: CROWN STREET ZONE 2

Project No: PN194002

Hole	BH104
Sample Depth	2.20-2.65m
Sample Type	B
Sample Ref	N77165

Sample Description

Orangish brown mottled dark brown very sandy silty fine to coarse GRAVEL.



Classification												
	CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	Cobbles	Boulde
		SILT			SAND			Gravel				

Classification	% of each
SILT (including CLAY)	5
SAND	36
GRAVEL	59
COBBLES	0
BOULDERS	0

Size	% Finer
125 mm	100
100 mm	100
75 mm	100
63 mm	100
50 mm	100
37.5 mm	96
20 mm	74
14 mm	67
10 mm	60
6.3 mm	52
5 mm	49
2 mm	41
1.18 mm	38
600 µm	34
300 µm	18
150 µm	10

Size	% Finer
63 µm	5

Uniformity Coefficient
62.77
Sieving Method
Wet sieve
Fine Particle Analysis

Method	
Pre-treated with	
% loss on Pre-treatment	
Particle Density	

Remarks Sieve:-Test performed in accordance with BS EN ISO 17892-4:2016

30/10/2019

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APPENDIX 8

Laboratory Test Results - Geotechnical (Rock)

LABORATORY REPORT

4043

Contract Number: PSL19/6037

Report Date: 23 October 2019

Client's Reference: PN194002

Client Name: Geotechnics Chester
The Geotechnical Centre
Unit 1 Borders Industrial Park
River Lane, Saltney
Chester
CH4 8RJ

For the attention of: Chris Bradley

Contract Title: Crown Street Zone 2

Date Received: 8/10/2019
Date Commenced: 8/10/2019
Date Completed: 23/10/2019

Notes: Opinions and Interpretations are outside the UKAS Accreditation

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced other than in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

R Gunson (Director)	A Watkins (Director)	R Berriman (Quality Manager)
L Knight (Senior Technician)	S Eyre (Senior Technician)	R Cowles (Senior Technician)

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DETERMINATION OF UNCONFINED COMPRESSIVE STRENGTH

ISRM Suggested Methods, pp 111 –116, 1981.

Hole Number	Sample Number	Sample Type	Top Depth (m)	Base Depth (m)	Sample Diameter (mm)	Sample Length (mm)	Height Ratio	Initial Mass (g)	Bulk Density (Mg/m)	Moisture Content (%)	Dry Density (Mg/m)	Load Failure (kN)	UCS (MPa)	Failure Mode	Date Tested	Remarks
BH101		C	13.00	13.24	85	202	2.4	2321	2.02	8.1	1.87	53.7	9.5	Brittle	18/10/19	
BH101		C	15.50	15.80	85	203	2.4	2404	2.09	8.9	1.92	39.0	6.9	Brittle	18/10/19	
BH101		C	18.73	19.03	85	200	2.4	2378	2.10	9.3	1.92	34.5	6.1	Brittle	18/10/19	
BH101		C	20.07	20.40	85	203	2.4	2484	2.16	9.4	1.97	37.7	6.6	Brittle	18/10/19	
BH102		C	17.47	17.67	70	129	1.8	1009	2.03	8.2	1.88	26.2	6.8	Brittle	18/10/19	
BH102		C	20.77	20.98	70	165	2.4	1408	2.22	5.7	2.10	59.4	15.4	Brittle	18/10/19	
BH103		C	11.46	11.69	75	140	1.9	1258	2.03	11	1.83	21.2	4.8	Brittle	18/10/19	
BH103		C	17.44	17.87	100	142	1.4	2621	2.35	12	2.10	36.4	4.6	Brittle	18/10/19	
BH103		C	19.72	19.87	100	129	1.3	2238	2.21	11	1.99	59.7	7.6	Brittle	18/10/19	
BH103		C	21.30	21.65	78	200	2.6	1955	2.05	10	1.85	23.8	5.0	Brittle	18/10/19	
BH103		C	29.44	29.72	100	202	2.0	3642	2.30	12	2.04	78.7	10.0	Brittle	18/10/19	
BH103		C	32.54	32.94	100	200	2.0	3621	2.30	11	2.08	76.4	9.7	Brittle	18/10/19	
BH103		C	36.53	36.82	100	202	2.0	3653	2.30	10	2.09	82.4	10.5	Brittle	22/10/19	
BH104		C	11.09	11.46	85	202	2.4	2429	2.12	10	1.92	41.9	7.4	Brittle	18/10/19	
BH104		C	15.52	15.82	85	201	2.4	2578	2.26	9.6	2.06	42.7	7.5	Brittle	18/10/19	
BH104		C	18.35	18.70	85	203	2.4	2554	2.22	12	1.98	49.9	8.8	Brittle	18/10/19	
BH104		C	22.69	23.00	85	201	2.4	2438	2.14	8.7	1.97	59.6	10.5	Brittle	18/10/19	

PSL
Professional Soils Laboratory

Crown Street Zone 2

Contract No:
PSL19/6037
Client Ref:
PN194002

DETERMINATION OF UNCONFINED COMPRESSIVE STRENGTH

ISRM Suggested Methods, pp 111 –116, 1981.

Hole Number	Sample Number	Sample Type	Top Depth (m)	Base Depth (m)	Sample Diameter (mm)	Sample Length (mm)	Height Ratio	Initial Mass (g)	Bulk Density (Mg/m)	Moisture Content (%)	Dry Density (Mg/m)	Load Failure (kN)	UCS (MPa)	Failure Mode	Date Tested	Remarks
BH105		C	12.33	12.52	85	153	1.8	2005	2.31	10	2.10	81.5	14.4	Brittle	18/10/19	
BH105		C	15.42	15.77	85	203	2.4	2532	2.20	9.9	2.00	42.1	7.4	Brittle	18/10/19	
BH105		C	18.62	18.97	85	200	2.4	2549	2.25	11	2.02	43.6	7.7	Brittle	18/10/19	
BH105		C	24.11	24.39	85	202	2.4	2528	2.21	9.5	2.01	55.7	9.8	Brittle	18/10/19	
BH106		C	13.19	13.44	85	203	2.4	2631	2.28	11	2.06	53.1	9.4	Brittle	18/10/19	
BH106		C	16.13	16.39	85	201	2.4	2430	2.13	9.9	1.94	54.2	9.6	Brittle	18/10/19	
BH106		C	18.29	18.69	85	200	2.4	2380	2.10	10	1.91	52.5	9.3	Brittle	18/10/19	
BH106		C	21.55	21.80	85	202	2.4	2423	2.11	9.8	1.92	42.6	7.5	Brittle	18/10/19	
BH106		C	23.07	23.36	85	192	2.3	2216	2.03	9.6	1.86	45.5	8.0	Brittle	18/10/19	
BH107		C	13.50	13.78	85	204	2.4	2514	2.17	12	1.94	31.8	5.6	Brittle	18/10/19	
BH107		C	17.09	17.38	85	200	2.4	2485	2.19	9.0	2.01	50.4	8.9	Brittle	18/10/19	
BH107		C	20.00	20.37	85	201	2.4	2469	2.16	9.5	1.98	54.6	9.6	Brittle	18/10/19	
BH107		C	22.00	22.30	85	202	2.4	2466	2.15	9.6	1.96	60.0	10.6	Brittle	18/10/19	
BH107		C	25.17	25.45	85	204	2.4	2668	2.30	9.1	2.11	61.6	10.9	Brittle	18/10/19	
BH107		C	31.69	32.00	85	196	2.3	2560	2.30	10	2.09	60.7	10.7	Brittle	18/10/19	
BH108		C	10.91	11.14	85	195	2.3	2412	2.18	13	1.92	40.3	7.1	Brittle	18/10/19	
BH108		C	12.78	13.01	85	200	2.4	2531	2.23	12	1.98	53.6	9.4	Brittle	18/10/19	
BH108		C	15.01	15.32	85	201	2.4	2417	2.12	13	1.87	32.2	5.7	Brittle	18/10/19	
BH108		C	22.66	22.89	85	153	1.8	1989	2.29	11	2.07	48.0	8.5	Brittle	18/10/19	
BH108		C	25.22	25.50	85	203	2.4	2461	2.14	9.2	1.96	46.4	8.2	Brittle	18/10/19	

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Crown Street Zone 2

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DETERMINATION OF UNCONFINED COMPRESSIVE STRENGTH

ISRM Suggested Methods, pp 111 –116, 1981.

Hole Number	Sample Number	Sample Type	Top Depth (m)	Base Depth (m)	Sample Diameter (mm)	Sample Length (mm)	Height Ratio	Initial Mass (g)	Bulk Density (Mg/m)	Moisture Content (%)	Dry Density (Mg/m)	Load Failure (kN)	UCS (MPa)	Failure Mode	Date Tested	Remarks
BH109		C	10.56	10.68	74	132	1.8	1274	2.24	11	2.02	24.8	5.8	Brittle	21/10/19	
BH109		C	14.57	14.73	100	126	1.3	2368	2.39	12	2.14	36.8	4.7	Brittle	21/10/19	
BH109		C	17.35	17.47	100	128	1.3	2468	2.45	9.8	2.24	54.2	6.9	Brittle	21/10/19	
BH109		C	18.75	18.94	75	169	2.3	1675	2.24	12	2.01	38.7	8.8	Brittle	21/10/19	
BH109		C	25.04	25.42	72	198	2.8	1910	2.37	8.2	2.19	41.5	10.2	Brittle	21/10/19	
BH109		C	31.50	31.97	100	204	2.0	3549	2.21	9.3	2.03	64.9	8.3	Brittle	21/10/19	
BH109		C	38.41	38.75	75	170	2.3	1792	2.39	13	2.12	19.2	4.3	Brittle	21/10/19	
BH109		C	46.64	47.02	100	199	2.0	3502	2.24	11	2.03	29.7	3.8	Brittle	21/10/19	

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Crown Street Zone 2

Contract No:

PSL19/6037

Client Ref:

PN194002

SUMMARY OF POINT LOAD TEST RESULTS

ISRM Suggested Methods : 2007

Borehole Number	Depth (m)	Sample Ref	Test Type	Orientation	Dimensions (mm)		Area	D_e^2	D_e	Failure Load (P)		I_s	Corr Fac	I_{s50}	Failure Type	Remarks
				Par / Perp	W	D	(mm2)		(mm)	(Mpa)	(kN)	(MPa)	F	(MPa)		
BH106	18.29		A	Perp	85	74	6290	8008.68	89.49	-	2.20	0.27	1.299	0.36	Valid	

Note All testing carried out on samples at as received water content

Par = parallel, Perp = perpendicular, U = Random

A = Axial, D = Diametral, I = Irregular

UKAS TESTING 4043

PSL Professional Soils Laboratory

Crown Street Zone 2

Contract No:

PSL19/6037

Client Ref:

PN194002

LABORATORY RESULTS - Point Load Strength Determination

Project CROWN STREET ZONE 2 **Project No:** PN194002

Sample					w	W	D	Fail Load	Test Type/ Direction	De	De^2	Is	F	Is_{50}
Hole	Depth (Specimen Depth) m	Type	Sample Ref	Description	%	mm	mm	kN		mm	mm^2	MN/m^2		MN/m^2
BH101	12.07-12.18 (12.07-12.18)	C	N77372	Very weak reddish brown fine to medium grained SANDSTONE.	8.5	85	85	0.60	D/PL	85.00	7225	0.083	1.270	0.105
						85	79	1.17	A/PD	92.47	8550	0.137	1.319	0.181
BH101	12.80-13.00 (12.80-13.00)	C	N77373	Very weak to weak reddish brown fine to medium grained SANDSTONE.	8.8	85	85	1.07	D/PL	85.00	7225	0.148	1.270	0.187
						85	85	1.08	D/PL	85.00	7225	0.149	1.270	0.190
						85	78	2.12	A/PD	91.88	8442	0.252	1.315	0.331
						85	74	1.81	A/PD	89.49	8009	0.226	1.300	0.293
						85	63	1.74	A/PD	82.57	6818	0.255	1.253	0.319
BH101	14.69-14.72 (14.69-14.72)	C	N77375	Weak reddish brown fine to medium grained SANDSTONE.	8.1	86	88	1.53	A/PD	98.16	9636	0.159	1.355	0.216
BH101	15.40-15.50 (15.40-15.50)	C	N77376	Very weak to weak reddish brown fine to medium grained SANDSTONE.	5.1	85	85	0.88	D/PL	85.00	7225	0.122	1.270	0.155
						85	55	0.99	A/PD	77.15	5952	0.166	1.216	0.202
						85	48	1.02	A/PD	72.08	5195	0.196	1.179	0.231
BH101	17.01-17.23 (17.01-17.23)	C	N77378	Weak reddish brown fine to medium grained SANDSTONE.	9.9	85	85	1.27	D/PL	85.00	7225	0.176	1.270	0.223
						85	85	1.63	D/PL	85.00	7225	0.226	1.270	0.287
						85	82	2.63	A/PD	94.20	8874	0.297	1.330	0.394
						85	73	1.67	A/PD	88.88	7900	0.211	1.296	0.273
						85	67	2.02	A/PD	85.15	7251	0.278	1.271	0.354
BH101	19.03-19.29 (19.03-19.29)	C	N77380	Very weak to weak reddish brown fine to medium grained SANDSTONE.	8.4	85	85	0.98	D/PL	85.00	7225	0.135	1.270	0.172
						85	85	1.67	D/PL	85.00	7225	0.231	1.270	0.293
						85	80	2.58	A/PD	93.05	8658	0.298	1.323	0.395
						85	78	2.51	A/PD	91.88	8442	0.297	1.315	0.391
						85	77	2.67	A/PD	91.29	8333	0.320	1.311	0.419
BH101	20.40-20.50 (20.40-20.50)	C	N77382	Weak reddish brown fine to medium grained SANDSTONE.	8.4	85	85	1.31	D/PL	85.00	7225	0.182	1.270	0.231
						85	49	1.43	A/PD	72.82	5303	0.270	1.184	0.320
						85	50	1.88	A/PD	73.56	5411	0.347	1.190	0.413
BH101	21.16-21.40 (21.16-21.40)	C	N77383	Very weak to weak reddish brown fine to medium grained SANDSTONE.	11.9	85	85	1.12	D/PL	85.00	7225	0.154	1.270	0.196
						85	85	1.10	D/PL	85.00	7225	0.152	1.270	0.193
						85	90	2.14	A/PD	98.69	9740	0.220	1.358	0.298
						85	79	2.26	A/PD	92.47	8550	0.264	1.319	0.349
						85	51	UF	A/PD					
BH101	22.57-22.74 (22.57-22.74)	C	N77384	Very weak to weak reddish brown fine to medium grained SANDSTONE.	8.5	85	85	0.95	D/PL	85.00	7225	0.132	1.270	0.168
						85	84	2.43	A/PD	95.35	9091	0.267	1.337	0.357
						85	83	2.38	A/PD	94.78	8983	0.265	1.334	0.354
BH101	24.84-24.95 (24.84-24.95)	C	N77385	Weak reddish brown fine to medium grained SANDSTONE.	10.2	86	85	1.17	D/PL	85.00	7225	0.162	1.270	0.206
						85	56	1.89	A/PD	77.85	6061	0.312	1.221	0.381
						85	61	2.25	A/PD	81.25	6602	0.341	1.244	0.424

Remarks AGS

Test Type D - Diametral, A - Axial, I - Lump or Irregular Test
Direction PL - parallel to planes of weakness, R - Random or unknown orientation, PD - perpendicular to planes of weakness
Fail Load UF - unacceptable failure
For Standards followed see Laboratory Test Certificate

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LABORATORY RESULTS - Point Load Strength Determination

Project CROWN STREET ZONE 2 **Project No:** PN194002

Sample					w	W	D	Fail Load	Test Type/ Direction	De	De^2	Is	F	Is_{50}
Hole	Depth (Specimen Depth) m	Type	Sample Ref	Description	%	mm	mm	kN		mm	mm^2	MN/m^2		MN/m^2
BH102	9.38-9.47 (9.38-9.47)	C	N77386	Weak reddish brown fine to medium grained SANDSTONE.	1.4	70	81	1.36	A/PD	84.97	7219	0.188	1.270	0.239
BH102	10.92-11.00 (10.92-11.00)	C	N77387	Weak reddish brown fine to medium grained SANDSTONE.	2.7	70	82	1.31	A/PD	85.49	7308	0.179	1.273	0.227
BH102	11.64-11.71 (11.64-11.71)	C	N77388	Very weak to weak reddish brown fine to medium grained SANDSTONE.	5.0	70	76	0.89	A/PD	82.30	6774	0.131	1.251	0.164
BH102	13.66-13.79 (13.66-13.79)	C	N77389	Weak reddish brown fine to medium grained SANDSTONE.	5.6	71	70	1.14	D/PL	70.00	4900	0.232	1.164	0.270
						70	66	1.97	A/PD	76.70	5882	0.335	1.212	0.406
						70	65	1.81	A/PD	76.11	5793	0.312	1.208	0.377
BH102	14.46-14.63 (14.46-14.63)	C	N77390	Very weak to weak reddish brown fine to medium grained SANDSTONE.	5.7	71	71	0.55	D/PL	71.00	5041	0.109	1.171	0.127
						71	79	1.78	A/PD	84.51	7142	0.250	1.266	0.316
						71	81	1.53	A/PD	85.57	7322	0.208	1.274	0.265
BH102	15.81-15.92 (15.81-15.92)	C	N77391	Weak reddish brown fine to medium grained SANDSTONE.	7.0	71	71	1.55	D/PL	71.00	5041	0.307	1.171	0.360
						71	60	2.55	A/PD	73.65	5424	0.471	1.190	0.561
						71	58	2.19	A/PD	72.41	5243	0.418	1.181	0.493
BH102	17.67-17.78 (17.67-17.78)	C	N77393	Very weak to weak reddish brown fine to medium grained SANDSTONE.	7.7	70	71	0.71	D/PL	71.00	5041	0.141	1.171	0.165
						71	61	0.96	A/PD	74.26	5514	0.173	1.195	0.207
						71	54	1.23	A/PD	69.87	4882	0.251	1.163	0.292
BH102	19.27-19.42 (19.27-19.42)	C	N77394	Weak reddish brown fine to medium grained SANDSTONE.	6.3	72	71	1.12	D/PL	71.00	5041	0.223	1.171	0.261
						71	80	1.96	A/PD	85.04	7232	0.271	1.270	0.345
						71	76	1.78	A/PD	82.89	6870	0.259	1.255	0.326
BH102	20.64-20.77 (20.64-20.77)	C	N77395	Very weak to weak reddish brown fine to medium grained SANDSTONE.	7.1	71	71	0.82	D/PL	71.00	5041	0.162	1.171	0.190
						71	70	2.28	A/PD	79.55	6328	0.361	1.232	0.444
						71	67	2.31	A/PD	77.83	6057	0.382	1.220	0.466
BH102	22.40-22.53 (22.40-22.53)	C	N77397	Very weak to weak reddish brown fine to medium grained SANDSTONE.	7.6	72	71	0.82	D/PL	71.00	5041	0.163	1.171	0.191
						86	67	1.58	A/PD	85.65	7336	0.215	1.274	0.274
						86	67	1.76	A/PD	85.65	7336	0.240	1.274	0.305
BH102	23.59-23.72 (23.59-23.72)	C	N77398	Weak reddish brown fine to medium grained SANDSTONE.	7.9	71	71	1.01	D/PL	71.00	5041	0.200	1.171	0.235
						71	67	1.56	A/PD	77.83	6057	0.258	1.220	0.315
						71	54	1.67	A/PD	69.87	4882	0.341	1.163	0.397

Remarks AGS

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LABORATORY RESULTS - Point Load Strength Determination

Project CROWN STREET ZONE 2 **Project No:** PN194002

Sample					w	W	D	Fail Load	Test Type/ Direction	De	De^2	Is	F	Is_{50}
Hole	Depth (Specimen Depth) m	Type	Sample Ref	Description	%	mm	mm	kN		mm	mm^2	MN/m^2		MN/m^2
BH102	24.50-24.63 (24.50-24.63)	C	N77399	Weak reddish brown fine to medium grained SANDSTONE.	8.0	71 71 71	71 69 61	1.02 2.03 1.91	D/PL A/PD A/PD	71.00 78.98 74.26	5041 6238 5514	0.202 0.326 0.346	1.171 1.228 1.195	0.236 0.401 0.413
BH102	27.07-27.17 (27.07-27.17)	C	N77400	Weak reddish brown fine to medium grained SANDSTONE.	7.1	71 71 71	71 63 56	1.43 1.87 1.64	D/PL A/PD A/PD	71.00 75.47 71.15	5041 5695 5062	0.284 0.329 0.323	1.171 1.204 1.172	0.332 0.396 0.379
BH102	27.76-27.86 (27.76-27.86)	C	N77401	Weak reddish brown fine to medium grained SANDSTONE.	7.7	72 71 71	71 50 51	1.14 1.62 1.58	D/PL A/PD A/PD	71.00 67.23 67.90	5041 4520 4610	0.227 0.359 0.342	1.171 1.143 1.148	0.265 0.411 0.393
BH102	30.18-30.30 (30.18-30.30)	C	N77402	Weak reddish brown fine to medium grained SANDSTONE.	8.0	71 71 71	71 60 59	1.57 2.45 2.48	D/PL A/PD A/PD	71.00 73.65 73.03	5041 5424 5334	0.311 0.451 0.465	1.171 1.190 1.186	0.364 0.537 0.552
BH102	32.40-32.53 (32.40-32.53)	C	N77403	Weak reddish brown fine to medium grained SANDSTONE.	6.8	71 71 71	71 66 65	1.74 2.69 2.29	D/PL A/PD A/PD	71.00 77.24 76.66	5041 5966 5876	0.344 0.451 0.390	1.171 1.216 1.212	0.403 0.549 0.473
BH103	8.55-8.69 (8.55-8.69)	C	N77404	Very weak to weak reddish brown fine to medium grained SANDSTONE.	9.1	101 101 101	101 80 73	0.74 1.28 1.01	D/PL A/PD A/PD	101.00 101.43 96.89	10201 10288 9388	0.072 0.124 0.108	1.372 1.375 1.347	0.099 0.171 0.145
BH103	8.77-8.90 (8.77-8.90)	C	N77405	Very weak to weak reddish brown fine to medium grained SANDSTONE.	10.2	100 101 101	101 79 59	1.09 2.03 0.95	D/PL A/PD A/PD	101.00 100.79 87.10	10201 10159 7587	0.107 0.199 0.125	1.372 1.371 1.284	0.147 0.273 0.160
BH103	9.75-9.86 (9.75-9.86)	C	N77406	Very weak reddish brown fine to medium grained SANDSTONE.	11.4	100 100 100	100 55 56	0.47 0.59 0.96	D/PL A/PD A/PD	100.00 83.68 84.44	10000 7003 7130	0.047 0.085 0.134	1.366 1.261 1.266	0.064 0.107 0.170
BH103	11.69-11.86 (11.69-11.86)	C	N77408	Very weak to weak reddish brown fine to medium grained SANDSTONE.	12.1	76 75 75	75 62 61	0.57 0.79 1.02	D/PL A/PD A/PD	75.00 76.95 76.32	5625 5921 5825	0.101 0.133 0.175	1.200 1.214 1.210	0.121 0.162 0.212
BH103	12.59-12.84 (12.59-12.84)	C	N77409	Very weak to weak reddish brown fine to medium grained SANDSTONE.	14.8	100 102 102 102 102	102 102 82 91 78	1.15 1.12 2.18 2.42 1.56	D/PL D/PL A/PD A/PD A/PD	102.00 102.00 103.20 108.71 100.65	10404 10404 10649 11818 10130	0.111 0.108 0.204 0.205 0.154	1.378 1.378 1.386 1.418 1.370	0.152 0.148 0.283 0.290 0.211
BH103	14.39-14.57 (14.39-14.57)	C	N77410	Extremely weak reddish brown fine to medium grained SANDSTONE.	12.5	80	82	0.09	A/PD	91.39	8352	0.011	1.312	0.014

Remarks AGS

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LABORATORY RESULTS - Point Load Strength Determination

