

26th September 2023

Project Ref: GUK-0823-04 (By email only)

Mr I. Hughes
Rutland UK Property Ltd
Moorlands
Main Road
Old Brampton
Chesterfield
S42 7JG

Dear Mr Hughes,

Geotechnical Laboratory Analysis: 20-22 Somersall Lane, Chesterfield

Further to our visit to your property (herein referred to as the 'Site') on the 4th September 2023 and the subsequent geotechnical laboratory testing of soil samples as recovered, we provide below a general summary of the data to assist with MDSP's foundation design work.

Classification

Shrinkable soils such as clays are subject to changes in volume as their water (moisture) content increases or decreases, with this being affected by seasonal change and/or other factors such as the water demand of trees. The resultant shrinkage or swelling of soil can cause subsidence or heave damage to foundations, the structures they support, and underground services.

Three trial excavations were completed to a maximum terminal depth of 2.6m bgl at the positions shown on the attached investigation location plan (Ref. 0823-04-001). As indicated on the trial excavation records, as appended, the underlying ground conditions broadly comprise a layer of made ground with firm becoming stiff to very stiff gravelly clay to variable depth and the deeper bedrock soils being either extremely weak laminated clayey mudstone/siltstone deposits or weathered sandstone with siltstone partings.

Geotechnical laboratory Index testing in conjunction with water content determination was carried out on five representative samples of these Coal Measures soils so that a basic assessment of the cohesive fraction could be established between a depth of 1.5m bgl and 2.5m bgl. The fine soil component represented by clay and silt and containing clay minerals (both alone and/or in mixture with coarser material) are typically classified according to their plasticity characteristics. This is determined by Atterberg Limits tests which are carried out on fine and any medium and fine sand particles to measure the liquid limit and plastic limit, this being in accordance with those methods prescribed in BS1377-2: 1990+Amendment No.1. The degree of plasticity of fine soils is classified using the following terms: non-plastic; low; intermediate, and high (after BS EN ISO 14688-2+A1: 2004+A1:2014).

Results

The results of the testing are summarised in Table 1, overleaf, whilst a copy of the individual laboratory certification (23-54631-1) is appended for reference.

Table 1 - Summary of Atterberg Limits Results

Determinand	No. of Samples	Depth Range (m bgl)	Range (%)	Comment
Water Content (W)	5	1.5 - 2.5	13 - 25*	Typical range of values for weathered Coal Measures deposits.
Liquid Limit (wL)	5		34 - 48	
Plastic Limit (Wp)	5		19 - 24	
Plasticity Index (Ip)	5		15 - 24**	
Passing 425µm test sieve	5		100	

* Moisture content of the samples at the time they were received by the laboratory.

** Plasticity Index as determined by the laboratory, not the modified plasticity index¹

Consistency & Liquidity

Correlation of the laboratory results in accordance with BS EN ISO 14688-2 (2002+A1:2013) to determine the Consistency Index (I_c) and Liquidity Index (I_L) of the cohesive fraction for the samples has been undertaken, where:

$$I_c = (w_L - w) / I_p$$

I_c = Consistency Index; w_L = Liquid Limit; w = Water Content; I_p = Plasticity Index

and

$$I_L = (w - w_p) / I_p$$

I_L = Liquidity Index; w = Water Content; w_p = Plastic Limit; I_p = Plasticity Index

A summary of the data (ordered on depth) is given in Table 2, below and overleaf.

Table 2 – Summary of Consistency & Liquidity Index Values of Clay Soils

Sample	Depth (m bgl)	Water Content (%)	Liquid Limit (%)	Plasticity Index (%)	Consistency Index (I_c)*	Liquidity Index (I_L)*^A
<i>Stiff becoming very stiff CLAY</i>						
TP1-DS1	1.5	17	48	24	1.29	-0.29
TP2-DS1	1.5	25	37	16	0.75	0.25

Table Contd./

¹ In accordance with current guidance (e.g. NHBC Standards) shrinkable soils may be classified as containing more than 35% fine particles and having a modified plasticity index of 10%, or greater. Soils which fall below 10% may be regarded as being non-plastic.

Sample	Depth (m bgl)	Water Content (%)	Liquid Limit (%)	Plasticity Index (%)	Consistency Index (I_c)*	Liquidity Index (I_L)*^
<i>Extremely weak MUDSTONE^</i>						
TP1-DS2	2.5	15	47	24	1.33	-0.33
TP3-DS1	1.5	13	34	15	1.40	-0.40
TP3-DS2	2.5	15	40	18	1.39	-0.39

FOR GUIDANCE ONLY:

* Suggested parameters for Consistency Index (I_c) are: <0.25 = Very soft; 0.25 - 0.5 = Soft; 0.5 - 0.75 = Firm; 0.75 - 1.0 = Stiff; >1.0 = Very Stiff (after BS EN ISO 14688-2:2002+A1:2013, Table 6).

*^ Suggested parameters for Liquidity Index (I_L) comparison are given in Waltham, A.C. (2009) *Foundations of Engineering Geology: Third Edition* as: >0.5 = Soft; 0.2 - 0.5 = Firm; -0.1 - 0.2 = Stiff; -0.4 - -0.1 = Very Stiff; < -0.4 = Hard.

^ Laboratory Index testing implies that the strata has completely weathered to clay. Comparison of data is not valid for rock. Field observations for weathered mudstone samples are consistent with descriptions given in Table 25 of BS 5930:2015+A1:2020 and are therefore regarded as extremely weak (0.6-1.0MPa).

Volume Change Potential (VCP)

The plasticity index results have been assessed in accordance with NHBC guidance. The Standards issued by the NHBC allow for an assessment of the index data so that a modified plasticity index (I'_p) may be calculated; *this is expressed as the plasticity index multiplied by the percentage of particles less than 425 μ m*. The resultant Volume Change Potential ('VCP') is expressed using the following terms: high, intermediate, or low.

