GEOTECHNICAL AND GEO-ENVIRONMENTAL ASSESSMENT

Client: West Somerset and Taunton Deane Borough Council

Watchet Harbour East Quay

Report No. 10501
December 2018
Version 1

SOUTH WEST GEOTECHNICAL LTD
Unit 3 Brooklands, Howden Road, Tiverton, Devon, EX16 5HW
T: 01884 252444 F: 01884 253974 E: mail@swgeotech.co.uk

CONTENTS

FIGURES

TABLES

APPENDICES

A. Site Location Plan
B. Geology Report
C. Exploratory Hole Location Plan
D. Exploratory Hole Logs and Photos
E. Plate Test Results
F. Geotechnical Laboratory Test Results
G. Geo-environmental Test Results
H. Stability Analysis Results

Document issue details:

SWG project no. 10501 Client's reference no.

Version no.	Issue date	Issue status	Distribution
1	December 2018	Draft - For Comment	Pick Everard

Executive Summary

South West Geotechnical Ltd (SWG) was commissioned by Pick Everard, on behalf of West Somerset and Taunton Deane Borough Council (the Client) to undertake a geotechnical and basic geo-environmental assessment of the East Quay at Watchet Harbour, West Somerset.

The purpose of the investigation works was to determine the ground conditions on site and to undertake stability analysis of the global stability of the quay wall.

Desk Study

The bedrock geology comprises a combination of the Mercia Mudstone Group (MMG) and the Blue Lias Formation (BLF).

An investigation was undertaken by Parkman Environment at the site in 1997. The investigation encountered made ground to depths of between 2.3 and 6.2m with the upper level of the MMG and BLF bedrock below these depths.

Ground Conditions

The investigation encountered made ground overlying the upper surface of the MMG and BLF bedrock. BHs 101, 102 and 103 encountered MMG materials whilst BHs 104 and 105 encountered BLF. Noticeably poorer ground conditions were encountered at depth in BH103 suggesting the faulted contact between the two geological units is in close proximity to this borehole.

Tidally influenced groundwater conditions are present.

Geo-environmental

The ground investigation and subsequent laboratory testing indicated have confirmed low contaminant concentrations and no remediation is required with regards to contaminated soils.

The materials are likely to be classed as non-hazardous from a waste perspective.

Should any obviously contaminated soils be encountered during the construction phase of the works, advice should be sought from a suitably experienced Geo-environmental Engineer.

Geotechnical

The stability analysis indicates that the stability of the wall in its current state is marginal. It is evident from investigations into the wall that it is narrow and has not been adequately designed to modern standards. This is not uncommon of historic quay walls in the south west.

It is considered that replacing the existing structure with a new, appropriately designed wall / crane supporting structure is necessary.

Three potential options could be considered for construction of a new wall in front of the existing structure as follows:

- Sheet piled wall.
- Construction of solid masonry retaining structure.
- Bored Pile Wall/ Crane Deck.

It is likely that further investigation, including rotary boreholes, will be required to enable an economic piled foundation design.

The Mercia Mudstone and Blue Lias bedrock at the base of the existing wall will provide adequate support to either gravity or piled foundations.

1 INTRODUCTION

1.1 General

South West Geotechnical Ltd (SWG) was commissioned by Pick Everard, on behalf of West Somerset and Taunton Deane Borough Council (the Client) to undertake a geotechnical and basic geo-environmental assessment of the East Quay at Watchet Harbour, West Somerset.

Pick Everard are the Structural Engineers for the project. The scope of works is broadly based on Pick Everards Scope of Works for Geotechnical Consultants (JRB/MGA/180968/10-11/2685-PEV-XX-XX-RP-S-0001- Issue No P01, dated 31.07.18).

1.2 Aims

The quay is currently used for boatyard operations, including the lifting of boats in and out of the harbour by crawler and mobile cranes. It is understood the change are to be made to the operation of the quay, including the use of a new crawler crane. To enable an assessment of the quay wall stability a ground investigation was required to determine the strength and nature of the soils and rock behind and beneath the quay wall. As part of the over stability assessment, SWG undertook an assessment of the potential for a slip failure beneath the wall.

1.3 Site Description

The site comprises a 10m strip along the edge of the east quay at Watchet Harbour. The site is roughly level and largely concrete surfaced. The northern third of the quay is surfaced in a mixture of tarmac and parches of poorer quality concrete.

The quay wall is essentially split into three sections, northern, central and southern. The northern and southern sections are constructed of stone blocks and these represent the original wall construction. The central section of the wall comprises a series of sheet piles with ground anchors. It is understood this section of the wall was constructed following a major collapse of the wall.

From a diver survey of the quay wall (undertaken by others), it is understood that the height of the quay wall to the silt within the harbour is between 6.60m and 6.90m, and between 8.45m and 9.90m to the bed rock.

Three shipping containers, converted for use as art studios and an art gallery, were located at the southern end of the quay.

The site location plan is included in Appendix A.

2 DESK STUDY

2.1 Geology

The site is located in a geologically complex area. The complexity is shown on the Envirocheck geology map included in Appendix B.

The bedrock geology comprises a combination of the Mercia Mudstone Group (MMG) and the Blue Lias Formation (BLF).

The MMG comprises weakly cemented interbedded mudstone, siltstone and sandstone grade materials. The materials are generally “massive” with widely spaced discontinuities. It is common for these rocks to be deeply weathered near surface and altered to predominantly cohesive soils although given the sites coastal location, any soils are expected to have been eroded. Evaporitic minerals containing sulphates (gypsum and halite) are known to occur within the MMG series of rocks.

The BLF comprises interbedded mudstone, siltstone and limestone. The mudstone and siltstone grade materials are typically extremely weak to very weak with the limestone being medium strong. The bedding of the materials is generally close to medium spaced as evidenced by outcrops on the beach to the north of the site.

The area is intensely folded and faulted as shown on the geology map and on freely available aerial photography. Faults are a result of brittle deformation of the bedrock and rock in the vicinity of faults typically have poorer engineering properties than un-faulted rocks. Faults also act as a conduit for groundwater flow. An east-west striking fault is shown to be present cutting through the southern part of the harbour.

The British Geological Survey Map for the area (Sheet 278, Minehead) shows the dip of the primary discontinuity set of the bedrock (Bedding) in the area to have highly variable angles and orientations. This highlights the highly complex natural of the structural geology of the area.

2.2 Previous Investigations

An investigation was undertaken by Parkman Environment at the site in 1997. The investigation comprised seven trial pits and four boreholes.

The boreholes were undertaken using cable percussive techniques. These are soft ground boring techniques and so limited data is available on geotechnical parameters for the bedrock beyond Standard Penetration Tests (SPTs).

The investigation encountered made ground to depths of between 2.3 and 6.2m with the upper level of the MMG and BLF bedrock below these depths.

The made ground was a combination of cohesive and granular soils which are largely reworked local soils with fill materials. Locally railway ballast and clinker materials were present.

The MMG was encountered as very stiff consistency clay with mudstone gravel.

3 GROUND INVESTIGATION

3.1 Fieldwork

An intrusive investigation was carried out between 6 and 16 November 2018, comprising the following:

- 2 no UKAS accredited plate load tests
- 5 no multi-technique boreholes
- Groundwater monitoring

The fieldwork was carried out following the guidelines of BS 5930 (2015): Code of Practice for Ground Investigation; British Standard BS10175 (2011): Investigation of Potentially Contaminated Sites – Code of Practice and BS EN 1997-2:2007 (Eurocode 7) – Geotechnical Design – Part 2: Ground investigation and testing).

The exploratory were positioned approximately at the locations selected by the Engineers for the project (Pick Everard). Locations of the exploratory holes are shown on the Exploratory Hole Location Plan, enclosed as Appendix C.

3.2 Multi-technique Boreholes

Five (5 No) boreholes were undertaken by a combination of techniques on the site using a Comacchio Geo205 multi-purpose rig.

Boreholes were advanced through soils using dynamic sampling with in-situ Standard Penetration Tests (SPTs) down to rock head, followed by rotary coring to enable approximately 5.0m of rock core to be recovered.

Where SPT blow counts exceed 50 without the reaching the full 300mm penetration, the actual penetration was recorded and the extrapolated N-value for the full penetration was calculated and plotted.

The coring was undertaken using an air-mist flush. Core samples were recovered from the core barrel in plastic liner and placed in wooden core boxes prior to being logged by a Geotechnical Engineer.

3.3 Plate Load Tests

Two UKAS accredited Plate Load Tests were undertaken on the site at locations agreed with the Engineer. PL01 was undertaken behind the central section of the quay wall and PL02 was undertaken behind the northern section of the wall. Both tests were undertaken at a depth of 0.20m following removal of the concrete surface/slab. The tests were undertaken to a maximum applied pressure of 208 kPa, in accordance with the Engineers requirements.

Plate Load Test Results are included in Appendix E.

3.4 Groundwater Monitoring Standpipes

Groundwater monitoring standpipes were installed in the boreholes to facilitate groundwater monitoring. The standpipes comprise a 50mm diameter slotted pipe with gravel cell from the base of the hole to near surface and plain pipe with bentonite seal to ground level, finished with a flush cover at ground level.

Electronic level loggers were installed in the boreholes to enable accurate groundwater data to be collected, in particular to measure any tidal influence.

4 LABORATORY TESTING

4.1 Geotechnical Laboratory Testing

All geotechnical testing was carried out in the SWG UKAS accredited laboratory in accordance with BS 1377; 1990, Methods of tests for soils for civil engineering purposes. Table 1 summarises geotechnical testing undertaken. The geotechnical laboratory test results are enclosed as Appendix F.

Table 1: Geotechnical Testing

Test	No. Tests
Soil	
Moisture Content	9
Atterberg Limits	9
Particle Size Distribution Sieve	7
Shear Box	1
pH & Soluble Sulphate	10
Rock	
Point Load Test	10
Uniaxial Compressive Strength Test	4

4.2 Geo-environmental testing

The investigation was not intended to be a full geo-environmental audit. However, a number of samples were obtained and tested for the suite of contaminants detailed in Table 2. The geo-environmental laboratory test results are enclosed as Appendix G.

Table 2: Geo-environmental Testing

Test	No. Tests
pH, Organic Matter, Sulphate (water soluble)	5
Speciated Polyaromatic Hydrocarbons (PAH)	5
Speciated Total Petroleum Hydrocarbons (aliphatic / aromatic split)	5
Asbestos screen	5
BTEX	5

Two Waste Acceptance Criteria (WAC) leachate analysis tests were undertaken on made ground materials.

5 GROUND CONDITIONS

5.1 Strata Encountered

The investigation encountered made ground overlying the upper surface of the MMG and BLF bedrock. BHs 101, 102 and 103 encountered MMG materials whilst BHs 104 and 105 encountered BLF. Noticeably poorer ground conditions were encountered at depth in BH103 suggesting the faulted contact between the two geological units is in close proximity to this borehole. The strata encountered in each borehole is summarised in Table 3.

Table 3: Stratum Summary

Stratum	BH ID and Maximum Depth of Stratum (m bgl)				
	BH101	BH102	BH103	BH104	BH105
Made Ground	6.0	6.2	7.2	6.5	5.2
Mercia Mudstone	>12.5	>12.5	>12.5		
Blue Lias				>12.4	>10.5

Standard Penetration Tests (SPTs) were undertaken at frequent intervals in the dynamic sample sections of the borehole to allow the relative strength / density of near surface soils to be assessed. The SPT N values have been plotted against depth in Figure 1.

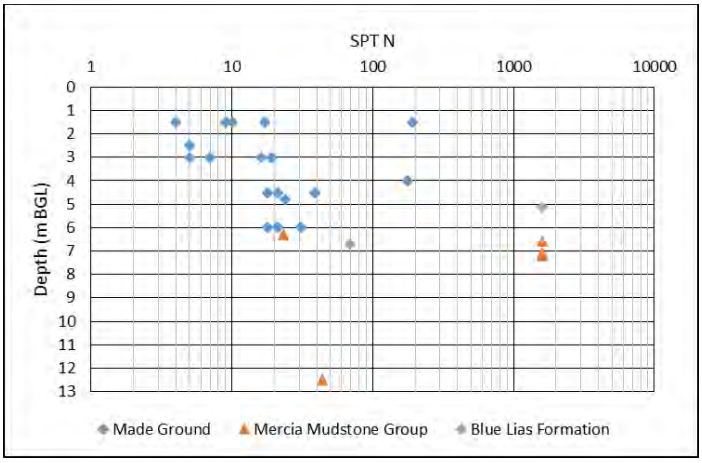


Figure 1: SPT N Vs Depth Plot

5.2 Made Ground

Surface coverings of tarmac or concrete were encountered in each exploratory hole. The concrete was 0.2m thick and contained 6mm diameter steel reinforcement.

Made ground extends to depths of between 5.2 and 7.2m below ground level. The heterogeneous materials are both cohesive and granular in nature and comprise essentially reworked local soils with fill materials including limestone boulders ash and clinker.

The cohesive made ground materials are generally very soft to soft consistency, sandy, gravelly clay. Locally the materials are firm and stiff consistency.

The more granular materials comprise loose to dense clayey gravel.

SPT N values recorded in the materials range from 4 to 192 (extrapolated). The high values (N >50) are coincident with boulders (BH101) and possibly sections of old wall (BH105). Discounting the high values, the average SPT N value for the materials is 16.

Liquid and Plastic (Atterberg) Limit tests undertaken on the cohesive made ground materials indicate the soils have low to intermediate plasticity (CL/CI).

Particle Size Distribution Sieves undertaken on the more granular made ground indicates the majority of the materials are gravel with relatively low fines content (Figure 2). More cohesive soils such as BH103 (2.8m) have a high sand content.

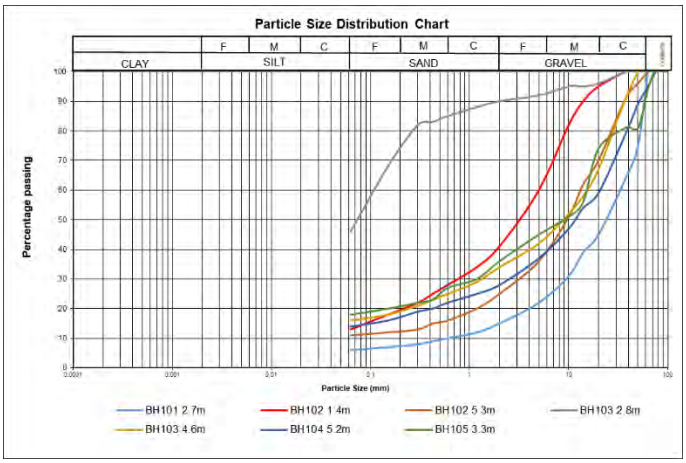


Figure 2: Particle Size Distribution Summary

A single shear box was undertaken on more granular made ground materials. This gave a friction angle of 34° for the soils.

Using correlations between plasticity and friction angle gives a basic friction angle of 28° for the more cohesive made ground.

5.3 Mercia Mudstone Group

The Mercia Mudstone Group materials were encountered in BHs 101, 102 and 103 undertaken along the more northern section of wall at depths of between 6.0 and 7.2m below ground level.

The materials generally comprise very weak to weak, closely to medium fractured mudstone. In general Rock Quality Designation (RQD) values are high (typically >40%) although towards the base of BH103, the RQD values are 0% and coincide with much lower strength (extremely weak) material. The low RQD and corresponding extremely weak rock is potentially indicative of the faulted contact between the MMG and BLF.

Laboratory strength tests undertaken on the MMG materials are summarised in Figure 3. The UCS test values (normalised) and UCS values derived from Point Load Tests confirm the range of strengths of the MMG materials with values ranging from 0.9 to 22 MPa.