Project CROWN STREET ZONE 2 **Project No:** PN194002

Sample					w	W	D	Fail Load	Test Type/ Direction	De	De^2	Is	F	Is_{50}
Hole	Depth (Specimen Depth) m	Type	Sample Ref	Description	%	mm	mm	kN		mm	mm^2	MN/m^2		MN/m^2
BH103	15.76-15.90 (15.76-15.90)	C	N77411	Weak reddish brown fine to medium grained SANDSTONE.	12.6	100	100	1.60	D/PL	100.00	10000	0.160	1.366	0.219
						100	92	3.23	A/PD	108.23	11714	0.276	1.416	0.391
						100	86	2.64	A/PD	104.64	10950	0.241	1.394	0.336
BH103	16.61-16.76 (16.61-16.76)	C	N77412	Extremely weak to very weak reddish brown fine to medium grained SANDSTONE.	15.4	100	37	0.08	A/PD	68.64	4711	0.017	1.153	0.020
						100	34	0.20	A/PD	65.80	4329	0.045	1.132	0.051
						100	28	0.09	A/PD	59.71	3565	0.026	1.083	0.028
BH103	17.87-18.00 (17.87-18.00)	C	N77414	Very weak reddish brown fine to medium grained SANDSTONE.	6.6	101	96	0.90	A/PD	111.11	12345	0.073	1.432	0.104
BH103	19.87-20.05 (19.87-20.05)	C	N77416	Very weak to weak reddish brown fine to medium grained SANDSTONE.	10.1	100	100	1.31	D/PL	100.00	10000	0.131	1.366	0.179
						100	89	2.75	A/PD	106.45	11332	0.243	1.405	0.341
						100	67	1.16	A/PD	92.36	8531	0.136	1.318	0.179
BH103	20.74-20.98 (20.74-20.98)	C	N77417	Very weak to weak reddish brown fine to medium grained SANDSTONE.	11.2	100	100	0.60	D/PL	100.00	10000	0.060	1.366	0.083
						100	88	3.23	A/PD	105.85	11205	0.288	1.401	0.404
						100	92	2.96	A/PD	108.23	11714	0.253	1.416	0.358
BH103	21.65-22.00 (21.65-22.00)	C	N77419	Very weak to weak reddish brown fine to medium grained SANDSTONE.	11.7	76	75	0.79	D/PL	75.00	5625	0.141	1.200	0.169
						75	75	0.85	D/PL	75.00	5625	0.151	1.200	0.181
						75	75	1.23	D/PL	75.00	5625	0.219	1.200	0.263
						75	86	2.21	A/PD	90.62	8212	0.269	1.307	0.351
						75	85	1.27	A/PD	90.09	8117	0.157	1.303	0.205
						75	83	1.86	A/PD	89.03	7926	0.235	1.296	0.305
						75	80	1.88	A/PD	87.40	7639	0.247	1.286	0.317
BH103	23.00-23.18 (23.00-23.18)	C	N77420	Weak reddish brown fine to medium grained SANDSTONE.	11.2	100	100	2.51	D/PL	100.00	10000	0.251	1.366	0.343
						100	91	3.54	A/PD	107.64	11586	0.306	1.412	0.432
						100	90	3.88	A/PD	107.05	11459	0.338	1.409	0.476
BH103	24.75-25.05 (24.75-25.05)	C	N77421	Weak reddish brown fine to medium grained SANDSTONE.	11.4	100	101	3.43	D/PL	101.00	10201	0.337	1.372	0.462
						101	101	2.58	D/PL	101.00	10201	0.253	1.372	0.347
						101	99	4.30	A/PD	112.83	12731	0.338	1.442	0.487
						101	81	3.92	A/PD	102.06	10416	0.376	1.379	0.519
						101	101	3.69	A/PD	113.97	12988	0.284	1.449	0.412
BH103	26.30-26.57 (26.30-26.57)	C	N77422	Weak reddish brown fine to medium grained SANDSTONE.	1.6	75	75	1.49	D/PL	75.00	5625	0.265	1.200	0.318
						75	75	1.59	D/PL	75.00	5625	0.283	1.200	0.340
						75	81	2.81	A/PD	87.95	7735	0.363	1.289	0.468
						75	79	2.96	A/PD	86.86	7544	0.392	1.282	0.502
						75	84	2.77	A/PD	89.56	8021	0.346	1.300	0.449
BH103	27.16-27.46 (27.16-27.46)	C	N77423	Weak reddish brown fine to medium grained SANDSTONE.	9.0	101	101	2.15	D/PL	101.00	10201	0.211	1.372	0.290
						101	101	2.19	D/PL	101.00	10201	0.215	1.372	0.295
						101	81	5.17	A/PD	102.06	10416	0.496	1.379	0.684
						101	79	4.84	A/PD	100.79	10159	0.476	1.371	0.653
						101	90	4.51	A/PD	107.58	11574	0.390	1.412	0.550

Remarks AGS

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LABORATORY RESULTS - Point Load Strength Determination

Project CROWN STREET ZONE 2 **Project No:** PN194002

Sample					w	W	D	Fail Load	Test Type/ Direction	De	De^2	Is	F	Is_{50}
Hole	Depth (Specimen Depth) m	Type	Sample Ref	Description	%	mm	mm	kN		mm	mm^2	MN/m^2		MN/m^2
BH103	29.19-29.44 (29.19-29.44)	C	N77424	Weak reddish brown fine to medium grained SANDSTONE.	10.8	101	101	2.18	D/PL	101.00	10201	0.214	1.372	0.294
						101	82	3.93	A/PD	102.69	10545	0.372	1.382	0.515
						101	80	2.89	A/PD	101.43	10288	0.281	1.375	0.386
						101	84	3.49	A/PD	103.93	10802	0.323	1.390	0.449
BH103	30.22-30.39 (30.22-30.39)	C	N77426	Weak reddish brown fine to medium grained SANDSTONE.	7.8	75	75	1.36	D/PL	75.00	5625	0.241	1.200	0.290
						75	88	2.16	A/PD	91.67	8403	0.257	1.314	0.337
						75	71	1.91	A/PD	82.34	6780	0.282	1.252	0.353
BH103	31.15-31.50 (31.15-31.50)	C	N77427	Weak reddish brown fine to medium grained SANDSTONE.	10.6	75	75	1.77	D/PL	75.00	5625	0.315	1.200	0.379
						75	75	2.02	D/PL	75.00	5625	0.359	1.200	0.431
						75	79	2.63	A/PD	86.86	7544	0.349	1.282	0.447
						75	81	2.22	A/PD	87.95	7735	0.287	1.289	0.370
						75	81	2.68	A/PD	87.95	7735	0.347	1.289	0.447
BH103	32.15-32.54 (32.15-32.54)	C	N77428	Weak reddish brown fine to medium grained SANDSTONE.	8.7	100	100	3.04	D/PL	100.00	10000	0.304	1.366	0.416
						100	100	3.28	D/PL	100.00	10000	0.328	1.366	0.448
						100	89	4.08	A/PD	106.45	11332	0.360	1.405	0.505
						100	88	3.98	A/PD	105.85	11205	0.355	1.401	0.498
						100	81	3.93	A/PD	101.55	10313	0.381	1.376	0.524
BH103	33.55-33.81 (33.55-33.81)	C	N77430	Weak reddish brown fine to medium grained SANDSTONE.	10.5	100	100	3.13	D/PL	100.00	10000	0.313	1.366	0.427
						100	100	2.87	D/PL	100.00	10000	0.287	1.366	0.393
						100	93	5.03	A/PD	108.82	11841	0.424	1.419	0.602
						100	83	3.88	A/PD	102.80	10568	0.367	1.383	0.508
						100	79	3.57	A/PD	100.29	10059	0.355	1.368	0.486
BH103	34.00-34.26 (34.00-34.26)	C	N77431	Weak reddish brown fine to medium grained SANDSTONE.	6.1	100	100	2.39	D/PL	100.00	10000	0.239	1.366	0.326
						100	100	2.18	D/PL	100.00	10000	0.218	1.366	0.298
						100	72	2.76	A/PD	95.75	9167	0.301	1.340	0.404
						100	69	3.37	A/PD	93.73	8785	0.384	1.327	0.509
						100	61	2.89	A/PD	88.13	7767	0.373	1.291	0.481
BH103	35.00-35.23 (35.00-35.23)	C	N77432	Weak reddish brown fine to medium grained SANDSTONE.	10.1	100	100	3.08	D/PL	100.00	10000	0.308	1.366	0.421
						100	82	4.76	A/PD	102.18	10441	0.456	1.379	0.628
						100	69	4.03	A/PD	93.73	8785	0.459	1.327	0.609
BH103	36.27-36.53 (36.27-36.53)	C	N77433	Weak reddish brown fine to medium grained SANDSTONE.	9.9	100	100	3.32	D/PL	100.00	10000	0.332	1.366	0.454
						100	100	2.96	D/PL	100.00	10000	0.296	1.366	0.404
						100	92	4.62	A/PD	108.23	11714	0.394	1.416	0.558
						100	86	3.86	A/PD	104.64	10950	0.353	1.394	0.491
						100	89	5.04	A/PD	106.45	11332	0.445	1.405	0.625
BH103	38.29-38.45 (38.29-38.45)	C	N77435	Weak reddish brown fine to medium grained SANDSTONE.	9.6	100	101	4.09	D/PL	101.00	10201	0.401	1.372	0.550
						101	80	4.08	A/PD	101.43	10288	0.396	1.375	0.545
						101	79	4.52	A/PD	100.79	10159	0.445	1.371	0.610
BH103	40.00-40.21 (40.00-40.21)	C	N77436	Very weak to weak reddish brown fine to medium grained SANDSTONE.	5.4	76	75	0.99	D/PL	75.00	5625	0.176	1.200	0.212
						75	78	3.10	A/PD	86.30	7448	0.416	1.278	0.532
						75	74	1.42	A/PD	84.06	7066	0.202	1.263	0.255
						75	48	0.39	A/PD	67.70	4584	0.086	1.146	0.098

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LABORATORY RESULTS - Point Load Strength Determination

Project CROWN STREET ZONE 2 **Project No:** PN194002

Sample					w	W	D	Fail Load	Test Type/ Direction	De	De^2	Is	F	Is_{50}
Hole	Depth (Specimen Depth) m	Type	Sample Ref	Description	%	mm	mm	kN		mm	mm^2	MN/m^2		MN/m^2
BH103	42.67-42.82 (42.67-42.82)	C	N77437	Very weak to weak reddish brown fine to medium grained SANDSTONE.	8.6	101 101 101	101 80 67	0.43 2.95 3.11	D/PL A/PD A/PD	101.00 101.43 92.82	10201 10288 8616	0.042 0.287 0.361	1.372 1.375 1.321	0.057 0.394 0.477
BH103	44.50-44.68 (44.50-44.68)	C	N77438	Weak reddish brown fine to medium grained SANDSTONE.	8.2	101 101 101	101 81 91	2.74 4.03 5.08	D/PL A/PD A/PD	101.00 102.06 108.18	10201 10416 11702	0.269 0.387 0.434	1.372 1.379 1.415	0.369 0.534 0.615
BH103	47.51-47.70 (47.51-47.70)	C	N77439	Very weak to weak reddish brown fine to medium grained SANDSTONE.	9.9	101 101 101	101 92 87	1.21 3.50 1.84	D/PL A/PD A/PD	101.00 108.77 105.77	10201 11831 11188	0.118 0.295 0.165	1.372 1.419 1.401	0.162 0.419 0.231
BH104	9.50-9.64 (9.50-9.64)	C	N77440	Very weak reddish brown fine to medium grained SANDSTONE.	8.2	86 85 85	85 67 64	0.61 0.68 0.92	D/PL A/PD A/PD	85.00 85.15 83.23	7225 7251 6926	0.085 0.093 0.133	1.270 1.271 1.258	0.108 0.118 0.167
BH104	10.60-10.72 (10.60-10.72)	C	N77441	Very weak to weak reddish brown fine to medium grained SANDSTONE.	9.0	85 85 85	85 56 56	0.92 1.82 1.57	D/PL A/PD A/PD	85.00 77.85 77.85	7225 6061 6061	0.128 0.300 0.259	1.270 1.221 1.221	0.162 0.366 0.317
BH104	11.65-11.78 (11.65-11.78)	C	N77443	Weak reddish brown fine to medium grained SANDSTONE.	11.2	86 86 86	86 69 66	1.33 2.09 1.64	D/PL A/PD A/PD	86.00 86.92 85.01	7396 7555 7227	0.179 0.277 0.227	1.276 1.283 1.270	0.229 0.355 0.288
BH104	13.25-13.50 (13.25-13.50)	C	N77444	Very weak to weak reddish brown fine to medium grained SANDSTONE.	11.5	86 86 86 86 86	86 86 84 84 85	1.09 0.79 1.95 1.94 2.69	D/PL D/PL A/PD A/PD A/PD	86.00 86.00 95.91 95.91 96.47	7396 7396 9198 9198 9307	0.147 0.106 0.212 0.211 0.289	1.276 1.276 1.341 1.341 1.344	0.188 0.136 0.285 0.283 0.389
BH104	15.82-16.02 (15.82-16.02)	C	N77446	Very weak to weak reddish brown fine to medium grained SANDSTONE.	12.3	86 86 86 86 86	86 86 74 75 68	0.84 0.87 1.61 1.71 1.30	D/PL D/PL A/PD A/PD A/PD	86.00 86.00 90.02 90.62 86.29	7396 7396 8103 8212 7446	0.113 0.118 0.199 0.209 0.175	1.276 1.276 1.303 1.307 1.278	0.145 0.151 0.260 0.273 0.224
BH104	16.45-16.59 (16.45-16.59)	C	N77447	Very weak to weak reddish brown fine to medium grained SANDSTONE.	9.6	86 86 86	86 67 67	0.91 1.58 1.76	D/PL A/PD A/PD	86.00 85.65 85.65	7396 7336 7336	0.123 0.215 0.240	1.276 1.274 1.274	0.157 0.274 0.305
BH104	18.70-18.94 (18.70-18.94)	C	N77449	Very weak to weak reddish brown fine to medium grained SANDSTONE.	11.5	86 86 86 86 86	86 86 77 73 75	0.87 1.22 1.94 1.74 1.68	D/PL D/PL A/PD A/PD A/PD	86.00 86.00 91.82 89.41 90.62	7396 7396 8431 7993 8212	0.118 0.165 0.230 0.217 0.205	1.276 1.276 1.315 1.299 1.307	0.151 0.211 0.302 0.282 0.267

Remarks AGS

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LABORATORY RESULTS - Point Load Strength Determination

Project CROWN STREET ZONE 2 **Project No:** PN194002

Sample					w	W	D	Fail Load	Test Type/ Direction	De	De^2	Is	F	Is_{50}
Hole	Depth (Specimen Depth) m	Type	Sample Ref	Description	%	mm	mm	kN		mm	mm^2	MN/m^2		MN/m^2
BH104	19.44-19.67 (19.44-19.67)	C	N77450	Very weak to weak reddish brown fine to medium grained SANDSTONE.	10.9	86	86	0.75	D/PL	86.00	7396	0.101	1.276	0.129
						86	86	0.69	D/PL	86.00	7396	0.093	1.276	0.119
						86	74	2.13	A/PD	90.02	8103	0.263	1.303	0.342
						86	72	2.26	A/PD	88.79	7884	0.287	1.295	0.372
						86	72	2.06	A/PD	88.79	7884	0.262	1.295	0.339
BH104	22.43-22.61 (22.43-22.61)	C	N77451	Very weak to weak reddish brown fine to medium grained SANDSTONE.	9.1	86	86	0.66	D/PL	86.00	7396	0.090	1.276	0.114
						86	89	1.44	A/PD	98.72	9745	0.148	1.358	0.201
						86	90	1.77	A/PD	99.27	9855	0.179	1.362	0.244
BH104	24.36-24.50 (24.36-24.50)	C	N77453	Weak reddish brown fine to medium grained SANDSTONE.	10.1	86	86	1.47	D/PL	86.00	7396	0.198	1.276	0.253
						86	64	2.14	A/PD	83.71	7008	0.306	1.261	0.385
						86	65	2.51	A/PD	84.36	7117	0.353	1.265	0.447
BH104	27.13-27.33 (27.13-27.33)	C	N77454	Weak reddish brown fine to medium grained SANDSTONE.	8.8	86	86	1.97	D/PL	86.00	7396	0.266	1.276	0.340
						86	96	2.93	A/PD	102.53	10512	0.279	1.382	0.385
						86	93	UF	A/PD					
BH104	29.62-29.87 (29.62-29.87)	C	N77455	Weak reddish brown fine to medium grained SANDSTONE.	7.7	86	86	1.59	D/PL	86.00	7396	0.216	1.276	0.275
						86	76	2.47	A/PD	91.22	8322	0.296	1.311	0.388
						86	75	2.50	A/PD	90.62	8212	0.305	1.307	0.398
BH104	32.00-32.25 (32.00-32.25)	C	N77456	Weak reddish brown fine to medium grained SANDSTONE.	8.6	86	86	1.69	D/PL	86.00	7396	0.228	1.276	0.291
						86	86	1.70	D/PL	86.00	7396	0.230	1.276	0.294
						86	81	3.30	A/PD	94.18	8869	0.372	1.330	0.494
						86	77	3.71	A/PD	91.82	8431	0.440	1.315	0.578
						86	90	3.13	A/PD	99.27	9855	0.317	1.362	0.432
BH105	8.73-8.95 (8.73-8.95)	C	N77457	Very weak reddish brown fine to medium grained SANDSTONE.	8.7	85	85	0.51	D/PL	85.00	7225	0.071	1.270	0.090
						85	85	0.57	D/PL	85.00	7225	0.079	1.270	0.101
						85	72	1.13	A/PD	88.27	7792	0.145	1.292	0.187
						85	71	1.14	A/PD	87.66	7684	0.148	1.287	0.191
						85	64	0.99	A/PD	83.23	6926	0.142	1.258	0.179
BH105	9.79-10.00 (9.79-10.00)	C	N77458	Weak reddish brown fine to medium grained SANDSTONE.	8.0	85	85	1.40	D/PL	85.00	7225	0.193	1.270	0.245
						85	85	1.31	D/PL	85.00	7225	0.182	1.270	0.231
						85	71	2.05	A/PD	87.66	7684	0.267	1.287	0.344
						85	79	2.55	A/PD	92.47	8550	0.298	1.319	0.393
						85	71	2.38	A/PD	87.66	7684	0.309	1.287	0.398
BH105	12.18-12.27 (12.18-12.27)	C	N77459	Very weak reddish brown fine to medium grained SANDSTONE.	11.8	85	85	1.31	A/PD	95.91	9199	0.142	1.341	0.191
BH105	13.00-13.15 (13.00-13.15)	C	N77461	Very weak to weak reddish brown fine to medium grained SANDSTONE.	9.9	85	85	0.96	D/PL	85.00	7225	0.133	1.270	0.169
						84	72	2.05	A/PD	87.75	7701	0.266	1.288	0.343
						85	69	2.23	A/PD	86.41	7468	0.299	1.279	0.382

Remarks AGS

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LABORATORY RESULTS - Point Load Strength Determination

Project CROWN STREET ZONE 2 **Project No:** PN194002

Sample					w	W	D	Fail Load	Test Type/ Direction	De	De^2	Is	F	Is_{50}
Hole	Depth (Specimen Depth) m	Type	Sample Ref	Description	%	mm	mm	kN		mm	mm^2	MN/m^2		MN/m^2
BH105	15.31-15.42 (15.31-15.42)	C	N77462	Very weak to weak reddish brown fine to medium grained SANDSTONE.	10.1	85 85 85	85 61 47	1.14 1.97 0.98	D/PL A/PD A/PD	85.00 81.25 71.32	7225 6602 5087	0.158 0.298 0.193	1.270 1.244 1.173	0.201 0.371 0.227
BH105	16.33-16.53 (16.33-16.53)	C	N77464	Very weak to weak reddish brown fine to medium grained SANDSTONE.	8.6	85 85 85 85 85	85 85 72 70 61	0.62 0.89 1.56 0.93 1.10	D/PL D/PL A/PD A/PD A/PD	85.00 85.00 88.27 87.04 81.25	7225 7225 7792 7576 6602	0.086 0.124 0.200 0.122 0.167	1.270 1.270 1.292 1.283 1.244	0.109 0.157 0.258 0.157 0.207
BH105	18.41-18.62 (18.41-18.62)	C	N77465	Weak reddish brown fine to medium grained SANDSTONE.	9.8	86 86 86 86 86	86 86 71 71 67	1.65 1.50 2.12 2.72 2.94	D/PL D/PL A/PD A/PD A/PD	86.00 86.00 88.17 88.17 85.65	7396 7396 7774 7774 7336	0.224 0.203 0.272 0.349 0.401	1.276 1.276 1.291 1.291 1.274	0.285 0.259 0.352 0.451 0.511
BH105	19.31-19.45 (19.31-19.45)	C	N77467	Weak reddish brown fine to medium grained SANDSTONE.	10.0	86 86 86	86 66 67	1.31 1.31 2.13	D/PL A/PD A/PD	86.00 85.01 85.65	7396 7227 7336	0.178 0.181 0.291	1.276 1.270 1.274	0.227 0.230 0.370
BH105	20.62-20.80 (20.62-20.80)	C	N77468	Weak reddish brown fine to medium grained SANDSTONE.	7.9	86 85 85	85 91 80	1.60 2.09 2.35	D/PL A/PD A/PD	85.00 99.24 93.05	7225 9849 8658	0.221 0.213 0.271	1.270 1.361 1.323	0.280 0.289 0.359
BH105	22.37-22.54 (22.37-22.54)	C	N77469	Weak reddish brown fine to medium grained SANDSTONE.	9.6	86 86 86	86 86 87	1.56 2.83 2.53	D/PL A/PD A/PD	86.00 97.04 97.60	7396 9417 9526	0.211 0.301 0.266	1.276 1.348 1.351	0.269 0.405 0.359
BH105	24.03-24.11 (24.03-24.11)	C	N77470	Weak reddish brown fine to medium grained SANDSTONE.	6.3	86	81	3.26	A/PD	94.18	8869	0.368	1.330	0.489
BH105	25.31-25.52 (25.31-25.52)	C	N77472	Very weak to weak reddish brown fine to medium grained SANDSTONE.	7.3	86 86 86 86 86	86 86 79 78 57	0.50 0.63 1.98 1.73 1.02	D/PL D/PL A/PD A/PD A/PD	86.00 86.00 93.01 92.42 79.00	7396 7396 8650 8541 6241	0.068 0.085 0.229 0.202 0.163	1.276 1.276 1.322 1.318 1.229	0.087 0.108 0.303 0.267 0.200
BH106	8.73-8.83 (8.73-8.83)	C	N77473	Very weak reddish brown fine to medium grained SANDSTONE.	9.4	85	73	1.21	A/PD	88.88	7900	0.153	1.296	0.198
BH106	10.36-10.50 (10.36-10.50)	C	N77474	Very weak reddish brown fine to medium grained SANDSTONE.	6.9	85 85	64 58	1.03 0.75	A/PD A/PD	83.23 79.23	6926 6277	0.148 0.119	1.258 1.230	0.186 0.146

Remarks AGS

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LABORATORY RESULTS - Point Load Strength Determination

Project CROWN STREET ZONE 2 **Project No:** PN194002

Sample					w	W	D	Fail Load	Test Type/ Direction	De	De^2	Is	F	Is_{50}
Hole	Depth (Specimen Depth) m	Type	Sample Ref	Description	%	mm	mm	kN		mm	mm^2	MN/m^2		MN/m^2
BH106	12.24-12.38 (12.24-12.38)	C	N77475	Very weak to weak reddish brown fine to medium grained SANDSTONE.	10.6	85 85 85	85 79 69	0.99 1.80 1.67	D/PL A/PD A/PD	85.00 92.47 86.41	7225 8550 7468	0.137 0.211 0.224	1.270 1.319 1.279	0.174 0.278 0.286
BH106	13.44-13.57 (13.44-13.57)	C	N77477	Very weak to weak reddish brown fine to medium grained SANDSTONE.	10.4	85 85 85	85 69 64	0.87 1.24 1.50	D/PL A/PD A/PD	85.00 86.41 83.23	7225 7468 6926	0.121 0.166 0.217	1.270 1.279 1.258	0.154 0.213 0.273
BH106	15.62-15.78 (15.62-15.78)	C	N77478	Weak reddish brown fine to medium grained SANDSTONE.	9.2	85 85 85	85 82 77	1.80 2.85 2.49	D/PL A/PD A/PD	85.00 94.20 91.29	7225 8874 8333	0.249 0.321 0.298	1.270 1.330 1.311	0.316 0.426 0.391
BH106	16.00-16.13 (16.00-16.13)	C	N77479	Weak reddish brown fine to medium grained SANDSTONE.	6.6	85 85 85	85 68 59	1.71 2.18 2.21	D/PL A/PD A/PD	85.00 85.79 79.91	7225 7359 6385	0.237 0.296 0.346	1.270 1.275 1.235	0.301 0.378 0.427
BH106	19.49-19.67 (19.49-19.67)	C	N77482	Very weak to weak reddish brown fine to medium grained SANDSTONE.	9.7	85 85 85	85 87 91	0.88 1.93 1.97	D/PL A/PD A/PD	85.00 97.03 99.24	7225 9416 9849	0.121 0.205 0.200	1.270 1.348 1.361	0.154 0.276 0.272
BH106	21.84-22.00 (21.84-22.00)	C	N77484	Weak reddish brown fine to medium grained SANDSTONE.	9.4	85 85 85	85 71 69	2.41 3.18 3.68	D/PL A/PD A/PD	85.00 87.66 86.41	7225 7684 7468	0.333 0.413 0.492	1.270 1.287 1.279	0.423 0.532 0.630
BH106	22.34-22.52 (22.34-22.52)	C	N77485	Weak reddish brown fine to medium grained SANDSTONE.	9.2	85 85 85	85 84 87	2.38 3.01 3.38	D/PL A/PD A/PD	85.00 95.35 97.03	7225 9091 9416	0.329 0.331 0.359	1.270 1.337 1.348	0.418 0.442 0.484
BH106	23.42-23.59 (23.42-23.59)	C	N77487	Weak reddish brown fine to medium grained SANDSTONE.	9.0	85 85 85	85 82 81	2.24 3.16 3.35	D/PL A/PD A/PD	85.00 94.20 93.63	7225 8874 8766	0.309 0.357 0.382	1.270 1.330 1.326	0.393 0.474 0.507
BH106	25.30-25.55 (25.30-25.55)	C	N77488	Weak reddish brown fine to medium grained SANDSTONE.	8.5	85 85 85	85 71 67	1.57 2.46 2.43	D/PL A/PD A/PD	85.00 87.66 85.15	7225 7684 7251	0.218 0.320 0.335	1.270 1.287 1.271	0.276 0.412 0.426
BH107	10.00-10.14 (10.00-10.14)	C	N77489	Very weak to weak reddish brown fine to medium grained SANDSTONE.	9.3	86 86 86	86 75 51	0.76 1.16 1.13	D/PL A/PD A/PD	86.00 90.62 74.73	7396 8212 5584	0.103 0.141 0.203	1.276 1.307 1.198	0.131 0.185 0.243
BH107	12.00-12.18 (12.00-12.18)	C	N77490	Very weak to weak reddish brown fine to medium grained SANDSTONE.	7.5	86 86 86	86 89 86	1.02 2.73 1.80	D/PL A/PD A/PD	86.00 98.72 97.04	7396 9745 9417	0.138 0.280 0.192	1.276 1.358 1.348	0.176 0.380 0.258