For pure clay soils and other soils with 100% of particles less than 425 μ m the modified result will be the same, however, for mixed materials where gravel is present and derived from the underlying bedrock material the use of the modified plasticity index can often result in a more economic foundation design as a classification may be downgraded. A summary of the VCP for the samples tested is given in Table 3, below.

Table 3 - Summary of Atterberg Limits Results

Sample	Depth (m bgl)	Plasticity Index (%)	% Passing 425 μ m	I'_p *	Volume Change Potential
TP1-DS1	1.5	24	100	24	Intermediate
TP2-DS1	1.5	16	100	16	Low
TP3-DS1	1.5	15	100	15	Low
TP1-DS2	2.5	24	100	24	Intermediate
TP3-DS2	2.5	18	100	18	Low

FOR GUIDANCE ONLY:

* <10% = Non-plastic. 10-19% = Low. 20-39% = Intermediate. 40% & greater = High (after NHBC: 2019).

The result of the VCP assessment indicate that the underlying cohesive soils have a low to intermediate modified plasticity. The highest reported VCP presented above should be adopted in construction where new foundations lie within influencing distance of existing, removed, or proposed trees and planting.

We trust that the above meets with your requirements at this time. However, if you require any further assistance, please do not hesitate to contact us.

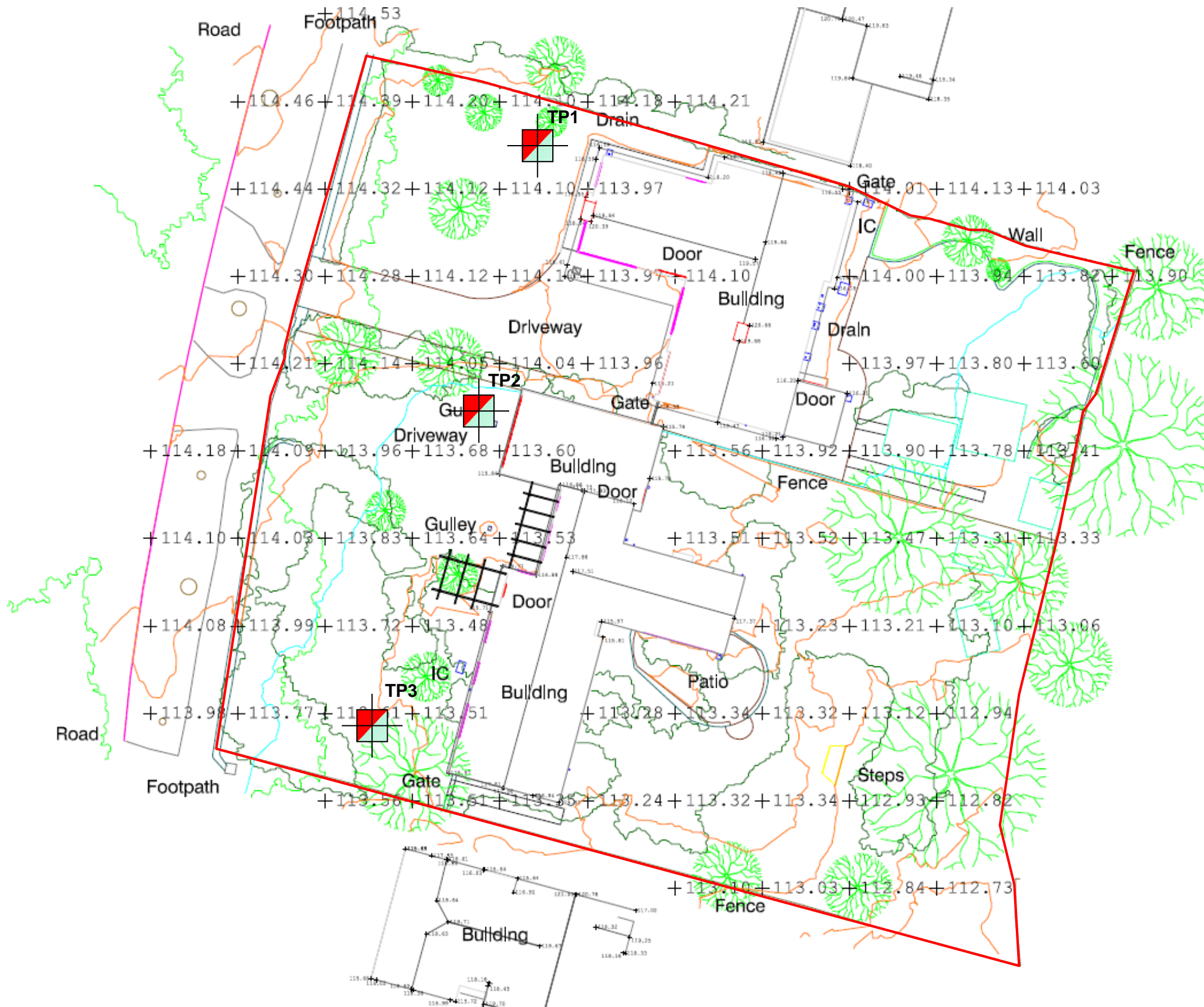
Kindest regards,


Andrew Spooner BSc (Hons) MPhil MEnvSc FGS
Director

For and on behalf of Groundsmiths (UK) Ltd

Enc. Investigation Location Plan, Trial Excavation records and i2 Analytical Laboratory Certification.

FIGURES & DRAWINGS



 Trial excavation position.

Project: 20-22 Somersall Lane, Chesterfield		Client: Rutland UK Property Ltd	
Drawing: Investigation Location Plan		Drawn/Checked: AJS	
Project No: 0823-04	Drawing No: 001	Date: Sept. 2023	

Source: Mining Surveys (UK) Ltd (Drawing Ref: SL/AD/HV/001, dated 7th March 2022).