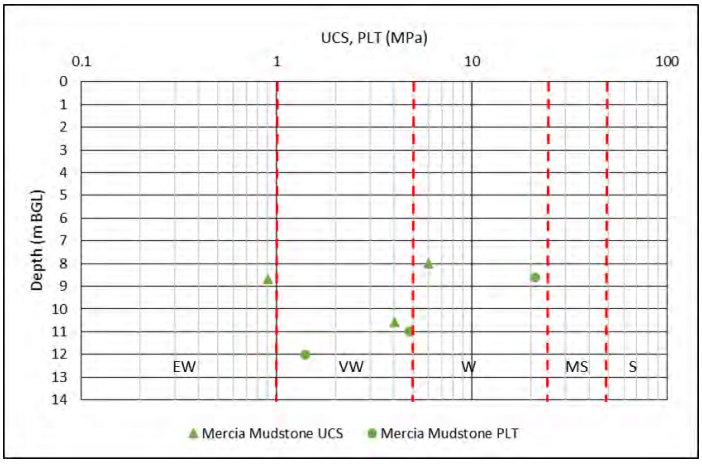


Figure 3: Laboratory Strength Test Results MMG

In order for parameters of cohesion and friction to be derived for the MMG rock mass, Geological Strength Index (GSI, Hoek and Marinos 2000) values have been determined for

the materials using the logging and laboratory strength data. Figure 4 summarises the GSI values determined for the MMG per metre of core. The average GSI value is 46 with the lower value (34) corresponding with the potentially faulted materials in BH103.

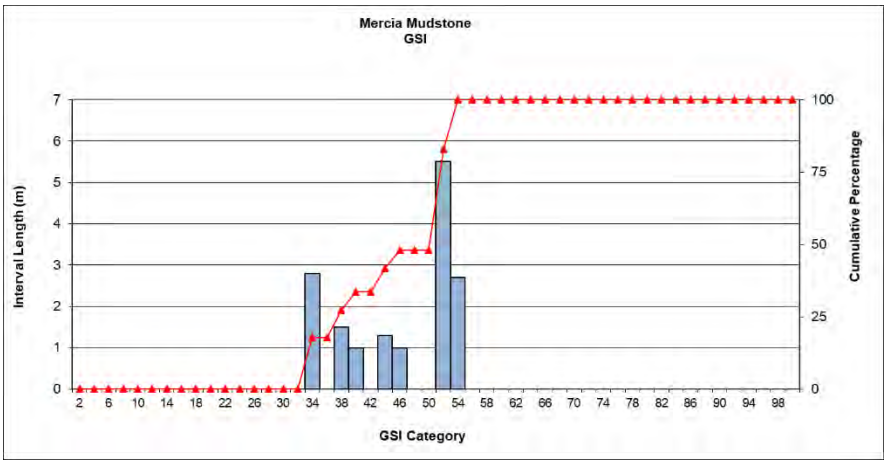


Figure 4: Histogram of GSI intervals for MMG

5.4 Blue Lias Formation

The Blue Lias Formation materials were encountered in BHs 104 and 105 undertaken along the more southern section of wall at depths of between 5.2 and 6.5m below ground level.

The materials generally comprise very weak and weak, closely to medium fractured mudstone. A band of strong limestone was encountered between 7.5 and 7.9m in BH105. The Rock Quality Designation (RQD) values are high (>50%).

The dip of the primary discontinuity set (bedding) in the materials is approximately 30-40°. The orientation of the bedding (dip direction) is not known although it is potentially to the north on the basis of the geology map.

Laboratory strength tests undertaken on the BLF materials are summarised in Figure 5. The UCS test values (normalised and UCS values derived from Point Load Tests confirm the range of strengths of the BLF materials with values ranging from 11 to 68 MPa. The high value (68 MPa) is representative of the limestone.

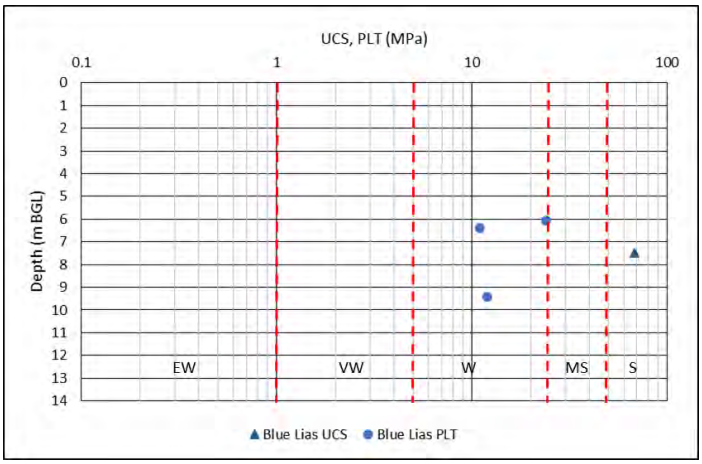


Figure 5: Laboratory Strength Test Results BLF

Geological Strength Index (GSI, Hoek and Marinos 2000) values have been determined for the materials using the logging and laboratory strength data. Figure 6 summarises the GSI values determined for the BLF per metre of core. The average GSI value is 48 with the high value (65) corresponding with the limestone.

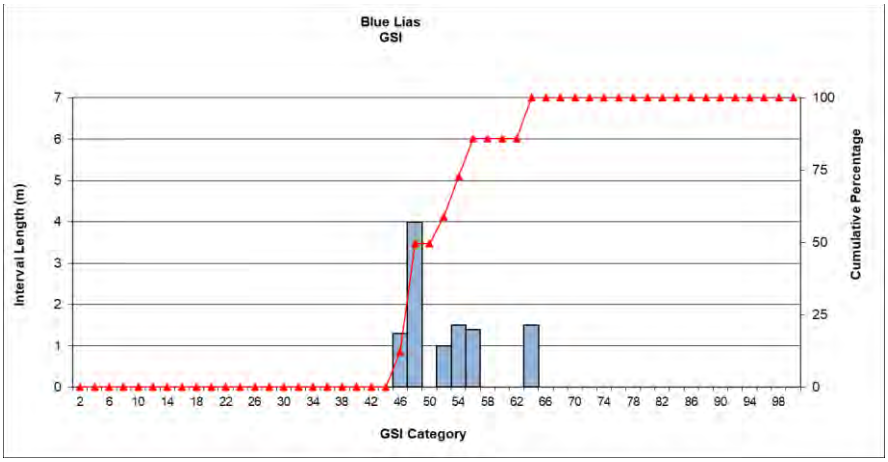


Figure 6: Histogram of GSI intervals for BLF

5.5 Groundwater

Barometric Level loggers were installed in all five boreholes between 17 November and 3 December 2018 to enable the groundwater levels to be monitored. The data is summarised in Figure 7. It is evident that the water levels in BHs 101, 102 and 103 are heavily tidally influenced with fluctuations mirroring tidal movements.

The tidal influence on boreholes 104 and 105 is much less pronounced, possibly due to the rock head levels being higher in BHs 104 and 105.

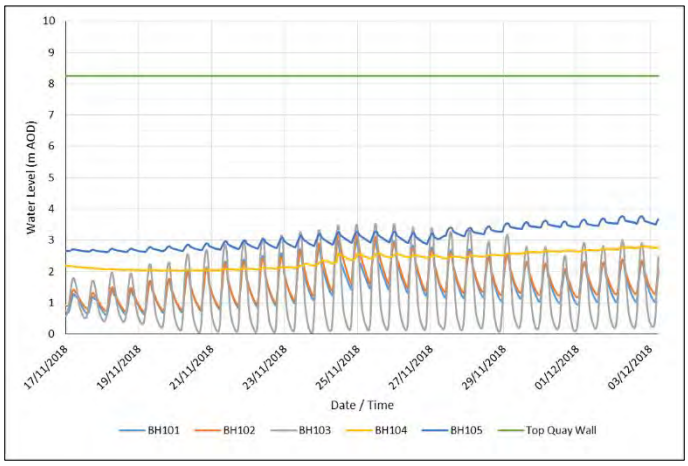


Figure 7: Barometric Logger Groundwater Level Summary

5.6 Signs of Contamination

In general, no visual or olfactory evidence of significantly contaminated soils was noted in the exploratory holes. However, ash and clinker material were encountered in BH102 and BH104.

6 GEO-ENVIRONMENTAL ASSESSMENT

6.1 General

The investigation was not intended to be a full geo-environmental audit. Instead, samples were collected primarily for construction worker health and safety and waste disposal purposes.

The contamination assessment has been carried out following the guidelines outlined in the Chartered Institute of Environmental Health (CIEH) & Contaminated Land: Applications in Real Environments (CL:AIRE) document – Guidance on Comparing Soil Contamination Data with a Critical Concentration, May 2008 and Environment Agency (EA) documents: SR2, SR3, SR4, SR7 & CLR11 using a source-pathway-receptor analysis method, so that an appropriate conceptual model can be developed.

On the basis of the desk study information and walkover survey, although some potential sources of contamination were identified, extensive contamination was not expected to be present.

6.2 Geo-environmental Soil Test Results

The results of the environmental laboratory testing, presented as Appendix G, have been compared to Suitable for Use Level (S4UL) values for commercial/industrial developments. For organic substances a 1% Soil Organic Matter (SOM) has been used, unless otherwise indicated, which represent the most stringent threshold limit.

LQM/ CIEH S4ULs have been developed by Land Quality Management Ltd jointly with the Chartered Institute of Environmental Health, and provide values for the assessment of potential risks to human health posed by contaminants in soil, and are compliant with UK legislative policy and guidelines. In particular, these include components of TPH and PAH. The S4ULS have been derived in accordance with UK legislation, national as well as Environment Agency (EA) policy, and using a modified version of the EA CLEA software. The Department for the Environment, Food & Rural Affairs (DEFRA) has published Category 4 Screening Levels (C4SLs) for six substances including lead. The C4SLs represent the most stringent guidance available for the assessment of lead contamination in soils, and have been used in this report.

Where other guidelines are not available, local guidance, Dutch standards or an in-house screening value is used to provide an initial comparison figure.

Very low contaminant levels were recorded across the site, with all recorded concentrations well below the relevant guideline values for commercial/ industrial use. Indeed, recorded hydrocarbon (TPH and PAH) concentrations are generally below detection limits.

No asbestos fibres or ACM fragments were recorded in the samples tested.

6.3 Human Health (Soils) Risk Assessment

In order for land affected by contamination to cause harm, there must be a source of contamination, a receptor that can be harmed and a pathway by which the receptor can be exposed to the contamination.

Based on the very low recorded contamination concentrations there is effectively no source and therefore no significant risk to possible receptors (future site users, construction works and the wider environment). Furthermore, as the site like to remain or be almost entirely hard covered, the risk to receptors is even further reduced.

6.4 Waste Acceptance Classification

The geo-environmental testing did not indicate any significantly elevated contaminants. The two WAC tests undertaken indicate the made ground soils exceed the limits for inert waste in the basis of elevated antimony and sulphate (BH102) and chloride (BH104). Therefore it is likely that the materials would be classified as non-hazardous in term of waste classification.

The results of the testing should be forwarded to preferred landfill operators who will determine the classification of the materials.

6.5 Remediation Requirements

The ground investigation and subsequent laboratory testing indicated have confirmed low contaminant concentrations and no remediation is required with regards to contaminated soils.

Should any obviously contaminated soils be encountered during the construction phase of the works, advice should be sought from a suitably experienced Geo-environmental Engineer.

7 GEOTECHNICAL ASSESSMENT

7.1 General

The investigation has highlighted that the made ground materials behind the wall predominantly comprise reworked local soils which are highly variable in terms of consistency (heterogeneous) with very low and low strength cohesive soils and locally loose granular soils present.

The SPTs and laboratory test results suggest the soils have variable and poor drained strength parameters (cohesion and friction).

The investigations focusing on quay wall construction (undertaken by others) indicate the wall is also highly variable. At the northern end (BHs 101 and 102), the wall is approximately 1.2-1.3m thick mass concrete. Through the central section (BH103) it is understood the sheet piles have horizontal tie-bars adding support. At the southern end in the vicinity of BH104 and 105, the wall is thin (0.6m) approx. masonry face potentially with soft clay behind.

It is evident that sections of the wall have failed in the past and have been rebuilt on an ad-hoc basis to ensure the serviceability of the harbour.

Proposals involve utilising large cranes on the site in a 10m wide corridor at the top of the quay wall. It is understood the cranes have the potential to generate very high point loads of up to 830 kN/m^2.

7.2 Initial Stability Assessment

In order to assist with determining the overall stability of the quay wall, two cross sections have been constructed through the wall based on sections provided in the Pick Everard presentation document JRBB/MGA/180968/17-2/R005 - Issue Number 01 and the findings of the ground investigation. These sections are through the northern and southern sections of the quay wall.

The initial stability of the area has been assessed using limit equilibrium (LE) stability analysis, undertaken using Rocscience SLIDE™ slope stability software.

When discussing stability using LE methods, the analysis is undertaken by determining a Factor of Safety (FoS) for the section in terms of the resisting forces preventing movement and driving forces causing movement. When the driving forces exceed the resisting theoretical failure occurs. A section with a FoS of 1.0 is in equilibrium and therefore in a state of marginal stability.

It should be noted that due to the complex overturning moments involved in retaining walls failing, LE methods of analysis do not allow accurate modelling of the failure mechanisms (i.e. failure due to overturning). However, when a retaining wall is considered as a block, the LE analysis can provide an indication of whether the retaining wall is “robust” enough (i.e. thick enough to resist the disturbing forces acting through the soil behind it).

The method does not consider the three dimensional effect of buttressing such as that acting on the northern and southern extremities of the wall (i.e. where the wall changes direction around the harbour).

It has not been possible to assess potential failure through the central sheet piled section of the quay wall, as this section is anchored back and we have no information as to how much ‘work’ (added strength) the anchors are doing and this will be crucial to the stability analysis.

On the basis of the above, the analysis is not considered a comprehensive stability assessment of the wall but it does provide important indicators of the potential stability and external forces acting to increase/ decrease the stability of the wall.

7.2.1 Stability Analysis Method

Analysis was undertaken using the GLE/Morgenstern & Price method and follows traditional British Standard methods where by a FoS of 1.0 indicates equilibrium rather than Eurocode methods where factors are applied to the input parameters and so there is not a true equilibrium state. Eurocode factored analysis is considered more applicable to the design of any new structure rather than the stability of the existing.

When considering a target FoS (i.e. acceptable in terms of long term stability) 1.2 is typically used in British Standard analysis.

As discussed, for the purpose of LE analysis, the retaining wall is considered to be a solid block, therefore, the strength parameters applied to it are somewhat arbitrary but are considered appropriate (i.e. the wall is currently standing).

The parameters for the made ground are based on a combination of factors including the results of the SPTs, laboratory testing and back analysis (again the wall is currently standing).

The parameters for the harbour silt materials is considered typical of such materials. It is noted that in the analysis the silt provides toe weight to the wall and so the drained strength parameters are not critical (i.e. the stability of the silt alone is not considered).

The rock parameters have been derived using RocScience RocLab™ calculations which are based on the strength of the intact rock and the GSI values derived in Section 5.

Table 4 details the drained strength parameters used for the stability analysis.

Table 4: Stability Analysis Parameters

Material Type	Cohesion (kPa)	Friction (°)	Unit Weight (kN/m^3)
Quay Wall	40	45	20
Made Ground	5	34	18
Harbour Silt	0	22	18
MMG	30	39	22
BLF	50	44	22

The groundwater behind the wall in Section 1 is heavily tidally influenced (See Section 5.5). To simplify the analysis the worst case groundwater conditions have been considered.

A surcharge of 10 kN/m^2 has been applied to the top of the sections as recommended by British Standard. This represents surcharges provided by general plant on the top of the quay wall. It should be noted that this value is considerably lower than the potential point loads provided by the new proposed cranes.

A colour code system of green (acceptable FoS), orange (marginal) and red (i.e. failure) have been used to highlight the stability results.