Remarks AGS

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LABORATORY RESULTS - Point Load Strength Determination

Project CROWN STREET ZONE 2 **Project No:** PN194002

Sample					w	W	D	Fail Load	Test Type/ Direction	De	De^2	Is	F	Is_{50}
Hole	Depth (Specimen Depth) m	Type	Sample Ref	Description	%	mm	mm	kN		mm	mm^2	MN/m^2		MN/m^2
BH107	13.24-13.46 (13.24-13.46)	C	N77491	Very weak to weak reddish brown fine to medium grained SANDSTONE.	11.3	86	86	1.07	D/PL	86.00	7396	0.144	1.276	0.184
						86	86	0.95	D/PL	86.00	7396	0.128	1.276	0.163
						86	84	1.91	A/PD	95.91	9198	0.208	1.341	0.279
						86	80	2.39	A/PD	93.59	8760	0.272	1.326	0.361
						86	78	1.65	A/PD	92.42	8541	0.193	1.318	0.254
BH107	15.54-15.69 (15.54-15.69)	C	N77493	Very weak to weak reddish brown fine to medium grained SANDSTONE.	9.6	86	86	0.67	D/PL	86.00	7396	0.091	1.276	0.116
						86	69	1.55	A/PD	86.92	7555	0.206	1.283	0.264
						86	67	1.32	A/PD	85.65	7336	0.180	1.274	0.230
BH107	17.38-17.50 (17.38-17.50)	C	N77495	Weak reddish brown fine to medium grained SANDSTONE.	7.2	86	86	1.60	D/PL	86.00	7396	0.216	1.276	0.275
						86	51	1.44	A/PD	74.73	5584	0.258	1.198	0.309
						86	52	1.89	A/PD	75.46	5694	0.332	1.204	0.400
BH107	18.36-18.70 (18.36-18.70)	C	N77496	Very weak to weak reddish brown fine to medium grained SANDSTONE.	6.7	86	86	0.53	D/PL	86.00	7396	0.072	1.276	0.092
						86	86	1.34	D/PL	86.00	7396	0.181	1.276	0.231
						86	86	1.71	D/PL	86.00	7396	0.231	1.276	0.295
						86	91	2.35	A/PD	99.82	9964	0.235	1.365	0.321
						86	88	2.61	A/PD	98.16	9636	0.271	1.355	0.367
						86	77	1.72	A/PD	91.82	8431	0.204	1.315	0.269
						86	74	2.03	A/PD	90.02	8103	0.250	1.303	0.326
BH107	19.00-19.30 (19.00-19.30)	C	N77497	Weak reddish brown fine to medium grained SANDSTONE.	7.3	86	86	1.76	D/PL	86.00	7396	0.237	1.276	0.303
						86	86	1.65	D/PL	86.00	7396	0.224	1.276	0.285
						86	99	3.50	A/PD	104.12	10840	0.323	1.391	0.450
						86	88	3.15	A/PD	98.16	9636	0.327	1.355	0.443
						86	80	2.91	A/PD	93.59	8760	0.332	1.326	0.440
BH107	20.49-20.74 (20.49-20.74)	C	N77499	Weak reddish brown fine to medium grained SANDSTONE.	9.1	86	86	2.13	D/PL	86.00	7396	0.289	1.276	0.368
						86	86	2.45	D/PL	86.00	7396	0.331	1.276	0.422
						86	84	4.68	A/PD	95.91	9198	0.509	1.341	0.682
						86	80	4.19	A/PD	93.59	8760	0.478	1.326	0.634
						86	85	4.69	A/PD	96.47	9307	0.504	1.344	0.678
BH107	22.30-22.48 (22.30-22.48)	C	N77501	Weak reddish brown fine to medium grained SANDSTONE.	8.9	85	86	2.01	D/PL	86.00	7396	0.272	1.276	0.347
						86	91	3.23	A/PD	99.82	9964	0.324	1.365	0.442
						86	89	3.44	A/PD	98.72	9745	0.353	1.358	0.479
BH107	24.73-25.00 (24.73-25.00)	C	N77502	Weak reddish brown fine to medium grained SANDSTONE.	8.1	85	85	2.14	D/PL	85.00	7225	0.296	1.270	0.375
						85	85	1.52	A/PD	68.22	4654	0.327	1.150	0.376
						85	89	3.87	A/PD	98.14	9632	0.402	1.355	0.545
						85	83	3.36	A/PD	94.78	8983	0.374	1.334	0.498
BH107	25.08-25.17 (25.08-25.17)	C	N77503	Weak reddish brown fine to medium grained SANDSTONE.	8.8	86	95	3.27	A/PD	101.99	10402	0.314	1.378	0.433
BH107	26.35-26.50 (26.35-26.50)	C	N77505	Weak reddish brown fine to medium grained SANDSTONE.	6.3	86	86	1.58	D/PL	86.00	7396	0.214	1.276	0.273
						76	68	2.21	A/PD	81.12	6580	0.336	1.243	0.418
						86	67	2.88	A/PD	85.65	7336	0.393	1.274	0.501

Remarks AGS

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LABORATORY RESULTS - Point Load Strength Determination

Project CROWN STREET ZONE 2 **Project No:** PN194002

Sample					w	W	D	Fail Load	Test Type/ Direction	De	De^2	Is	F	Is_{50}
Hole	Depth (Specimen Depth) m	Type	Sample Ref	Description	%	mm	mm	kN		mm	mm^2	MN/m^2		MN/m^2
BH107	29.79-30.00 (29.79-30.00)	C	N77506	Weak reddish brown fine to medium grained SANDSTONE.	7.1	85	85	2.80	D/PL	85.00	7225	0.388	1.270	0.492
						85	89	5.13	A/PD	98.14	9632	0.532	1.355	0.721
						85	87	4.09	A/PD	97.03	9416	0.435	1.348	0.586
BH107	30.38-30.58 (30.38-30.58)	C	N77507	Very weak to weak reddish brown fine to medium grained SANDSTONE.	10.1	85	85	1.10	D/PL	85.00	7225	0.153	1.270	0.194
						85	69	2.48	A/PD	86.41	7468	0.332	1.279	0.424
						85	61	2.09	A/PD	81.25	6602	0.316	1.244	0.394
BH107	31.53-31.69 (31.53-31.69)	C	N77508	Weak reddish brown fine to medium grained SANDSTONE.	10.1	85	86	2.67	D/PL	86.00	7396	0.362	1.276	0.461
						85	79	4.10	A/PD	92.47	8550	0.479	1.319	0.632
						85	81	4.02	A/PD	93.63	8766	0.459	1.326	0.608
BH107	33.00-33.17 (33.00-33.17)	C	N77510	Weak reddish brown fine to medium grained SANDSTONE.	8.7	85	85	1.86	D/PL	85.00	7225	0.258	1.270	0.328
						85	82	3.51	A/PD	94.20	8874	0.395	1.330	0.526
						85	80	3.82	A/PD	93.05	8658	0.441	1.323	0.583
BH107	34.72-35.00 (34.72-35.00)	C	N77511	Very weak to weak reddish brown fine to medium grained SANDSTONE.	6.0	85	86	1.31	D/PL	86.00	7396	0.177	1.276	0.226
						86	86	1.61	D/PL	86.00	7396	0.218	1.276	0.278
						86	86	0.97	D/PL	86.00	7396	0.131	1.276	0.167
						86	83	2.81	A/PD	95.33	9088	0.309	1.337	0.413
						86	69	3.29	A/PD	86.92	7555	0.435	1.283	0.558
						86	61	2.33	A/PD	81.73	6679	0.348	1.248	0.434
						86	57	2.06	A/PD	79.00	6241	0.330	1.229	0.406
BH108	10.56-10.63 (10.56-10.63)	C	N77512	Weak reddish brown fine to medium grained SANDSTONE.	10.3	86	90	1.76	A/PD	99.27	9855	0.179	1.362	0.243
BH108	10.77-10.91 (10.77-10.91)	C	N77513	Very weak to weak reddish brown fine to medium grained SANDSTONE.	10.1	86	86	1.07	D/PL	86.00	7396	0.144	1.276	0.184
						86	73	2.28	A/PD	89.41	7993	0.286	1.299	0.371
						86	69	1.82	A/PD	86.92	7555	0.240	1.283	0.308
BH108	13.01-13.18 (13.01-13.18)	C	N77516	Weak reddish brown fine to medium grained SANDSTONE.	10.8	86	86	1.20	D/PL	86.00	7396	0.162	1.276	0.207
						86	92	2.30	A/PD	100.37	10074	0.228	1.368	0.312
						86	92	2.58	A/PD	100.37	10074	0.256	1.368	0.350
BH108	13.96-14.21 (13.96-14.21)	C	N77517	Very weak to weak reddish brown fine to medium grained SANDSTONE.	6.6	86	85	1.17	D/PL	85.00	7225	0.162	1.270	0.205
						85	85	0.92	D/PL	85.00	7225	0.127	1.270	0.162
						85	89	3.14	A/PD	98.14	9632	0.326	1.355	0.442
						85	71	2.26	A/PD	87.66	7684	0.294	1.287	0.378
						85	73	1.68	A/PD	88.88	7900	0.213	1.296	0.276
BH108	14.92-15.01 (14.92-15.01)	C	N77518	Weak reddish brown fine to medium grained SANDSTONE.	10.0	85	91	2.55	A/PD	99.24	9849	0.259	1.361	0.353

Remarks AGS

Test Type D - Diametral, A - Axial, I - Lump or Irregular Test
Direction PL - parallel to planes of weakness, R - Random or unknown orientation, PD - perpendicular to planes of weakness
Fail Load UF - unacceptable failure
For Standards followed see Laboratory Test Certificate

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LABORATORY RESULTS - Point Load Strength Determination

Project CROWN STREET ZONE 2 **Project No:** PN194002

Sample					w	W	D	Fail Load	Test Type/ Direction	De	De^2	Is	F	Is_{50}
Hole	Depth (Specimen Depth) m	Type	Sample Ref	Description	%	mm	mm	kN		mm	mm^2	MN/m^2		MN/m^2
BH108	16.50-16.75 (16.50-16.75)	C	N77520	Weak reddish brown fine to medium grained SANDSTONE.	8.5	86	86	1.23	D/PL	86.00	7396	0.167	1.276	0.213
						86	86	1.30	D/PL	86.00	7396	0.176	1.276	0.225
						86	91	2.47	A/PD	99.82	9964	0.248	1.365	0.339
						86	78	2.11	A/PD	92.42	8541	0.247	1.318	0.325
						86	62	2.42	A/PD	82.39	6789	0.357	1.252	0.447
BH108	17.75-17.98 (17.75-17.98)	C	N77521	Weak reddish brown fine to medium grained SANDSTONE.	9.4	86	86	1.59	D/PL	86.00	7396	0.215	1.276	0.274
						86	86	1.33	D/PL	86.00	7396	0.180	1.276	0.230
						86	80	2.95	A/PD	93.59	8760	0.337	1.326	0.446
						86	72	2.64	A/PD	88.79	7884	0.335	1.295	0.434
						86	69	2.31	A/PD	86.92	7555	0.306	1.283	0.392
BH108	19.91-20.23 (19.91-20.23)	C	N77522	Weak reddish brown fine to medium grained SANDSTONE.	9.0	86	86	1.49	D/PL	86.00	7396	0.201	1.276	0.257
						86	86	1.54	D/PL	86.00	7396	0.208	1.276	0.266
						86	86	1.50	D/PL	86.00	7396	0.202	1.276	0.258
						86	89	3.05	A/PD	98.72	9745	0.313	1.358	0.425
						86	80	2.29	A/PD	93.59	8760	0.261	1.326	0.346
						86	79	2.22	A/PD	93.01	8650	0.257	1.322	0.340
						86	77	2.34	A/PD	91.82	8431	0.278	1.315	0.365
BH108	21.15-21.35 (21.15-21.35)	C	N77523	Very weak to weak reddish brown fine to medium grained SANDSTONE.	12.5	86	86	1.32	D/PL	86.00	7396	0.178	1.276	0.227
						86	86	0.95	D/PL	86.00	7396	0.128	1.276	0.164
						86	85	1.53	A/PD	96.47	9307	0.165	1.344	0.222
						86	69	1.31	A/PD	86.92	7555	0.173	1.283	0.222
						86	67	1.18	A/PD	85.65	7336	0.160	1.274	0.204
BH108	22.50-22.66 (22.50-22.66)	C	N77524	Very weak to weak reddish brown fine to medium grained SANDSTONE.	10.7	85	85	0.56	D/PL	85.00	7225	0.077	1.270	0.098
						85	82	1.60	A/PD	94.20	8874	0.180	1.330	0.239
						85	78	1.08	A/PD	91.88	8442	0.128	1.315	0.169
BH108	25.10-25.22 (25.10-25.22)	C	N77526	Weak reddish brown fine to medium grained SANDSTONE.	9.7	85	85	1.95	D/PL	85.00	7225	0.270	1.270	0.342
						85	65	2.67	A/PD	83.87	7035	0.380	1.262	0.480
						85	64	2.50	A/PD	83.23	6926	0.360	1.258	0.453
BH108	26.60-26.72 (26.60-26.72)	C	N77528	Weak reddish brown fine to medium grained SANDSTONE.	9.9	85	85	1.77	D/PL	85.00	7225	0.246	1.270	0.312
						85	52	1.83	A/PD	75.02	5628	0.324	1.200	0.389
						85	59	2.49	A/PD	79.91	6385	0.390	1.235	0.482
BH108	27.95-28.23 (27.95-28.23)	C	N77529	Weak reddish brown fine to medium grained SANDSTONE.	6.8	85	85	1.15	D/PL	85.00	7225	0.159	1.270	0.202
						85	85	1.22	D/PL	85.00	7225	0.169	1.270	0.214
						85	83	2.64	A/PD	94.78	8983	0.294	1.334	0.392
						85	63	1.98	A/PD	82.57	6818	0.291	1.253	0.364
						85	56	2.06	A/PD	77.85	6061	0.340	1.221	0.415
BH108	31.30-31.50 (31.30-31.50)	C	N77530	Very weak to weak reddish brown fine to medium grained SANDSTONE.	7.5	85	85	0.67	D/PL	85.00	7225	0.092	1.270	0.117
						85	85	0.72	D/PL	85.00	7225	0.100	1.270	0.127
						85	82	1.42	A/PD	94.20	8874	0.160	1.330	0.213
						85	62	1.23	A/PD	81.91	6710	0.184	1.249	0.229
						85	57	1.17	A/PD	78.54	6169	0.190	1.225	0.233

Remarks AGS

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Direction PL - parallel to planes of weakness, R - Random or unknown orientation, PD - perpendicular to planes of weakness
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LABORATORY RESULTS - Point Load Strength Determination

Project CROWN STREET ZONE 2 **Project No:** PN194002

Sample					w	W	D	Fail Load	Test Type/ Direction	De	De^2	Is	F	Is_{50}
Hole	Depth (Specimen Depth) m	Type	Sample Ref	Description	%	mm	mm	kN		mm	mm^2	MN/m^2		MN/m^2
BH108	31.59-31.82 (31.59-31.82)	C	N77531	Very weak to weak reddish brown fine to medium grained SANDSTONE.	11.3	85	85	1.01	D/PL	85.00	7225	0.139	1.270	0.177
						85	85	1.22	D/PL	85.00	7225	0.169	1.270	0.214
						85	81	2.64	A/PD	93.63	8766	0.302	1.326	0.400
						85	79	1.98	A/PD	92.47	8550	0.232	1.319	0.306
						85	76	2.06	A/PD	90.69	8225	0.251	1.307	0.328
BH108	34.00-34.24 (34.00-34.24)	C	N77532	Very weak to weak reddish brown fine to medium grained SANDSTONE.	11.9	85	85	0.65	D/PL	85.00	7225	0.090	1.270	0.114
						85	85	1.17	D/PL	85.00	7225	0.162	1.270	0.206
						85	84	1.78	A/PD	67.42	4545	0.392	1.144	0.448
						85	81	2.17	A/PD	66.61	4437	0.489	1.138	0.556
						85	78	1.89	A/PD	64.97	4221	0.449	1.125	0.505
BH108	34.65-34.86 (34.65-34.86)	C	N77533	Very weak to weak reddish brown fine to medium grained SANDSTONE.	9.5	85	85	1.04	D/PL	85.00	7225	0.144	1.270	0.182
						85	85	0.84	D/PL	85.00	7225	0.116	1.270	0.147
						85	84	1.81	A/PD	95.35	9091	0.199	1.337	0.266
						85	69	1.08	A/PD	86.41	7468	0.144	1.279	0.184
						85	58	1.06	A/PD	79.23	6277	0.169	1.230	0.207
BH109	10.77-10.89 (10.77-10.89)	C	N77535	Very weak reddish brown fine to medium grained SANDSTONE.	12.2	100	100	0.74	D/PL	100.00	10000	0.074	1.366	0.102
						100	61	0.92	A/PD	88.13	7767	0.118	1.291	0.153
						100	55	0.65	A/PD	83.68	7003	0.093	1.261	0.117
BH109	12.25-12.35 (12.25-12.35)	C	N77536	Very weak to weak reddish brown fine to medium grained SANDSTONE.	11.6	100	100	1.26	D/PL	100.00	10000	0.126	1.366	0.173
						100	59	3.04	A/PD	86.67	7512	0.404	1.281	0.518
						100	54	2.02	A/PD	82.92	6875	0.294	1.256	0.369
BH109	14.73-14.86 (14.73-14.86)	C	N77538	Very weak to weak reddish brown fine to medium grained SANDSTONE.	8.1	75	75	0.28	D/PL	75.00	5625	0.050	1.200	0.061
						75	76	1.53	A/PD	85.19	7257	0.211	1.271	0.269
						75	57	1.17	A/PD	73.78	5443	0.216	1.191	0.257
BH109	14.86-15.00 (14.86-15.00)	C	N77539	Very weak to weak reddish brown fine to medium grained SANDSTONE.	10.1	75	75	0.69	D/PL	75.00	5625	0.122	1.200	0.147
						75	80	1.36	A/PD	87.40	7639	0.179	1.286	0.230
						75	79	1.68	A/PD	86.86	7544	0.223	1.282	0.286
BH109	15.00-15.22 (15.00-15.22)	C	N77540	Very weak to weak reddish brown fine to medium grained SANDSTONE.	9.6	101	101	1.36	D/PL	101.00	10201	0.133	1.372	0.182
						101	92	2.68	A/PD	108.77	11831	0.227	1.419	0.322
						101	79	2.68	A/PD	100.79	10159	0.264	1.371	0.362
BH109	17.03-17.28 (17.03-17.28)	C	N77541	Weak reddish brown fine to medium grained SANDSTONE.	13.2	101	101	1.95	D/PL	101.00	10201	0.191	1.372	0.262
						101	101	1.97	D/PL	101.00	10201	0.193	1.372	0.265
						101	81	2.80	A/PD	102.06	10416	0.269	1.379	0.371
						101	80	2.96	A/PD	101.43	10288	0.288	1.375	0.396
						101	78	2.75	A/PD	100.15	10031	0.274	1.367	0.374
BH109	18.65-18.75 (18.65-18.75)	C	N77543	Very weak to weak reddish brown fine to medium grained SANDSTONE.	10.1	76	75	0.42	D/PL	75.00	5625	0.074	1.200	0.089
						75	66	1.85	A/PD	79.39	6303	0.293	1.231	0.361
						75	64	0.99	A/PD	78.18	6112	0.162	1.223	0.198

Remarks AGS

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LABORATORY RESULTS - Point Load Strength Determination

Project CROWN STREET ZONE 2 **Project No:** PN194002

Sample					w	W	D	Fail Load	Test Type/ Direction	De	De^2	Is	F	Is_{50}
Hole	Depth (Specimen Depth) m	Type	Sample Ref	Description	%	mm	mm	kN		mm	mm^2	MN/m^2		MN/m^2
BH109	18.94-19.14 (18.94-19.14)	C	N77545	Very weak to weak reddish brown fine to medium grained SANDSTONE.	9.9	75	65	1.38	A/PD	78.78	6207	0.222	1.227	0.272
						75	64	1.33	A/PD	78.18	6112	0.217	1.223	0.266
						75	40	0.63	A/PD	61.80	3820	0.165	1.100	0.182
BH109	21.38-21.60 (21.38-21.60)	C	N77546	Weak reddish brown fine to medium grained SANDSTONE.	11.4	101	101	1.78	D/PL	101.00	10201	0.174	1.372	0.239
						101	101	1.89	D/PL	101.00	10201	0.185	1.372	0.254
						101	88	3.04	A/PD	106.38	11317	0.268	1.405	0.377
						101	76	3.15	A/PD	98.86	9773	0.323	1.359	0.438
						101	59	2.49	A/PD	87.10	7587	0.328	1.284	0.421
BH109	23.22-23.42 (23.22-23.42)	C	N77547	Weak reddish brown fine to medium grained SANDSTONE.	10.3	101	101	2.22	D/PL	101.00	10201	0.218	1.372	0.299
						101	96	4.16	A/PD	111.11	12345	0.337	1.432	0.482
						101	87	3.56	A/PD	105.77	11188	0.318	1.401	0.446
BH109	24.14-24.30 (24.14-24.30)	C	N77548	Weak reddish brown fine to medium grained SANDSTONE.	9.2	75	75	1.61	D/PL	75.00	5625	0.287	1.200	0.344
						75	77	2.09	A/PD	85.75	7353	0.284	1.275	0.362
						75	77	2.34	A/PD	85.75	7353	0.318	1.275	0.406
BH109	24.79-25.04 (24.79-25.04)	C	N77549	Weak reddish brown fine to medium grained SANDSTONE.	9.9	75	75	1.29	D/PL	75.00	5625	0.229	1.200	0.275
						75	78	1.82	A/PD	86.30	7448	0.244	1.278	0.312
						75	75	1.58	A/PD	84.63	7162	0.221	1.267	0.280
						75	75	2.10	A/PD	84.63	7162	0.294	1.267	0.372
BH109	27.85-28.01 (27.85-28.01)	C	N77551	Very weak to weak reddish brown fine to medium grained SANDSTONE.	10.0	101	101	0.52	D/PL	101.00	10201	0.051	1.372	0.070
						101	81	2.82	A/PD	102.06	10416	0.271	1.379	0.374
						101	67	3.16	A/PD	92.82	8616	0.367	1.321	0.484
BH109	29.22-29.47 (29.22-29.47)	C	N77552	Weak reddish brown fine to medium grained SANDSTONE.	10.7	75	75	1.36	D/PL	75.00	5625	0.242	1.200	0.291
						75	75	1.39	D/PL	75.00	5625	0.246	1.200	0.296
						75	86	3.01	A/PD	90.62	8212	0.366	1.307	0.478
						75	80	2.65	A/PD	87.40	7639	0.347	1.286	0.446
						75	80	2.27	A/PD	87.40	7639	0.298	1.286	0.383
BH109	30.12-30.40 (30.12-30.40)	C	N77553	Weak reddish brown fine to medium grained SANDSTONE.	7.1	101	101	2.33	D/PL	101.00	10201	0.229	1.372	0.314
						101	100	2.92	D/PL	100.00	10000	0.292	1.366	0.399
						101	82	5.22	A/PD	102.69	10545	0.495	1.382	0.685
						101	69	5.18	A/PD	94.20	8873	0.584	1.330	0.777
						101	67	3.49	A/PD	92.82	8616	0.406	1.321	0.536
BH109	31.97-32.11 (31.97-32.11)	C	N77555	Weak reddish brown fine to medium grained SANDSTONE.	9.0	101	101	2.90	D/PL	101.00	10201	0.284	1.372	0.390
						101	62	2.78	A/PD	89.29	7973	0.349	1.298	0.453
						101	58	3.06	A/PD	86.36	7459	0.410	1.279	0.524
BH109	33.14-33.46 (33.14-33.46)	C	N77556	Weak reddish brown fine to medium grained SANDSTONE.	9.7	76	75	1.66	D/PL	75.00	5625	0.295	1.200	0.355
						75	75	1.64	D/PL	75.00	5625	0.292	1.200	0.350
						75	81	3.66	A/PD	87.95	7735	0.474	1.289	0.611
						75	81	3.29	A/PD	87.95	7735	0.426	1.289	0.549
						75	77	2.84	A/PD	85.75	7353	0.387	1.275	0.493

Remarks AGS

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LABORATORY RESULTS - Point Load Strength Determination

Project CROWN STREET ZONE 2 **Project No:** PN194002

Sample					w	W	D	Fail Load	Test Type/ Direction	De	De^2	Is	F	Is_{50}
Hole	Depth (Specimen Depth) m	Type	Sample Ref	Description	%	mm	mm	kN		mm	mm^2	MN/m^2		MN/m^2
BH109	33.77-33.90 (33.77-33.90)	C	N77557	Weak reddish brown fine to medium grained SANDSTONE.	9.5	75	75	1.29	D/PL	75.00	5625	0.229	1.200	0.274
						75	59	2.38	A/PD	75.06	5634	0.422	1.201	0.506
						75	59	1.98	A/PD	75.06	5634	0.352	1.201	0.423
BH109	36.75-36.93 (36.75-36.93)	C	N77558	Weak reddish brown fine to medium grained SANDSTONE.	10.2	101	100	1.98	D/PL	100.00	10000	0.198	1.366	0.270
						100	81	4.02	A/PD	101.55	10313	0.390	1.376	0.536
						100	78	4.43	A/PD	99.66	9931	0.446	1.364	0.608
BH109	38.15-38.31 (38.15-38.31)	C	N77559	Weak reddish brown fine to medium grained SANDSTONE.	6.4	75	75	1.46	D/PL	75.00	5625	0.260	1.200	0.312
						75	79	2.20	A/PD	86.86	7544	0.292	1.282	0.374
						75	74	1.87	A/PD	84.06	7066	0.265	1.263	0.335
BH109	39.11-39.40 (39.11-39.40)	C	N77561	Weak reddish brown fine to medium grained SANDSTONE.	10.0	100	100	3.24	D/PL	100.00	10000	0.324	1.366	0.443
						100	100	3.22	D/PL	100.00	10000	0.322	1.366	0.439
						100	90	4.19	A/PD	107.05	11459	0.366	1.409	0.515
						100	91	4.19	A/PD	107.64	11586	0.362	1.412	0.511
						100	98	4.76	A/PD	111.70	12478	0.381	1.436	0.547
BH109	42.52-42.81 (42.52-42.81)	C	N77562	Weak reddish brown fine to medium grained SANDSTONE.	9.1	101	100	3.83	D/PL	100.00	10000	0.383	1.366	0.523
						101	100	3.31	D/PL	100.00	10000	0.331	1.366	0.453
						101	91	7.34	A/PD	108.18	11702	0.627	1.415	0.887
						101	103	5.30	A/PD	115.09	13246	0.400	1.455	0.582
						101	71	2.77	A/PD	95.55	9130	0.304	1.338	0.407
BH109	46.50-46.64 (46.50-46.64)	C	N77563	Weak reddish brown fine to medium grained SANDSTONE.	9.6	100	100	2.30	D/PL	100.00	10000	0.230	1.366	0.315
						100	66	2.83	A/PD	91.67	8403	0.337	1.314	0.443
						100	65	2.03	A/PD	90.97	8276	0.245	1.309	0.320
BH109	48.68-49.07 (48.68-49.07)	C	N77565	Weak reddish brown fine to medium grained SANDSTONE.	10.1	100	100	3.38	D/PL	100.00	10000	0.338	1.366	0.462
						100	100	2.65	D/PL	100.00	10000	0.265	1.366	0.362
						100	96	5.86	A/PD	110.56	12223	0.480	1.429	0.686
						100	102	6.47	A/PD	113.96	12987	0.498	1.449	0.721
						100	101	6.18	A/PD	113.40	12860	0.481	1.446	0.695

Remarks AGS

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APPENDIX 9

Laboratory Test Results - BRE SD1 Test Suites

Certificate of Analysis

Certificate Number	19-19193
	02-Oct-19
Client	Geotechnics LTD 203 Torrington Avenue Tile Hill Coventry CV4 9AP
Our Reference	19-19193
Client Reference	PN194002
Order No	AUTH-OL22936
Contract Title	Crown Street Zone 2
Description	20 Soil samples.
Date Received	26-Sep-19
Date Started	26-Sep-19
Date Completed	02-Oct-19
Test Procedures	Identified by prefix DETSn (details on request).
Notes	Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Adam Fenwick
Contracts Manager

UKAS TESTING
2139

Summary of Chemical Analysis
Soil Samples

Our Ref 19-19193
Client Ref PN194002
Contract Title Crown Street Zone 2

			Lab No	1570596	1570597	1570598	1570599	1570600	1570601	1570602	1570603	1570604	1570605	1570606
			Sample ID	BH101	BH101	BH104	BH104	BH104	BH107	BH107	BH108	BH108	BH109	BH109
			Depth	3.20-3.65	4.20-4.65	2.20-2.65	3.65-3.75	9.00-9.25	2.20-2.65	3.65-3.75	2.20-2.65	8.20-8.37	1.20-1.65	2.20-2.65
			Other ID											
			Sample Type	D	UT	D	D	D	D	D	B	D	D	D
			Sampling Date	24/09/19	24/09/19	24/09/19	24/09/19	24/09/19	24/09/19	24/09/19	24/09/19	24/09/19	24/09/19	24/09/19
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**											
Inorganics														
pH	DETSC 2008#		pH	8.3	8.8	7.6	8.1	8.4	7.6	8.2	8.5	8.6	7.9	8.2
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	110	140	110	180	37	81	78	53	11	36	30

Key: # -MCERTS (accreditation only applies if report carries the MCERTS logo). n/s -not supplied.