GROUND INVESTIGATION RECORDS

Project: Residential Development	Project No: GUK-0823-04	Approx. Coordinates: See attached plan	Sheet 1 of 1
Location: 20-22 Somersall Lane, Chesterfield		Approx. Level: 114.10 mAOD	Plant: JCB 3CX
Client: Rutland UK Property Ltd		Date: 04/09/2023	Logged: AS

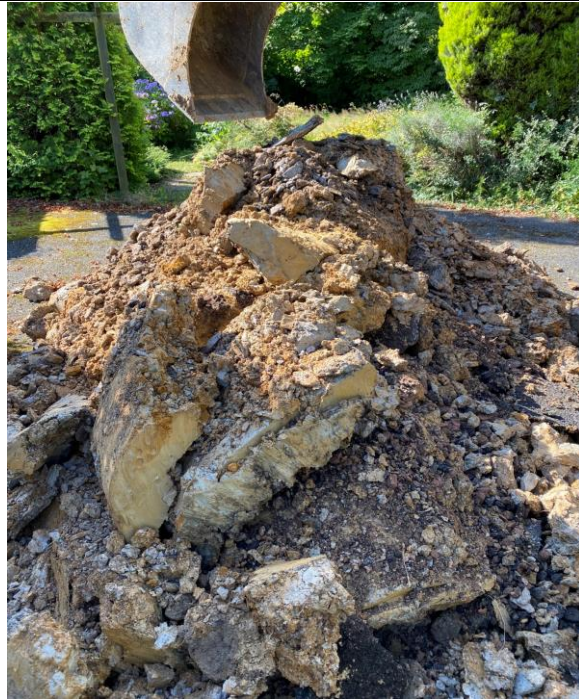
Well	Water (m bgl)	Samples & Testing			Water Content & Plasticity Indices				Depth (m)	Level (mAOD)	Stratum Description
		Depth (m bgl)	Type	Shear Vane (kPa) (Undisturbed/Remould)	Water Content (%)	Liquid Limit (wL)	Plasticity Index (Ip)	Plastic Limit (wp)			
									0.0-0.05	114.10	Grass over loam.
									0.05-0.5	114.05	MADE GROUND: Loose brown sandy clay and loam with occasional glass fragments and bricks. Reworked natural strata (RECONSTITUTED GROUND).
	0.5								0.5-1.0	113.60	Firm becoming stiff yellow mottled grey slightly gravelly CLAY with mudstone lithorelicts, occasional ironstone fragments and fractured sandstone. Medium to high undrained shear strength. Intermediate plasticity (COAL MEASURES).
	1.0			83/29 @0.9m					1.0-1.8	113.10	Stiff becoming very stiff grey mottled brown slightly gravelly CLAY with mudstone lithorelicts and occasional ironstone fragments. High undrained shear strength. Intermediate becoming low plasticity. Recovered as gravel (COAL MEASURES).
	1.5	1.5	DS1		17	48	24	24			
	2.0								1.8-2.6	112.30	Extremely weak thinly laminated grey mottled brown weathered clayey MUDSTONE. Becoming increasingly competent with depth. High undrained shear strength. Low plasticity. Recovered as gravel (COAL MEASURES).
	2.5	2.5	DS2		15	47	24	23			
	3.0										Trial excavation complete at 2.6m bgl




Excavation Details		Dimensions (m)	General Remarks
Shoring:	None required	 Final Depth:	ES - Environmental Sample. DS - Small Disturbed Sample. B - Large Disturbed Sample. Strengths given are based on field observations only.
Stability:	Very good		
Groundwater:	None encountered		

Project: Residential Development	Project No: GUK-0823-04	Approx. Coordinates: See attached plan	Sheet 1 of 1
Location: 20-22 Somersall Lane, Chesterfield		Approx. Level: 113.68 m AOD	Plant: JCB 3CX
Client: Rutland UK Property Ltd		Date: 04/09/2023	Logged: AS

Well	Water (m bgl)	Samples & Testing			Water Content & Plasticity Indices				Depth (m)	Level (mAOD)	Stratum Description
		Depth (m bgl)	Type	Shear Vane (kPa) (Undisturbed/Remould)	Water Content (%)	Liquid Limit (wL)	Plasticity Index (Ip)	Plastic Limit (wp)			
									0.0-0.05	113.68	Tarmac.
									0.05-0.5	113.63	MADE GROUND: Loose red-brown shale over brown sandy clay and loam (RECONSTITUTED GROUND).
	0.5			97/34 @0.8m					0.5-0.9	113.18	Firm becoming stiff yellow mottled grey slightly gravelly CLAY with mudstone lithorelicts. Medium undrained shear strength. Intermediate plasticity (COAL MEASURES).
	1.0								0.9-1.6	112.78	Firm to stiff grey mottled brown-orange very gravelly slightly sandy CLAY with much angular / sub-angular fragments of brown fine grained sandstone and occasional ironstone. High undrained shear strength. Low plasticity. Recovered as gravel. (COAL MEASURES).
	1.5	1.5	DS1		25	37	16	21	1.6-1.9	112.08	Medium strong fine grained thinly bedded dark brown-grey SANDSTONE with clayey partings and SILTSTONE laminations. Recovered as angular and sub-angular fragments. Limited penetration. Becoming increasingly competent with depth (COAL MEASURES).
	2.0										Trial excavation complete at 1.9m bgl
	2.5										
	3.0										




Excavation Details		Dimensions (m)	General Remarks
Shoring:	None required	 Final Depth:	ES - Environmental Sample. DS - Small Disturbed Sample. B - Large Disturbed Sample. Strengths given are based on field observations only.
Stability:	Very good		
Groundwater:	None encountered		

Project: Residential Development	Project No: GUK-0823-04	Approx. Coordinates: See attached plan	Sheet 1 of 1
Location: 20-22 Somersall Lane, Chesterfield		Approx. Level: 113.61 m AOD	Plant: JCB 3CX
Client: Rutland UK Property Ltd		Date: 04/09/2023	Logged: AS