7.2.2 Stability Analysis Results

Full details of all analysis is included in Appendix H. Based on LE analysis, currently the wall is in a state of marginal stability and that there must be external factors (beyond the capability of LE analysis) acting to increase the overall stability to a level that the wall is not currently failing.

Three scenarios have been analysed for each section. These are as follows;

- Current condition low tide
- Current condition high tide
- Silt dredged from toe of wall

Section 1 (Northern End)

The results for Section 1 are detailed in Table 5 and indicate that the wall is in a state of marginal stability (when considering soil and rock parameters alone). At low tide the wall is marginally stable with the lowest failure plane daylighting through the wall just above the level of the silt in the harbour. The failure mechanism is considered accurate given the wall has been rebuilt in this area.

Table 5: *SLIDE* Analysis Summary (Section 1)

Factor of Safety		
Low Tide	**High Tide**	**Dredged**
1.05	1.19	0.79

At high tide the buttressing effect of the water significantly increases the stability (12% increase) as would be expected.

At low tide with the harbour silt removed, the stability significantly reduces (24% reduction) indicating the silt is providing a significant buttressing effect to the toe of the wall.

It is emphasised that the analysis indicates potential instability and suggests likely failure mechanisms rather than showing actual occurrences.

Section 3 (Southern End)

The results for Section 3 are detailed in Table 6. It is evident from this analysis, that there are other factors increasing the stability of the wall (beyond the soil and rock parameters along) as in all instances, the FoS is </=1.0 (i.e. indicating failure). Again in all instances, the failures are close to the wall indicating failure of the wall rather than of the rock.

Table 6: *SLIDE* Analysis Summary (Section 3)

Factor of Safety		
Low Tide	**High Tide**	**Dredged**
0.86	1.0	0.86

It is clear that the wall itself is too thin to be providing adequate support to the soils alone and it is likely that the three dimensional buttressing effect along with other external factors are increasing the overall stability.

7.2.3 Discussion

The stability analysis clearly indicates that the stability of the wall in its current state is marginal when considering the soil and to a lesser extent the rock parameters alone (i.e. deep seated rotational failure through the rock is unlikely to occur). It is evident from investigations into the wall that it is relatively thin and has not been adequately designed to modern standards. This is not uncommon of historic quay walls in the south west. Indeed SWG have been involved in the investigation of a number of walls, particularly in the Plymouth and South Hams area where walls have either had inadequate foundations, thicknesses or both.

Using numerical modelling techniques such as Finite Element Analysis or Discrete Element Analysis (beyond SWGs current remit/capability) could be considered to assist with determining the overall stability of the structure although in both instances, it is likely to indicate marginal current stability and certainly inadequate stability in terms of long term future use with large cranes generating large point loads impacting directly on the wall.

On this basis, it is considered that replacing the existing structure with a new, appropriately designed wall / crane supporting structure is necessary.

7.2.4 Remediation Options

Due to the high loads generated by the proposed cranes, any new wall will need to be suitably robust to provide adequate support. Alternatively, a new facing wall could be constructed to support the existing wall and a separate structure built, independent of both walls (or incorporated into the new) to provide a trackway for the new cranes.

Three potential options could be considered for construction of a new wall in front of the existing structure as follows.

- Sheet piled wall. Given the strength of the underlying bedrock, achieving sufficient fixivity with driven sheet piles is likely to be difficult. The crane used to lift boats from the water will impose high loads and it is unlikely that a sheet piled wall alone would provide sufficient support. Anchors would likely be required and given the variable nature of the existing wall, installing anchors may be difficult.
- Construction of solid masonry retaining structure. Given bedrock is relatively close to surface, construction of a new gravity wall could be considered if the water can be kept out and silt removed from the excavation. BH103 encountered poorer ground conditions than the other boreholes potentially due to the faulted contact between the MMG and BLF being present. Some variable settlement could be expected for a gravity wall due to the fault.
- Bored Pile Wall/ Crane Deck. Potentially the most straight forward option whereby a new facing wall is constructed in-front of the existing wall coupled with piles through the trackway/ crane working area to provide a piled trackway on which cranes operate. The faulted contact between the MMG and BLF striking east-west through the centre of the wall (BH103) would mean bored piles are likely to have variable lengths.

Following the design of any new structures and or remedial measures to the existing structures, it is recommended the global stability is re-analysed based on the new geometry.

7.3 Foundation and Pile Design

The MMG and BLF bedrock will provide adequate support for any new structure. Foundations for new structures.

7.3.1 Foundations

If a gravity wall is to be used, an allowable bearing capacity of 330 kN/m^2 has been calculated (using for the MMG (weakest materials) for a 5.0m wide foundation, using Equation 5.7 Wyllie (2009). CIRIA C570 (2001), indicates that settlements rarely exceed 20mm for relatively light loads such as this on MMG materials.

7.3.2 Piles

If bored piles were to be utilised for the basement perimeter, it would make sense to utilise them for the internal columns to support the centre of the structure as they will provide a higher capacity than traditional pad foundations. Piles should be installed into the upper levels of the MMG.

Preliminary pile capacity from skin friction Qs has been calculated for a 0.6m diameter pile using the equation:

$Qs = \alpha \times \beta \times q_{uc} \times A_s / F$ (Tomlinson, 2001, p302) with parameters defined as follows;

- α a factor applied to the soil / rock shear strength (taken as 0.2 for the MMG),
- q_{uc} is the unconfined compressive rock strength with a value of 6000 kPa used for the purposes of this assessment. This is the average value of all PLT and UCS tests.
- β is the rock socket correction factor (taken as 0.8 for the MMG, based on an average RQD of 63%),
- A_s is the shaft area
- F is a factor of safety, taken as 3 for the purposes of this assessment.

Based on the preliminary design of a 0.6m diameter pile and 4.0m rock socket, the preliminary capacity of the pile has been determined to be 2590 kN based on a FoS of 3. This is considered a preliminary working load for piles with a relatively short rock socket.

Where piles are free standing (i.e. anchors are not utilised), the embedment of the pile it typically twice the retained height, subsequently longer rock sockets would allow higher capacity. An anchored capping beam forming the top of a new quay wall could be used to reduce the length of the piles.

Final pile design should take into account additional factors such as the soil /rock effective stress parameters, pile settlement and structural limits on settlement acceptability, negative skin friction from down-drag of the overlying fill, lateral pressures, the effects interaction between neighbouring piles and pile group effects.

7.4 Retaining Wall Design

The parameters used in the stability analysis detailed in Table 4 can generally be used for the design of any new retaining structure.

Due to the high variability of the made ground, it is recommended that a cohesion value of 0 kPa and friction angle 30° is used for the design of any new structure.

Any eccentric loads generated by overturning moments will need to be kept below the allowable bearing capacity detailed in Section 7.3.1.

7.5 Re-use of Materials

Seven PSD sieves were undertaken on the made ground materials (see Figure 2). The sieves indicate the materials would generally be classified as either Class 1B uniformly graded granular materials or Class 2C stony cohesive in accordance with Highways Agency, Specification for Highways Works (2016). One sample (BH103 2.8m), would be Classed as 2A wet cohesive materials.

Given the granular nature of the majority of the near surface materials, the natural moisture content is expected to be close to optimum although it is noted that the deeper materials

have significantly higher moisture content than the near surface material due to tides. The lower moisture content values (12-14% approx.) are expected to be optimum.

7.6 Modulus of Sub-Grade Reaction

Modulus of sub-grade reaction has been calculated for each stage of the two plate load tests undertaken beneath the existing concrete slab.

As would be expected for non-engineered fill materials the values are highly variable ranging from 9059 to 79010 kPa/m.

7.7 Sulphate Classification

The 9 no soluble sulphate test results indicate concentrations of between 0.05 and 1.42g/l, with pH values of between 7.8 and 10 (average 8.5). Taking the average of the two sulphate concentrations as recommended by (BRE SD1, 2005), concrete should be designed to a Design Sulphate Class of DS-2, and ACEC Class AC-2.

Given the marine environment, marine concrete will be required.

Peter Wilson
BSc FGS
Senior Geotechnical Engineer
Author

Ben Ogden
CGeol MSc BSc FGS
Principal
Author

Neil Forrow
CGeol PGDip BSc FGS
Director
Approver

8 REFERENCES AND BIBLIOGRAPHY

Barnes, G. E. (2000). Soil Mechanics, Principles and Practice, 2nd edition. Basingstoke: Palgrave Macmillan.

British Standard BS10175: Investigation of Potentially Contaminated Sites – Code of Practice.

BRE Digest 211 (2007), Radon: Guidance on Protective Measures for New Buildings.

BS 5930 (2015) Code of Practice for site investigations

BS 1377 (1990) Methods of test for soils for civil engineering purposes

BRE Special Digest 1 (2005) - Concrete in Aggressive Ground

Chartered Institute of Environmental Health (CIEH) & Contaminated Land: Applications in Real Environments (CL:AIRE): Guidance on Comparing Soil Contamination Data with a Critical Concentration, May 2008

CIRIA C570. (2001). Chandler, R, J, & Forster, A. Engineering in Mercia Mudstone. London: CIRIA

DEFRA: Development of Category 4 Screening Levels (C4SLs) for assessment of land affected by contamination – SP1010

DEFRA & Environment Agency (2004): CLR 11: Model Procedures for the Management of Land Contamination.

Environment Agency January 2009: Human health toxicological assessment of contaminants in soil, Science Report – Final SC050021/SR2

Environment Agency January 2009: Updated technical background to the CLEA model, Science Report – SC050021/SR3

Environment Agency 2015: CLEA Software Version 1.071

Environment Agency September 2009: CLEA Software (Version 1.05) Handbook, Science report: SC050021/SR4

Environment Agency November 2008: Compilation of data for priority organic pollutants for derivation of Soil Guideline Values, Science report: SC050021/SR7

Hoek, E. & Marinos, P. (2000). GSI: A geologically friendly tool for rock mass strength estimation, in Proceedings of GeoEng 2000, Melbourne.

The LQM/CIEH S4ULs for Human Health Risk Assessment (2015)

The Standard Penetration Test (SPT): Methods and Use (1995) CIRIA Report 143

Tomlinson, M. J. (2001) Foundation Design and Construction. 7th Edn. London: Pearson Education Ltd.

Wyllie, D. C. (2009). Foundations on rock. Second Ed.

9 LIMITATIONS

This report has been prepared by SWG solely for the benefit of West Somerset and Taunton Deane Borough Council. It shall not be relied upon or transferred to any third party without the prior written authorisation of SWG.

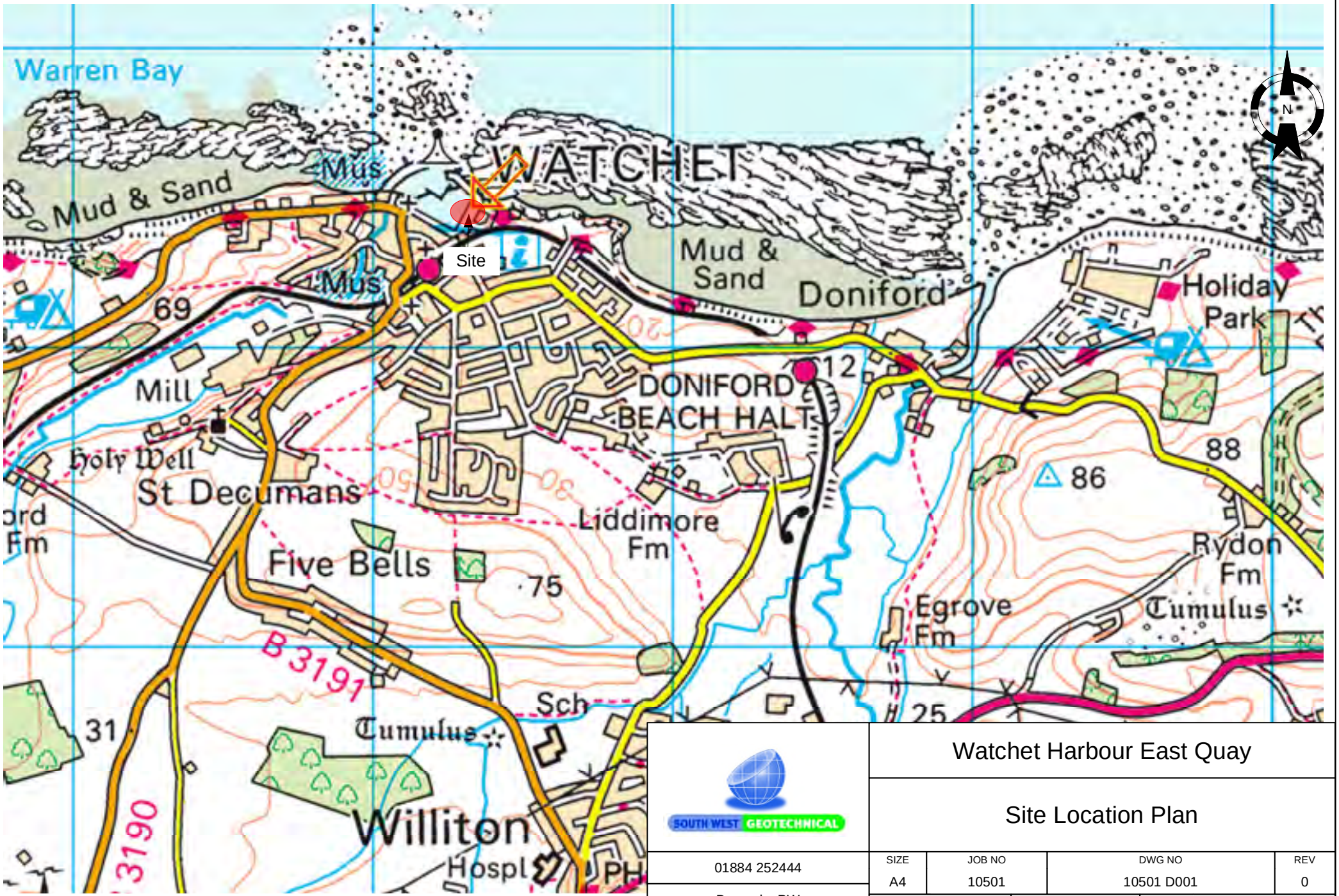
All information given in this report is based on the ground conditions encountered during the site work, and on the results of laboratory and field tests performed during the investigation. However, there may be conditions at the site which have not been taken into account, such as unpredictable soil strata, contaminant concentrations, and water conditions between or below exploratory holes.

It should be noted that groundwater levels usually vary due to seasonal and/or other effects and may at times differ to those measured during the investigation.

British Standards Institute (BSI, 2015) ordinarily recommends that laboratory measurements of strength in cohesive soils be undertaken only on high-quality (Category 'A') undisturbed samples, necessitating the use of wire-line drilling or thin-wall samples tubes. However, given the relatively low geotechnical risk presented and the low probability of being able to recover Category 'A' samples from the anticipated strata, it is considered that the use of such techniques is neither appropriate nor cost-effective.