Summary of Chemical Analysis
Soil Samples

Our Ref 19-19193
Client Ref PN194002
Contract Title Crown Street Zone 2

			Lab No	1570607	1570608	1570609	1570610	1570611	1570612	1570613	1570614	1570615
			Sample ID	BH109	BH102	BH102	BH103	BH103	BH103	BH105	BH106	BH106
			Depth	4.20-4.65	2.20-2.65	3.65-3.75	1.20-1.65	3.65-3.75	4.20-4.65	3.65-3.75	2.20-2.65	3.65-3.75
			Other ID									
			Sample Type	D	D	D	D	D	D	D	D	D
			Sampling Date	24/09/19	24/09/19	24/09/19	24/09/19	24/09/19	24/09/19	24/09/19	24/09/19	24/09/19
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**									
Inorganics												
pH	DETSC 2008#		pH	7.7	7.9	8.3	8.0	8.2	8.1	8.3	8.0	8.3
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	85	49	85	1500	230	190	81	33	65

Key: # -MCERTS (accreditation only applies if report carries the MCERTS logo). n/s -not supplied.

Information in Support of the Analytical Results

Our Ref 19-19193
Client Ref PN194002
Contract Crown Street Zone 2

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
1570596	BH101 3.20-3.65 SOIL	24/09/19	PT 1L		
1570597	BH101 4.20-4.65 SOIL	24/09/19	PT 1L		
1570598	BH104 2.20-2.65 SOIL	24/09/19	PT 1L		
1570599	BH104 3.65-3.75 SOIL	24/09/19	PT 1L		
1570600	BH104 9.00-9.25 SOIL	24/09/19	PT 1L		
1570601	BH107 2.20-2.65 SOIL	24/09/19	PT 1L		
1570602	BH107 3.65-3.75 SOIL	24/09/19	PT 1L		
1570603	BH108 2.20-2.65 SOIL	24/09/19	PT 1L		
1570604	BH108 8.20-8.37 SOIL	24/09/19	PT 1L		
1570605	BH109 1.20-1.65 SOIL	24/09/19	PT 1L		
1570606	BH109 2.20-2.65 SOIL	24/09/19	PT 1L		
1570607	BH109 4.20-4.65 SOIL	24/09/19	PT 1L		
1570608	BH102 2.20-2.65 SOIL	24/09/19	PT 1L		
1570609	BH102 3.65-3.75 SOIL	24/09/19	PT 1L		
1570610	BH103 1.20-1.65 SOIL	24/09/19	PT 1L		
1570611	BH103 3.65-3.75 SOIL	24/09/19	PT 1L		
1570612	BH103 4.20-4.65 SOIL	24/09/19	PT 1L		
1570613	BH105 3.65-3.75 SOIL	24/09/19	PT 1L		
1570614	BH106 2.20-2.65 SOIL	24/09/19	PT 1L		
1570615	BH106 3.65-3.75 SOIL	24/09/19	PT 1L		

Key: P-Plastic T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

APPENDIX 10

Laboratory Test Results - Contamination (Soil)

Certificate of Analysis

Certificate Number	19-15962
	27-Aug-19
Client	Geotechnics LTD 203 Torrington Avenue Tile Hill Coventry CV4 9AP
Our Reference	19-15962
Client Reference	PN194002
Order No	(not supplied)
Contract Title	Crown Street
Description	9 Soil samples.
Date Received	19-Aug-19
Date Started	19-Aug-19
Date Completed	27-Aug-19
Test Procedures	Identified by prefix DETSn (details on request).
Notes	Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Adam Fenwick
Contracts Manager

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Summary of Chemical Analysis
Soil Samples

Our Ref 19-15962
Client Ref PN194002
Contract Title Crown Street

			Lab No	1549037	1549038	1549039	1549041	1549042	1549043
			Sample ID	BH103	BH104	BH104	BH07	BH07	BH09
			Depth	0.50	0.30	0.50	0.50	1.00	0.50
			Other ID						
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date	15/08/19	15/08/19	15/08/19	12/08/19	12/08/19	12/08/19
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**						
Metals									
Arsenic	DETSC 2301#	0.2	mg/kg	16	6.4	30	14	7.7	13
Boron, Water Soluble	DETSC 2311#	0.2	mg/kg	0.8	0.4	1.4	0.5	0.4	0.4
Cadmium	DETSC 2301#	0.1	mg/kg	0.3	0.7	0.2	0.3	< 0.1	0.9
Chromium	DETSC 2301#	0.15	mg/kg	12	7.3	16	16	18	15
Chromium, Hexavalent	DETSC 2204*	1	mg/kg	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	55	26	200	85	24	680
Lead	DETSC 2301#	0.3	mg/kg	240	78	180	130	25	230
Mercury	DETSC 2325#	0.05	mg/kg	0.73	0.15	0.75	0.39	0.09	0.58
Nickel	DETSC 2301#	1	mg/kg	14	10	26	19	13	32
Selenium	DETSC 2301#	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Zinc	DETSC 2301#	1	mg/kg	77	48	97	71	41	480
Inorganics									
Total Organic Carbon	DETSC 2002	0.1	%	1.9	0.5	3.3	2.2	1.1	1.3
Petroleum Hydrocarbons									
Aliphatic C5-C6	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Aliphatic C6-C8	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Aliphatic C8-C10	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Aliphatic C10-C12	DETSC 3072#	1.5	mg/kg	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
Aliphatic C12-C16	DETSC 3072#	1.2	mg/kg	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2
Aliphatic C16-C21	DETSC 3072#	1.5	mg/kg	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
Aliphatic C21-C35	DETSC 3072#	3.4	mg/kg	< 3.4	< 3.4	< 3.4	< 3.4	< 3.4	< 3.4
Aliphatic C5-C35	DETSC 3072*	10	mg/kg	< 10	< 10	< 10	< 10	< 10	< 10
Aromatic C5-C7	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Aromatic C7-C8	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Aromatic C8-C10	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Aromatic C10-C12	DETSC 3072#	0.9	mg/kg	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9
Aromatic C12-C16	DETSC 3072#	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Aromatic C16-C21	DETSC 3072#	0.6	mg/kg	0.9	< 0.6	< 0.6	0.9	< 0.6	< 0.6
Aromatic C21-C35	DETSC 3072#	1.4	mg/kg	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4
Aromatic C5-C35	DETSC 3072*	10	mg/kg	< 10	< 10	< 10	< 10	< 10	< 10
TPH Ali/Aro Total	DETSC 3072*	10	mg/kg	< 10	< 10	< 10	< 10	< 10	< 10
Benzene	DETSC 3321#	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ethylbenzene	DETSC 3321#	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Toluene	DETSC 3321#	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Xylene	DETSC 3321#	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
PAHs									
Naphthalene	DETSC 3301	0.1	mg/kg	< 0.1	0.1	< 0.1	0.2	< 0.1	< 0.1
Acenaphthylene	DETSC 3301	0.1	mg/kg	0.2	< 0.1	< 0.1	0.2	< 0.1	0.1
Acenaphthene	DETSC 3301	0.1	mg/kg	0.9	< 0.1	< 0.1	0.1	< 0.1	0.2
Fluorene	DETSC 3301	0.1	mg/kg	0.8	< 0.1	< 0.1	0.2	< 0.1	0.2
Phenanthrene	DETSC 3301	0.1	mg/kg	5.8	0.2	< 0.1	1.2	< 0.1	1.9
Anthracene	DETSC 3301	0.1	mg/kg	1.3	0.2	< 0.1	0.1	< 0.1	< 0.1

Key: * -not accredited. # -MCERTS (accreditation only applies if report carries the MCERTS logo). n/s -not supplied.

Summary of Chemical Analysis
Soil Samples

Our Ref 19-15962
Client Ref PN194002
Contract Title Crown Street

				Lab No	1549037	1549038	1549039	1549041	1549042	1549043
				Sample ID	BH103	BH104	BH104	BH07	BH07	BH09
				Depth	0.50	0.30	0.50	0.50	1.00	0.50
				Other ID						
				Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
				Sampling Date	15/08/19	15/08/19	15/08/19	12/08/19	12/08/19	12/08/19
				Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**							
Fluoranthene	DETSC 3301	0.1	mg/kg		6.8	0.4	< 0.1	0.8	< 0.1	2.6
Pyrene	DETSC 3301	0.1	mg/kg		6.9	0.4	< 0.1	0.8	< 0.1	2.4
Benzo(a)anthracene	DETSC 3301	0.1	mg/kg		2.8	0.2	< 0.1	0.4	< 0.1	1.1
Chrysene	DETSC 3301	0.1	mg/kg		2.9	0.2	< 0.1	0.5	< 0.1	1.2
Benzo(b)fluoranthene	DETSC 3301	0.1	mg/kg		1.7	0.2	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(k)fluoranthene	DETSC 3301	0.1	mg/kg		1.1	0.2	< 0.1	0.4	< 0.1	0.8
Benzo(a)pyrene	DETSC 3301	0.1	mg/kg		2.2	0.1	< 0.1	0.2	< 0.1	0.4
Indeno(1,2,3-c,d)pyrene	DETSC 3301	0.1	mg/kg		1.4	< 0.1	< 0.1	< 0.1	< 0.1	0.5
Dibenzo(a,h)anthracene	DETSC 3301	0.1	mg/kg		0.3	< 0.1	< 0.1	0.2	< 0.1	0.3
Benzo(g,h,i)perylene	DETSC 3301	0.1	mg/kg		1.0	0.1	< 0.1	0.3	< 0.1	0.6
PAH Total	DETSC 3301	1.6	mg/kg		36	2.6	< 1.6	5.9	< 1.6	12

Summary of Chemical Analysis
Soil Samples

Our Ref 19-15962
Client Ref PN194002
Contract Title Crown Street

			Lab No	1549044
			Sample ID	BH09
			Depth	1.00
			Other ID	
			Sample Type	SOIL
			Sampling Date	12/08/19
			Sampling Time	n/s
Test	**Method**	**LOD**	**Units**	
Metals				
Arsenic	DETSC 2301#	0.2	mg/kg	9.3
Boron, Water Soluble	DETSC 2311#	0.2	mg/kg	0.5
Cadmium	DETSC 2301#	0.1	mg/kg	0.4
Chromium	DETSC 2301#	0.15	mg/kg	19
Chromium, Hexavalent	DETSC 2204*	1	mg/kg	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	68
Lead	DETSC 2301#	0.3	mg/kg	170
Mercury	DETSC 2325#	0.05	mg/kg	0.52
Nickel	DETSC 2301#	1	mg/kg	21
Selenium	DETSC 2301#	0.5	mg/kg	< 0.5
Zinc	DETSC 2301#	1	mg/kg	110
Inorganics				
Total Organic Carbon	DETSC 2002	0.1	%	1.3
Petroleum Hydrocarbons				
Aliphatic C5-C6	DETSC 3321*	0.01	mg/kg	< 0.01
Aliphatic C6-C8	DETSC 3321*	0.01	mg/kg	< 0.01
Aliphatic C8-C10	DETSC 3321*	0.01	mg/kg	< 0.01
Aliphatic C10-C12	DETSC 3072#	1.5	mg/kg	< 1.5
Aliphatic C12-C16	DETSC 3072#	1.2	mg/kg	< 1.2
Aliphatic C16-C21	DETSC 3072#	1.5	mg/kg	< 1.5
Aliphatic C21-C35	DETSC 3072#	3.4	mg/kg	< 3.4
Aliphatic C5-C35	DETSC 3072*	10	mg/kg	< 10
Aromatic C5-C7	DETSC 3321*	0.01	mg/kg	< 0.01
Aromatic C7-C8	DETSC 3321*	0.01	mg/kg	< 0.01
Aromatic C8-C10	DETSC 3321*	0.01	mg/kg	< 0.01
Aromatic C10-C12	DETSC 3072#	0.9	mg/kg	< 0.9
Aromatic C12-C16	DETSC 3072#	0.5	mg/kg	< 0.5
Aromatic C16-C21	DETSC 3072#	0.6	mg/kg	< 0.6
Aromatic C21-C35	DETSC 3072#	1.4	mg/kg	< 1.4
Aromatic C5-C35	DETSC 3072*	10	mg/kg	< 10
TPH Ali/Aro Total	DETSC 3072*	10	mg/kg	< 10
Benzene	DETSC 3321#	0.01	mg/kg	< 0.01
Ethylbenzene	DETSC 3321#	0.01	mg/kg	< 0.01
Toluene	DETSC 3321#	0.01	mg/kg	< 0.01
Xylene	DETSC 3321#	0.01	mg/kg	< 0.01
PAHs				
Naphthalene	DETSC 3301	0.1	mg/kg	< 0.1
Acenaphthylene	DETSC 3301	0.1	mg/kg	< 0.1
Acenaphthene	DETSC 3301	0.1	mg/kg	< 0.1
Fluorene	DETSC 3301	0.1	mg/kg	< 0.1
Phenanthrene	DETSC 3301	0.1	mg/kg	< 0.1
Anthracene	DETSC 3301	0.1	mg/kg	< 0.1

Key: * -not accredited. # -MCERTS (accreditation only applies if report carries the MCERTS logo). n/s -not supplied.

Summary of Chemical Analysis
Soil Samples

Our Ref 19-15962
Client Ref PN194002
Contract Title Crown Street

Lab No	1549044
Sample ID	BH09
Depth	1.00
Other ID	
Sample Type	SOIL
Sampling Date	12/08/19
Sampling Time	n/s

Test	Method	LOD	Units	
Fluoranthene	DETSC 3301	0.1	mg/kg	< 0.1
Pyrene	DETSC 3301	0.1	mg/kg	< 0.1
Benzo(a)anthracene	DETSC 3301	0.1	mg/kg	< 0.1
Chrysene	DETSC 3301	0.1	mg/kg	< 0.1
Benzo(b)fluoranthene	DETSC 3301	0.1	mg/kg	< 0.1
Benzo(k)fluoranthene	DETSC 3301	0.1	mg/kg	< 0.1
Benzo(a)pyrene	DETSC 3301	0.1	mg/kg	< 0.1
Indeno(1,2,3-c,d)pyrene	DETSC 3301	0.1	mg/kg	< 0.1
Dibenzo(a,h)anthracene	DETSC 3301	0.1	mg/kg	< 0.1
Benzo(g,h,i)perylene	DETSC 3301	0.1	mg/kg	< 0.1
PAH Total	DETSC 3301	1.6	mg/kg	< 1.6

Summary of Asbestos Analysis
Soil Samples

Our Ref 19-15962
Client Ref PN194002
Contract Title Crown Street

Lab No	Sample ID	Material Type	Result	Comment*	Analyst
1549036	BH103 0.25	SOIL	NAD	none	Jordan Eadington
1549037	BH103 0.50	SOIL	NAD	none	Jordan Eadington
1549038	BH104 0.30	SOIL	NAD	none	Jordan Eadington
1549039	BH104 0.50	SOIL	NAD	none	Jordan Eadington
1549040	BH07 0.20	SOIL	NAD	none	Jordan Eadington
1549041	BH07 0.50	SOIL	NAD	none	Jordan Eadington
1549042	BH07 1.00	SOIL	NAD	none	Jordan Eadington
1549043	BH09 0.50	SOIL	NAD	none	Jordan Eadington
1549044	BH09 1.00	SOIL	NAD	none	Jordan Eadington

Crocidolite = Blue Asbestos, Amosite = Brown Asbestos, Chrysotile = White Asbestos. Anthophyllite, Actinolite and Tremolite are other forms of Asbestos. Samples are analysed by DETSC 1101 using polarised light microscopy in accordance with HSG248 and documented in-house methods. NAD = No Asbestos Detected. Where a sample is NAD, the result is based on analysis of at least 2 sub-samples and should be taken to mean 'no asbestos detected in sample'. Key: * - not included in laboratory scope of accreditation.

Information in Support of the Analytical Results

Our Ref 19-15962
Client Ref PN194002
Contract Crown Street

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
1549036	BH103 0.25 SOIL	15/08/19	GJ 250ml x2, GJ 60ml		
1549037	BH103 0.50 SOIL	15/08/19	GJ 250ml x2, GJ 60ml		
1549038	BH104 0.30 SOIL	15/08/19	GJ 250ml x2, GJ 60ml		
1549039	BH104 0.50 SOIL	15/08/19	GJ 250ml x2, GJ 60ml		
1549040	BH07 0.20 SOIL	12/08/19	GJ 250ml x2, GJ 60ml		
1549041	BH07 0.50 SOIL	12/08/19	GJ 250ml x2, GJ 60ml		
1549042	BH07 1.00 SOIL	12/08/19	GJ 250ml x2, GJ 60ml		
1549043	BH09 0.50 SOIL	12/08/19	GJ 250ml x2, GJ 60ml		
1549044	BH09 1.00 SOIL	12/08/19	GJ 250ml x2, GJ 60ml		

Key: G-Glass J-Jar

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

Certificate of Analysis

Certificate Number	19-17124	13-Sep-19
Client	Geotechnics LTD The Geotechnical Centre Unit 1B Borders Ind. Park River Lane Saltney Chester CH4 8RJ	
Our Reference	19-17124	
Client Reference	PN194002	
Order No	(not supplied)	
Contract Title	Crown Street	
Description	11 Soil samples, 8 Leachate samples.	
Date Received	03-Sep-19	
Date Started	03-Sep-19	
Date Completed	13-Sep-19	
Test Procedures	Identified by prefix DETSn (details on request).	
Notes	Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.	

Approved By

Adam Fenwick
Contracts Manager

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Summary of Chemical Analysis
Soil Samples

Our Ref 19-17124
Client Ref PN194002
Contract Title Crown Street

	Lab No	1557208	1557210	1557212	1557213	1557214	1557215	1557216
	Sample ID	BH106	BH102	BH108	BH108	BH108	BH101	BH101
	Depth	1.00	0.50	1.00	2.00	3.00-3.20	0.50	1.00
	Other ID							
	Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
	Sampling Date	n/s	n/s	19/08/19	19/08/19	19/08/19	21/08/19	21/08/19
	Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**					
Metals								
Arsenic	DETSC 2301#	0.2	mg/kg	18	18	32	8.6	7.1	9.3	10
Boron, Water Soluble	DETSC 2311#	0.2	mg/kg	0.5	1.2	1.1	0.4	< 0.2	0.4	0.6
Cadmium	DETSC 2301#	0.1	mg/kg	0.4	0.2	0.5	0.1	0.2	0.4	0.2
Chromium	DETSC 2301#	0.15	mg/kg	16	18	23	21	24	15	19
Chromium, Hexavalent	DETSC 2204*	1	mg/kg	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	81	45	290	19	26	35	62
Lead	DETSC 2301#	0.3	mg/kg	180	98	840	26	18	99	87
Mercury	DETSC 2325#	0.05	mg/kg	0.96	0.27	0.93	< 0.05	< 0.05	0.11	0.17
Nickel	DETSC 2301#	1	mg/kg	29	20	27	17	29	15	22
Selenium	DETSC 2301#	0.5	mg/kg	< 0.5	< 0.5	0.7	< 0.5	< 0.5	0.5	0.6
Zinc	DETSC 2301#	1	mg/kg	97	51	230	48	58	120	65
Inorganics										
Total Organic Carbon	DETSC 2084#	0.5	%	6.6	5.1	5.5	0.8	1.0	1.8	4.6
Petroleum Hydrocarbons										
Aliphatic C5-C6	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Aliphatic C6-C8	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Aliphatic C8-C10	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Aliphatic C10-C12	DETSC 3072#	1.5	mg/kg	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
Aliphatic C12-C16	DETSC 3072#	1.2	mg/kg	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2
Aliphatic C16-C21	DETSC 3072#	1.5	mg/kg	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
Aliphatic C21-C35	DETSC 3072#	3.4	mg/kg	< 3.4	< 3.4	< 3.4	< 3.4	< 3.4	< 3.4	< 3.4
Aliphatic C5-C35	DETSC 3072*	10	mg/kg	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Aromatic C5-C7	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Aromatic C7-C8	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Aromatic C8-C10	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Aromatic C10-C12	DETSC 3072#	0.9	mg/kg	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9
Aromatic C12-C16	DETSC 3072#	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.8	< 0.5
Aromatic C16-C21	DETSC 3072#	0.6	mg/kg	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	6.0	< 0.6
Aromatic C21-C35	DETSC 3072#	1.4	mg/kg	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4	7.8	< 1.4
Aromatic C5-C35	DETSC 3072*	10	mg/kg	< 10	< 10	< 10	< 10	< 10	15	< 10
TPH Ali/Aro Total	DETSC 3072*	10	mg/kg	< 10	< 10	< 10	< 10	< 10	15	< 10
Benzene	DETSC 3321#	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Ethylbenzene	DETSC 3321#	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Toluene	DETSC 3321#	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Xylene	DETSC 3321#	0.01	mg/kg	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
PAHs										
Naphthalene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1	2.7	< 0.1	< 0.1	2.3	0.5
Acenaphthylene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1	1.2	< 0.1	< 0.1	0.1	< 0.1
Acenaphthene	DETSC 3301	0.1	mg/kg	0.1	< 0.1	0.8	< 0.1	< 0.1	5.7	1.0
Fluorene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1	1.5	< 0.1	< 0.1	5.2	0.9
Phenanthrene	DETSC 3301	0.1	mg/kg	0.4	0.1	6.5	< 0.1	< 0.1	27	4.9

Key: * -not accredited. # -MCERTS (accreditation only applies if report carries the MCERTS logo). n/s -not supplied.