Well	Water (m bgl)	Samples & Testing			Water Content & Plasticity Indices				Depth (m)	Level (mAOD)	Stratum Description
		Depth (m bgl)	Type	Shear Vane (kPa) (Undisturbed/Remould)	Water Content (%)	Liquid Limit (wL)	Plasticity Index (Ip)	Plastic Limit (wp)			
									0.0-0.05	113.61	Grass over loam.
									0.05-0.4	113.56	MADE GROUND: Loose red-brown shale over brown sandy clay and loam (RECONSTITUTED GROUND).
	0.5								0.4-1.0	113.21	Firm brown sandy gravelly CLAY with angular, sub-angular and tabular fragments of sandstone. Medium undrained shear strength. Intermediate plasticity. Recovered as gravel (COAL MEASURES).
	1.0								1.0-1.4	112.61	Medium strong thinly bedded orange-brown-grey fine grained SANDSTONE within a very stiff clayey matrix. Recovered as angular, sub-angular and tabular fragments (COAL MEASURES).
	1.5	1.5	DS1		13	34	15	19	1.4-2.5	112.21	Extremely weak thinly laminated grey mottled brown weathered clayey MUDSTONE with SILTSTONE laminations. Becoming increasingly competent with depth. High undrained shear strength. Low plasticity. Recovered as gravel (COAL MEASURES).
	2.0										
	2.5	2.5	DS2		15	40	18	22			
	3.0										Trial excavation complete at 2.5m bgl



Excavation Details		Dimensions (m)	General Remarks
Shoring:	None required	 Final Depth:	ES - Environmental Sample. DS - Small Disturbed Sample. B - Large Disturbed Sample. Strengths given are based on field observations only.
Stability:	Very good		
Groundwater:	None encountered		

GEOTECHNICAL LABORATORY CERTIFICATION



TEST CERTIFICATE

DETERMINATION OF LIQUID AND PLASTIC LIMITS
 Tested in Accordance with: BS 1377-2:1990: Clause 4.4 and 5

i2 Analytical Ltd
 Unit 8 Harrowden Road
 Brackmills Industrial Estate
 Northampton NN4 7EB



4041

Client: Groundsmiths Ltd
 Client Address: 12 Spruce Close, Brampton,
 Chesterfield, Derbyshire,
 340 3FG
 Contact: Andrew Spooner
 Site Address: 20-22 Somersall Lane, Cheterfield

Client Reference: GUK-0823-04
 Job Number: 23-54631-1
 Date Sampled: 04/09/2023
 Date Received: 05/09/2023
 Date Tested: 14/09/2023
 Sampled By: Client - AJS

Testing carried out at i2 Analytical Limited, ul. Pionierow, 41-711 Ruda Slaska, Poland

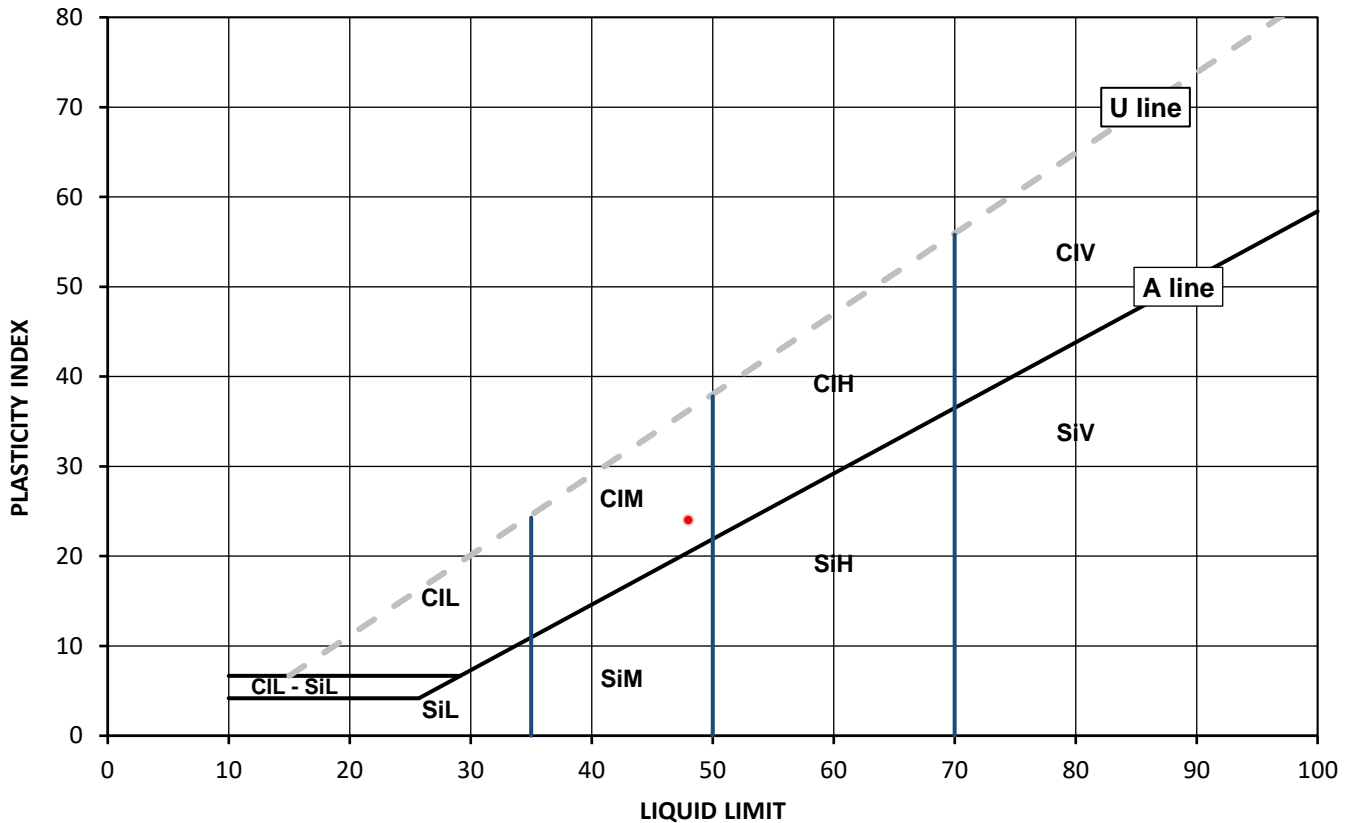
Test Results:

Laboratory Reference: 2800831
 Hole No.: TP1-DS1
 Sample Reference: Not Given
 Sample Description: Brownish grey slightly sandy CLAY

Depth Top [m]: 1.50
 Depth Base [m]: Not Given
 Sample Type: D

Sample Preparation: Tested in natural condition

As Received Water Content [W] %	Liquid Limit [WL] %	Plastic Limit [Wp] %	Plasticity Index [Ip] %	% Passing 425µm BS Test Sieve
17	48	24	24	100



Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

Cl	Clay	Plasticity	Liquid Limit
Si	Silt	L	below 35
		M	35 to 50
		H	50 to 70
		V	exceeding 70
		O	append to classification for organic material (eg CIHO)

Note: Water Content by BS 1377-2: 1990: Clause 3.2

Remarks:

Signed:

Monika Janoszek
 PL Environmental & Geotechnical Lab Production Specialist
 for and on behalf of i2 Analytical Ltd

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i2 Analytical Ltd
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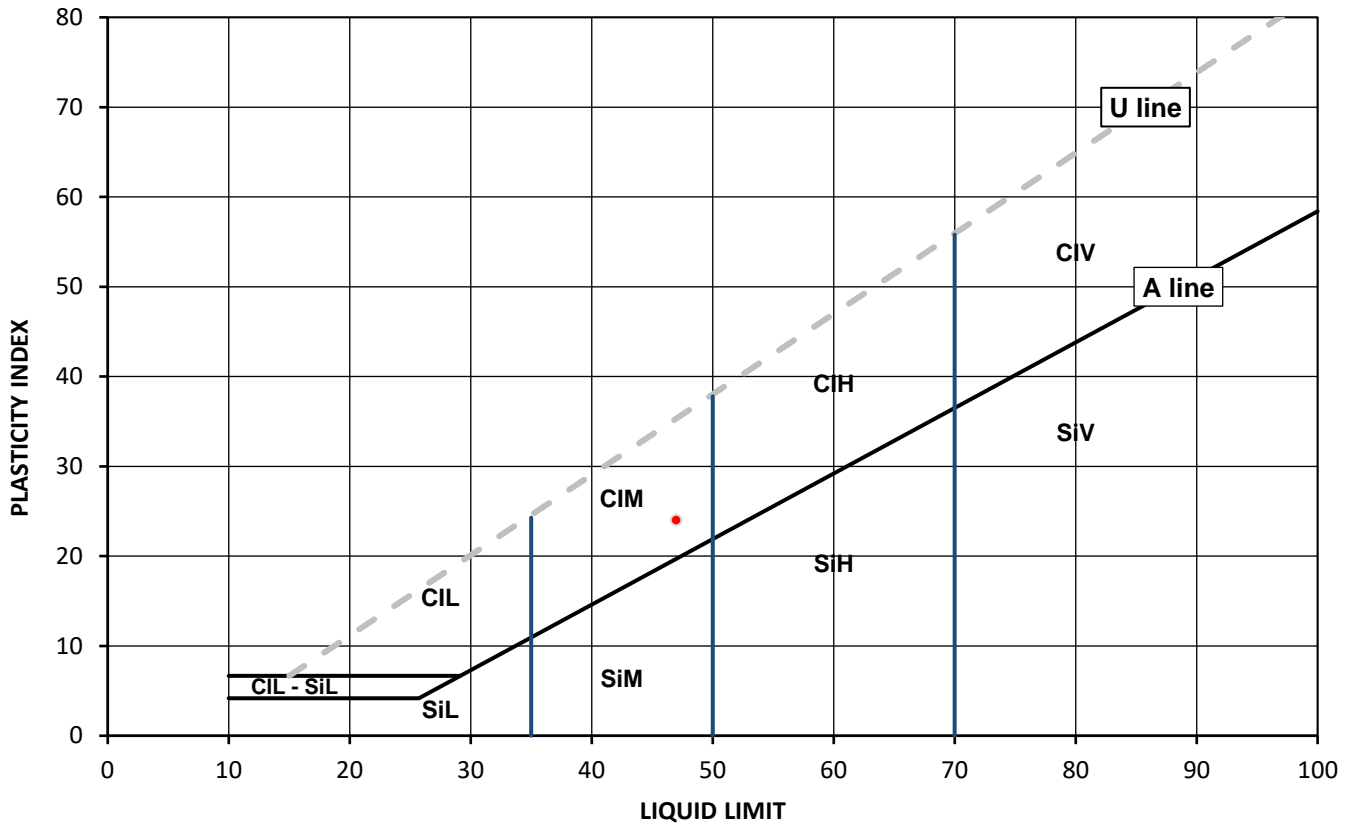
Test Results:

Laboratory Reference: 2800832
 Hole No.: TP1-DS2
 Sample Reference: Not Given
 Sample Description: Brownish grey slightly sandy CLAY

Depth Top [m]: 2.50
 Depth Base [m]: Not Given
 Sample Type: D

Sample Preparation: Tested in natural condition

As Received Water Content [W] %	Liquid Limit [WL] %	Plastic Limit [Wp] %	Plasticity Index [Ip] %	% Passing 425µm BS Test Sieve
15	47	23	24	100



Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

Cl	Clay	Plasticity	Liquid Limit
Si	Silt	L	below 35
		M	35 to 50
		H	50 to 70
		V	exceeding 70
		O	append to classification for organic material (eg CIHO)

Note: Water Content by BS 1377-2: 1990: Clause 3.2

Remarks:

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Testing carried out at i2 Analytical Limited, ul. Pionierow, 41-711 Ruda Slaska, Poland