Appendix A

Site Location Plan



SOUTH WEST GEOTECHNICAL				Watchet Harbour East Quay
				Site Location Plan
01884 252444	SIZE	JOB NO	DWG NO	REV
	A4	10501	10501 D001	0
Drawn by PW	SCALE NTS	12 December 2018	SHEET 1 OF 1	

Appendix B

Geology Report

Geology 1:50,000 Maps Legends

Artificial Ground and Landslip

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	MGR	Made Ground (Undivided)	Artificial Deposit	Not Supplied - Holocene
	SLIP	Landslide Deposit	Clay	Not Supplied - Quaternary

Superficial Geology

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	ALV	Alluvium	Clay, Silt, Sand and Gravel	Not Supplied - Holocene
	HEAD	Head	Clay, Silt, Sand and Gravel	Not Supplied - Quaternary
	BTFU	Beach and Tidal Flat Deposits (Undifferentiated)	Clay, Silt, Sand and Gravel	Not Supplied - Quaternary
	MDU	Marine Deposits	Gravel	Not Supplied - Quaternary
	RTDU	River Terrace Deposits (Undifferentiated)	Sand and Gravel	Not Supplied - Quaternary

Bedrock and Faults

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	LPBL	Langport Member and Blue Lias Formation (Undifferentiated)	Mudstone and Limestone, Interbedded	Not Supplied - Rhaetian
	WBCT	Westbury Formation and Cotham Member (Undifferentiated)	Mudstone and Limestone, Interbedded	Not Supplied - Rhaetian
	PNG	Penarth Group	Mudstone and Limestone, Interbedded	Not Supplied - Rhaetian
	BLI	Blue Lias Formation	Mudstone and Limestone, Interbedded	Not Supplied - Rhaetian
	LPBLC	Langport Member, Blue Lias Formation and Charmouth Mudstone Formation (Undifferentiated)	Mudstone and Limestone, Interbedded	Not Supplied - Rhaetian
	LPBLC	Langport Member, Blue Lias Formation and Charmouth Mudstone Formation (Undifferentiated)	Mudstone	Not Supplied - Rhaetian
	BLCD	Blue Lias Formation, Charmouth Mudstone	Mudstone	Not Supplied - Rhaetian
		Formation and Dyrham Formation (Undifferentiated)		
	BAN	Blue Anchor Formation	Mudstone	Not Supplied - Norian
	MMG	Mercia Mudstone Group	Mudstone	Not Supplied - Early Triassic
	MMG	Mercia Mudstone Group	Mudstone and Halite-stone	Not Supplied - Early Triassic
	MMG	Mercia Mudstone Group	Sandstone	Not Supplied - Early Triassic
		Faults		

Envirocheck®
LANDMARK INFORMATION GROUP

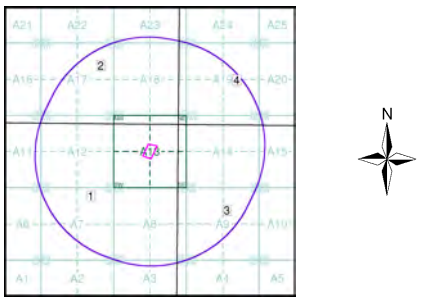
Geology 1:50,000 Maps

This report contains geological map extracts taken from the BGS Digital Geological map of Great Britain at 1:50,000 scale and is designed for users carrying out preliminary site assessments who require geological maps for the area around the site. This mapping may be more up to date than previously published paper maps.
The various geological layers - artificial and landslip deposits, superficial geology and solid (bedrock) geology are displayed in separate maps, but superimposed on the final 'Combined Surface Geology' map. All map legends feature on this page. Not all layers have complete nationwide coverage, so availability of data for relevant map sheets is indicated below.

Geology 1:50,000 Maps Coverage

Map ID:	**3**	**Map ID:**	**4**
Map Sheet No:	**295**	**Map Sheet No:**	**279**
Map Name:	**Taunton**	**Map Name:**	**Weston-super-M**
Map Date:	**1984**	**Map Date:**	**1980**
Bedrock Geology:	**Available**	**Bedrock Geology:**	**Available**
Superficial Geology:	**Available**	**Superficial Geology:**	**Available**
Artificial Geology:	**Available**	**Artificial Geology:**	**Available**
Faults:	**Not Supplied**	**Faults:**	**Not Supplied**
Landslip:	**Available**	**Landslip:**	**Available**
Rock Segments:	**Not Supplied**	**Rock Segments:**	**Not Supplied**
Map ID:	**1**	**Map ID:**	**2**
Map Sheet No:	**294**	**Map Sheet No:**	**278**
Map Name:	**Dulverton**	**Map Name:**	**Minehead**
Map Date:	**1969**	**Map Date:**	**1997**
Bedrock Geology:	**Available**	**Bedrock Geology:**	**Available**
Superficial Geology:	**Available**	**Superficial Geology:**	**Available**
Artificial Geology:	**Available**	**Artificial Geology:**	**Available**
Faults:	**Not Supplied**	**Faults:**	**Not Supplied**
Landslip:	**Available**	**Landslip:**	**Available**
Rock Segments:	**Not Supplied**	**Rock Segments:**	**Not Supplied**

Geology 1:50,000 Maps - Slice A



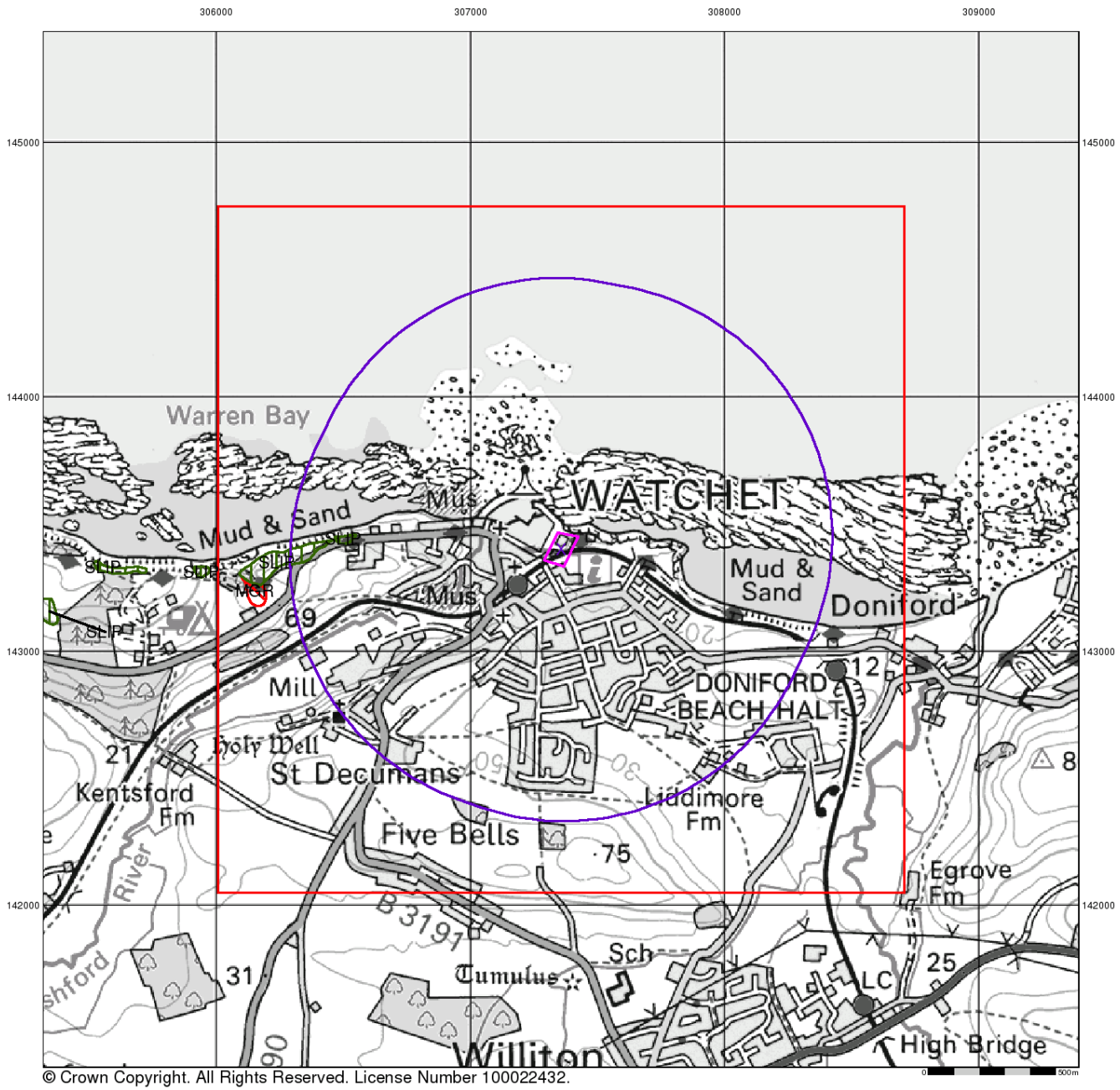
Order Details:

Order Number:	189169426_1_1
Customer Reference:	10501
National Grid Reference:	307360, 143400
Slice:	A
Site Area (Ha):	1.02
Search Buffer (m):	1000

Site Details:

The Harbour, Harbour Road, Watchet, TA23 0AQ

Landmark INFORMATION GROUP
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



Envirocheck®

LANDMARK INFORMATION GROUP®

Artificial Ground and Landslip

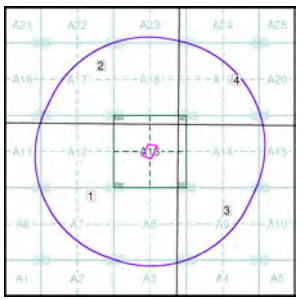
Artificial ground is a term used by BGS for those areas where the ground surface has been significantly modified by human activity. Information about previously developed ground is especially important, as it is often associated with potentially contaminated material, unpredictable engineering conditions and unstable ground.

Artificial ground includes:

- Made ground - man-made deposits such as embankments and spoil heaps on the natural ground surface.
- Worked ground - areas where the ground has been cut away such as quarries and road cuttings.
- Infilled ground - areas where the ground has been cut away then wholly or partially backfilled.
- Landscaped ground - areas where the surface has been reshaped.
- Disturbed ground - areas of ill-defined shallow or near surface mineral workings where it is impracticable to map made and worked ground separately.

Mass movement (landslip) deposits on BGS geological maps are primarily superficial deposits that have moved down slope under gravity to form landslips. These affect bedrock, other superficial deposits and artificial ground. The dataset also includes foundered strata, where the ground has collapsed due to subsidence.

Artificial Ground and Landslip Map - Slice A



Order Details:

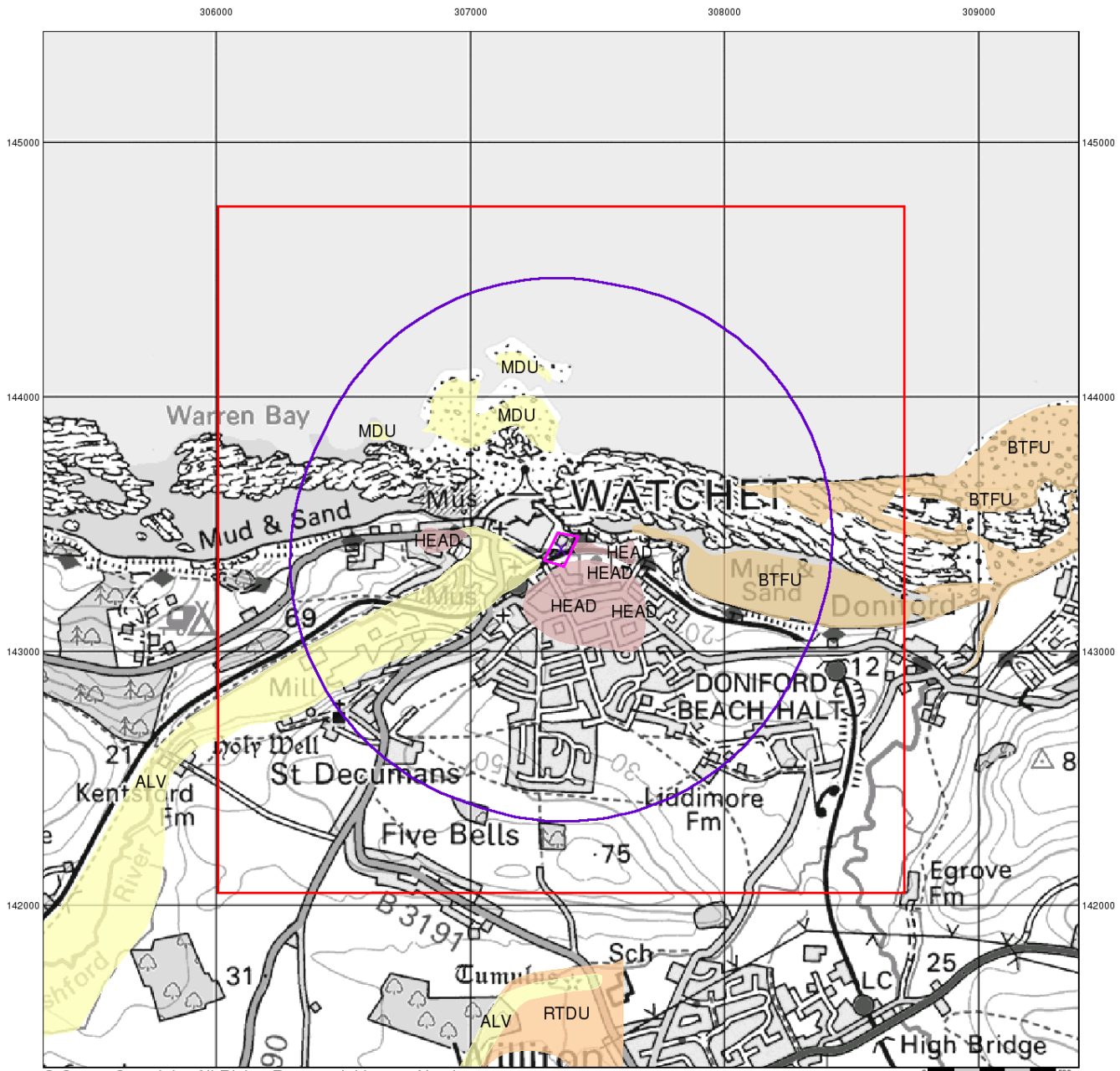
Order Number:	189169426_1_1
Customer Reference:	10501
National Grid Reference:	307360, 143400
Slice:	A
Site Area (Ha):	1.02
Search Buffer (m):	1000

Site Details:

The Harbour, Harbour Road, Watchet, TA23 0AQ

Landmark INFORMATION GROUP

Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



Envirocheck®

LANDMARK INFORMATION GROUP®

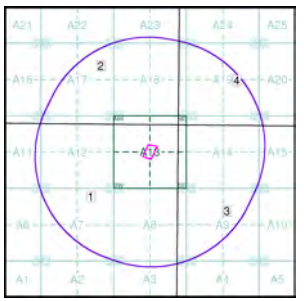
Superficial Geology

Superficial Deposits are the youngest geological deposits formed during the most recent period of geological time, the Quaternary, which extends back about 1.8 million years from the present.

They rest on older deposits or rocks referred to as Bedrock. This dataset contains Superficial deposits that are of natural origin and 'in place'. Other superficial strata may be held in the Mass Movement dataset where they have been moved, or in the Artificial Ground dataset where they are of man-made origin.

Most of these Superficial deposits are unconsolidated sediments such as gravel, sand, silt and clay, and onshore they form relatively thin, often discontinuous patches or larger spreads.