Summary of Chemical Analysis
Soil Samples

Our Ref 19-17124
Client Ref PN194002
Contract Title Crown Street

			Lab No	1557208	1557210	1557212	1557213	1557214	1557215	1557216
			Sample ID	BH106	BH102	BH108	BH108	BH108	BH101	BH101
			Depth	1.00	0.50	1.00	2.00	3.00-3.20	0.50	1.00
			Other ID							
			Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date	n/s	n/s	19/08/19	19/08/19	19/08/19	21/08/19	21/08/19
			Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**							
Anthracene	DETSC 3301	0.1	mg/kg	0.2	< 0.1	1.6	< 0.1	< 0.1	7.4	1.4
Fluoranthene	DETSC 3301	0.1	mg/kg	0.5	0.1	5.7	< 0.1	0.2	22	4.4
Pyrene	DETSC 3301	0.1	mg/kg	0.7	0.2	6.2	< 0.1	< 0.1	19	4.2
Benzo(a)anthracene	DETSC 3301	0.1	mg/kg	0.3	0.3	3.6	< 0.1	< 0.1	7.9	1.6
Chrysene	DETSC 3301	0.1	mg/kg	0.3	0.1	3.6	< 0.1	< 0.1	8.4	1.7
Benzo(b)fluoranthene	DETSC 3301	0.1	mg/kg	0.3	0.2	2.4	< 0.1	< 0.1	6.1	1.2
Benzo(k)fluoranthene	DETSC 3301	0.1	mg/kg	0.1	0.2	1.4	< 0.1	< 0.1	3.4	0.7
Benzo(a)pyrene	DETSC 3301	0.1	mg/kg	0.4	0.2	3.6	< 0.1	< 0.1	8.2	1.7
Indeno(1,2,3-c,d)pyrene	DETSC 3301	0.1	mg/kg	0.3	0.3	2.1	< 0.1	< 0.1	5.0	1.1
Dibenzo(a,h)anthracene	DETSC 3301	0.1	mg/kg	0.1	0.2	0.6	< 0.1	< 0.1	0.8	0.2
Benzo(g,h,i)perylene	DETSC 3301	0.1	mg/kg	0.3	0.6	2.6	< 0.1	< 0.1	4.9	1.1
PAH Total	DETSC 3301	1.6	mg/kg	4.1	2.9	46	< 1.6	< 1.6	130	27

WASTE ACCEPTANCE CRITERIA TESTING
ANALYTICAL REPORT

Our Ref 19-17124
Client Ref PN194002
Contract Title Crown Street
Sample Id BH106 1.00

Sample Numbers 1557208 1557217 1557218
Date Analysed 13/09/2019

Test Results On Waste

Determinand and Method Reference	Units	Result	WAC Limit Values: Inert Waste	SNRHW	Hazardous Waste
DETSC 2084# Total Organic Carbon	%	6.6	3	5	6
DETSC 2003# Loss On Ignition	%	7.1	n/a	n/a	10
DETSC 3321# BTEX	mg/kg	< 0.04	6	n/a	n/a
DETSC 3401# PCBs (7 congeners)	mg/kg	< 0.01	1	n/a	n/a
DETSC 3311# TPH (C10 - C40)	mg/kg	< 10	500	n/a	n/a
DETSC 3301 PAHs	mg/kg	4.1	100	n/a	n/a
DETSC 2008# pH	pH Units	8.1	n/a	>6	n/a
DETSC 2073* Acid Neutralisation Capacity (pH4)	mol/kg	< 1	n/a	TBE	TBE
DETSC 2073* Acid Neutralisation Capacity (pH7)	mol/kg	< 1	n/a	TBE	TBE

Test Results On Leachate

Determinand and Method Reference	Conc in Eluate ug/l		Amount Leached* mg/kg		WAC Limit Values (Limit values for LS10 Leachate): Inert Waste	SNRHW	Hazardous Waste
	2:1	8:1	LS2	LS10			
DETSC 2306 Arsenic as As	2.4	2.5	0.005	0.025	0.5	2	25
DETSC 2306 Barium as Ba	3.6	3.1	< 0.02	< 0.1	20	100	300
DETSC 2306 Cadmium as Cd	< 0.03	< 0.03	< 0.004	< 0.02	0.04	1	5
DETSC 2306 Chromium as Cr	0.46	< 0.25	< 0.02	< 0.1	0.5	10	70
DETSC 2306 Copper as Cu	1.4	1	< 0.004	< 0.02	2	50	100
DETSC 2306 Mercury as Hg	0.03	0.02	< 0.0004	< 0.002	0.01	0.2	2
DETSC 2306 Molybdenum as Mo	4.9	1.3	< 0.02	< 0.1	0.5	10	30
DETSC 2306 Nickel as Ni	< 0.5	< 0.5	< 0.02	< 0.1	0.4	10	40
DETSC 2306 Lead as Pb	1	0.82	< 0.01	< 0.05	0.5	10	50
DETSC 2306 Antimony as Sb	0.52	1.1	< 0.01	< 0.05	0.06	0.7	5
DETSC 2306 Selenium as Se	0.48	< 0.25	< 0.006	< 0.03	0.1	0.5	7
DETSC 2306 Zinc as Zn	< 1.3	1.4	< 0.002	0.012	4	50	200
DETSC 2055 Chloride as Cl	1800	1000	< 20	< 100	800	15,000	25,000
DETSC 2055* Fluoride as F	170	< 100	0.34	0.22	10	150	500
DETSC 2055 Sulphate as SO4	4700	2400	< 20	< 100	1000	20,000	50,000
DETSC 2009* Total Dissolved Solids	46000	25000	92	277.1	4000	60,000	100,000
DETSC 2130 Phenol Index	< 100	< 100	< 0.2	< 1	1	n/a	n/a
* Dissolved Organic Carbon	5500	2900	11	< 50	500	800	1000

TBE - To Be Evaluated
SNRHW - Stable Non-Reactive Hazardous Waste

Additional Information

DETSC 2008 pH	6.7	7.2
DETSC 2009 Conductivity uS/cm	65.6	36
* Temperature*	17	18

Mass of Sample Kg*	0.140
Mass of dry Sample Kg*	0.121

Stage 1

Volume of Leachant L2*	0.222
Volume of Eluate VE1*	0.156

Stage 2

Volume of Leachant L8*	0.966
Volume of Eluate VE2*	0.9

Disclaimer: *The WAC limit values are provided for guidance only. DETS does not accept responsibility for errors or omissions. Values are correct at time of issue.*
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WASTE ACCEPTANCE CRITERIA TESTING
ANALYTICAL REPORT

Our Ref 19-17124
Client Ref PN194002
Contract Title Crown Street
Sample Id BH108 1.00

Sample Numbers 1557212 1557219 1557220
Date Analysed 13/09/2019

Test Results On Waste

Determinand and Method Reference	Units	Result	WAC Limit Values: Inert Waste	SNRHW	Hazardous Waste
DETSC 2084# Total Organic Carbon	%	5.5	3	5	6
DETSC 2003# Loss On Ignition	%	6.1	n/a	n/a	10
DETSC 3321# BTEX	mg/kg	< 0.04	6	n/a	n/a
DETSC 3401# PCBs (7 congeners)	mg/kg	< 0.01	1	n/a	n/a
DETSC 3311# TPH (C10 - C40)	mg/kg	130	500	n/a	n/a
DETSC 3301 PAHs	mg/kg	46	100	n/a	n/a
DETSC 2008# pH	pH Units	8.7	n/a	>6	n/a
DETSC 2073* Acid Neutralisation Capacity (pH4)	mol/kg	< 1	n/a	TBE	TBE
DETSC 2073* Acid Neutralisation Capacity (pH7)	mol/kg	< 1	n/a	TBE	TBE

Test Results On Leachate

Determinand and Method Reference	Conc in Eluate ug/l		Amount Leached* mg/kg		WAC Limit Values (Limit values for LS10 Leachate): Inert Waste	SNRHW	Hazardous Waste
	2:1	8:1	LS2	LS10			
DETSC 2306 Arsenic as As	13	11	0.026	0.112	0.5	2	25
DETSC 2306 Barium as Ba	11	8.2	0.02	< 0.1	20	100	300
DETSC 2306 Cadmium as Cd	< 0.03	< 0.03	< 0.004	< 0.02	0.04	1	5
DETSC 2306 Chromium as Cr	2.6	1.1	< 0.02	< 0.1	0.5	10	70
DETSC 2306 Copper as Cu	6.1	4.2	0.012	0.044	2	50	100
DETSC 2306 Mercury as Hg	0.05	0.02	< 0.0004	< 0.002	0.01	0.2	2
DETSC 2306 Molybdenum as Mo	5.8	1.6	< 0.02	< 0.1	0.5	10	30
DETSC 2306 Nickel as Ni	< 0.5	< 0.5	< 0.02	< 0.1	0.4	10	40
DETSC 2306 Lead as Pb	14	8.2	0.03	0.089	0.5	10	50
DETSC 2306 Antimony as Sb	7.6	2.9	0.02	< 0.05	0.06	0.7	5
DETSC 2306 Selenium as Se	1.4	0.6	< 0.006	< 0.03	0.1	0.5	7
DETSC 2306 Zinc as Zn	3.7	2.2	0.007	0.024	4	50	200
DETSC 2055 Chloride as Cl	2100	920	< 20	< 100	800	15,000	25,000
DETSC 2055* Fluoride as F	360	120	0.72	1.47	10	150	500
DETSC 2055 Sulphate as SO4	30000	6200	60	< 100	1000	20,000	50,000
DETSC 2009* Total Dissolved Solids	100000	51000	200	566.1	4000	60,000	100,000
DETSC 2130 Phenol Index	< 100	< 100	< 0.2	< 1	1	n/a	n/a
* Dissolved Organic Carbon	4500	2300	< 10	< 50	500	800	1000

TBE - To Be Evaluated
SNRHW - Stable Non-Reactive Hazardous Waste

Additional Information

DETSC 2008 pH	6.6	7.3
DETSC 2009 Conductivity uS/cm	148	73.5
* Temperature*	16	18

Mass of Sample Kg*	0.140
Mass of dry Sample Kg*	0.117

Stage 1

Volume of Leachant L2*	0.211
Volume of Eluate VE1*	0.134

Stage 2

Volume of Leachant L8*	0.937
Volume of Eluate VE2*	0.9

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WASTE ACCEPTANCE CRITERIA TESTING
ANALYTICAL REPORT

Our Ref 19-17124
Client Ref PN194002
Contract Title Crown Street
Sample Id BH101 0.50

Sample Numbers 1557215 1557221 1557222
Date Analysed 13/09/2019

Test Results On Waste

Determinand and Method Reference	Units	Result	WAC Limit Values: Inert Waste	SNRHW	Hazardous Waste
DETSC 2084# Total Organic Carbon	%	1.8	3	5	6
DETSC 2003# Loss On Ignition	%	3.2	n/a	n/a	10
DETSC 3321# BTEX	mg/kg	< 0.04	6	n/a	n/a
DETSC 3401# PCBs (7 congeners)	mg/kg	0.22	1	n/a	n/a
DETSC 3311# TPH (C10 - C40)	mg/kg	200	500	n/a	n/a
DETSC 3301 PAHs	mg/kg	130	100	n/a	n/a
DETSC 2008# pH	pH Units	10.5	n/a	>6	n/a
DETSC 2073* Acid Neutralisation Capacity (pH4)	mol/kg	< 1	n/a	TBE	TBE
DETSC 2073* Acid Neutralisation Capacity (pH7)	mol/kg	< 1	n/a	TBE	TBE

Test Results On Leachate

Determinand and Method Reference	Conc in Eluate ug/l		Amount Leached* mg/kg		WAC Limit Values (Limit values for LS10 Leachate): Inert Waste	SNRHW	Hazardous Waste
	2:1	8:1	LS2	LS10			
DETSC 2306 Arsenic as As	3.4	4.3	0.007	0.042	0.5	2	25
DETSC 2306 Barium as Ba	16	11	0.03	0.12	20	100	300
DETSC 2306 Cadmium as Cd	< 0.03	< 0.03	< 0.004	< 0.02	0.04	1	5
DETSC 2306 Chromium as Cr	19	7.3	0.04	< 0.1	0.5	10	70
DETSC 2306 Copper as Cu	4.6	2.3	0.009	0.026	2	50	100
DETSC 2306 Mercury as Hg	< 0.01	< 0.01	< 0.0004	< 0.002	0.01	0.2	2
DETSC 2306 Molybdenum as Mo	9.7	2.3	< 0.02	< 0.1	0.5	10	30
DETSC 2306 Nickel as Ni	< 0.5	< 0.5	< 0.02	< 0.1	0.4	10	40
DETSC 2306 Lead as Pb	0.2	0.3	< 0.01	< 0.05	0.5	10	50
DETSC 2306 Antimony as Sb	30	22	0.06	0.232	0.06	0.7	5
DETSC 2306 Selenium as Se	1.2	0.83	< 0.006	< 0.03	0.1	0.5	7
DETSC 2306 Zinc as Zn	1.9	2.6	0.004	0.025	4	50	200
DETSC 2055 Chloride as Cl	4000	1400	< 20	< 100	800	15,000	25,000
DETSC 2055* Fluoride as F	120	< 100	0.24	0.18	10	150	500
DETSC 2055 Sulphate as SO4	200000	55000	400	765.9	1000	20,000	50,000
DETSC 2009* Total Dissolved Solids	360000	120000	720	1557.4	4000	60,000	100,000
DETSC 2130 Phenol Index	< 100	< 100	< 0.2	< 1	1	n/a	n/a
* Dissolved Organic Carbon	4900	3500	< 10	< 50	500	800	1000

TBE - To Be Evaluated
SNRHW - Stable Non-Reactive Hazardous Waste

Additional Information

DETSC 2008 pH	8.2	8.5
DETSC 2009 Conductivity uS/cm	511	171
* Temperature*	16	18

Mass of Sample Kg*	0.140
Mass of dry Sample Kg*	0.124

Stage 1

Volume of Leachant L2*	0.231
Volume of Eluate VE1*	0.184

Stage 2

Volume of Leachant L8*	0.988
Volume of Eluate VE2*	0.93

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WASTE ACCEPTANCE CRITERIA TESTING ANALYTICAL REPORT

Our Ref 19-17124
Client Ref PN194002
Contract Title Crown Street
Sample Id BH101 1.00

Sample Numbers 1557216 1557223 1557224
Date Analysed 13/09/2019

Test Results On Waste

Determinand and Method Reference	Units	Result	WAC Limit Values: Inert Waste	SNRHW	Hazardous Waste
DETSC 2084# Total Organic Carbon	%	4.6	3	5	6
DETSC 2003# Loss On Ignition	%	5.0	n/a	n/a	10
DETSC 3321# BTEX	mg/kg	< 0.04	6	n/a	n/a
DETSC 3401# PCBs (7 congeners)	mg/kg	< 0.01	1	n/a	n/a
DETSC 3311# TPH (C10 - C40)	mg/kg	36	500	n/a	n/a
DETSC 3301 PAHs	mg/kg	27	100	n/a	n/a
DETSC 2008# pH	pH Units	8.6	n/a	>6	n/a
DETSC 2073* Acid Neutralisation Capacity (pH4)	mol/kg	< 1	n/a	TBE	TBE
DETSC 2073* Acid Neutralisation Capacity (pH7)	mol/kg	< 1	n/a	TBE	TBE

Test Results On Leachate

Determinand and Method Reference	Conc in Eluate ug/l		Amount Leached* mg/kg		WAC Limit Values (Limit values for LS10 Leachate): Inert Waste	SNRHW	Hazardous Waste
	2:1	8:1	LS2	LS10			
DETSC 2306 Arsenic as As	0.69	0.69	< 0.002	< 0.01	0.5	2	25
DETSC 2306 Barium as Ba	9.9	7.2	< 0.02	< 0.1	20	100	300
DETSC 2306 Cadmium as Cd	< 0.03	< 0.03	< 0.004	< 0.02	0.04	1	5
DETSC 2306 Chromium as Cr	0.74	0.31	< 0.02	< 0.1	0.5	10	70
DETSC 2306 Copper as Cu	1.9	0.9	< 0.004	< 0.02	2	50	100
DETSC 2306 Mercury as Hg	< 0.01	< 0.01	< 0.0004	< 0.002	0.01	0.2	2
DETSC 2306 Molybdenum as Mo	< 1.1	< 1.1	< 0.02	< 0.1	0.5	10	30
DETSC 2306 Nickel as Ni	< 0.5	< 0.5	< 0.02	< 0.1	0.4	10	40
DETSC 2306 Lead as Pb	0.24	0.11	< 0.01	< 0.05	0.5	10	50
DETSC 2306 Antimony as Sb	2.1	1.4	< 0.01	< 0.05	0.06	0.7	5
DETSC 2306 Selenium as Se	0.25	< 0.25	< 0.006	< 0.03	0.1	0.5	7
DETSC 2306 Zinc as Zn	< 1.3	3	< 0.002	0.026	4	50	200
DETSC 2055 Chloride as Cl	3500	1300	< 20	< 100	800	15,000	25,000
DETSC 2055* Fluoride as F	< 100	< 100	< 0.02	< 0.1	10	150	500
DETSC 2055 Sulphate as SO4	40000	23000	80	254.2	1000	20,000	50,000
DETSC 2009* Total Dissolved Solids	100000	67000	200	717	4000	60,000	100,000
DETSC 2130 Phenol Index	< 100	< 100	< 0.2	< 1	1	n/a	n/a
* Dissolved Organic Carbon	6300	2200	12.6	< 50	500	800	1000

TBE - To Be Evaluated
SNRHW - Stable Non-Reactive Hazardous Waste

Additional Information

DETSC 2008 pH	8.2	8.2
DETSC 2009 Conductivity uS/cm	143	95.4
* Temperature*	16	18

Mass of Sample Kg*	0.140
Mass of dry Sample Kg*	0.121

Stage 1

Volume of Leachant L2*	0.222
Volume of Eluate VE1*	0.172

Stage 2

Volume of Leachant L8*	0.966
Volume of Eluate VE2*	0.91

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Summary of Asbestos Analysis
Soil Samples

Our Ref 19-17124
Client Ref PN194002
Contract Title Crown Street

Lab No	Sample ID	Material Type	Result	Comment*	Analyst
1557206	BH106 0.20	SOIL	NAD	none	Colin Patrick
1557207	BH106 0.50	SOIL	NAD	none	Colin Patrick
1557208	BH106 1.00	SOIL	NAD	none	Colin Patrick
1557209	BH102 0.30	SOIL	NAD	none	Colin Patrick
1557210	BH102 0.50	SOIL	NAD	none	Colin Patrick
1557211	BH108 0.50	SOIL	NAD	none	Colin Patrick
1557212	BH108 1.00	SOIL	NAD	none	Colin Patrick
1557213	BH108 2.00	SOIL	NAD	none	Colin Patrick
1557215	BH101 0.50	SOIL	NAD	none	Colin Patrick
1557216	BH101 1.00	SOIL	NAD	none	Colin Patrick

Crocidolite = Blue Asbestos, Amosite = Brown Asbestos, Chrysotile = White Asbestos. Anthophyllite, Actinolite and Tremolite are other forms of Asbestos. Samples are analysed by DETSC 1101 using polarised light microscopy in accordance with HSG248 and documented in-house methods. NAD = No Asbestos Detected. Where a sample is NAD, the result is based on analysis of at least 2 sub-samples and should be taken to mean 'no asbestos detected in sample'. Key: * - not included in laboratory scope of accreditation.

Information in Support of the Analytical Results

Our Ref 19-17124
Client Ref PN194002
Contract Crown Street

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
1557206	BH106 0.20 SOIL		GJ 250ml x2, GJ 60ml		
1557207	BH106 0.50 SOIL		GJ 250ml x2, GJ 60ml		
1557208	BH106 1.00 SOIL		GJ 250ml x2, GJ 60ml	Sample date not supplied, Aliphatics/Aromatics (14 days), ANC (1095 days), Boron (365 days), BTEX (14 days), Chromium, Hexavalent (365 days), Mercury (365 days), ICP WS Boron (365 days), Metals ICP (365 days), Metals ICP Prep (365 days), Kone Cr6 (1095 days), Loss on Ignition (730 days), Naphthalene (14 days), Organic Matter (Auto) (28 days), PAH FID (14 days), PCB (30 days), pH + Conductivity (7 days), EPH/TPH (14 days)	
1557209	BH102 0.30 SOIL		GJ 250ml x2, GJ 60ml		
1557210	BH102 0.50 SOIL		GJ 250ml x2, GJ 60ml	Sample date not supplied, Aliphatics/Aromatics (14 days), Boron (365 days), BTEX (14 days), Chromium, Hexavalent (365 days), Mercury (365 days), ICP WS Boron (365 days), Metals ICP (365 days), Metals ICP Prep (365 days), Kone Cr6 (1095 days), Naphthalene (14 days), Organic Matter (Auto) (28 days), PAH FID (14 days)	
1557211	BH108 0.50 SOIL	19/08/19	GJ 250ml x2, GJ 60ml		
1557212	BH108 1.00 SOIL	19/08/19	GJ 250ml x2, GJ 60ml	Aliphatics/Aromatics (14 days), BTEX (14 days), Naphthalene (14 days), PAH FID (14 days), pH + Conductivity (7 days), EPH/TPH (14 days)	
1557213	BH108 2.00 SOIL	19/08/19	GJ 250ml x2, GJ 60ml	Aliphatics/Aromatics (14 days), BTEX (14 days), Naphthalene (14 days), PAH FID (14 days)	
1557214	BH108 3.00-3.20 SOIL	19/08/19	GJ 250ml x2, GJ 60ml	Aliphatics/Aromatics (14 days), BTEX (14 days), Naphthalene (14 days), PAH FID (14 days)	
1557215	BH101 0.50 SOIL	21/08/19	GJ 250ml x2, GJ 60ml	pH + Conductivity (7 days)	
1557216	BH101 1.00 SOIL	21/08/19	GJ 250ml x2, GJ 60ml	pH + Conductivity (7 days)	
1557217	BH106 1.00 LEACHATE		GJ 250ml x2, GJ 60ml	Sample date not supplied	
1557218	BH106 1.00 LEACHATE		GJ 250ml x2, GJ 60ml	Sample date not supplied	
1557219	BH108 1.00 LEACHATE	19/08/19	GJ 250ml x2, GJ 60ml		
1557220	BH108 1.00 LEACHATE	19/08/19	GJ 250ml x2, GJ 60ml		
1557221	BH101 0.50 LEACHATE	21/08/19	GJ 250ml x2, GJ 60ml		
1557222	BH101 0.50 LEACHATE	21/08/19	GJ 250ml x2, GJ 60ml		
1557223	BH101 1.00 LEACHATE	21/08/19	GJ 250ml x2, GJ 60ml		
1557224	BH101 1.00 LEACHATE	21/08/19	GJ 250ml x2, GJ 60ml		

Information in Support of the Analytical Results

Our Ref 19-17124
Client Ref PN194002
Contract Crown Street

Key: G-Glass J-Jar

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

Certificate of Analysis

Certificate Number	19-17808
	01-Oct-19
Client	Geotechnics LTD The Geotechnical Centre Unit 1B Borders Ind. Park River Lane Saltney Chester CH4 8RJ
Our Reference	19-17808
Client Reference	PN194002
Order No	(not supplied)
Contract Title	Crown Street
Description	2 Soil samples, 2 Leachate samples.
Date Received	11-Sep-19
Date Started	11-Sep-19
Date Completed	01-Oct-19
Test Procedures	Identified by prefix DETSn (details on request).
Notes	Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Adam Fenwick
Contracts Manager

UKAS TESTING
2139

Summary of Chemical Analysis

Soil Samples

Our Ref 19-17808
Client Ref PN194002
Contract Title Crown Street

			Lab No	1561640	1561641
			Sample ID	BH105	BH105
			Depth	0.50-0.70	1.00-1.20
			Other ID		
			Sample Type	SOIL	SOIL
			Sampling Date	19/08/19	19/08/19
			Sampling Time	n/s	n/s
Test	**Method**	**LOD**	**Units**		
Metals					
Arsenic	DETSC 2301#	0.2	mg/kg	13	15
Boron, Water Soluble	DETSC 2311#	0.2	mg/kg	0.4	0.5
Cadmium	DETSC 2301#	0.1	mg/kg	0.2	0.3
Chromium	DETSC 2301#	0.15	mg/kg	15	16
Chromium, Hexavalent	DETSC 2204*	1	mg/kg	< 1.0	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	47	46
Lead	DETSC 2301#	0.3	mg/kg	98	280
Mercury	DETSC 2325#	0.05	mg/kg	0.58	0.61
Nickel	DETSC 2301#	1	mg/kg	20	20
Selenium	DETSC 2301#	0.5	mg/kg	< 0.5	< 0.5
Zinc	DETSC 2301#	1	mg/kg	69	68
Inorganics					
Total Organic Carbon	DETSC 2084#	0.5	%	2.0	3.7
Petroleum Hydrocarbons					
Aliphatic C5-C6	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01
Aliphatic C6-C8	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01
Aliphatic C8-C10	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01
Aliphatic C10-C12	DETSC 3072#	1.5	mg/kg	< 1.5	< 1.5
Aliphatic C12-C16	DETSC 3072#	1.2	mg/kg	< 1.2	< 1.2
Aliphatic C16-C21	DETSC 3072#	1.5	mg/kg	< 1.5	< 1.5
Aliphatic C21-C35	DETSC 3072#	3.4	mg/kg	< 3.4	< 3.4
Aliphatic C5-C35	DETSC 3072*	10	mg/kg	< 10	< 10
Aromatic C5-C7	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01
Aromatic C7-C8	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01
Aromatic C8-C10	DETSC 3321*	0.01	mg/kg	< 0.01	< 0.01
Aromatic C10-C12	DETSC 3072#	0.9	mg/kg	< 0.9	< 0.9
Aromatic C12-C16	DETSC 3072#	0.5	mg/kg	3.3	< 0.5
Aromatic C16-C21	DETSC 3072#	0.6	mg/kg	23	5.7
Aromatic C21-C35	DETSC 3072#	1.4	mg/kg	36	7.3
Aromatic C5-C35	DETSC 3072*	10	mg/kg	62	13
TPH Ali/Aro Total	DETSC 3072*	10	mg/kg	62	13
PAHs					
Naphthalene	DETSC 3301	0.1	mg/kg	1.1	< 0.1
Acenaphthylene	DETSC 3301	0.1	mg/kg	0.5	< 0.1
Acenaphthene	DETSC 3301	0.1	mg/kg	3.8	0.6
Fluorene	DETSC 3301	0.1	mg/kg	3.9	0.6
Phenanthrene	DETSC 3301	0.1	mg/kg	22	2.8
Anthracene	DETSC 3301	0.1	mg/kg	7.4	0.8
Fluoranthene	DETSC 3301	0.1	mg/kg	32	6.0

Key: * -not accredited. # -MCERTS (accreditation only applies if report carries the MCERTS logo). n/s -not supplied.