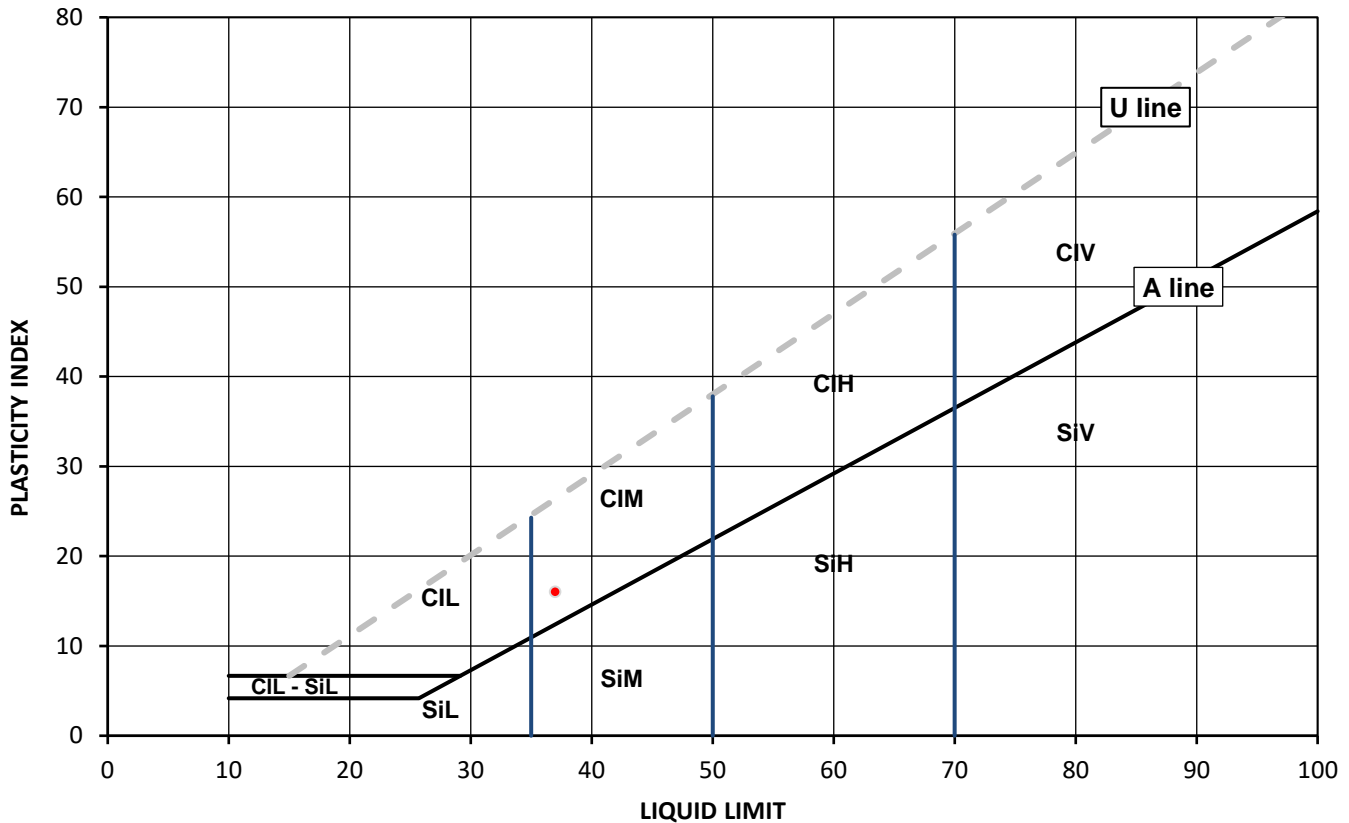
Test Results:

Laboratory Reference: 2800833
 Hole No.: TP2-DS1
 Sample Reference: Not Given
 Sample Description: Light brown sandy CLAY

Depth Top [m]: 1.50
 Depth Base [m]: Not Given
 Sample Type: D

Sample Preparation: Tested in natural condition

As Received Water Content [W] %	Liquid Limit [WL] %	Plastic Limit [Wp] %	Plasticity Index [Ip] %	% Passing 425µm BS Test Sieve
25	37	21	16	100



Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

Cl	Clay	Plasticity	Liquid Limit
Si	Silt	L	below 35
		M	35 to 50
		H	50 to 70
		V	exceeding 70
		O	append to classification for organic material (eg CIHO)

Note: Water Content by BS 1377-2: 1990: Clause 3.2

Remarks:

Signed:

Monika Janoszek
 PL Environmental & Geotechnical Lab Production Specialist
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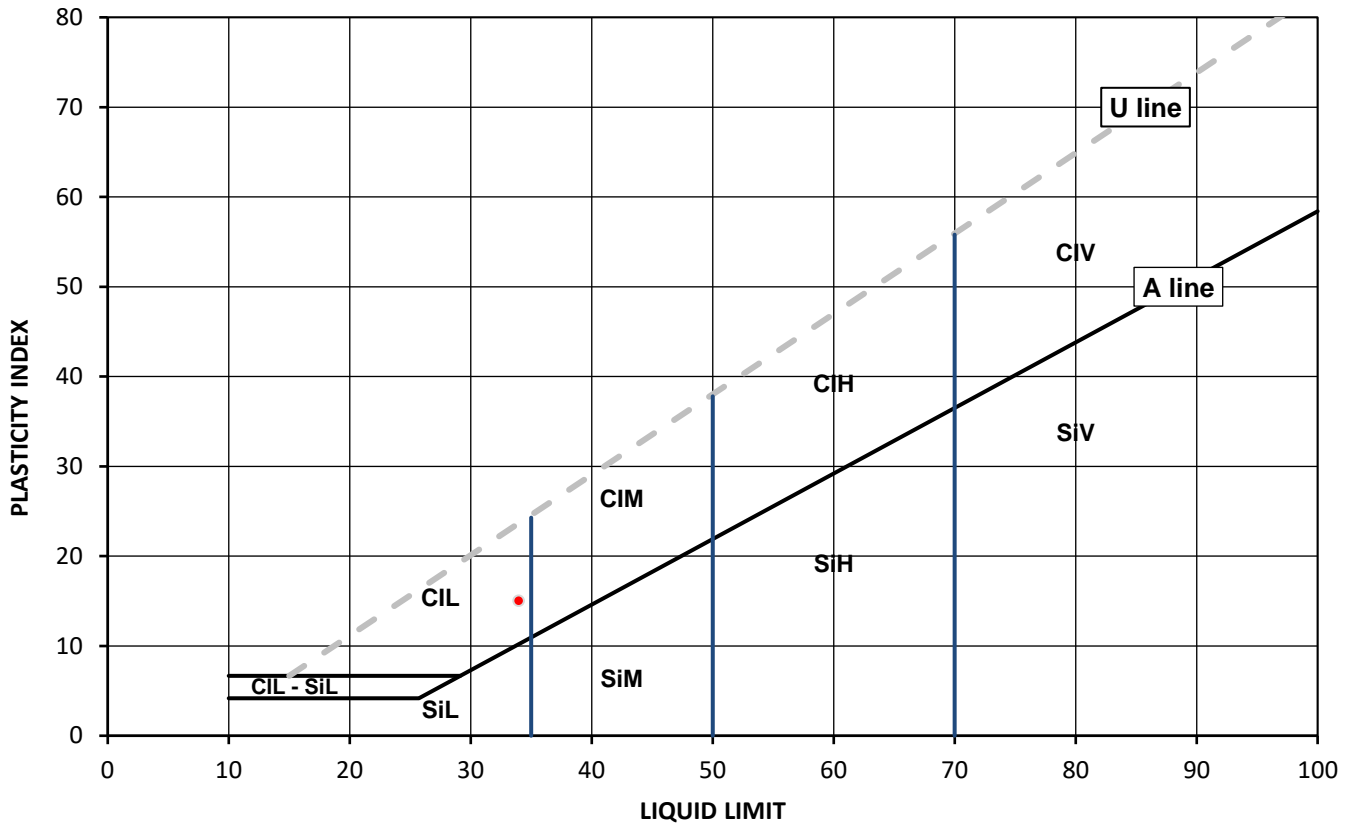
Test Results:

Laboratory Reference: 2800834
 Hole No.: TP3-DS1
 Sample Reference: Not Given
 Sample Description: Yellowish brown sandy CLAY

Depth Top [m]: 1.50
 Depth Base [m]: Not Given
 Sample Type: D

Sample Preparation: Tested in natural condition

As Received Water Content [W] %	Liquid Limit [WL] %	Plastic Limit [Wp] %	Plasticity Index [Ip] %	% Passing 425µm BS Test Sieve
13	34	19	15	100



Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

Cl	Clay	Plasticity	Liquid Limit
Si	Silt	L	below 35
		M	35 to 50
		H	50 to 70
		V	exceeding 70
		O	append to classification for organic material (eg CIHO)

Note: Water Content by BS 1377-2: 1990: Clause 3.2

Remarks:

Signed:

Monika Janoszek
 PL Environmental & Geotechnical Lab Production Specialist
 for and on behalf of i2 Analytical Ltd

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TEST CERTIFICATE

DETERMINATION OF LIQUID AND PLASTIC LIMITS
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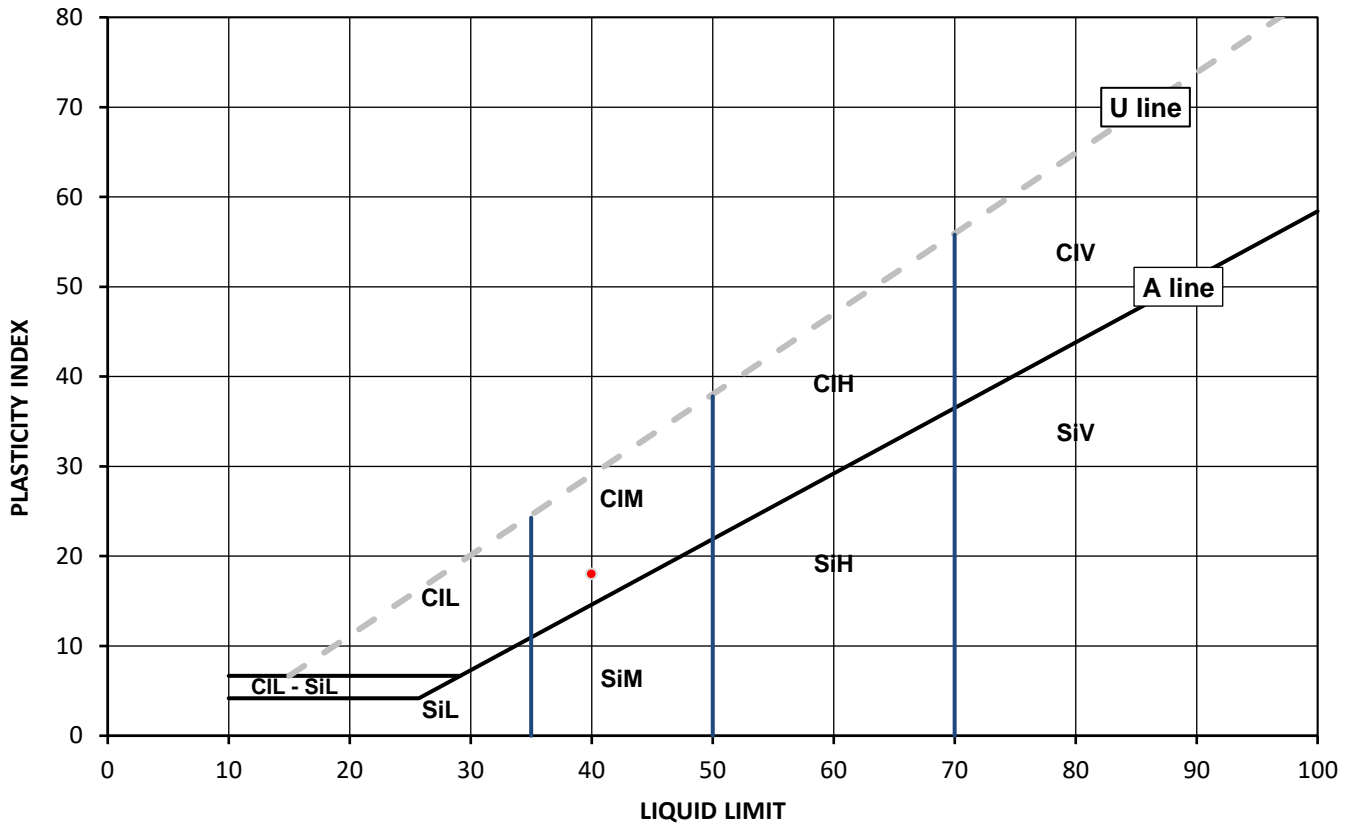
Test Results:

Laboratory Reference: 2800835
 Hole No.: TP3-DS2
 Sample Reference: Not Given
 Sample Description: Brownish grey sandy CLAY

Depth Top [m]: 2.50
 Depth Base [m]: Not Given
 Sample Type: D

Sample Preparation: Tested in natural condition

As Received Water Content [W] %	Liquid Limit [WL] %	Plastic Limit [Wp] %	Plasticity Index [Ip] %	% Passing 425µm BS Test Sieve
15	40	22	18	100



Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

Cl	Clay	Plasticity	Liquid Limit
Si	Silt	L	below 35
		M	35 to 50
		H	50 to 70
		V	exceeding 70
		O	append to classification for organic material (eg CIHO)

Note: Water Content by BS 1377-2: 1990: Clause 3.2

Remarks:

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SUMMARY REPORT

SUMMARY OF CLASSIFICATION TEST RESULTS

Tested in Accordance with:

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB



Environmental Science

4041

Client: Groundsmiths Ltd
Client Address: 12 Spruce Close, Brampton,
Chesterfield, Derbyshire,
340 3FG

Water Content by BS 1377-2:1990: Clause 3.2 Atterberg by BS 1377-2: 1990:
Clause 4.3 (4 Point Test), Clause 4.4 (1 Point Test) and 5

Client Reference: GUK-0823-04
Job Number: 23-54631-1
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Date Tested: 14/09/2023
Sampled By: Client - AJS

Contact: Andrew Spooner
Site Address: 20-22 Somersall Lane, Cheterfield

Testing carried out at i2 Analytical Limited, ul. Pionierow, 41-711 Ruda Slaska, Poland

Test results

Laboratory Reference	Hole No.	Sample				Description	Remarks	Water Content BS 1377-2 [W] %	Water Content BS EN ISO 17892-1 [W] %	Atterberg				Density			Total Porosity# %	
		Reference	Depth Top m	Depth Base m	Type					% Passing 425um	WL %	Wp %	Ip %	bulk Mg/m3	dry Mg/m3	PD Mg/m3		
2800831	TP1-DS1	Not Given	1.50	Not Given	D	Brownish grey slightly sandy CLAY	Atterberg 1 Point	17		100	48	24	24					
2800832	TP1-DS2	Not Given	2.50	Not Given	D	Brownish grey slightly sandy CLAY	Atterberg 1 Point	15		100	47	23	24					
2800833	TP2-DS1	Not Given	1.50	Not Given	D	Light brown sandy CLAY	Atterberg 1 Point	25		100	37	21	16					
2800834	TP3-DS1	Not Given	1.50	Not Given	D	Yellowish brown sandy CLAY	Atterberg 1 Point	13		100	34	19	15					
2800835	TP3-DS2	Not Given	2.50	Not Given	D	Brownish grey sandy CLAY	Atterberg 1 Point	15		100	40	22	18					

Note: # Non accredited; NP - Non plastic

Comments:

Signed:

Monika Janoszek
PL Environmental & Geotechnical Lab Production Specialist
for and on behalf of i2 Analytical Ltd

Opinions and interpretations expressed herein are outside of the scope of the UKAS Accreditation. This report may not be reproduced other than in full without the prior written approval of the issuing laboratory. The results included within the report relate only to the sample(s) submitted for testing.



SUMMARY REPORT

DETERMINATION OF WATER CONTENT

Tested in Accordance with: BS 1377-2: 1990: Clause 3.2

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB



Environmental Science

4041

Client: Groundsmiths Ltd
Client Address: 12 Spruce Close, Brampton,
Chesterfield, Derbyshire,
340 3FG

Contact: Andrew Spooner
Site Address: 20-22 Somersall Lane, Cheterfield

Client Reference: GUK-0823-04
Job Number: 23-54631-1
Date Sampled: 04/09/2023
Date Received: 05/09/2023
Date Tested: 14/09/2023
Sampled By: Client - AJS

Testing carried out at i2 Analytical Limited, ul. Pionierow, 41-711 Ruda Slaska, Poland

Test results

Laboratory Reference	Hole No.	Sample				Description	Remarks	WC %	Sample preparation / Oven temperature at the time of testing			
		Reference	Depth Top m	Depth Base m	Type							
2800831	TP1-DS1	Not Given	1.50	Not Given	D	Brownish grey slightly sandy CLAY		17	Sample was quartered, oven dried at 109 °C			
2800832	TP1-DS2	Not Given	2.50	Not Given	D	Brownish grey slightly sandy CLAY		15	Sample was quartered, oven dried at 109 °C			
2800833	TP2-DS1	Not Given	1.50	Not Given	D	Light brown sandy CLAY		25	Sample was quartered, oven dried at 109 °C			
2800834	TP3-DS1	Not Given	1.50	Not Given	D	Yellowish brown sandy CLAY		13	Sample was quartered, oven dried at 109 °C			
2800835	TP3-DS2	Not Given	2.50	Not Given	D	Brownish grey sandy CLAY		15	Sample was quartered, oven dried at 109 °C			

Comments:

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Signed:

Monika Janoszek
PL Environmental & Geotechnical Lab Production Specialist
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GROUNDSMITHS
GEOTECHNICAL ENGINEERS