Superficial Geology Map - Slice A



Order Details:

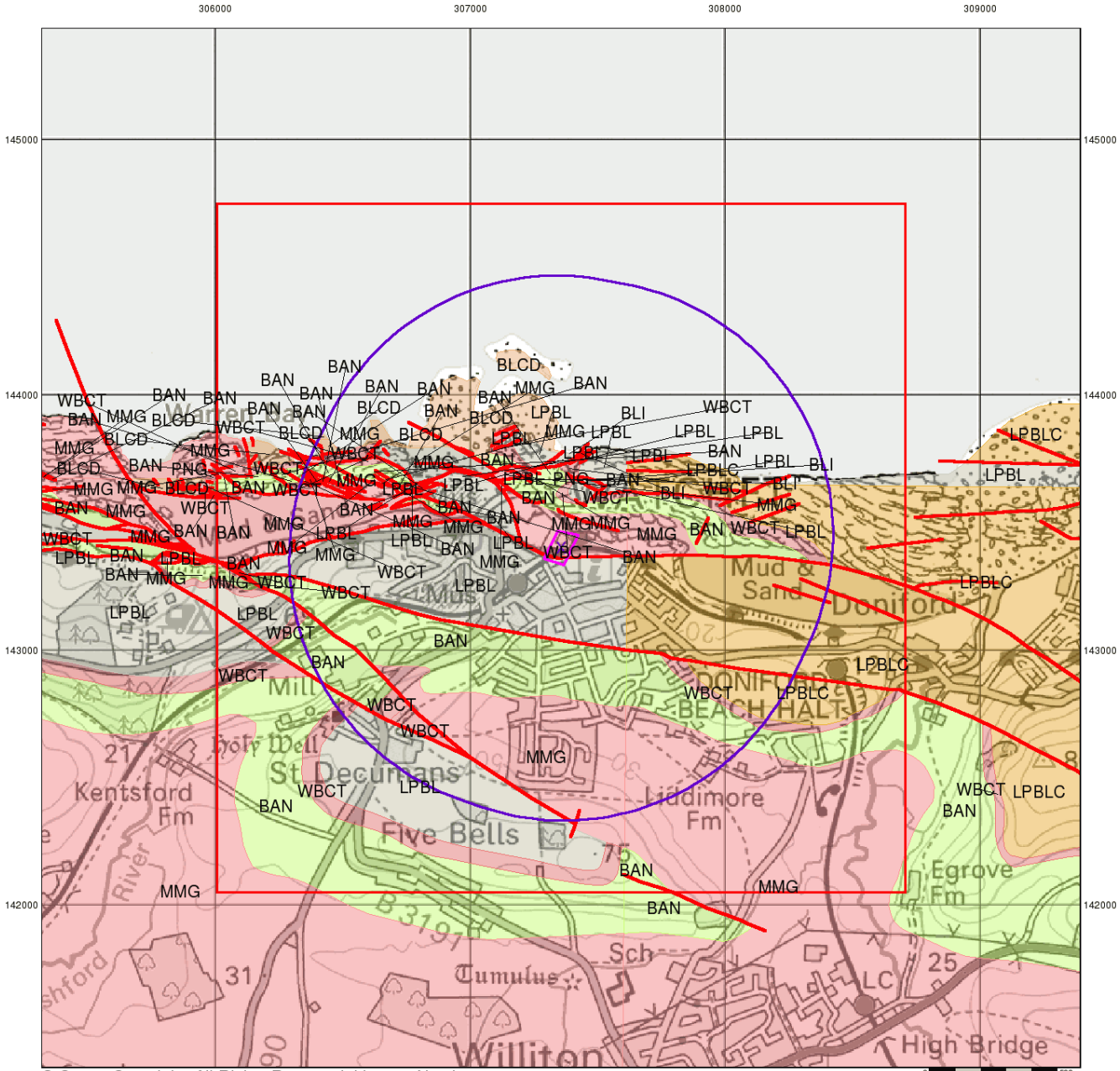
Order Number:	189169426_1_1
Customer Reference:	10501
National Grid Reference:	307360, 143400
Slice:	A
Site Area (Ha):	1.02
Search Buffer (m):	1000

Site Details:

The Harbour, Harbour Road, Watchet, TA23 0AQ

Landmark INFORMATION GROUP

Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



Envirocheck®

LANDMARK INFORMATION GROUP

Bedrock and Faults

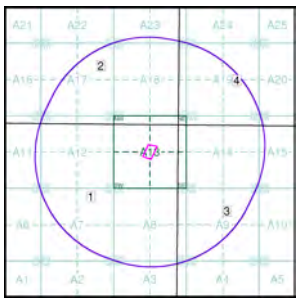
Bedrock geology is a term used for the main mass of rocks forming the Earth and are present everywhere, whether exposed at the surface in outcrops or concealed beneath superficial deposits or water.

The bedrock has formed over vast lengths of geological time ranging from ancient and highly altered rocks of the Proterozoic, some 2500 million years ago, or older, up to the relatively young Pliocene, 1.8 million years ago.

The bedrock geology includes many lithologies, often classified into three types based on origin: igneous, metamorphic and sedimentary.

The BGS Faults and Rock Segments dataset includes geological faults (e.g. normal, thrust), and thin beds mapped as lines (e.g. coal seam, gypsum bed). Some of these are linked to other particular 1:50,000 Geology datasets, for example, coal seams are part of the bedrock sequence, most faults and mineral veins primarily affect the bedrock but cut across the strata and post date its deposition.

Bedrock and Faults Map - Slice A



Order Details:

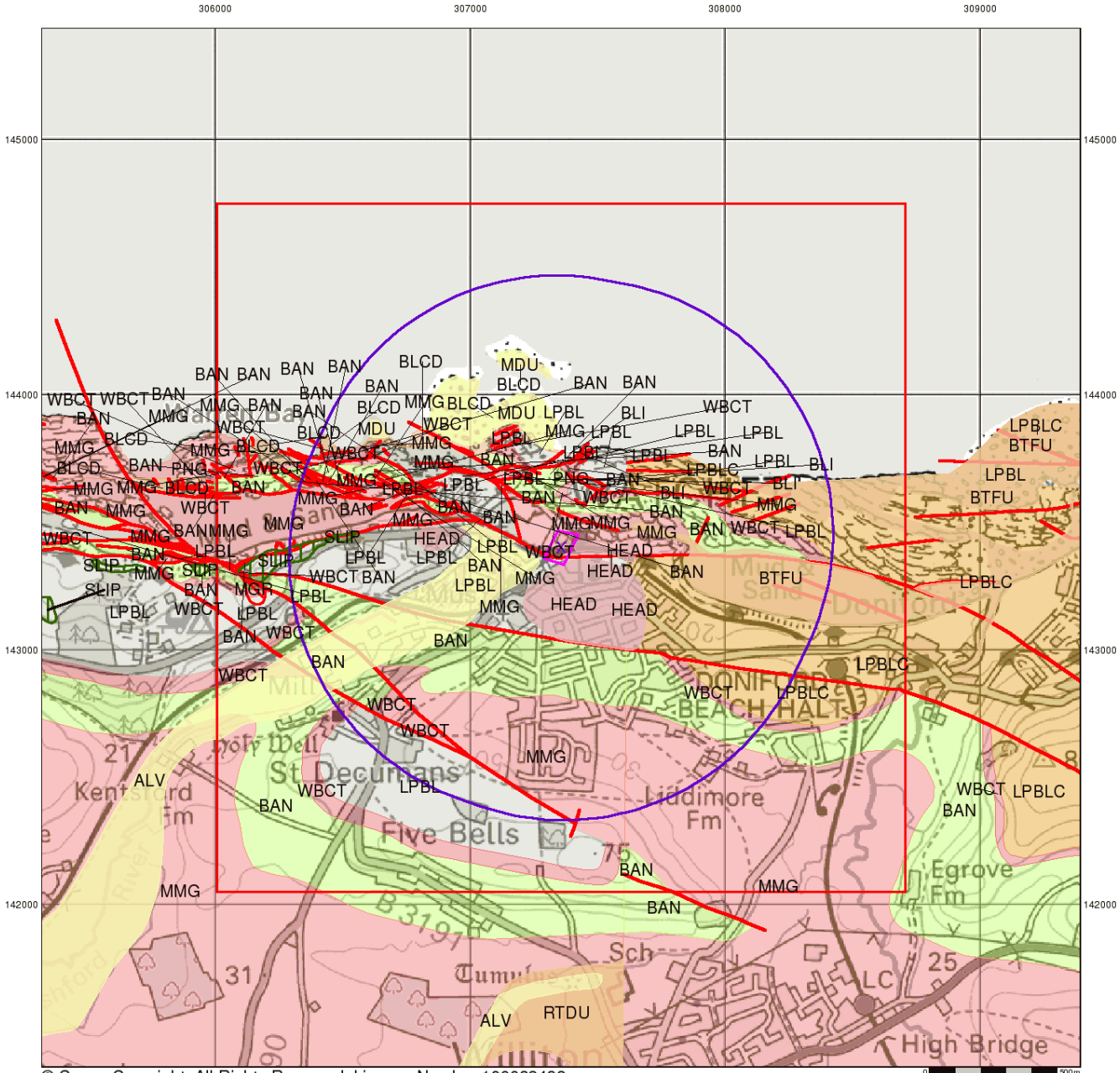
Order Number:	189169426_1_1
Customer Reference:	10501
National Grid Reference:	307360, 143400
Slice:	A
Site Area (Ha):	1.02
Search Buffer (m):	1000

Site Details:

The Harbour, Harbour Road, Watchet, TA23 0AQ

Landmark INFORMATION GROUP

Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



Envirocheck®

LANDMARK INFORMATION GROUP®

Combined Surface Geology

The Combined Surface Geology map combines all the previous maps into one combined geological overview of your site.

Please consult the legends to the previous maps to interpret the Combined "Surface Geology" map.

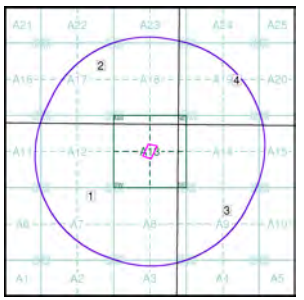
Additional Information

More information on 1:50,000 Geological mapping and explanations of rock classifications can be found on the BGS website. Using the LEX Codes in this report, further descriptions of rock types can be obtained by interrogating the 'BGS Lexicon of Named Rock Units'. This database can be accessed by following the 'Information and Data' link on the BGS website.

Contact

British Geological Survey
Kingsley Dunham Centre
Keyworth
Nottingham
NG12 5GG
Telephone: 0115 936 3143
Fax: 0115 936 3276
email: xxxxxxxx@xxx.xx.xx
website: www.bgs.ac.uk

Combined Geology Map - Slice A



Order Details:

Order Number:	189169426_1_1
Customer Reference:	10501
National Grid Reference:	307360, 143400
Slice:	A
Site Area (Ha):	1.02
Search Buffer (m):	1000

Site Details:

The Harbour, Harbour Road, Watchet, TA23 0AQ

Appendix C

Exploratory Hole Location Plan

N

BH101

PL02

BH102

BH103

PL01

BH104

BH105

EXPLORATORY HOLE LOCATION PLAN

WATCHET HARBOUR

SCALE	PROJECT NO
NTS	10501

SOUTH WEST GEOTECHNICAL

Appendix D

Exploratory Hole Logs and Photos

KEY TO EXPLORATORY HOLE LOGS

SAMPLING

Undisturbed

U	Driven tube sample (Blow count recorded in results column i.e. U = 20)
TW	Pushed thin wall tube sample
P	Pushed piston sample
L	Liner sample
CBR	CBR mould sample
BLK	Block sample
WS	Window sample
CS	Core sample

Disturbed

D	Small sample
B	Bulk sample

Other

W	Water sample
G	Gas sample
ES	Soil sample for environmental analysis
EW	Water sample for environmental analysis

IN-SITU TESTING

SPT S or SPT C — Standard Penetration Test, open shoe (S) or solid cone (C)

As defined in BS 1377 : Part 9 (1990). Standard Penetration Test (SPT): a 50mm split spoon or solid cone sampler is driven 450mm into the base of the borehole using a 63.5 kg hammer with a 760mm drop. The penetration resistance (e.g. 21) is expressed as the N-value, and represents the number of blows required to obtain 300mm penetration below an initial seating drive of 150mm.

The depth on the borehole/ trial pit record is that of the start and end of the test. Where full penetration for the test has not been achieved, the final penetration depth is recorded.

HVP (kPa)	In-situ Hand Vane shear strength: a hand shear vane test (or average of a series), conducted on undisturbed samples or within trial pits.
GIVN (kPa)	Geonor in-situ vane shear strength carried out in base of borehole or self bored hole
VN (kPa)	Hand Vane shear strength, conducted on disturbed or remoulded samples.
PP (kg/cm^2)	Pocket penetrometer test: a pocket Penetrometer reading (or average of a series). If reported in kPa, the value has been converted to an equivalent undrained shear strength.
Ik	In situ permeability test
ICBR	In-situ CBR test
IPBT	In-situ plate bearing test
IPST	In-situ plate settlement test

All test results are provided in Results column

DRILLING RECORDS

TCR	Total Core Recovery %
SCR	Solid Core Recovery %
RQD	Rock Quality Designation %
FI	Fracture Spacing mm. Minimum, typical and maximum spacings are recorded.

GROUNDWATER

Groundwater Strike

Groundwater level after standing time

INSTALLATION

Standpipe/ piezometer

Details of standpipe/piezometer installations are given on the left side of the log. The column shows installed instrument depths including slotted pipe section or tip depth, response zone filter material type and layers of backfill.

SP	Standpipe
SPIE	Standpipe piezometer
PPIE	Pneumatic piezometer
EPIE	Electronic piezometer

NOTES

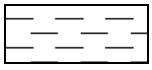
Water level observations of discernible entries during the advancing of the exploratory hole are given at the foot of the log and in the Legend column. The term “none observed” is used where no discrete entries are identified although this does not necessarily indicate that the hole has not been advanced below groundwater level. Under certain conditions groundwater cannot be observed, for instance, drilling with water flush or over water, or boring at a rate much faster than water can make its way into the borehole.

The declination of bedding and joints is given with respect to the normal to the core axis. Thus in a vertical borehole this will be the dip.

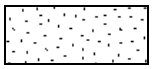
Remarks on chiselling times can be affected by a variety of factors not always related to the geotechnical properties of the strata. Chiselling records are given at the foot of the log.

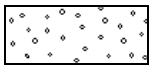
The assessment of SCR, RQD and Fracture Spacing excludes artificial fractures.

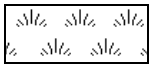
KEY TO SOIL LEGENDS

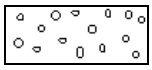

CLAY

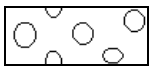

SILT

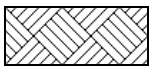

SAND

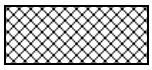

GRAVEL


PEAT

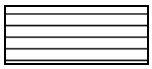

COBBLES


BOULDERS

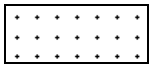

TOPSOIL

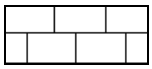

MADE GROUND

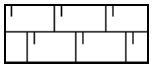
KEY TO ROCK LEGENDS

 MUDSTONE

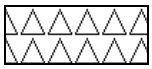
 SILTSTONE

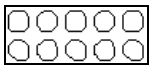
 SANDSTONE

 LIMESTONE

 CHALK

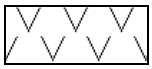
 COAL

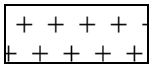
 BRECCIA

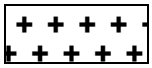
 CONGLOMERATE

 FINE GRAINED METAMORPHIC

 MEDIUM/COARSE GRAINED METAMORPHIC

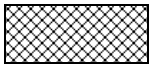
 FINE GRAINED IGNEOUS

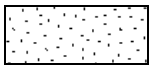
 MEDIUM GRAINED IGNEOUS

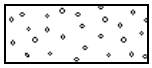
 COARSE GRAINED IGNEOUS

KEY TO BACKFILL LEGENDS

 BENTONITE

 ARISINGS

 SAND

 GRAVEL

REFERENCES

BS 1377 : 1990 : British Standard Methods of test for soils for civil engineering purposes. British Standards Institution.
BS 5930 : 1999 : Code of practice for site investigations. British Standards Institution.