Summary of Chemical Analysis

Soil Samples

Our Ref 19-17808
Client Ref PN194002
Contract Title Crown Street

			Lab No	1561640	1561641
			Sample ID	BH105	BH105
			Depth	0.50-0.70	1.00-1.20
			Other ID		
			Sample Type	SOIL	SOIL
			Sampling Date	19/08/19	19/08/19
			Sampling Time	n/s	n/s
Test	**Method**	**LOD**	**Units**		
Pyrene	DETSC 3301	0.1	mg/kg	31	5.7
Benzo(a)anthracene	DETSC 3301	0.1	mg/kg	14	3.2
Chrysene	DETSC 3301	0.1	mg/kg	16	3.0
Benzo(b)fluoranthene	DETSC 3301	0.1	mg/kg	12	2.1
Benzo(k)fluoranthene	DETSC 3301	0.1	mg/kg	6.8	1.2
Benzo(a)pyrene	DETSC 3301	0.1	mg/kg	15	2.7
Indeno(1,2,3-c,d)pyrene	DETSC 3301	0.1	mg/kg	10	2.1
Dibenzo(a,h)anthracene	DETSC 3301	0.1	mg/kg	2.1	0.5
Benzo(g,h,i)perylene	DETSC 3301	0.1	mg/kg	9.1	1.8
PAH Total	DETSC 3301	1.6	mg/kg	190	33

WASTE ACCEPTANCE CRITERIA TESTING
ANALYTICAL REPORT

Our Ref 19-17808
Client Ref PN194002
Contract Title Crown Street
Sample Id BH105 0.50-0.70

Sample Numbers 1561640 1561642 1561643
Date Analysed 23/09/2019

Test Results On Waste

Determinand and Method Reference	Units	Result	WAC Limit Values: Inert Waste	SNRHW	Hazardous Waste
DETSC 2084# Total Organic Carbon	%	2.0	3	5	6
DETSC 2003# Loss On Ignition	%	3.2	n/a	n/a	10
DETSC 3321# BTEX	mg/kg	< 0.04	6	n/a	n/a
DETSC 3401# PCBs (7 congeners)	mg/kg	< 0.01	1	n/a	n/a
DETSC 3311# TPH (C10 - C40)	mg/kg	380	500	n/a	n/a
DETSC 3301 PAHs	mg/kg	190	100	n/a	n/a
DETSC 2008# pH	pH Units	8.2	n/a	>6	n/a
DETSC 2073* Acid Neutralisation Capacity (pH4)	mol/kg	< 1	n/a	TBE	TBE
DETSC 2073* Acid Neutralisation Capacity (pH7)	mol/kg	< 1	n/a	TBE	TBE

Test Results On Leachate

Determinand and Method Reference	Conc in Eluate ug/l		Amount Leached* mg/kg		WAC Limit Values (Limit values for LS10 Leachate): Inert Waste	SNRHW	Hazardous Waste
	2:1	8:1	LS2	LS10			
DETSC 2306 Arsenic as As	1.1	0.97	0.002	< 0.01	0.5	2	25
DETSC 2306 Barium as Ba	7.7	5.2	< 0.02	< 0.1	20	100	300
DETSC 2306 Cadmium as Cd	< 0.03	< 0.03	< 0.004	< 0.02	0.04	1	5
DETSC 2306 Chromium as Cr	0.27	< 0.25	< 0.02	< 0.1	0.5	10	70
DETSC 2306 Copper as Cu	2.4	1.8	0.005	< 0.02	2	50	100
DETSC 2306 Mercury as Hg	0.01	0.03	< 0.0004	< 0.002	0.01	0.2	2
DETSC 2306 Molybdenum as Mo	1.4	< 1.1	< 0.02	< 0.1	0.5	10	30
DETSC 2306 Nickel as Ni	< 0.5	< 0.5	< 0.02	< 0.1	0.4	10	40
DETSC 2306 Lead as Pb	0.46	0.5	< 0.01	< 0.05	0.5	10	50
DETSC 2306 Antimony as Sb	0.4	0.74	< 0.01	< 0.05	0.06	0.7	5
DETSC 2306 Selenium as Se	0.88	0.74	< 0.006	< 0.03	0.1	0.5	7
DETSC 2306 Zinc as Zn	3.2	2.3	0.006	0.024	4	50	200
DETSC 2055 Chloride as Cl	1900	1400	< 20	< 100	800	15,000	25,000
DETSC 2055* Fluoride as F	380	340	0.76	3.45	10	150	500
DETSC 2055 Sulphate as SO4	3300	3000	< 20	< 100	1000	20,000	50,000
DETSC 2009* Total Dissolved Solids	35000	26000	70	271.2	4000	60,000	100,000
DETSC 2130 Phenol Index	< 100	< 100	< 0.2	< 1	1	n/a	n/a
DETSC 2085 Dissolved Organic Carbon	4800	< 2000	< 10	< 50	500	800	1000

TBE - To Be Evaluated
SNRHW - Stable Non-Reactive Hazardous Waste

Additional Information

DETSC 2008 pH	7.7	6.6
DETSC 2009 Conductivity uS/cm	49.4	37.4
* Temperature*	20	20

Mass of Sample Kg*	0.140
Mass of dry Sample Kg*	0.121

Stage 1

Volume of Leachant L2*	0.222
Volume of Eluate VE1*	0.15

Stage 2

Volume of Leachant L8*	0.965
Volume of Eluate VE2*	0.88

Disclaimer: *The WAC limit values are provided for guidance only. DETS does not accept responsibility for errors or omissions. Values are correct at time of issue.*

WASTE ACCEPTANCE CRITERIA TESTING ANALYTICAL REPORT

Our Ref 19-17808
Client Ref PN194002
Contract Title Crown Street
Sample Id BH105 0.50-0.70

Sample Numbers 1561640 1561642 1561643
Date Analysed 23/09/2019

Test Results On Waste			WAC Limit Values		
Determinand and Method Reference	**Units**	**Result**	**Inert Waste**	**SNRHW**	**Hazardous Waste**
DETSC 2084# Total Organic Carbon	%	2.0	3	5	6
DETSC 2003# Loss On Ignition	%	3.2	n/a	n/a	10

** DETS are accredited for the testing of leachates and not the leachate preparation stage which is unaccredited.*

Summary of Asbestos Analysis

Soil Samples

Our Ref 19-17808
Client Ref PN194002
Contract Title Crown Street

Lab No	Sample ID	Material Type	Result	Comment*	Analyst
1561640	BH105 0.50-0.70	SOIL	NAD	none	A Christodoulou

Crocidolite = Blue Asbestos, Amosite = Brown Asbestos, Chrysotile = White Asbestos. Anthophyllite, Actinolite and Tremolite are other forms of Asbestos. Samples are analysed by DETSC 1101 using polarised light microscopy in accordance with HSG248 and documented in-house methods. NAD = No Asbestos Detected. Where a sample is NAD, the result is based on analysis of at least 2 sub-samples and should be taken to mean 'no asbestos detected in sample'. Key: * - not included in laboratory scope of accreditation.

Information in Support of the Analytical Results

Our Ref 19-17808
Client Ref PN194002
Contract Crown Street

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
1561639	BH105 0.20-0.40 SOIL	19/08/19	GJ 250ml x2, GJ 60ml		
1561640	BH105 0.50-0.70 SOIL	19/08/19	GJ 250ml x2, GJ 60ml	Aliphatics/Aromatics (14 days), BTEX (14 days), Naphthalene (14 days), PAH FID (14 days), pH + Conductivity (7 days), EPH/TPH (14 days)	
1561641	BH105 1.00-1.20 SOIL	19/08/19	GJ 250ml x2, GJ 60ml	Aliphatics/Aromatics (14 days), BTEX (14 days), Naphthalene (14 days), PAH FID (14 days)	
1561642	BH105 0.50-0.70 LEACHATE	19/08/19	GJ 250ml x2, GJ 60ml		
1561643	BH105 0.50-0.70 LEACHATE	19/08/19	GJ 250ml x2, GJ 60ml		

Key: G-Glass J-Jar

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

APPENDIX 11

Laboratory Test Results - Contamination (Groundwater)

Certificate of Analysis

Certificate Number	19-25394
	19-Dec-19
Client	Geotechnics LTD The Geotechnical Centre Unit 1B Borders Ind. Park River Lane Saltney Chester CH4 8RJ
Our Reference	19-25394
Client Reference	PN194002
Order No	AUTH-OL23841
Contract Title	Crown Street
Description	6 Water samples.
Date Received	11-Dec-19
Date Started	11-Dec-19
Date Completed	19-Dec-19
Test Procedures	Identified by prefix DETSn (details on request).
Notes	Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Adam Fenwick
Contracts Manager

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Summary of Chemical Analysis

Water Samples

Our Ref 19-25394
Client Ref PN194002
Contract Title Crown Street

			Lab No	1611879	1611880	1611881	1611882	1611883	1611884
			Sample ID	BH108	BH109	BH107	BH101	BH104	BH103
			Depth	5.88	2.71	6.60	9.82	2.82	2.62
			Other ID						
			Sample Type	WATER	WATER	WATER	WATER	WATER	WATER
			Sampling Date	09/12/19	09/12/19	09/12/19	09/12/19	09/12/19	09/12/19
			Sampling Time	1445	1415	1350	1330	1305	1240
Test	**Method**	**LOD**	**Units**						
Metals									
Arsenic, Dissolved	DETSC 2306	0.16	ug/l	2.1	I/S	0.49	0.29	0.60	2.2
Boron, Dissolved	DETSC 2306*	12	ug/l	47	I/S	61	190	73	88
Cadmium, Dissolved	DETSC 2306	0.03	ug/l	0.04	I/S	0.06	0.04	0.08	< 0.03
Chromium, Dissolved	DETSC 2306	0.25	ug/l	0.77	I/S	< 0.25	< 0.25	1.4	0.29
Copper, Dissolved	DETSC 2306	0.4	ug/l	2.1	I/S	2.0	1.3	3.2	1.7
Lead, Dissolved	DETSC 2306	0.09	ug/l	0.37	I/S	0.11	0.12	0.24	0.11
Mercury, Dissolved	DETSC 2306	0.01	ug/l	0.02	I/S	0.03	0.03	0.14	0.10
Nickel, Dissolved	DETSC 2306	0.5	ug/l	0.8	I/S	5.0	5.9	3.7	4.7
Selenium, Dissolved	DETSC 2306	0.25	ug/l	1.4	I/S	1.6	3.4	1.2	0.67
Zinc, Dissolved	DETSC 2306	1.3	ug/l	2.5	I/S	15	16	15	7.1
Inorganics									
pH	DETSC 2008		pH	6.9	I/S	7.2	7.0	7.6	7.8
Sulphate as SO4	DETSC 2055	0.1	mg/l	45	I/S	130	240	330	81
Petroleum Hydrocarbons									
Aliphatic C5-C6	DETSC 3322	0.1	ug/l	< 0.1	I/S	< 0.1	< 0.1	< 0.1	< 0.1
Aliphatic C6-C8	DETSC 3322	0.1	ug/l	< 0.1	I/S	< 0.1	< 0.1	< 0.1	< 0.1
Aliphatic C8-C10	DETSC 3322	0.1	ug/l	< 0.1	I/S	< 0.1	< 0.1	< 0.1	< 0.1
Aliphatic C10-C12	DETSC 3072*	1	ug/l	< 1.0	I/S	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic C12-C16	DETSC 3072*	1	ug/l	< 1.0	I/S	< 1.0	< 1.0	130	< 1.0
Aliphatic C16-C21	DETSC 3072*	1	ug/l	< 1.0	I/S	< 1.0	< 1.0	1100	1.5
Aliphatic C21-C35	DETSC 3072*	1	ug/l	< 1.0	I/S	< 1.0	< 1.0	8700	83
Aliphatic C5-C35	DETSC 3072*	10	ug/l	< 10	I/S	< 10	< 10	10000	85
Aromatic C5-C7	DETSC 3322	0.1	ug/l	< 0.1	I/S	< 0.1	< 0.1	< 0.1	< 0.1
Aromatic C7-C8	DETSC 3322	0.1	ug/l	< 0.1	I/S	< 0.1	< 0.1	< 0.1	< 0.1
Aromatic C8-C10	DETSC 3322	0.1	ug/l	< 0.1	I/S	< 0.1	< 0.1	< 0.1	< 0.1
Aromatic C10-C12	DETSC 3072*	1	ug/l	< 1.0	I/S	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic C12-C16	DETSC 3072*	1	ug/l	< 1.0	I/S	< 1.0	< 1.0	4.6	< 1.0
Aromatic C16-C21	DETSC 3072*	1	ug/l	< 1.0	I/S	< 1.0	< 1.0	310	< 1.0
Aromatic C21-C35	DETSC 3072*	1	ug/l	< 1.0	I/S	< 1.0	< 1.0	3500	< 1.0
Aromatic C5-C35	DETSC 3072*	10	ug/l	< 10	I/S	< 10	< 10	3800	< 10
TPH Ali/Aro Total	DETSC 3072*	10	ug/l	< 10	I/S	< 10	< 10	14000	85
PAHs									
Naphthalene	DETSC 3304	0.05	ug/l	< 0.05	I/S	< 0.05	0.05	0.06	< 0.05
Acenaphthylene	DETSC 3304	0.01	ug/l	< 0.01	I/S	< 0.01	< 0.01	0.01	< 0.01
Acenaphthene	DETSC 3304	0.01	ug/l	< 0.01	I/S	< 0.01	0.03	0.01	< 0.01
Fluorene	DETSC 3304	0.01	ug/l	< 0.01	I/S	< 0.01	0.01	0.02	< 0.01
Phenanthrene	DETSC 3304	0.01	ug/l	0.01	I/S	< 0.01	0.02	0.17	0.01
Anthracene	DETSC 3304	0.01	ug/l	< 0.01	I/S	< 0.01	< 0.01	0.03	< 0.01
Fluoranthene	DETSC 3304	0.01	ug/l	0.02	I/S	< 0.01	0.02	0.24	< 0.01
Pyrene	DETSC 3304	0.01	ug/l	0.03	I/S	< 0.01	0.02	0.30	0.02

Key: * -not accredited. I/S -insufficient sample.

Summary of Chemical Analysis

Water Samples

Our Ref 19-25394
Client Ref PN194002
Contract Title Crown Street

			Lab No	1611879	1611880	1611881	1611882	1611883	1611884
			Sample ID	BH108	BH109	BH107	BH101	BH104	BH103
			Depth	5.88	2.71	6.60	9.82	2.82	2.62
			Other ID						
			Sample Type	WATER	WATER	WATER	WATER	WATER	WATER
			Sampling Date	09/12/19	09/12/19	09/12/19	09/12/19	09/12/19	09/12/19
			Sampling Time	1445	1415	1350	1330	1305	1240
Test	**Method**	**LOD**	**Units**						
Benzo(a)anthracene	DETSC 3304	0.01	ug/l	< 0.01	I/S	< 0.01	< 0.01	0.15	< 0.01
Chrysene	DETSC 3304	0.01	ug/l	0.02	I/S	< 0.01	< 0.01	0.21	< 0.01
Benzo(b)fluoranthene	DETSC 3304	0.01	ug/l	0.03	I/S	< 0.01	< 0.01	0.31	< 0.01
Benzo(k)fluoranthene	DETSC 3304	0.01	ug/l	< 0.01	I/S	< 0.01	< 0.01	0.10	< 0.01
Benzo(a)pyrene	DETSC 3304	0.01	ug/l	0.01	I/S	< 0.01	< 0.01	0.22	< 0.01
Indeno(1,2,3-c,d)pyrene	DETSC 3304	0.01	ug/l	0.02	I/S	< 0.01	< 0.01	0.32	< 0.01
Dibenzo(a,h)anthracene	DETSC 3304	0.01	ug/l	< 0.01	I/S	< 0.01	< 0.01	0.09	< 0.01
Benzo(g,h,i)perylene	DETSC 3304	0.01	ug/l	0.02	I/S	< 0.01	< 0.01	0.38	< 0.01
PAH Total	DETSC 3304	0.2	ug/l	0.21	I/S	< 0.20	< 0.20	2.6	< 0.20

Key: * -not accredited. I/S -insufficient sample.

Information in Support of the Analytical Results

Our Ref 19-25394
Client Ref PN194002
Contract Crown Street

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
1611879	BH108 5.88 WATER	09/12/19	GB 1L x2, GV x2	pH/Cond/TDS (1 days)	
1611880	BH109 2.71 WATER	09/12/19	GV x2	pH/Cond/TDS (1 days)	
1611881	BH107 6.60 WATER	09/12/19	GB 1L x2, GV x2	pH/Cond/TDS (1 days)	
1611882	BH101 9.82 WATER	09/12/19	GB 1L x2, GV x2	pH/Cond/TDS (1 days)	
1611883	BH104 2.82 WATER	09/12/19	GB 1L, GV x2	pH/Cond/TDS (1 days)	
1611884	BH103 2.62 WATER	09/12/19	GB 1L, GV x2	pH/Cond/TDS (1 days)	

Key: G-Glass B-Bottle V-Vial

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

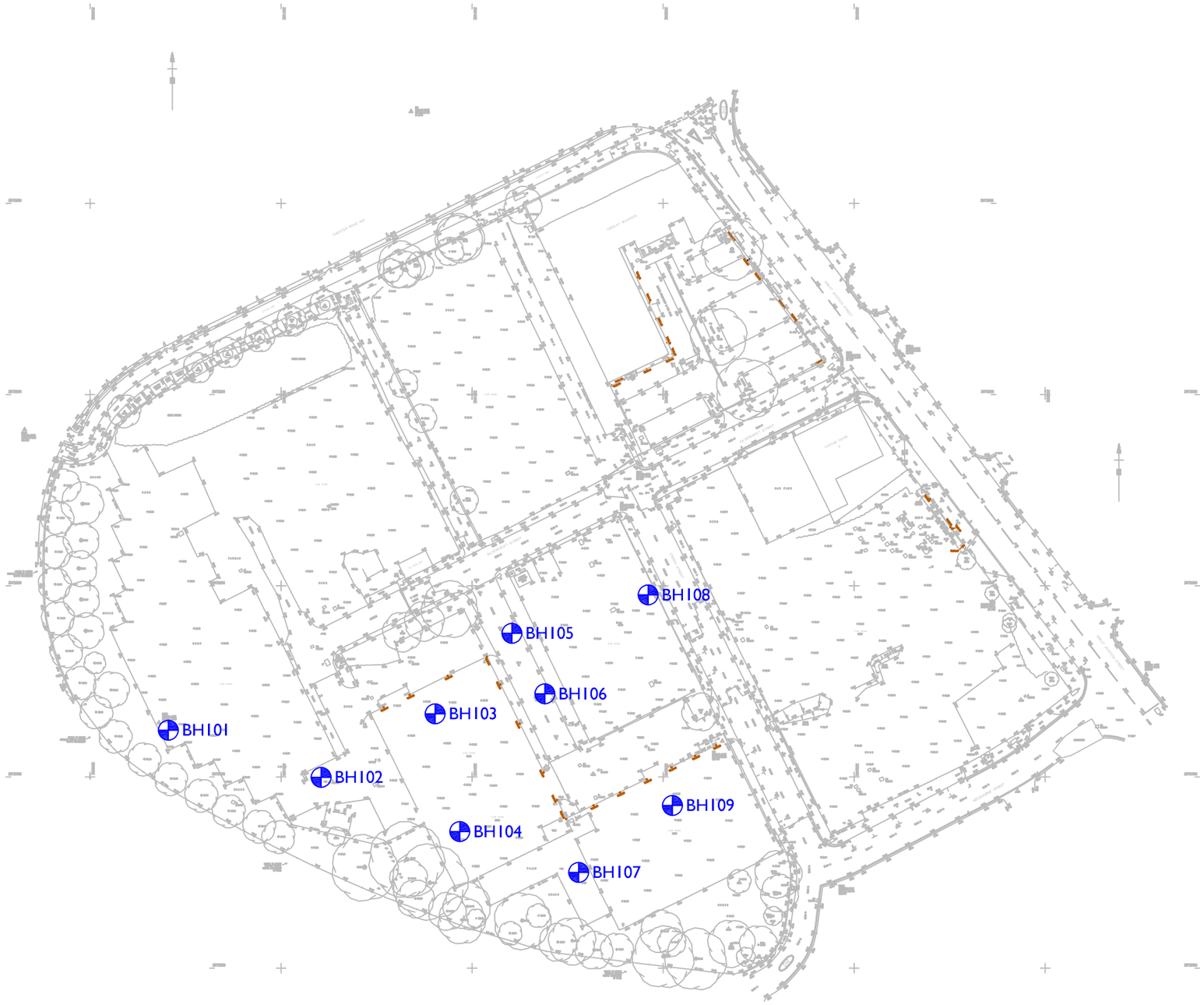
Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

APPENDIX 12

Exploratory Hole Location Plan



Key

Cable Percussion with Rotary Follow-On Borehole

Hole ID	Easting (mE)	Northing (mN)	Level (mOD)
BH101	383096.4	397249.8	33.42
BH102	383128.4	397239.9	33.28
BH103	383152.3	397253.2	33.23
BH104	383157.4	397228.6	33.22
BH105	383168.3	397270.1	32.84
BH106	383175.2	397257.4	32.96
BH107	383182.3	397220.0	33.20
BH108	383196.9	397278.1	32.77
BH109	383202.0	397234.0	33.20

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Engineer:
WSP UK Limited

Client:
WSP UK Limited

Project:
Crown Street Zone 2

Drawing Title:

Exploratory Hole Location Plan

Scale: 1:1000@A3

Date:
September 2019

Project No:
PN194002

File Name:
Geo-PN194002-001(1)

G:\Projects\Chester\2019\PN194002\Drawings\Geo-PN194002-001.dwg

APPENDIX 13

Investigation Techniques and General Notes

INVESTIGATION TECHNIQUES

INTRODUCTION

The following brief review of Ground Investigation techniques, generally used as part of most Site Investigations in the UK, summarises their methodology, advantages and limitations. Detailed descriptions of the techniques are available and can be provided on request. This review should be read in conjunction with the accompanying General Notes.

TRIAL PITS

The trial pit is amongst the simplest yet most effective means of identifying shallow ground conditions on a site. Its advantages include simplicity, speed, potential accuracy and cost-effectiveness. The trial pit is most commonly formed using a back-acting excavator which can typically determine ground conditions to some 4 metres below ground level. Hand excavation is often used to locate, expose and detail existing foundations, features or services. In general, it is difficult to extend pits significantly below the water table in predominantly granular soils, where flows can cause instability. Unless otherwise stated, the trial pits will not have been provided with temporary side support during their construction. Under such circumstances, entrance into the pit is not permitted and hence observations will have been made from the ground surface and samples taken from the excavator bucket.

Where access for personnel is required to allow close observation of the exposed strata, the taking of samples and the carrying out of in situ tests, the sides of the trial pits (Observation Pits in BS 5930:2015) will be made safe using temporary supports or the sides battered back to a stable angle. Some limited access to such Trial Pits (Observation Pits) at depths less than 1m may be allowed in stable conditions or where the sides are benched or battered back to a safe angle.

Trends in strata type, level and thickness can be determined, shear surfaces identified and the behaviour of plant, excavation sides and excavated materials can be related to the construction process. They are particularly valuable in land slip investigations. Some types of in situ test can be undertaken in such pits and large disturbed or block samples obtained.

CABLE PERCUSSION BORING

The light Cable Percussion technique of soft ground boring, typically at a diameter of 150mm, is a well-established simple and flexible method of boring vertical holes and generally allows data to be obtained in respect of strata conditions other than rock. A tubular cutter (for cohesive soils) or shell with a flap valve (for granular soils) is repeatedly lifted and dropped using a winch and rope operating from an "A" frame. Soil which enters these tools is regularly removed and either sampled for subsequent examination or test, or laid to one side for later removal off site and licensed disposal or, if permitted by the Client, use as backfill. Steel casing will have been used to prevent collapse of the borehole sides where necessary. A degree of disturbance of soil and mixing of layers is inevitable and the presence of very thin layers of different soils within a particular stratum may not be identified. Changes in strata type can only be detected on recognition of a change in soil samples at the surface, after the interface has been passed. For the foregoing reasons, depth measurements should not be considered to be more accurate than 0.10 metre. The technique can determine ground conditions to depths in excess of 30 metres under suitable circumstances and usually causes less surface disturbance than trial pitting.

In cohesive soils cylindrical samples are retrieved by driving or pushing in 100mm nominal diameter tubes. In soft soils, piston sampling or vane testing may be undertaken. In granular soils and often in cohesive materials, in situ Standard Penetration Tests (SPT's) are performed. The SPT records the number of standard blows required to drive a 50mm diameter open or cone ended probe for 300mm after an initial 150mm penetration. A modified method of recording is used in denser strata. Small disturbed samples are obtained throughout.

ROTARY DRILLING

Rotary Drilling to produce cores by rotating an annular diamond-impregnated tube or barrel into the ground is the technique most appropriate to the forming of site investigation boreholes through rock or other hard strata. It has the advantage of being able to be used vertically or at an angle. Core diameters of less than 100mm are most common for site investigation purposes. Core is normally retrieved in plastic lining tubes. A flushing fluid such as air, water or foam is used to cool the bit and carry cuttings to the surface. Depths in excess of 60 metres can be achieved under suitable circumstances using rotary techniques, with minimal surface disturbance.

Examination of cores allows detailed rock description and generally enables angled discontinuity surfaces to be observed. However, vertical holes do not necessarily reveal the presence of vertical or near-vertical fissures or joint discontinuities. The core type and/or techniques used will depend on the ground conditions. Where open hole rotary drilling is employed, descriptions of strata result from examination at the surface of small particles ejected from the borehole in the flushing medium. In consequence, no indication of fissuring, bedding, consistency or degree of weathering can be obtained.

DYNAMIC SAMPLING

This technique involves the driving of an open-ended tube into the ground and retrieval of the soil which enters the tube. It was previously called window or windowless sampling. The term "window sample" arose from the original device which had a "window" or slot cut into the side of the tube through which samples were taken. This was superseded by the use of a thin-walled plastic liner to retrieve the soil sample from within a sampler (windowless sampling) which has a solid wall. Line diameters range from 36 to 86mm. Such samples can be used for qualitative logging, selection of samples for classification and chemical analysis and for obtaining a rudimentary assessment of strength.

Driving devices can be hand-held or machine mounted and the drive tubes are typically in 1m lengths. Depending on the type of rig used, the hole formed can be cased to prevent collapse of the borehole sides. Where the type of rig does not allow the insertion of casing, the success of this technique can be limited when soils and groundwater conditions are such that the sides of the hole collapse on withdrawal of the sampler. Obstructions within the ground, the density of the material or its strength can also limit the depth and rate of penetration of this light-weight investigation technique. Nevertheless, it is a valuable tool where access is constrained such as within buildings or on embankments. Depths of up to 10m can be achieved in suitable circumstances depending on the rig type but depths of 5m to 6m are more common.

EXPLORATORY HOLE RECORDS

The data obtained by these techniques are generally presented on Trial Pit, Borehole, Drillhole or Dynamic Sample Records. The descriptions of strata result from information gathered from a number of sources which may include published geological data, preliminary field observations and descriptions, in situ test results, laboratory test results and specimen descriptions. A key to the symbols and abbreviations used accompanies the records. The descriptions on the exploratory hole records accommodate but may not necessarily be identical to those on any preliminary records or the laboratory summaries.

The records show ground conditions at the exploratory hole locations. The degree to which they can be used to represent conditions between or beyond such holes, however, is a matter for geological interpretation rather than factual reporting and the associated uncertainties must be recognised.

DYNAMIC PROBING

This technique typically measures the number of blows of a standard weight falling over a standard height to advance a cone-ended rod over sequential standard distances (typically 100mm). Some devices measure the penetration of the probe per standard blow. It is essentially a profiling tool and is best used in conjunction with other investigation techniques where site-specific correlation can be used to delineate the distribution of soft or loose soils or the upper horizon of a dense or strong layer such as rock.

Both machine-driven and hand-driven equipment is available, the selection depending upon access restrictions and the depth of penetration required. It is particularly useful where access for larger equipment is not available, disturbance is to be minimised or where there are cost constraints. No samples are recovered and some techniques leave a sacrificial cone head in the ground. As with other lightweight techniques, progress is limited in strong or dense soils. The results are presented both numerically and graphically. Depths of up to 10m are commonly achieved in suitable circumstances.

The hand-driven DCP probing device has been calibrated by the Highways Agency to provide a profile of CBR values over a range of depths.

INSTRUMENTATION

The most common form of instrument used in site investigation is either the standpipe or else the standpipe piezometer which can be installed in investigation holes. They are used to facilitate monitoring of groundwater levels and water sampling over a period of time following site work. Normally a standpipe would be formed using rigid plastic tubing which has been perforated or slotted over much of its length whilst a standpipe piezometer would have a filter tip which would be placed at a selected level and the hole sealed above and sometimes below to isolate the zone of interest. Groundwater levels are determined using an electronic "dip meter" to measure the depth to the water surface from ground level. Piezometers can also be used to measure permeability. They are simple and inexpensive instruments for long term monitoring but response times can limit their use in tidal areas and access to the ground surface at each instrument is necessary. Remote reading requires more sophisticated hydraulic, electronic or pneumatic equipment.

Settlement can be monitored using surface or buried target plates whilst lateral movement over a range of depths is monitored using slip indicator or inclinometer equipment.

GENERAL NOTES

1. *The report is prepared for the exclusive use of the Client named in the document and copyright subsists with Geotechnics Limited. Prior written permission must be obtained to reproduce all or part of the report. It is prepared on the understanding that its contents are only disclosed to parties directly involved in the current investigation, preparation and development of the site.*

2. *Further copies may be obtained with the Client's written permission, from Geotechnics Limited with whom the master copy of the document will be retained.*

3. *The report and/or opinion is prepared for the specific purpose stated in the document and in relation to the nature and extent of proposals made available to Geotechnics Limited at that time. Re-consideration will be necessary should those details change. The recommendations should not be used for other schemes on or adjacent to the site without further reference to Geotechnics Limited.*

4. *The assessment of the significance of the factual data, where called for, is provided to assist the Client and their Engineer and/or Advisers in the preparation of their designs.*

5. *The report is based on the ground conditions encountered in the exploratory holes together with the results of field and laboratory testing in the context of the proposed development. The data from any commissioned desk study and site reconnaissance are also drawn upon. There may be special conditions appertaining to the site, however, which are not revealed by the investigation and which may not be taken into account in the report.*

6. *Methods of construction and/or design other than those proposed by the designers or referred to in the report may require consideration during the evolution of the proposals and further assessment of the geotechnical and any geoenvironmental data would be required to provide discussion and evaluations appropriate to these methods.*

7. *The accuracy of results reported depends upon the technique of measurement, investigation and test used and these values should not be regarded necessarily as characteristics of the strata as a whole (see accompanying notes on Investigation Techniques). Where such measurements are critical, the technique of investigation will need to be reviewed and supplementary investigation undertaken in accordance with the advice of the Company where necessary.*

8. *The samples selected for laboratory test are prepared and tested in accordance with the relevant Clauses and Parts of BS EN ISO 17892 and BS 1377 Parts 1 to 8, where appropriate, in Geotechnics Limited's UKAS accredited Laboratory, where possible. A list of tests is given.*

9. *Tests requiring the use of another laboratory having UKAS accreditation where possible are identified.*

10. *Any unavoidable variations from specified procedures are identified in the report.*

11. *Specimens are cut vertically, where this is relevant and can be identified, unless otherwise stated*

12. *All the data required by the test procedures are recorded on individual test sheets but the results in the report are presented in summary form to aid understanding and assimilation for design purposes. Where all details are required, these can be made available.*

13. *Whilst the report may express an opinion on possible configurations of strata between or beyond exploratory holes, or on the possible presence of features based on either visual, verbal, written, cartographical, photographic or published evidence, this is for guidance only and no liability can be accepted for its accuracy.*

14. *The Code of Practice for Ground Investigations – BS 5930:2015 calls for man-made soils to be described as Anthropogenic Ground with soils placed in an un-controlled manner classified as Made Ground and soils placed in a controlled manner as Fill. In view of the difficulty in always accurately determining the origin of man-made soils in exploratory holes, Geotechnics Limited classify such materials as Made Ground. Where soils can be clearly identified as being placed in a controlled manner then further classification of the soils as Fill has been added to the Exploratory Hole Records.*

15. *Classification of man-made soils is based on the inspection of retrieved samples or exposed excavations. Where it is obvious that foreign matter such as paper, plastic or metal is present, classification is clear. Frequently, however, for man-made soils that arise from the adjacent ground or from the backfilling of excavations, their visual characteristics can closely resemble those of undisturbed ground. Other evidence such as site history, exploratory hole location or other tests may need to be drawn upon to provide clarification. For these reasons, classification of soils on the exploratory hole records as either Made Ground or naturally occurring strata, the boundary between them and any interpretation that this gives rise to should be regarded as provisional and subject to re-evaluation in the light of further data.*

16. *The classification of materials as Topsoil is generally based on visual description and should not be interpreted to mean that the material so described complies with the criteria for Topsoil used in BS 3882:2015. Specific testing would be necessary where such a definition is a requirement.*

17. *Ground conditions should be monitored during the construction of the works and the report should be re-evaluated in the light of these data by the supervising geotechnical engineers.*

18. *Any comments on groundwater conditions are based on observations made at the time of the investigation, unless specifically stated otherwise. It should be noted, however, that the observations are subject to the method and speed of boring, drilling or excavation and that groundwater levels will vary due to seasonal or other effects.*

19. *Any bearing capacities for conventional spread foundations which are given in the report and interpreted from the investigation are for bases at a minimum depth of 1m below finished ground level in naturally occurring strata and at broadly similar levels throughout individual structures, unless otherwise stated. Typically they are based on serviceability criteria taking account of an assessment of the shear strength and/or density data obtained by the investigation. The foundations should be designed in accordance with the good practice embodied in BS 8004:2015 - Foundations, supplemented for housing by NHBC Standards. Foundation design is an iterative process and bearing pressures may need adjustment or other measures may need to be taken in the context of final layouts and levels prior to finalisation of proposals.*

20. *Unless specifically stated, the investigation does not take account of the possible effects of mineral extraction or of gases from fill or natural sources within, below or outside the site.*

21. *The costs or economic viability of the proposals referred to in the report, or of the solutions put forward to any problems encountered, will depend on very many factors in addition to geotechnical or geoenvironmental considerations and hence their evaluation is outside the scope of the report.*

Appendix E

GUIDE TO HUMAN HEALTH RISK ASSESSMENT

CONFIDENTIAL

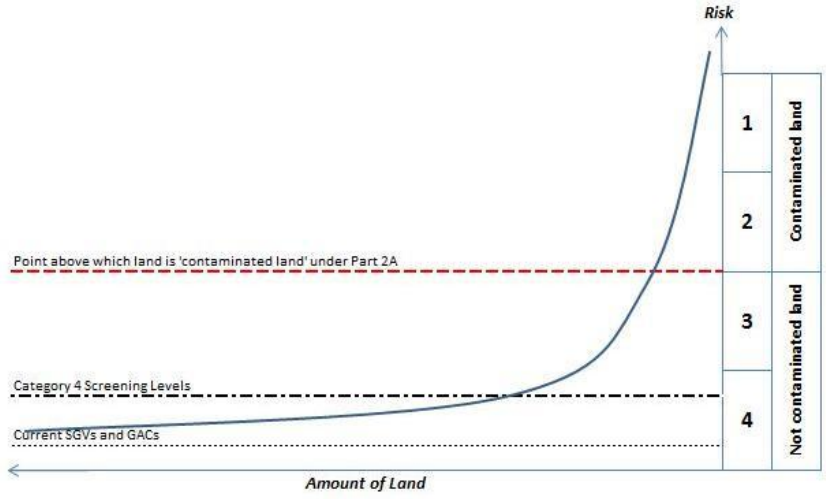
METHODOLOGY FOR THE DERIVATION OF GENERIC QUANTITATIVE ASSESSMENT CRITERIA TO EVALUATE RISKS TO HUMAN HEALTH FROM SOIL & GROUNDWATER CONTAMINATION

UK APPROACH

In the UK, the potential risks to human health from contamination in the ground are usually evaluated through a generic quantitative risk assessment (GQRA) approach. This allows generic and conservative exposure assumptions to be readily applied to risk assessments, and can be a useful tool for rapidly screening data and to identify those contaminants or scenarios that could benefit from further investigation and/or site-specific detailed quantitative risk assessment (DQRA). Current industry good practice is to use the approach presented in the Environment Agency (EA) publications SR2[1] and SR3[2]. This approach allows the derivation of Generic Assessment Criteria (GACs), primarily for chronic exposure.

In April 2012, the Department of Environment, Food and Rural Affairs (Defra) published updated statutory guidance[3] which introduced a four category approach to determining whether land in England and Wales is contaminated or not on the grounds of significant possibility of significant harm (SPOSH). **Figure 1** presents a graphical representation of the categories.

Figure 1: Four Categories for Determining if Land Represent a SPOSH



Cases classified as Category 1 are considered to be SPOSH based on actual evidence or an unacceptably high probability of harm existing. Category 4 cases are those where there is no risk, or a low risk of SPOSH.

[1] Environment Agency '*Human Health Toxicological Assessment of Contaminants in Soil',* Report SC050021/SR2. January 2009.
[2] Environment Agency '*Updated Technical Background to the CLEA Model*,' Report SC050021/SR3. January 2009.
[3] Defra '*Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance'.* April 2012.

GACs represent a minimal risk level, well within Category 4. A 2014 publication by Contaminated Land: Applicatons in Real Environments (CL:AIRE),SP1010[4] and endorsed by Defra[5] provided an approach to determine Category 4 Screening Levels (C4SLs) which are higher than the GACs whilst being "more pragmatic but still strongly precautionary". It also provided C4SLs for six contaminants of concern. Although the C4SLs were designed to support Part 2A assessments to determine 'contaminated land' they are specifically mentioned, along with reference to the Part 2A statutory guidance, by the Department for Communities and Local Government (DCLG) for use in a planning context[6].

An updated version the Contaminated Land Exposure Assessment (CLEA) Workbook (v1.071) was released by the EA in September 2015 to take into account the publication of SP1010. The updates comprised: additional toxicity data for the six chemicals for which C4SLs were derived; two new public open space land use scenarios; updated exposure parameters; options to run the model using C4SL exposure assumptions; and increased functionality. There were no changes to algorithms, so it is still possible to replicate the withdrawn SGVs using the input parameters held within v1.071.

It should be noted that the four category approach has not been adopted in Scotland under Part 2A or the planning regime. The Part 2A statutory guidance applicable in Scotland (Paper SE/2006/44 dated May 2006) does not reflect the changes introduced by Defra in April 2012 which allow for the use of C4SLs within Part 2A risk assessments. Additionally, it is considered that the principal of 'minimal risk' should still apply under planning in Scotland, based on current guidance.

WSP APPROACH

Following the withdrawal of the SGVs, and in the absence of an industry-wide, accepted set of GACs it is down to individual practitioners to derive their own soil assessment criteria. WSP has used the approach provided within SR2, SR3, SP1010, CLEA Workbook v1.071 and SR4[7] to produce a set of minimal risk GACs. The chemical-specific data within two key publications were considered during their production: CL:AIRE 2010[8] and LQM 2015[9]. Both documents provide comprehensive sets of GACs for different contaminants of concern.

The LQM Suitable For Use Levels (S4ULs) have selected exposure parameters consistent with the C4SL exposure scenarios. This approach was rejected by WSP as not representing minimal risk. However, the LQM S4UL document was critically reviewed and the approach and chemical input parameters were utilised where considered to be appropriate.

An industry-led C4SL Working Group is in the process of deriving a larger set of C4SLs in the near future, for approximately 20 contaminants. This will include a critical review of the chemical input data for all selected substances, and may therefore lead to further amendments to the chemical input data used in the WSP in-house screening values. It is considered likely that the contaminant list will

[4] CL:AIRE *'Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination'* SP1010, Final Project Report (Revision 2). September 2014.
[5] Defra 'SP1010: *Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document'*. December 2014.
[6] DCLG Planning Practice Guidance '*Land Affected by Contamination'*, particularly Paragraphs 001 and 007. Ref IDs: 33-001-20140306 & 33-007-20140612.
[7] Environment Agency '*CLEA Software (Version 1.05) Handbook (and Software)',* Report SC050021/SR4. September 2009.
[8] CL:AIRE 'The EIC/AGS/CL:AIRE *Soil Generic Assessment Criteria for Human Health Risk Assessment'.* ISBN 978-1-05046-20-1. January 2010.
[9] Nathanail et al '*The LQM/CIEH S4ULs for Human Health Risk Assessment'*, Land Quality Press, ISBN 978-0-9931084-0-2. 2015.

crossover with the 2009 EIC/AGS/CL:AIRE GACs. As such, this document was not critically reviewed by WSP.

WSP's current approach to the assessment of risks to human health is to continue to evaluate minimal risk through the use of in-house derived GACs, and to use the published C4SLs as a secondary tier of assessment until such time as additional C4SLs are published and/or in-house values are derived.

EXPOSURE MODELS

LAND USES

WSP has largely adopted the exposure assumptions of the generic land use scenarios included within SR3, with two additional public open space scenarios included from within SP1010 and two bespoke exposure scenarios (highways):

- Residential with homegrown produce consumption;
- Residential without homegrown produce consumption;
- Allotments;
- Commercial;
- Public open space near residential housing (POS_{resi});
- Public park (POS_{park});
- Highways (surface soils); and
- Highways (subsurface soils).

Exceptions are described in the following Sections.

SOIL PROPERTIES

SR3 assumes a sandy loam soil with a pH of 7 and a Soil Organic Matter (SOM) content of 6% for its generic land uses, based on the geographical spread of topsoils in the UK. WSP has adopted these default values. In addition, GACs based on an SOM of 1% and 2.5% have been derived, based on common experience of the nature of Made Ground and lack of topsoil on many brownfield sites.

RECEPTOR CHARACTERISTICS AND BEHAVIOURS

SP1010 provides some updated exposure parameters for long-term inhalation rates[10] and the consumption rates for homegrown produce[11] compared to those provided in SR3. This data was used to derived WSP's GACs.

The changes in inhalation rates do not apply to the allotment generic land use scenario, as these are based on the breathing rates for short-term exposure of light to moderate intensity activity which were derived from a study that was not updated in USEPA 2011, so the SR3 rates were retained.

[10] USEPA, National Centre for Environmental Assessment '*Exposure Factors Handbook: 2011 Edition*' EPA/600/R-09/052F. September 2011.
[11] National Diet and Nutrition Survey 2008/2009 to 2010/2011.

HIGHWAYS EXPOSURE SCENARIOS

Human health GAC for a Highways exposure scenario have been derived. The site area is defined by publicly accessible land adjacent to highways, comprising both hard and soft landscaped areas. Exposure is considered to be largely transitory.

There are no publicly available GAC for this exposure scenario. Consequently, WSP have derived GAC for the following exposure scenarios:

- à Highways (surface soils); and
- à Highways (sub-surface soils).

Surface soils GAC are for soil at ground level and within 300mm of the surface. Conversely, subsurface GAC are for soils at a depth exceeding 0.3m bgl. These GAC are not to be used as import criteria.

The critical receptor is a young female child, CLEA age classes 4-9. This is consistent with the critical receptor for the POS(resi) exposure scenario, and considered to be appropriate for a child potentially playing outside without direct adult supervision.

For all GAC, a sandy loam soil and a soil organic matter content of 1% is assumed. There is no building on site.

Exposure scenarios for surface and subsurface soils are detailed below. These are considered to be conservative estimtes, due to the mostly transitory use of publically accessible lands adjacent to highways.

HIGHWAYS GAC (SURFACE SOILS)

The relevant exposure pathways include direct soil and dust ingestion, dermal contact (outdoors) and the inhalation of outdoor dust and vapour.

The exposure frequency is 170 days per annum, and the occupancy period outdoors is 1 hour per day (as per the POS (resi) exposure scenario). The soil and dust ingestion rate has been set at 50 mg/day, consistent with a POS(park) exposure scenario.

HIGHWAYS GAC (SUBSURFACE SOILS)

The single relevant exposure pathway is the inhalation of outdoor vapour. Direct exposure pathways are not viable due to the depth of the soils below ground level.

The exposure frequency is 170 days per annum, and the occupancy period outdoors is 1 hour per day (as per the POS (resi) exposure scenario). The soil and dust ingestion rate has been set to zero, as direct exposure pathways to soils at this depth are not viable.

CHEMICAL DATA

PHYSICO-CHEMICAL PARAMETERS

Physico-chemical properties for the contaminants for which GACs have been derived have been obtained following critical review of the following hierarchy of data sources:

1. Environment Agency/Defra SGV reports where available;
2. Environment Agency '*Compilation of Data for Priority Organic Pollutants for Derivation of Soil Guideline Values*', Report SC050021/SR7, November 2008; and
3. Published fate and transport reviews within Nathanail et. al 2015 and CL:AIRE 2010.

Where appropriate, and where sufficient data is available, values were adjusted to reflect a UK soil temperature of 10ºC (e.g. K_{aw}).

TOXICOLOGICAL DATA

Toxicological data for the derivation of minimal risk Health Criteria Values (HCV) for each contaminant was selected with due regard to the approach presented in SR2. Where appropriate, the following hierarchy of data sources was used:

1. UK toxicity reviews published by authoritative bodies including:
   - EA;
   - Public Health England (PHE);
   - Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment (COT); and
   - Committee on Carcinogenicity of Chemicals in Food, Consumer Products and the Environment (COC).
2. Authoritative European sources such as European Food Standards Agency (EFSA)
3. International organisations including:
   - World Health Organisation (WHO); and
   - Joint FAO/WHO Expert Committee on Food Additives (JECFA).
4. Authoritative country-specific sources including:
   - United States Environmental Protection Agency (USEPA);
   - US Agency for Toxic Substances and Disease Registry (ATSDR);
   - US Integrated Risk Information System (IRIS); and
   - Netherlands National Institute for Public Health and the Environment (RIVM).

Factors such as the applicability of the data to human health (e.g. epidemiological vs. animal studies), the quality of the data, the level of uncertainty in the results and the age of the data were also taken into account in the final selection. Details for specific substances are available on request.

MEAN DAILY INTAKES

Estimations of background exposure for each threshold substance have been updated. In line with the SR2 approach, the exposure from non-threshold substances in the soil does not take into account exposure from other sources, and as such GACs were derived without consideration of the Mean Daily Intake (MDI) for those substances.

The data published by the EA in its series of TOX reports between 2002 and 2009 was evaluated to determine whether the values were considered to remain valid today. Values from these current UK published sources were not amended unless they were considered to be significantly different so that the GACs remained as comparable as possible with the revoked SGVs.

ORAL MEAN DAILY INTAKES

Oral MDI were generally estimated as the sum of exposure via the ingestion of food and drinking water using the default adult physiological parameters presented in Table 3.3 of SR2.

Data on the exposure of substances from food ingestion was generally obtained from UK Total Diet Studies (TDS) published by the Food Standards Agency (FSA) and its predecessor the Ministry of Agriculture, Fisheries and Food (MAFF) and from studies commissioned by COT. Where no UK-specific data was available, MDI were derived from the European Food Safety Authority (EFSA), Health Canada and US sources. This was a rare occurrence, and in these instances, the data was evaluated to determine its applicability to the UK.

Data on the concentrations of substances in tap water was obtained from a variety of sources. UK data was used where available, with preference given to Drinking Water Inspectorate (DWI) 2014 data from water company tap water testing (LOD, 1st and 99th percentile data is available). Where the substance was not included in tap water testing, other UK sources of information were considered including:

- à DWI data from water company tap water testing from previous years;
- à COT; and
- à FSA.

Where UK data was not available, a number of other data sources were considered, largely WHO International Programme on Chemical Safety (IPCS) Concise International Chemical Assessment Documents (CICADs) and background documents for the development of Guidelines for Drinking Water Quality, using professional judgement on the relevance of the data to the UK. The final decision on the MDI from drinking water was made using professional judgement on the balance of relevance and probability, taking into account the detection limit where not detected, Koc and solubility, reduction in use of the substance, banned substances, tight controls (e.g. on explosives) and with due consideration to the SR2 instruction that “if no data or information in background exposure are available, background exposure should be assumed to be negligible and the MDI set to zero….”.

Data from other countries was generally not used because it was considered that the hydrogeology of these countries along with industrial practices were unlikely to be reflective of the UK.

INHALATION MEAN DAILY INTAKES

Inhalation MDIs were based on estimates of average daily exposure by the inhalation pathway and calculated using the default adult physiological parameters presented in Table 3.3 of SR2.

The inhalation MDIs were generally estimated using background exposure data from the UK, derived from Defra's UK-AIR: Air Information Resource[12], which provides ambient air quality data from a number of sites forming a UK-wide monitoring network. The MDIs for heavy metals were based on rolling annual average metal mass concentration data from Defra's UK Heavy Metals Monitoring Network from the period October 2009 to September 2010[13].

Information for some substances was obtained from UK sources including Environment Agency TOX reports and data from the UK Expert Panel on Air Quality Standards (EPAQS). Where recent UK data was not available, data was sourced from the International Programme on Chemical Safety (IPCS), the World Health Organisation (WHO), the Agency for Toxic Substances and Diseases Registry (ATSDR), Health Canada, and various other peer-reviewed sources summarised by LQM/CIEH[14].

For other substances, where no data or information on background exposure was available, background exposure was assumed to be negligible and the MDI set at 0.5*TDI in accordance with guidance in SR2.

PLANT UPTAKE

Soil to plant concentration factors are available in CLEA v1.071 for arsenic, cadmium, hexavalent chromium, lead, mercury, nickel and selenium. For all remaining inorganic chemicals, concentration factors were obtained using the PRISM model. Substance-specific correction factors have been selected in accordance with the guidance established within SR3. This is consistent to the approach utilised in the derivation of the LQM S4UL and the EIC/AGS/CL:AIRE GAC.

Where there is a lack of appropriate data to enable the derivation of specific soil to plant concentrations factors for organic chemicals, plant uptake was modelled within CLEA v1.071 using the generic equations recommended within SR3, as follows:

- Green Vegetables – Ryan et al. (1988);
- Root Vegetables – Trapp (2002);
- Tuber Vegetables – Trapp et al. (2007); and
- Tree Fruit – Trapp et al. (2003).

There are no suitable models available for modelling uptake for herbaceous fruit or shrub fruit. Exposure is considered negligible.

[12] Crown 2016 copyright Defra via uk-air.defra.gov.uk, licenced under the Open Government Licence (OGL).
[13] Defra, 2013 Spreadsheet of historic data for multiple years for the Metals network. Available online at: http://uk-air.defra.gov.uk/data/metals-data. [Accessed 13/03/2016].
[14] LQM/CIEH, 2015. The LQM/CIEH S4ULs for Human Health Risk Assessment.