Borehole Log

Borehole No. **BH101**

Sheet 1 of 2

Project Name: Watchet Harbour	Project No. 10501	Co-ords:	Hole Type CP+RC
Location: Somerset		Level: 8.30	Scale 1:50
Client: Taunton Dean Bourough Council		Dates: 06/11/2018	Logged By PW

Well	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
					0.10	8.20		Tarmac
		0.40	D					(MADE GROUND). Grey brown sandy slightly gravelly silt with occasional limestone cobbles.
		0.40	ES		0.50	7.80		(MADE GROUND). Firm reddy brown sandy gravelly clay. Tending to very clayey very sandy gravel. Gravel is fine to coarse subangular mudstone and limestone fragments. Rare brick fragments.
		1.20 - 1.65	D					
		1.20	SPT	N=9 (2,2/3,2,2,2)				
		1.50	D					
		2.70 - 3.15	D		2.70	5.60		(MADE GROUND). Medium dense orange brown silty sandy gravel. Gravel is fine to coarse subangular mudstone fragments.
		2.70 - 3.60	B					
		2.70	SPT	N=16 (2,2/1,5,5,5)				
		3.70 - 3.95	D		3.60	4.70		(MADE GROUND). Soft grey sandy slightly gravelly clay. Gravel is fine to coarse subrounded mudstone and sandstone fragments.
		3.70	SPT	50 (2,2/50 for 85mm)	3.95	4.35		(MADE GROUND). Strong grey limestone boulder.
					4.15	4.15		(MADE GROUND). Soft to firm grey brown sandy gravelly clay. Tending to very clayey very sandy gravel. Gravel is fine to coarse subangular and subrounded mudstone fragments.
		4.50	D					
		4.50	SPT	N=24 (2,3/6,5,7,6)	4.70	3.60		(MADE GROUND). Stiff pale green slightly gravelly clay/silt.
					5.00	3.30		(MADE GROUND). Loose light brown very clayey very sandy gravel with rare mudstone cobbles.
		5.50	D					
					5.80	2.50		(MADE GROUND?). Medium dense? Grey green very clayey sandy gravel. Gravel is fine to medium subangular mudstone and rare subrounded mudstone fragments.
		6.00 - 7.00	B		6.00	2.30		Medium dense grey green and red brown clayey sandy GRAVEL. Gravel is fine to coarse angular mudstone fragments. (RESIDUAL SOIL).
		6.00	SPT	N=23 (2,3/7,5,5,6)				
		7.00	SPT	50 (25 for 5mm/50 for 10mm)	7.00	1.30		Very weak to weak, grey green and red brown, slightly weathered, MUDSTONE with occasional fine (1-2mm) gypsum veins. (MERCIA MUDSTONE GROUP).
		7.20 - 8.70	5	100 100 84				Fractures are closely to medium spaced (80, 200, 380), undulating smooth and rough, dipping at 20-30° (J1) and 45° (J2), no infill.
		8.70 - 10.00	50/5	100 73 45	9.90	-1.60		

Remarks

Location CAT scanned and inspection pit hand excavated to 1.2m prior to drilling. Hole drilled by dynamic sampling to 7.20mbgl, then continued by rotary coring. Monitoring well installed to base of hole.

Rotary Core Log

Borehole No. **BH101**

Sheet 2 of 2

Project Name: Watchet Harbour	Project No. 10501	Co-ords:	Hole Type CP+RC
Location: Somerset		Level: 8.30	Scale 1:50
Client: Taunton Dean Bourough Council		Dates: 06/11/2018 - 07/11/2018	Logged By PW

Well	Water Strikes	Depth (m)	Type /FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m AOD)	Legend	Stratum Description
		10.00 - 11.50	4	100	95	75				Weak to medium strong becoming weak below 12.30m, reddy brown, fresh locally slightly weathered, MUDSTONE with occasional fine gypsum veins (MERCIA MUDSTONE GROUP). Fractures are closely to widely spaced (80, 300, 750), undulating rough and smooth, dipping at 25° (J1) and 45° (J2), no infill.
		11.50 - 12.50	13	80	64	43	12.50	-4.20		End of Borehole at 12.500m

11 12 13 14 15 16 17 18 19 20

Remarks

Location CAT scanned and inspection pit hand excavated to 1.2m prior to drilling. Hole drilled by dynamic sampling to 7.20mbgl, then continued by rotary coring. Monitoring well installed to base of hole.

BH101: 7.20 – 10.0m

BH101: 10.0 – 12.50m

Borehole Log

Borehole No. **BH102**

Sheet 1 of 2

Project Name: Watchet Harbour	Project No. 10501	Co-ords:	Hole Type CP+RC
Location: Somerset		Level: 8.20	Scale 1:50
Client: Taunton Dean Bourough Council		Dates: 07/11/2018	Logged By PW

Well	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
					0.20	8.00		Concrete with 1 layer of 6mm twisted rebar.
		0.30	D		0.35	7.85		(MADE GROUND) Compact black slightly silty sandy gravel- ballast material.
		0.30	ES					
					0.70	7.50		(MADE GROUND) grey and red brown slightly silty sandy gravel and cobbles. Occasional limestone boulders up to 300mm.
		0.80	D					
		0.80	ES					(MADE GROUND) very loose to loose becoming medium dense black silty very sandy gravel of ash and clinker.
		1.20	SPT	N=4 (2,1/1,1,1,1)				
		1.40 - 2.70	B					
		2.70	SPT	N=19 (3,4/3,5,5,6)				
					3.00	5.20		(MADE GROUND) Medium dense red brown and grey slightly silty sandy gravel. Gravel is fine to coarse subangular mudstone fragments.
					3.40	4.80		(MADE GROUND) Soft grey brown silty slightly sandy gravelly clay with occasional mudstone cobbles. Tending to very clayey very sandy gravel.
		3.60	D					
					4.10	4.10		(MADE GROUND) dense reddy brown slightly clayey slightly sandy gravel. Gravel is fine to coarse subangular mudstone fragments.
		4.20	SPT	N=39 (3,3/6,10,14,9)	4.40	3.80		(MADE GROUND) Very soft light brown clayey slightly gravelly clay with occasional mudstone cobbles.
		4.60	D					
		5.30 - 5.90	B		5.30	2.90		(MADE GROUND) Medium dense? Grey green and red brown clayey sandy gravel. Gravel and cobbles are fine to coarse subangular mudstone fragments.
		5.70	SPT	N=18 (10,11/6,6,3,3)				
					5.90	2.30		(MADE GROUND) Very soft light brown clayey slightly gravelly clay with occasional mudstone cobbles.
					6.20	2.00		Medium dense grey green and red brown clayey sandy GRAVEL. Gravel is fine to coarse angular mudstone fragments. (RESIDUAL SOIL).
		6.50	SPT	50 (25 for 50mm/50 for 5mm)	6.50	1.70		Weak locally very weak (9.3-9.8m), red brown and locally grey green slightly weathered MUDSTONE. (MERCIA MUDSTONE GROUP).
		6.80 - 8.30	4	93 93 93				Fractures are closely to medium spaced (80, 300, 520), undulating smooth, dipping at 15-20° (J1) and 50° (J2), rare 2-3mm gypsum infill.
		8.30 - 9.80		100 83 83				

Remarks

Location CAT scanned and inspection pit hand excavated to 1.2m prior to drilling. Hole drilled by dynamic sampling to 6.80mbgl, then continued by rotary coring. Monitoring well installed to base of hole.

Rotary Core Log

Borehole No. **BH102**

Sheet 2 of 2

Project Name: Watchet Harbour	Project No. 10501	Co-ords:	Hole Type CP+RC
Location: Somerset		Level: 8.20	Scale 1:50
Client: Taunton Dean Bourough Council		Dates: 07/11/2018 - 08/11/2018	Logged By PW

Well	Water Strikes	Depth (m)	Type /FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m AOD)	Legend	Stratum Description
		9.80 - 11.30	50 5 50	93	48	20				Weak locally very weak (9.3-9.8m), red brown and locally grey green slightly weathered MUDSTONE. (MERCIA MUDSTONE GROUP). Fractures are closely to medium spaced (80, 300, 520), undulating smooth, dipping at 15-20° (J1) and 50° (J2), rare 2-3mm gypsum infill.
		11.30 - 12.50	5	100	100	91				
							12.50	-4.30		End of Borehole at 12.500m

11 12 13 14 15 16 17 18 19 20

Remarks

Location CAT scanned and inspection pit hand excavated to 1.2m prior to drilling. Hole drilled by dynamic sampling to 6.80mbgl, then continued by rotary coring. Monitoring well installed to base of hole.

BH102: 6.80 – 9.80m

BH102: 9.80 – 12.50m

Borehole Log

Borehole No. **BH103**

Sheet 1 of 2

Project Name: Watchet Harbour	Project No. 10501	Co-ords:	Hole Type CP+RC
Location: Somerset		Level: 8.20	Scale 1:50
Client: Taunton Dean Bourough Council		Dates: 09/11/2018	Logged By PW

Well	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
					0.20	8.00		Concrete with 1 layer of 6mm twisted rebar.
					0.40	7.80		(MADE GROUND) Compact black slightly silty sandy gravel- ballast material.
		0.50	D		0.55	7.65		(MADE GROUND) Compact red brown sandy gravel- Sub-base material.
		0.50	ES					(MADE GROUND) black silty sandy gravel with occasional limestone cobbles
		1.20	SPT	N=10 (6,3/2,2,3,3)				
		2.70	SPT	N=5 (1,0/1,1,1,2)	2.70	5.50		
		2.80 - 3.10	B		2.80	5.40		(MADE GROUND) loose red brown clayey sandy gravel. Gravel is fine to medium subangular mudstone fragments.
		3.20	D		3.10	5.10		(MADE GROUND) Soft sandy slightly gravelly clay.
		3.30 - 4.30	B		3.30	4.90		(MADE GROUND) soft light brown slightly sandy gravelly clay. Gravel is fine to coarse subangular mudstone fragments.
								(MADE GROUND) medium dense ? Grey very clayey sandy gravel. Gravel is fine to coarse subangular mudstone fragments.
		4.20	SPT	N=18 (3,4/4,4,5,5)	4.30	3.90		(MADE GROUND) medium dense grey brown clayey gravelly fine to medium sand.
		4.60 - 5.70	B		4.60	3.60		(MADE GROUND) Medium dense? Grey clayey sand gravel. Gravel is fine to coarse subangular mudstone fragments.
		5.70	SPT	N=31 (2,3/3,9,10,9)	5.80	2.40		(MADE GROUND) dense grey brown clayey very sandy gravel. Gravel is fine to coarse subangular and subrounded mudstone and sandstone fragments.
		7.20	SPT	50 (25 for 5mm/50 for 5mm)	7.00 7.20	1.20 1.00		(MADE GROUND) Firm to stiff light brown slightly sandy slightly gravelly clay. Extremely weak, locally very weak, red brown slightly weathered, MUDSTONE. Becoming moderately weathered below 9.70m with potential clay bands not recovered reflecting core lose. (MERCIA MUDSTONE GROUP). Fractures are closely to medium spaced (180, 250, 380) undulating smooth, dipping at 20-25° (J1) and 45-50° (J2), no infill. Fracture detail lost below 9.70m.
		7.70 - 8.70	4	100 64 64				
		8.70 - 9.70		100 90 90				

Remarks

Location CAT scanned and inspection pit hand excavated to 1.2m prior to drilling. Hole drilled by dynamic sampling to 7.70mbgl, then continued by rotary coring. Monitoring well installed to base of hole.

Rotary Core Log

Borehole No. **BH103**

Sheet 2 of 2

Project Name: Watchet Harbour	Project No. 10501	Co-ords:	Hole Type CP+RC
Location: Somerset		Level: 8.20	Scale 1:50
Client: Taunton Dean Bourough Council		Dates: 09/11/2018 - 12/11/2018	Logged By PW

Well	Water Strikes	Depth (m)	Type /FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m AOD)	Legend	Stratum Description
		9.70 - 11.20		30	8	0				Extremely weak, locally very weak, red brown slightly weathered, MUDSTONE. Becoming moderately weathered below 9.70m with potential clay bands not recovered reflecting core lose. (MERCIA MUDSTONE GROUP). Fractures are closely to medium spaced (180, 250, 380) undulating smooth, dipping at 20-25° (J1) and 45-50° (J2), no infill. Fracture detail lost below 9.70m.
		11.20 - 12.50		38	8	0				
		~~12.50 - 12.95~~ N=44 (25 for 80mm/13,15,8,8)	D SPT				12.50	-4.30		End of Borehole at 12.500m

Remarks

Location CAT scanned and inspection pit hand excavated to 1.2m prior to drilling. Hole drilled by dynamic sampling to 7.70mbgl, then continued by rotary coring. Monitoring well installed to base of hole.

BH103: 7.70 – 12.50m

Borehole Log

Borehole No. **BH104**

Sheet 1 of 2

Project Name: Watchet Harbour	Project No. 10501	Co-ords:	Hole Type CP+RC
Location: Somerset		Level: 8.35	Scale 1:50
Client: Taunton Dean Bourough Council		Dates: 13/11/2018	Logged By PW

Well	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
					0.20	8.15		Concrete with 1 layer of 6mm twisted rebar.
		0.50	D					(MADE GROUND) Compact black slightly silty sandy gravel- ballast material.
		0.50	ES		0.60	7.75		
					0.80	7.55		(MADE GROUND) dense grey slightly sandy gravel and cobbles of limestone and quartzite.
		1.20	SPT	N=17 (1,2/5,8,2,2)				(MADE GROUND) loose black sandy gravel of ash and clinker with brick and mortar fragments at 1.40m.
		1.80	D		1.70	6.65		(MADE GROUND) firm grey slightly sandy gravelly clay with occasional brick and limestone cobbles. Tending to very clayey very sandy gravel.
		2.70	SPT	N=7 (2,3/1,2,2,2)				
		3.20 - 4.20	B					
		3.40	D		3.30	5.05		(MADE GROUND) soft light brown slightly sandy gravelly clay. Gravel is fine to coarse subangular mudstone fragments.
					3.70	4.65		(MADE GROUND) medium dense? Grey clayey slightly sandy gravel. Gravel is fine to coarse subangular weak mudstone fragments.
		4.20	SPT	N=21 (3,5/6,8,3,4)	4.20	4.15		(MADE GROUND) firm to stiff slightly sandy gravelly clay. Gravel is fine to coarse subangular mudstone and rare brick fragments.
		4.30	D					
		4.50	D					
		4.50	ES					
		5.20 - 6.20	B		5.10	3.25		(MADE GROUND) medium dense? Grey clayey sandy gravel. Gravel is fine to coarse subangular weak mudstone fragments.
		5.70	SPT	N=21 (9,11/6,5,5,5)				
					6.20	2.15		(MADE GROUND) loose to medium dense? Light brown slightly silty very sandy gravel. Gravel is fine to medium occasionally coarse subrounded mudstone and quartzite fragments and rare limestone cobbles.
		6.50	SPT	50 (5,6/50 for 215mm)	6.50	1.85		Very weak, locally extremely weak and weak, grey slightly to moderately weathered calcareous MUDSTONE with occasional 5-10mm thick calcite veins. (BLUE LIAS FORMATION).
		7.00 - 8.40	4	100 96 96				Fractures are medium spaced (200, 350, 600) undulating smooth, dipping at 30-40°, no infill.
		8.40 - 9.90		93 76 62				

Remarks

Location CAT scanned and inspection pit hand excavated to 1.2m prior to drilling. Hole drilled by dynamic sampling to 7.00mbgl, then continued by rotary coring. Monitoring well installed to base of hole.

Rotary Core Log

Borehole No. **BH104**

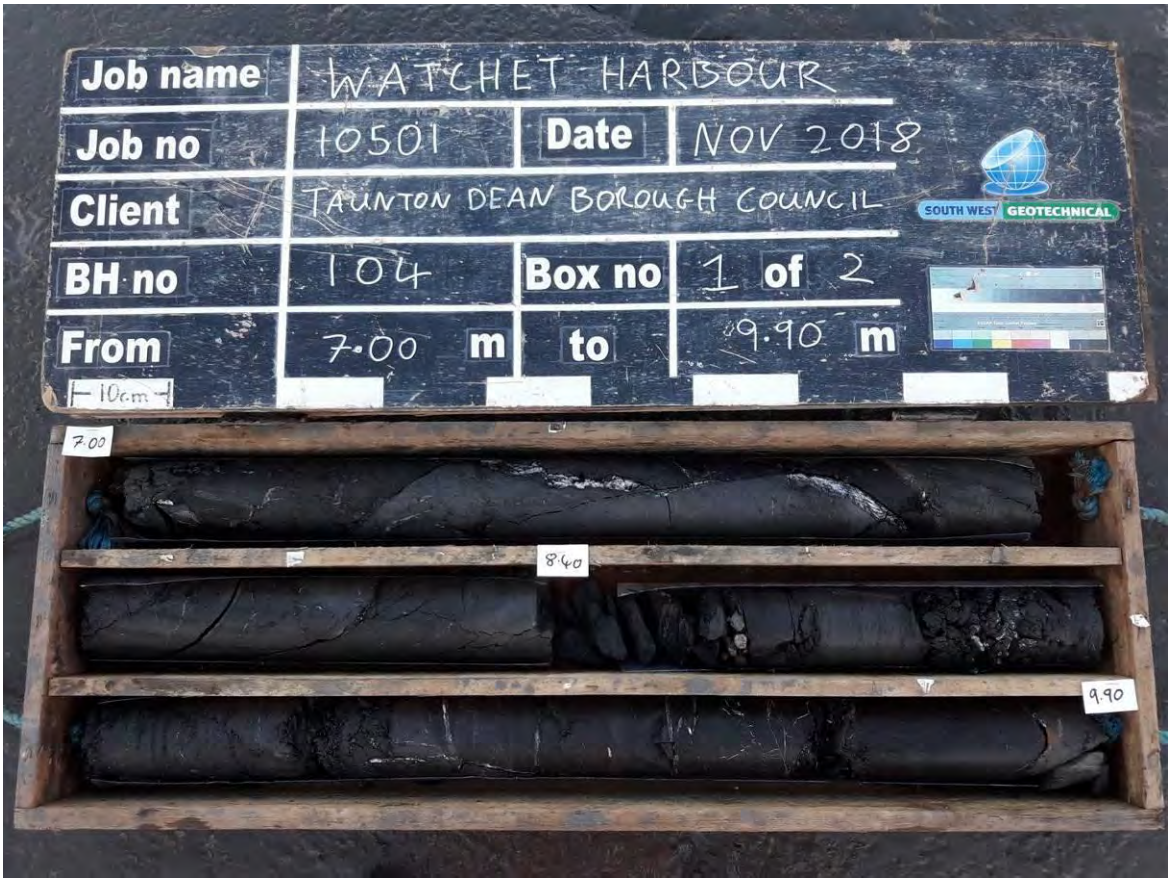
Sheet 2 of 2

Project Name: Watchet Harbour	Project No. 10501	Co-ords:	Hole Type CP+RC
Location: Somerset		Level: 8.35	Scale 1:50
Client: Taunton Dean Bourough Council		Dates: 13/11/2018 - 14/11/2018	Logged By PW

Well	Water Strikes	Depth (m)	Type /FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m AOD)	Legend	Stratum Description
		9.90 - 10.90		100	62	52	10.60	-2.25		Very weak, locally extremely weak and weak, grey slightly to moderately weathered calcareous MUDSTONE with occasional 5-10mm thick calcite veins. (BLUE LIAS FORMATION). Fractures are medium spaced (200, 350, 600) undulating smooth, dipping at 30-40°, no infill.
		10.90 - 12.40	1	97	97	97				Extremely weak, grey, calcareous MUDSTONE with rare calcite veins. Highly weathered and tending to very stiff clay. (BLUE LIAS FORMATION). No fractures visible
							12.35 12.40	-4.00 -4.05		Weak to medium strong grey LIMESTONE. (BLUE LIAS FORMATION). End of Borehole at 12.400m

Remarks

Location CAT scanned and inspection pit hand excavated to 1.2m prior to drilling. Hole drilled by dynamic sampling to 7.00mbgl, then continued by rotary coring. Monitoring well installed to base of hole.



BH104: 7.00 – 9.90m

BH104: 9.90 – 12.50m

Borehole Log

Project Name: Watchet Harbour	Project No. 10501	Co-ords:	Borehole No. **BH105** Sheet 1 of 2
Location: Somerset		Level: 8.50	Hole Type CP+RC
Client: Taunton Dean Bourough Council		Dates: 15/11/2018	Scale 1:50
			Logged By PW

Well	Water Strikes	Sample and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
					0.20	8.30		Concrete with 1 layer of 6mm rebar.
					0.30	8.20		(MADE GROUND) compact red brown sandy gravel-sub-base material
		0.50	D					
		0.50	ES		0.70	7.80		(MADE GROUND) brown slightly sandy gravelly clay with occasional brick fragments.
		1.00	D					(MADE GROUND) Grey sandy slightly gravelly silt.
		1.00	ES					
		1.20	SPT	50 (25 for 85mm/50 for 80mm)	1.20	7.30		(MADE GROUND) pale yellow very lime mortar.
					1.80	6.70		(MADE GROUND) Medium brown and grey brown slightly sandy slightly gravelly clay with occasional brick fragments.
		2.20	D		2.20	6.30		(MADE GROUND) Soft light brown slightly gravelly clay. Gravel is fine to coarse subangular mudstone and limestone fragments.
		2.20	SPT	N=5 (1,1/2,1,1,1)	2.40	6.10		
					2.60	5.90		(MADE GROUND) Soft grey slightly sandy slightly gravelly clay.
		3.00	D					(MADE GROUND) Soft red brown slightly gravelly clay with low cobble content. Gravel and cobbles are subangular mudstone fragments.
		3.30 - 4.80	B		3.30	5.20		(MADE GROUND) medium dense grey clayey sandy gravel with medium cobble content. Gravel is fine to coarse subangular mudstone fragments.
		3.70	SPT	N=15 (6,5/3,6,3,3)				4.85-4.90 Layer of sandy subrounded gravel.
		5.05	SPT	50 (3,11/50 for 15mm)	5.05	3.45		(MADE GROUND/ALLUVIUM?) Medium brown sandy
		5.20 - 5.60	50	100 16 0	5.20	3.30		slightly gravelly clay. Gravel is fine to medium subrounded mudstone and quartzite fragments.
		5.60 - 6.50	5	100 78 64				Very weak, locally extremely weak, dark grey, moderately locally highly weathered, calcareous MUDSTONE. (BLUE LIAS FORMATION).
		6.50 - 7.50		100 80 80				Fractures are closely to medium spaced (160, 200, 340), planar smooth, dipping at 30-40° (J1) and 65-70° (J2), no infill
		7.50 - 9.00		100 93 65	7.50	1.00		Strong, pale, grey, fresh LIMESTONE with 1-30mm thick calcite veins. (BLUE LIAS FORMATION).
					7.90	0.60		No fractures.
			50					Very weak, locally extremely weak, dark grey, moderately locally highly weathered, calcareous MUDSTONE. (BLUE LIAS FORMATION).
		9.00 - 10.50	4	100 70 60				Fractures are closely to medium spaced (120, 300, 400), planar smooth, dipping at 30-40° (J1) and 65-70° (J2), no infill

Remarks

Location CAT scanned and inspection pit hand excavated to 1.2m prior to drilling. Hole drilled by dynamic sampling to 5.20mbgl, then continued by rotary coring. Monitoring well installed to base of hole.

Rotary Core Log

Borehole No. **BH105**

Sheet 2 of 2

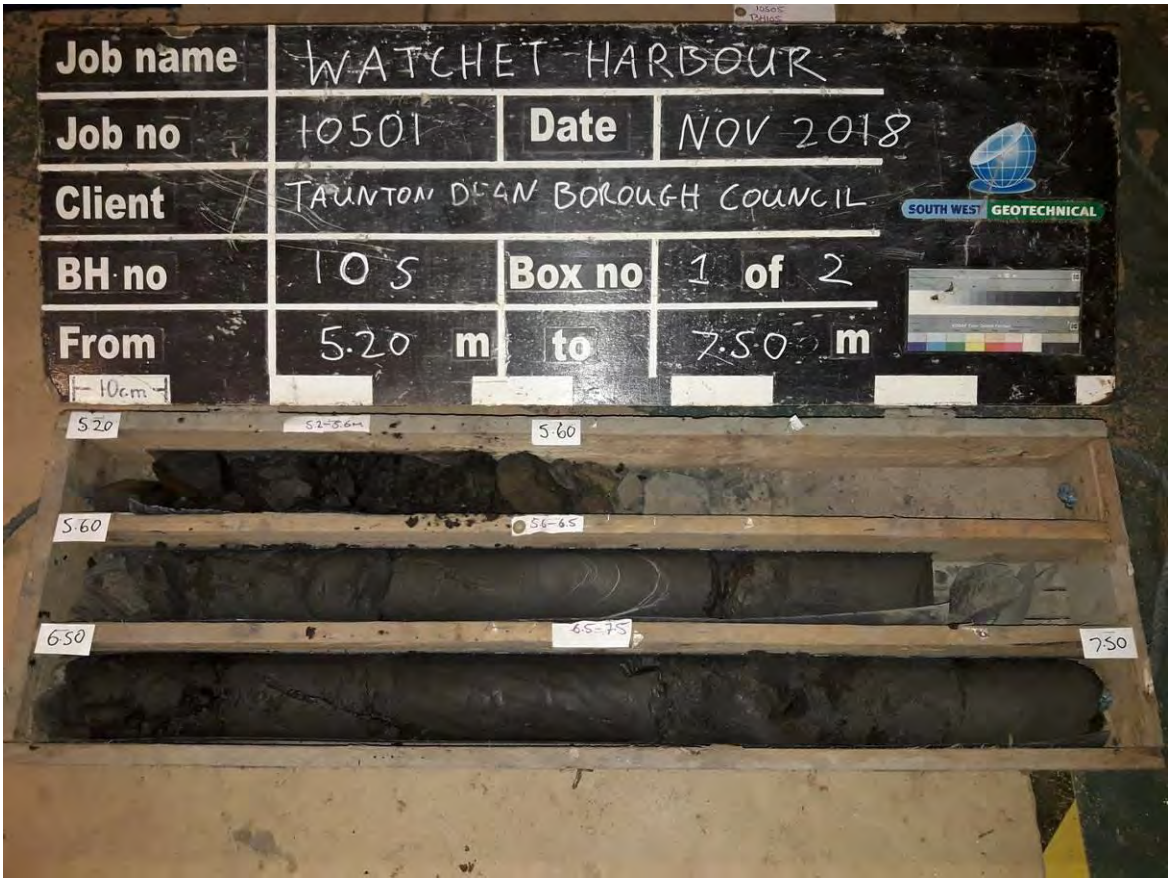
Project Name: Watchet Harbour	Project No. 10501	Co-ords:	Hole Type CP+RC
Location: Somerset		Level: 8.50	Scale 1:50
Client: Taunton Dean Bourough Council		Dates: 15/11/2018 - 16/11/2018	Logged By PW

Well	Water Strikes	Depth (m)	Type /FI	Coring TCR	Coring SCR	Coring RQD	Depth (m)	Level (m AOD)	Legend	Stratum Description
							10.50	-2.00		Very weak, locally extremely weak, dark grey, moderately locally highly weathered, calcareous MUDSTONE. (BLUE LIAS FORMATION). Fractures are closely to medium spaced (120, 300, 400), planar smooth, dipping at 30-40° (J1) and 65-70° (J2), no infill End of Borehole at 10.500m

11 12 13 14 15 16 17 18 19 20

Remarks

Location CAT scanned and inspection pit hand excavated to 1.2m prior to drilling. Hole drilled by dynamic sampling to 5.20mbgl, then continued by rotary coring. Monitoring well installed to base of hole.



BH105: 5.20 – 7.50m

BH105: 7.50 – 10.50m

Appendix E

Plate Load Test Results

Transmittal Note

South West Geotechnical Ltd
Unit 3 Brooklands,
Howden Road,
Tiverton,
Devon
EX16 5HW

Job No:	10501	**Date Received:**	09/11/18
Job Name:	Watchet Harbour	**Date Sent:**	12/11/18
Client Name:	Internal Job	**Transmittal Number:**	T4039
Client Job No:	-	**Senders Initials:**	DT
Client Address	For client address details, please refer to the final report.		

Ref.	Test Detail	No. of Tests / Report No.
PLOAD	BS1377: Part 9: 1990: Clause 4.1 - Determination of Vertical Deformation and Strength Characteristics of Soil by the Plate Loading Test - UKAS Accredited	2

Approved Signatories:

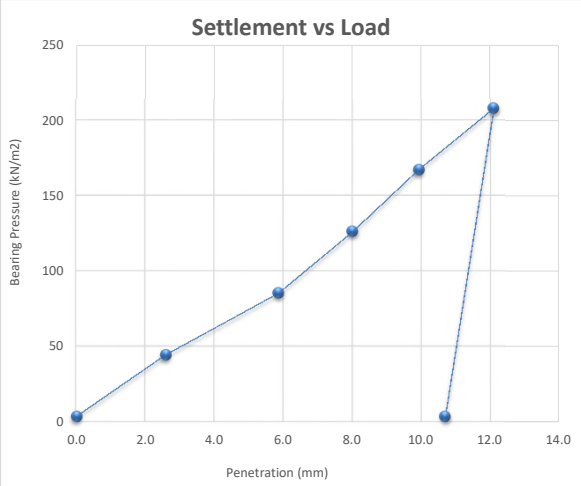
Nick Worthington-Williams (Laboratory Quality Manager), Dan Ayre (Deputy Quality Manager)

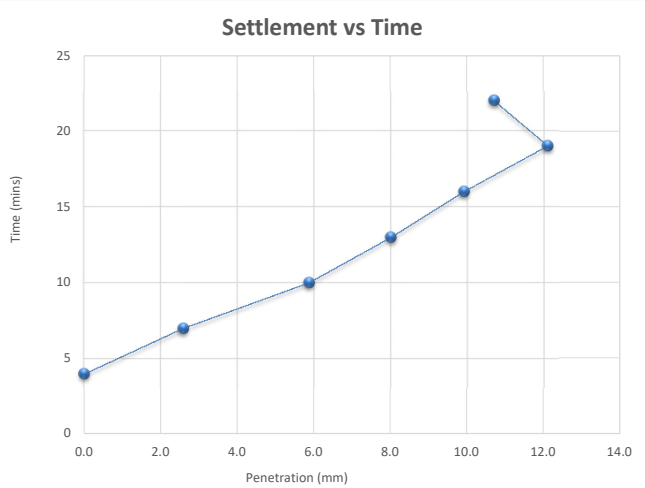
David Trowbridge (Laboratory Manager)

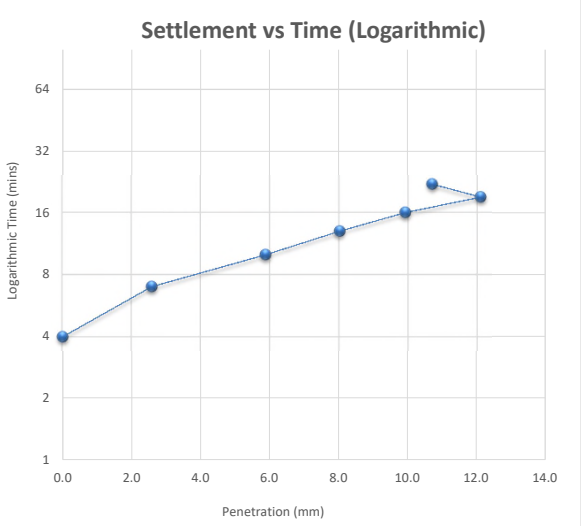
8260
Accredited to
ISO/IEC
17025:2005

Unit 3 Brooklands, Howden Road,
Tiverton, Devon, EX16 5HW

SOUTH WEST GEOTECHNICAL	**Report on the Determination of Vertical Deformation and Strength Characteristics of Soil to BS1377:Part 9 CL 4.1**			**Project No.**	**10501**
				Test Location ID	PL01
Project Name	Watchet Harbour			**Depth, m**	0.20
Soil Description	Mixed Fill			**Reaction Load / Kentledge**	4 Tonne
Client Job No.	-	**Date Tested**	09/11/2018	**Easting**	-
Client	Internal Job			**Northing**	-
Test Location	Logged by engineer			**Weather**	Dry