SOIL SATURATION LIMITS

GACs are not limited to their theoretical soil saturation within CLEA, although where either the aqueous or the vapour-based saturation is exceeded, this is highlighted within the Workbook (compared with the lower of the two values). This affects pathways which depend on partitioning calculations so in reality this only affects the vapour pathways and is relevant to organic substances and other substances, such as elemental mercury, that have a significant volatile component. However, the Workbook highlights saturation for direct contact pathways to indicate to the user where further qualitative consideration of free phase contamination at the surface may be required.

Where the lower of the two saturation limits is exceeded and the vapour pathway is the only exposure route being considered, the chronic risks to human health are likely to be negligible. Further evaluation could be undertaken using an alternative model suitable for evaluating non-aqueous phase liquids (NAPLs), such as the Johnson & Ettinger (J&E) approach described in USEPA 2003. However, WSP considers that if NAPLs are suspected, given the known limitations and over-simplifications of J&E, soil vapour monitoring is a more accurate way of assessing potential risks.

Where the lower saturation limit is exceeded for the vapour pathway and a number of exposure routes are being considered, then the contribution from the NAPL via vapour inhalation to the overall exposure can be evaluated using the procedure provided in SR4. WSP would evaluate this as part of a DQRA process or through soil vapour monitoring on-site to determine site-specific soil vapour concentrations.

CHEMICAL SPECIFIC ASSUMPTIONS

CYANIDES

Cyanide has high acute toxicity, and short term exposure is an important consideration when assessing the risks from soils contaminated with cyanide. The primary risk to human receptors from free cyanide in soils is an acute risk.

There is no current UK guidance available for calculating acute risks from free cyanide. Consequently, GAC for acute exposure were derived using the algorithms presented in MADEP 1992[15] and assuming a one-off ingestion of 10g of soil (this conservative value has been taken as an upper bound estimate for a one-off soil ingestion rate amongst children). Receptor body weights have been selected according to the critical receptor for each exposure scenario. The lowest of the chronic and acute GAC for each land use scenario were adopted by WSP.

LEAD

The SGV for lead was withdrawn by the EA in 2009, and in 2011 the EA withdrew their published TOX report in light of new scientific evidence. The C4SL for lead was derived using the latest scientific evidence from a large human dataset. As such, no chemical-specific margin was applied in the derivation of the C4SL for lead. It may be possible for WSP to derive a GAC for lead using the same dataset and applying a chemical-specific margin, but the value is likely to be lower than UK natural background concentrations. Therefore, WSP has adopted the toxicological data used to derive the C4SLs in deriving the GAC for lead until such time as alternative GACs are published by an authoritative body. The relative bioavailability was set at 100% in line with the approach taken for other GACs, whereas the C4SL assumes 60% for soil and 64% for airborne dust. Thus, the WSP GAC are lower than the C4SLs.

[15] MADEP '*Background Documentation for the Development of an "Available Cyanide" Benchmark Concentration'* 1992. http://www.mass.gov/dep/toxics/cn_soil.htm

POLYCYCLIC AROMATIC HYDROCARBONS

WSP's approach to the assessment of polycyclic aromatic hydrocarbons (PAHs) uses the surrogate marker approach. BaP was used as a surrogate marker for all genotoxic PAHs in line with the Health Protection Agency 2010[16] recommendations and SP1010. This assumes that the PAH profile of the data is similar to that of the coal tars used in the Culp *et al* oral carcinogenicity study from which the toxicity data for BaP was produced. In reality, this profile has been shown by HPA to be applicable on the majority of contaminated sites based on assessment of sites across the country.

The alternative is the Toxic Equivalency Factor (TEF) approach which uses a reference compound and assigns TEFs for other compounds based on estimates of potency. Key uncertainties with this approach include the assumption that all compounds have the same toxic mechanism of action within the body and that no compounds with a greater potency than the reference compound are present. It is considered by the HPA that the TEF approach is likely to under predict the true carcinogenicity of PAHs and therefore favours the surrogate marker approach.

For these reasons, WSP considers that the adoption of BaP as a surrogate marker for genotoxic PAHs, as opposed to the TEF approach, is reasonable. In rare cases where the PAH profile may differ from the wide definitions of the Culp *et al* study the user should discuss their project with an experienced risk assessor. In addition, WSP has derived a GAC for naphthalene, which is commonly a risk driver due to its high volatility, relative to other PAH compounds.

TRIMETHYLBENZENES

The GAC for trimethylbenzenes can be used for the assessment of any individual isomer (1,2,3-trimethylbenzene, 1,2,4-trimethylbenzene or 1,3,5-trimethylbenzene), or a mixture of the three isomers.

CHEMICAL GROUPS

For a number of chemical groups, the available toxicity data is for combinations of chemicals. Given that the physico-chemical parameters may differ between the chemicals, the GACs for the chemicals within the groups have been calculated and then the lowest GAC selected to represent the entire group. This was the approach taken by the EA for m-, o- and p-xylenes, and has also been adopted by WSP for:

- 2-chlorophenol, 2,4-dichlorophenol, 2,4,6-trichlorophenol and 2,3,4,6-tetrachlorophenol;
- 2-, 3- and 4-methylphenol (total cresols);
- aldrin and dieldrin; and
- α- and β-endosulphan.

[16] HPA Contaminated Land Information Sheet '*Risk Assessment Approaches for Polycyclic Aromatic Hydrocarbons (PAHs)* 2010

EXPOSURE TO VAPOURS

INHALATION OF MEASURED VAPOURS

WSP has derived a set of soil vapour GACs (GAC_{sv}) that allow for the assessment of measured site soil vapour concentrations, using J&E, in order to establish potential risks via indoor inhalation of vapours. This methodology enables a more robust assessment of exposure via the inhalation of soil vapours indoors than using CLEA-derived soil GAC, as it is based upon measured soil vapour concentrations beneath the site. It also allows for the assessment of vapours from all source terms (i.e. groundwater, soil or NAPL). Outdoor inhalation was not included. WSP considers that the indoor inhalation pathway is the significantly dominant risk-driver.

The generic land use scenarios within CLEA (residential and commercial) that were used to derive the soil GAC were used to define the receptor and building characteristics for the soil vapour GAC. Only residential and commercial generic land use scenarios include the indoor inhalation of vapours pathway.

The GAC_{sv} were derived for three different soil types; sand, sandy loam and clay, reflecting the importance of this parameter within the J&E model. A depth to contamination of 0.85 m below the base of the building foundation was assumed (i.e. 1 m below ground level). This differs from the depth assumed for the soil GAC (0.5 m bgl), but was selected by WSP as a reasonable worst case scenario.

It is acknowledged that the J&E commonly over-predicts indoor vapour concentrations. In particular, it will significantly over-predict vapour concentrations for suspended floor slabs, which many new builds are constructed with, it does not take into account lateral migration and assumes an infinite source of contamination at steady state conditions. In addition, it is common for soil gas/vapour wells to be installed with at least 1 m of plain riser at the surface and this equates to a total depth of 0.85 m below the building foundation plus a 0.15 m thick foundation, and so is more representative of the depth that samples will be taken from.

The TDSIs and IDs for each substance were converted from $\mu gkg^{-1}_{bw}day^{-1}$ to μgm^{-3} using the standard conversions quoted in Table 3.3 of SR2, thereby replacing the need to model C_{air} in the equation:

$$C_{air} = \alpha . C_{vap} . 1{,}000{,}000 cm^3 m^{-3}$$

Where:

C_{air} is the concentration of vapours within the building, mg^{-3}
α is the steady state attenuation coefficient between soil and indoor air, dimensionless
C_{vap} is the soil vapour concentration, $mgcm^{-3}$

The target concentrations within indoor air for each substance (C_{air}) are a function of receptor inhalation rates and occupancy periods, as defined by the site conceptual exposure model (assuming standard CLEA occupancy periods and receptors).

The attenuation factor was calculated using J&E (Equation 10.4 in SR3) and the resulting C_{vap} is equivalent to the GAC_{sv} for the modelled exposure scenario.

Where reported soil vapour concentrations exceed the relevant saturated vapour concentration, free product may occur, and the user should discuss their project with an experienced risk assessor.

INHALATION OF GROUNDWATER-DERIVED VAPOURS

WSP has derived a set of groundwater GACs (GAC_{gw}) to evaluate the potential risks through the indoor inhalation of groundwater-derived vapours by first applying the approach described above for the derivation of the WSP GAC_{sv} to determine the acceptable concentration in soil vapour directly above the water table.

The depth to groundwater was assumed to be 1 m bgl (i.e. 0.85 m below the base of the building foundation). This depth was considered to be more representative of commonly encountered groundwater conditions than the 0.5 m below the base of the building foundation (i.e. 0.65 m bgl) that is used by CLEA for an unsaturated source present in the overlying soil.

The GAC_{gw} was then back-calculated from the GAC_{sv} using the air-water partition coefficient (K_{aw}) for each substance.

The WSP Groundwater Vapour GAC are protective against a dissolved phase contaminant source only. If the presence of NAPL is suspected, the risks from this source will need to be assessed. Where reported groundwater concentrations exceed the relevant solubility limit, free product may occur, and the user should discuss their project with an experienced risk assessor.

Appendix F

HUMAN HEALTH RISK ASSESSMENT

CONFIDENTIAL

Crown Street Zone 2 - Human Health Risk Assessment

Test	LOD	Units	Sample ID	BH101	BH101	BH102	BH106	BH108	BH108	BH108
			Depth	0.50	1.00	0.50	1.00	1.00	2.00	3.00-3.20
			Sampling Date	21/08/19	21/08/19	n/s	n/s	19/08/19	19/08/19	19/08/19
			GAC - Residential Without Plant Uptake							
Metals										
Arsenic	0.2	mg/kg	35	9.3	10	18	18	32	8.6	7.1
Boron, Water Soluble	0.2	mg/kg	10500	0.4	0.6	1.2	0.5	1.1	0.4	*< 0.2*
Cadmium	0.1	mg/kg	87	0.4	0.2	0.2	0.4	0.5	0.1	0.2
Chromium	0.15	mg/kg	1590	15	19	18	16	23	21	24
Chromium, Hexavalent	1	mg/kg	4.5	*< 1.0*	*< 1.0*	*< 1.0*	*< 1.0*	*< 1.0*	*< 1.0*	*< 1.0*
Copper	0.2	mg/kg	7520	35	62	45	81	290	19	26
Lead	0.3	mg/kg	188	99	87	98	180	840	26	18
Mercury	0.05	mg/kg	56	0.11	0.17	0.27	0.96	0.93	*< 0.05*	*< 0.05*
Nickel	1	mg/kg	181	15	22	20	29	27	17	29
Selenium	0.5	mg/kg	430	0.5	0.6	*< 0.5*	*< 0.5*	0.7	*< 0.5*	*< 0.5*
Zinc	1	mg/kg	40400	120	65	51	97	230	48	58
Inorganics										
Total Organic Carbon	0.5	%	-	1.8	4.6	5.1	6.6	5.5	0.8	1
Petroleum Hydrocarbons										
Aliphatic C5-C6	0.01	mg/kg	161	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
Aliphatic C6-C8	0.01	mg/kg	529	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
Aliphatic C8-C10	0.01	mg/kg	154	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
Aliphatic C10-C12	1.5	mg/kg	754	*< 1.5*	*< 1.5*	*< 1.5*	*< 1.5*	*< 1.5*	*< 1.5*	*< 1.5*
Aliphatic C12-C16	1.2	mg/kg	3490	*< 1.2*	*< 1.2*	*< 1.2*	*< 1.2*	*< 1.2*	*< 1.2*	*< 1.2*
Aliphatic C16-C21	1.5	mg/kg	89100	*< 1.5*	*< 1.5*	*< 1.5*	*< 1.5*	*< 1.5*	*< 1.5*	*< 1.5*
Aliphatic C21-C35	3.4	mg/kg	89100	*< 3.4*	*< 3.4*	*< 3.4*	*< 3.4*	*< 3.4*	*< 3.4*	*< 3.4*
Aliphatic C5-C35	10	mg/kg	-	*< 10*	*< 10*	*< 10*	*< 10*	*< 10*	*< 10*	*< 10*
Aromatic C5-C7	0.01	mg/kg	1360	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
Aromatic C7-C8	0.01	mg/kg	3640	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
Aromatic C8-C10	0.01	mg/kg	265	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
Aromatic C10-C12	0.9	mg/kg	1090	*< 0.9*	*< 0.9*	*< 0.9*	*< 0.9*	*< 0.9*	*< 0.9*	*< 0.9*
Aromatic C12-C16	0.5	mg/kg	1730	0.8	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*	*< 0.5*
Aromatic C16-C21	0.6	mg/kg	1340	6	*< 0.6*	*< 0.6*	*< 0.6*	*< 0.6*	*< 0.6*	*< 0.6*
Aromatic C21-C35	1.4	mg/kg	1340	7.8	*< 1.4*	*< 1.4*	*< 1.4*	*< 1.4*	*< 1.4*	*< 1.4*
Aromatic C5-C35	10	mg/kg	-	15	*< 10*	*< 10*	*< 10*	*< 10*	*< 10*	*< 10*
TPH Ali/Aro Total	10	mg/kg	-	15	*< 10*	*< 10*	*< 10*	*< 10*	*< 10*	*< 10*
Benzene	0.01	mg/kg	1.4	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
Ethylbenzene	0.01	mg/kg	435	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
Toluene	0.01	mg/kg	3700	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
Xylene	0.01	mg/kg	424	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*
PAHs										
Naphthalene	0.1	mg/kg	13	2.3	0.5	*< 0.1*	*< 0.1*	2.7	*< 0.1*	*< 0.1*
Acenaphthylene	0.1	mg/kg	-	0.1	*< 0.1*	*< 0.1*	*< 0.1*	1.2	*< 0.1*	*< 0.1*
Acenaphthene	0.1	mg/kg	-	5.7	1	*< 0.1*	0.1	0.8	*< 0.1*	*< 0.1*
Fluorene	0.1	mg/kg	-	5.2	0.9	*< 0.1*	*< 0.1*	1.5	*< 0.1*	*< 0.1*
Phenanthrene	0.1	mg/kg	-	27	4.9	0.1	0.4	6.5	*< 0.1*	*< 0.1*
Anthracene	0.1	mg/kg	-	7.4	1.4	*< 0.1*	0.2	1.6	*< 0.1*	*< 0.1*
Fluoranthene	0.1	mg/kg	-	22	4.4	0.1	0.5	5.7	*< 0.1*	0.2
Pyrene	0.1	mg/kg	-	19	4.2	0.2	0.7	6.2	*< 0.1*	*< 0.1*
Benzo(a)anthracene	0.1	mg/kg	-	7.9	1.6	0.3	0.3	3.6	*< 0.1*	*< 0.1*
Chrysene	0.1	mg/kg	-	8.4	1.7	0.1	0.3	3.6	*< 0.1*	*< 0.1*
Benzo(b)fluoranthene	0.1	mg/kg	-	6.1	1.2	0.2	0.3	2.4	*< 0.1*	*< 0.1*
Benzo(k)fluoranthene	0.1	mg/kg	-	3.4	0.7	0.2	0.1	1.4	*< 0.1*	*< 0.1*
Benzo(a)pyrene	0.1	mg/kg	1.7	8.2	1.7	0.2	0.4	3.6	*< 0.1*	*< 0.1*
Indeno(1,2,3-c,d)pyrene	0.1	mg/kg	-	5	1.1	0.3	0.3	2.1	*< 0.1*	*< 0.1*
Dibenzo(a,h)anthracene	0.1	mg/kg	-	0.8	0.2	0.2	0.1	0.6	*< 0.1*	*< 0.1*
Benzo(g,h,i)perylene	0.1	mg/kg	-	4.9	1.1	0.6	0.3	2.6	*< 0.1*	*< 0.1*
PAH Total	1.6	mg/kg	-	130	27	2.9	4.1	46	*< 1.6*	*< 1.6*

	Exceeds GAC
	Less than Laboratory limit of detection

Appendix G

CONTROLLED WATERS GQRA

CONFIDENTIAL

Generic Quantitative Risk Assessment - Controlled Waters and Human Health Groundwater (volatiles)
Crown Street - Zone 2

Our Ref 19-25394
Client Ref PN194002
Contract Title Crown Street

Shallow installations within Made Ground shown in pink
Concentration exceeds screening criteria in blue

										SCREENING CRITERIA FOR GQRA				
										Controlled Waters - Water Quality Standard				Human Health
Test	Method	LOD	Units							EQS	EQS note	DWS	WHO 2008	Volatile GAC
Metals				Shading indicates WQS / GAC Exeedance										
Lab No				1611879	1611880	1611881	1611882	1611883	1611884					
Sample ID				BH108	BH109	BH107	BH101	BH104	BH103					
Depth				5.88	2.71	6.60	9.82	2.82	2.62					
Well screen depth (m bgl)				8.5 to 20	0.5 to 3.0	10 to 15	9 to 20	0.5 to 3.0	0.5 to 30					
Screened stratum				Sandstone	MG / sand	Sandstone	Clay / gravel / sandstone	MG / clay	MG / Clay					
Sample Type				WATER	WATER	WATER	WATER	WATER	WATER					
Sampling Date				09/12/19	09/12/19	09/12/19	09/12/19	09/12/19	09/12/19					
Arsenic, Dissolved	DETSC 2306	0.16	ug/l	2.1	I/S	0.49	0.29	0.60	2.2	50		10		
Boron, Dissolved	DETSC 2306*	12	ug/l	47	I/S	61	190	73	88			1000		
Cadmium, Dissolved	DETSC 2306	0.03	ug/l	0.04	I/S	0.06	0.04	0.08	< 0.03	0.08		5		
Chromium, Dissolved	DETSC 2306	0.25	ug/l	0.77	I/S	< 0.25	< 0.25	1.4	0.29	3.4	VI	50		
Copper, Dissolved	DETSC 2306	0.4	ug/l	2.1	I/S	2.0	1.3	3.2	1.7	1		2000		
Lead, Dissolved	DETSC 2306	0.09	ug/l	0.37	I/S	0.11	0.12	0.24	0.11	1.2		10		
Mercury, Dissolved	DETSC 2306	0.01	ug/l	0.02	I/S	0.03	0.03	0.14	0.10			1		
Nickel, Dissolved	DETSC 2306	0.5	ug/l	0.8	I/S	5.0	5.9	3.7	4.7	4		20		
Selenium, Dissolved	DETSC 2306	0.25	ug/l	1.4	I/S	1.6	3.4	1.2	0.67			10		
Zinc, Dissolved	DETSC 2306	1.3	ug/l	2.5	I/S	15	16	15	7.1	10.9				
Inorganics														
pH	DETSC 2008		pH	6.9	I/S	7.2	7.0	7.6	7.8					
Sulphate as SO4	DETSC 2055	0.1	mg/l	45	t/f	130	240	t/f	81					
Petroleum Hydrocarbons														
Aliphatic C5-C6	DETSC 3322	0.1	ug/l	< 0.1	I/S	< 0.1	< 0.1	< 0.1	< 0.1				15000	
Aliphatic C6-C8	DETSC 3322	0.1	ug/l	< 0.1	I/S	< 0.1	< 0.1	< 0.1	< 0.1				15000	
Aliphatic C8-C10	DETSC 3322	0.1	ug/l	< 0.1	I/S	< 0.1	< 0.1	< 0.1	< 0.1				300	84
Aliphatic C10-C12	DETSC 3072*	1	ug/l	< 1.0	I/S	< 1.0	< 1.0	< 1.0	< 1.0				300	
Aliphatic C12-C16	DETSC 3072*	1	ug/l	< 1.0	I/S	< 1.0	< 1.0	130	< 1.0				300	
Aliphatic C16-C21	DETSC 3072*	1	ug/l	< 1.0	I/S	< 1.0	< 1.0	1100	1.5					
Aliphatic C21-C35	DETSC 3072*	1	ug/l	< 1.0	I/S	< 1.0	< 1.0	8700	83					
Aliphatic C5-C35	DETSC 3072*	10	ug/l	< 10	I/S	< 10	< 10	10000	85					
Aromatic C5-C7	DETSC 3322	0.1	ug/l	< 0.1	I/S	< 0.1	< 0.1	< 0.1	< 0.1	8				
Aromatic C7-C8	DETSC 3322	0.1	ug/l	< 0.1	I/S	< 0.1	< 0.1	< 0.1	< 0.1	74				
Aromatic C8-C10	DETSC 3322	0.1	ug/l	< 0.1	I/S	< 0.1	< 0.1	< 0.1	< 0.1	20				
Aromatic C10-C12	DETSC 3072*	1	ug/l	< 1.0	I/S	< 1.0	< 1.0	< 1.0	< 1.0	2	Naphthalene proxy - conservative		90	
Aromatic C12-C16	DETSC 3072*	1	ug/l	< 1.0	I/S	< 1.0	< 1.0	4.6	< 1.0	2	Naphthalene proxy - conservative		90	
Aromatic C16-C21	DETSC 3072*	1	ug/l	< 1.0	I/S	< 1.0	< 1.0	310	< 1.0	0.1	Anthracene proxy - conservative		90	
Aromatic C21-C35	DETSC 3072*	1	ug/l	< 1.0	I/S	< 1.0	< 1.0	3500	< 1.0	0.00017	Based on BaP - ultra-conservative		90	
Aromatic C5-C35	DETSC 3072*	10	ug/l	< 10	I/S	< 10	< 10	3800	< 10					
TPH Ali/Aro Total	DETSC 3072*	10	ug/l	< 10	I/S	< 10	< 10	14000	85					
PAHs														
Naphthalene	DETSC 3304	0.05	ug/l	< 0.05	I/S	< 0.05	0.05	0.06	< 0.05	2				373
Acenaphthylene	DETSC 3304	0.01	ug/l	< 0.01	I/S	< 0.01	< 0.01	0.01	< 0.01					
Acenaphthene	DETSC 3304	0.01	ug/l	< 0.01	I/S	< 0.01	0.03	0.01	< 0.01					
Fluorene	DETSC 3304	0.01	ug/l	< 0.01	I/S	< 0.01	0.01	0.02	< 0.01					
Phenanthrene	DETSC 3304	0.01	ug/l	0.01	I/S	< 0.01	0.02	0.17	0.01					
Anthracene	DETSC 3304	0.01	ug/l	< 0.01	I/S	< 0.01	< 0.01	0.03	< 0.01	0.1				
Fluoranthene	DETSC 3304	0.01	ug/l	0.02	I/S	< 0.01	0.02	0.24	< 0.01	0.0063				
Pyrene	DETSC 3304	0.01	ug/l	0.03	I/S	< 0.01	0.02	0.30	0.02					
Benzo(a)anthracene	DETSC 3304	0.01	ug/l	< 0.01	I/S	< 0.01	< 0.01	0.15	< 0.01					
Chrysene	DETSC 3304	0.01	ug/l	0.02	I/S	< 0.01	< 0.01	0.21	< 0.01					
Benzo(b)fluoranthene	DETSC 3304	0.01	ug/l	0.03	I/S	< 0.01	< 0.01	0.31	< 0.01			Sum of four 0.1		
Benzo(k)fluoranthene	DETSC 3304	0.01	ug/l	< 0.01	I/S	< 0.01	< 0.01	0.10	< 0.01			Sum of four 0.1		
Benzo(a)pyrene	DETSC 3304	0.01	ug/l	0.01	I/S	< 0.01	< 0.01	0.22	< 0.01	0.00017	BaP - ultra-conservative	0.01		
Indeno(1,2,3-c,d)pyrene	DETSC 3304	0.01	ug/l	0.02	I/S	< 0.01	< 0.01	0.32	< 0.01			Sum of four 0.1		
Dibenzo(a,h)anthracene	DETSC 3304	0.01	ug/l	< 0.01	I/S	< 0.01	< 0.01	0.09	< 0.01					
Benzo(g,h,i)perylene	DETSC 3304	0.01	ug/l	0.02	I/S	< 0.01	< 0.01	0.38	< 0.01			Sum of four 0.1		
PAH Total	DETSC 3304	0.2	ug/l	0.21	I/S	< 0.20	< 0.20	2.6	< 0.20					

Key: * -not accredited. I/S -insufficient sample. t/f -to follow.

Appendix H

IMPORTED SOIL CRITERIA

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IMPORTED SOIL CRITERIA

Contaminant	Import criteria concentration (mg/kg)	Source
TPH Aliphatic C5-C6	78	WSP GAC
TPH Aliphatic C6-C8	231	WSP GAC
TPH Aliphatic C8-C10	65	WSP GAC
TPH Aliphatic C10-C12	325	WSP GAC
TPH Aliphatic C12-C16	2230	WSP GAC
TPH Aliphatic C16-C35	89100	WSP GAC
TPH Aliphatic C35-C44	89100	WSP GAC
TPH Aromatic C5-C7	681	WSP GAC
TPH Aromatic C7-C8	1790	WSP GAC
TPH Aromatic C8-C10	114	WSP GAC
TPH Aromatic C10-C12	571	WSP GAC
TPH Aromatic C12-C16	1660	WSP GAC
TPH Aromatic C16-C21	1340	WSP GAC
TPH Aromatic C21-C35	1340	WSP GAC
TPH Aromatic C35-C44	1340	WSP GAC
Benzo(a)pyrene	1.7	WSP GAC
Naphthalene	5.6	WSP GAC
Arsenic	35	WSP GAC
Cadmium	87	WSP GAC
Chromium	1590	WSP GAC
Hexavalent chromium	4.5	WSP GAC
Copper	7520	WSP GAC
Mercury	56	WSP GAC
Manganese	1820	WSP GAC
Nickel	181	WSP GAC
Lead	188	WSP GAC

Contaminant	Import criteria concentration (mg/kg)	Source
Selenium	430	WSP GAC
Zinc	40400	WSP GAC
Phenol (total)	353	WSP GAC
Asbestos screen	No asbestos detected	-



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