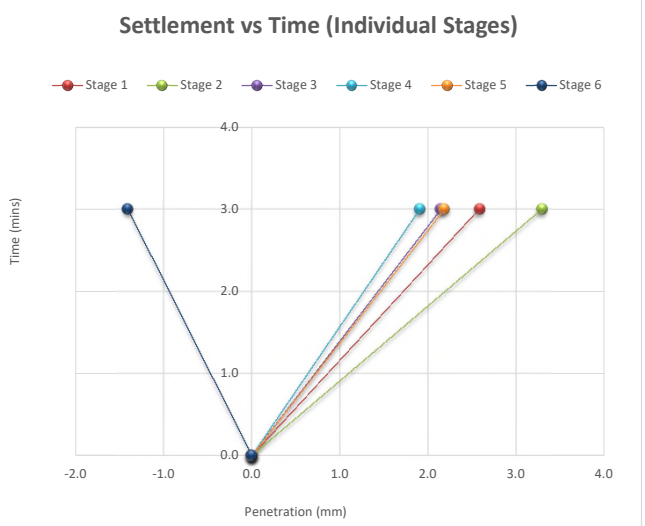


Plate Diameter (mm)	450	**Maximum Applied Pressure (kPa)**	207.9	**Maximum Deformation (mm)**	12.09

In-situ Density (Mg/m3) (If requested)	-	**Moisture Content (%) (If requested)**	-

Notes:

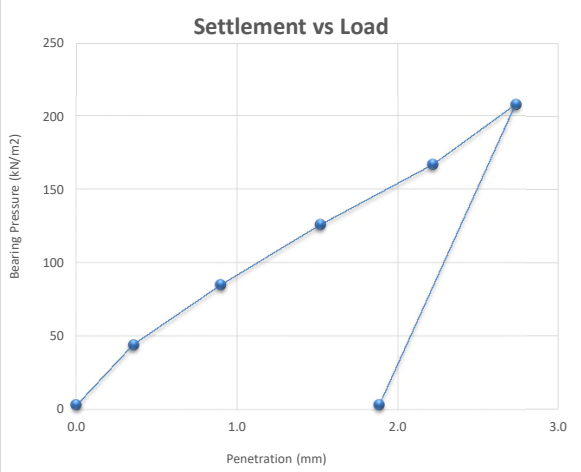
Modulus of subgrade reaction
Stage 1 - 10732 Stage 2 - 9059 Stage 3 - 9814
Stage 4 - 10499 Stage 5 - 10709

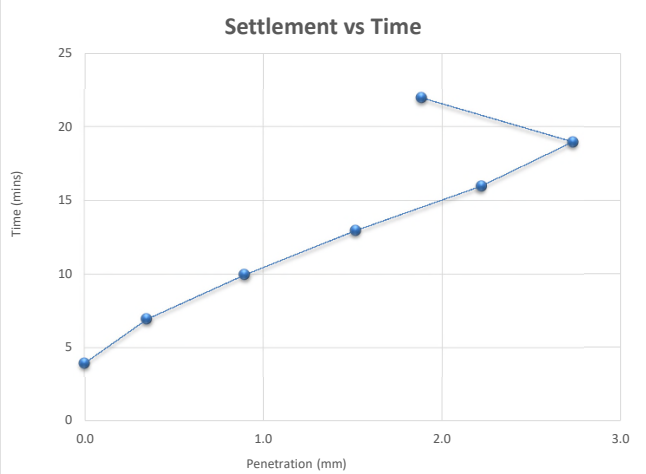
Page No.	**1**	**Date**	**Approved**
KL039 Plate Load (Incremental)		18/12/2018	David Trowbridge - Laboratory Manager

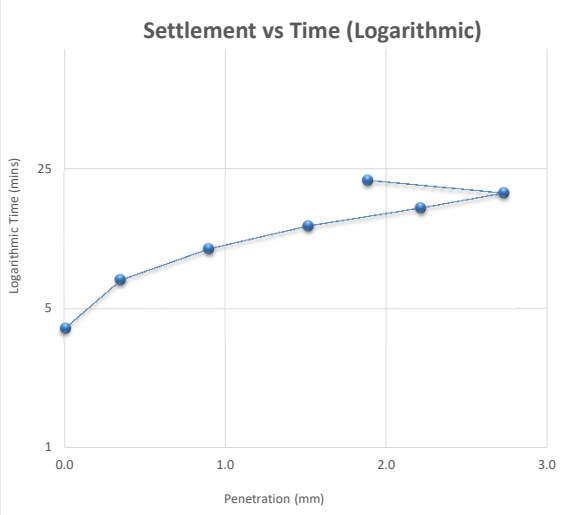
UKAS TESTING
8260
Accredited to ISO/IEC 17025:2005

Unit 3 Brooklands, Howden Road,
Tiverton, Devon, EX16 5HW

SOUTH WEST GEOTECHNICAL	**Report on the Determination of Vertical Deformation and Strength Characteristics of Soil to BS1377:Part 9 CL 4.1**			**Project No.**	**10501**
				Test Location ID	PL02
Project Name	Watchet Harbour			**Depth, m**	0.20
Soil Description	Mixed Fill			**Reaction Load / Kentledge**	4 Tonnes
Client Job No.	-	**Date Tested**	09/11/2018	**Easting**	-
Client	Internal Job			**Northing**	-
Test Location	Logged by engineer			**Weather**	Dry







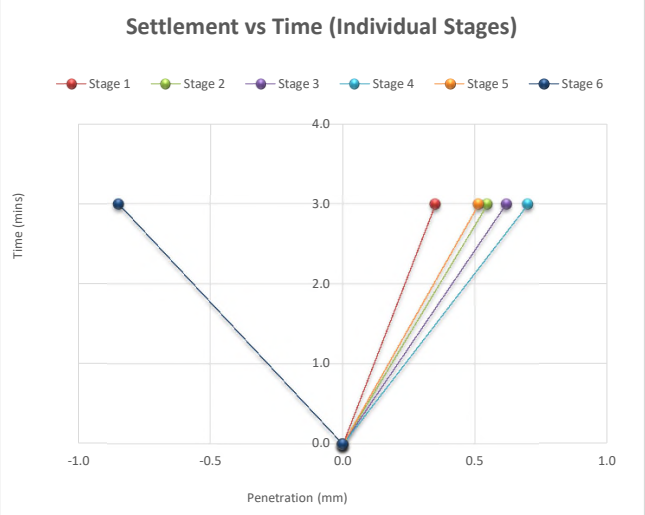


Plate Diameter (mm)	450	**Maximum Applied Pressure (kPa)**	207.9	**Maximum Deformation (mm)**	2.73

In-situ Density (Mg/m3) (If requested)	-	**Moisture Content (%) (If requested)**	-

Notes:

Modulus of subgrade reaction
Stage 1 - 79010 Stage 2 - 59239 Stage 3 - 51926
Stage 4 - 47008 Stage 5 - 47497

Page No.	**2**	**Date**	**Approved**
KL039 Plate Load (Incremental)		18/12/2018	David Trowbridge - Laboratory Manager

UKAS TESTING
8260
Accredited to ISO/IEC 17025:2005

Appendix F

Geotechnical Laboratory Test Results

Transmittal Note

South West Geotechnical Ltd
Unit 3 Brooklands,
Howden Road,
Tiverton,
Devon
EX16 5HW

Job No:	10501	**Date Received:**	20/11/18
Job Name:	Watchet Harbour	**Date Sent:**	10/12/18
Client Name:	Internal Job	**Transmittal Number:**	T4026
Client Job No:	-	**Senders Initials:**	MB
Client Address	For client address details, please refer to the final report.		

Ref.	Test Detail	No. of Tests / Report No.
A1	BS1377: Part 2: 1990: Clause 3 - Moisture Content - UKAS Accredited	9
A5	BS1377: Part 2: 1990: Clause 4 & 5 - Atterberg Limits - UKAS Accredited	9
A9	BS1377: Part 2: 1990: Clause 9.2 / 9.3 - Particle Size Distribution - UKAS Accredited	7
C3	Point Load Test on Regular Core and Irregular Specimens Tested in Accordance with the International Journal of Rock Mechanics and Mining	10
C4	ISRM: 1981: Part 2 Suggested Methods - Uniaxial Compressive Strength of Rock Materials	4
C1	BS1377: Part 7: 1990: Clause 4 - Direct shear test on 60mm square specimen by direct shearing on a set of 3 specimens including 1st day for each specimen - UKAS Accredited	1

Approved Signatories:

Nick Worthington-Williams (Laboratory Quality Manager), Dan Ayre (Deputy Quality Manager)

David Trowbridge (Laboratory Manager)

8260
Accredited to
ISO/IEC
17025:2005

Summary of Classification Test Results

Unit 3 Brooklands,
Howden Road,
Tiverton,
Devon
EX16 5HW

Project No.	Project Name
10501	Watchet Harbour
Client Job No.	**Client**
10501	Internal

8260
Accredited to ISO/IEC 17025:2005

Hole No.	Sample				Soil Description	*mc* Cl.3.2	Passing 425µm	LL	PL Cl5.3	PI Cl5.4	Particle density	Remarks
	Type	Top	Base	Ref		%	%	%	%	%	Mg/m3	
BH101	D	1.50		-	Reddish brown and greenish grey very sandy clayey silty GRAVEL	14	35 - Sieved	32 - 1pt	22	10	-	
BH101	B	2.70	3.60	-	Grey and reddish brown sandy silty GRAVEL	7.3	-	-	-	-	-	
BH101	D	4.50		-	Greenish grey and brown sandy clayey GRAVEL	21	29 - Sieved	50 - 1pt	23	27	-	
BH101	D	5.50		-	Brown and greenish grey sandy clayey GRAVEL	21	25 - Sieved	45 - 1pt	22	23	-	
BH102	B	1.40	2.70	-	Black silty very sandy GRAVEL	24	-	-	-	-	-	
BH102	D	3.60		-	Dark brown silty very sandy GRAVEL	16	29 - Sieved	31 - 1pt	19	12	-	
BH102	B	5.30	5.90	-	Brown sandy clayey GRAVEL	13	-	-	-	-	-	
BH103	B	2.80	3.10	-	Reddish brown and brown slightly gravelly sandy silty CLAY	12	-	-	-	-	-	
BH103	B	4.60	5.70	-	Grey sandy clayey GRAVEL	14	-	-	-	-	-	
BH104	D	1.80		-	Dark brown sandy silty GRAVEL	12	32 - Sieved	31 - 1pt	19	12	-	

Preparation Clauses: Particle Density (BS1377:Part 1: 1990: CL7.4.4) Atterberg Limits (BS1377:Part 1: 1990: CL7.4.3) Moisture Content (BS1377: Part 1: 1990: CL7.3.3 & 7.4.2)

Key

Atterberg Limits BS1377-2:1990
4pt cone (CL.4.3) unless :
1pt - single point test (CL.4.4)
4.2.3 - Natural
4.2.4 - Sieved
Moisture Content (mc) %

Particle density BS1377-2:1990
sp - small pyknometer CL.8.3
gj - gas jar CL.8.2

Date	Approved By	Page No.	1
18/12/2018	Nick W-W - QM	KL001R Index Summary	

Summary of Classification Test Results

SOUTH WEST GEOTECHNICAL

Unit 3 Brooklands,
Howden Road,
Tiverton,
Devon
EX16 5HW

Project No.	Project Name
10501	Watchet Harbour
Client Job No.	**Client**
10501	Internal

UKAS TESTING 8260 Accredited to ISO/IEC 17025:2005

Hole No.	Sample				Soil Description	*mc* Cl.3.2	Passing 425µm	LL	PL Cl5.3	PI Cl5.4	Particle density	Remarks
	Type	Top	Base	Ref		%	%	%	%	%	Mg/m3	
BH104	D	3.40		-	Reddish brown very sandy very clayey GRAVEL	16	48 - Sieved	31 - 1pt	18	13	-	
BH104	D	4.30		-	Grey very sandy silty GRAVEL	12	33 - Sieved	34 - 1pt	20	14	-	
BH104	B	5.20	6.20	-	Grey sandy clayey GRAVEL	13	-	-	-	-	-	
BH105	D	2.20		-	Greenish brown slightly sandy slightly gravelly CLAY	26	69 - Sieved	50 - 1pt	23	27	-	
BH105	D	3.00		-	Reddish brown and greenish grey slightly sandy gravelly CLAY	16	43 - Sieved	34 - 1pt	18	16	-	
BH105	B	3.30	4.80	-	Grey sandy clayey GRAVEL	13	-	-	-	-	-	
						-	-	-	-	-	-	
						-	-	-	-	-	-	
						-	-	-	-	-	-	
						-	-	-	-	-	-	

Preparation Clauses: Particle Density (BS1377:Part 1: 1990: CL7.4.4) Atterberg Limits (BS1377:Part 1: 1990: CL7.4.3) Moisture Content (BS1377: Part 1: 1990: CL7.3.3 & 7.4.2)

Key

Atterberg Limits BS1377-2:1990
4pt cone (CL.4.3) unless :
1pt - single point test (CL.4.4)
4.2.3 - Natural
4.2.4 - Sieved
Moisture Content (mc) %

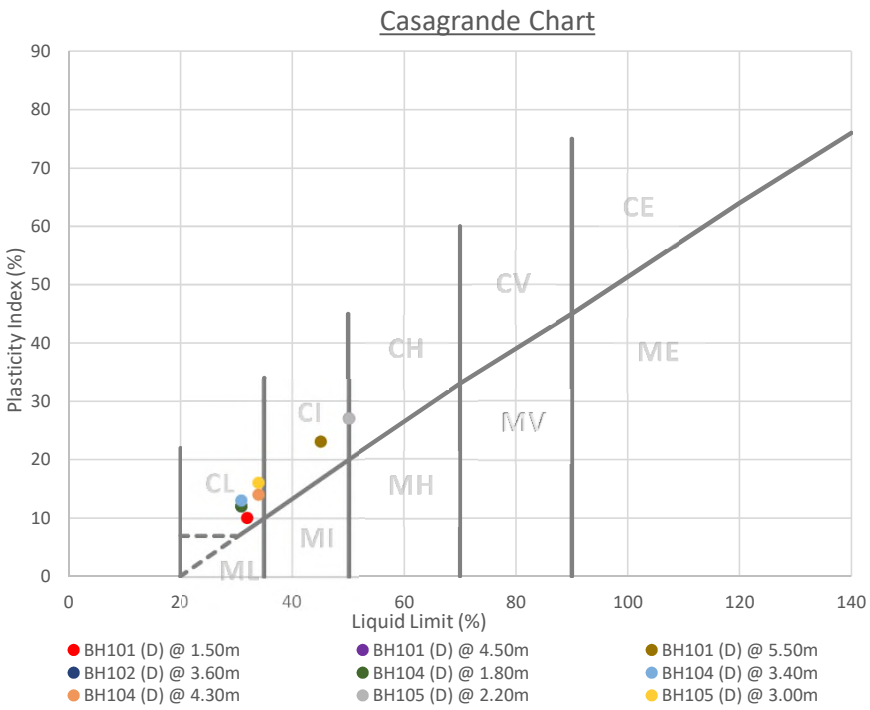
Particle density BS1377-2:1990
sp - small pyknometer CL.8.3
gj - gas jar CL.8.2

Date	Approved By	Page No.	2
18/12/2018	Nick W-W - QM	KL001R Index Summary	

Graphical Summary of Atterberg Test Results

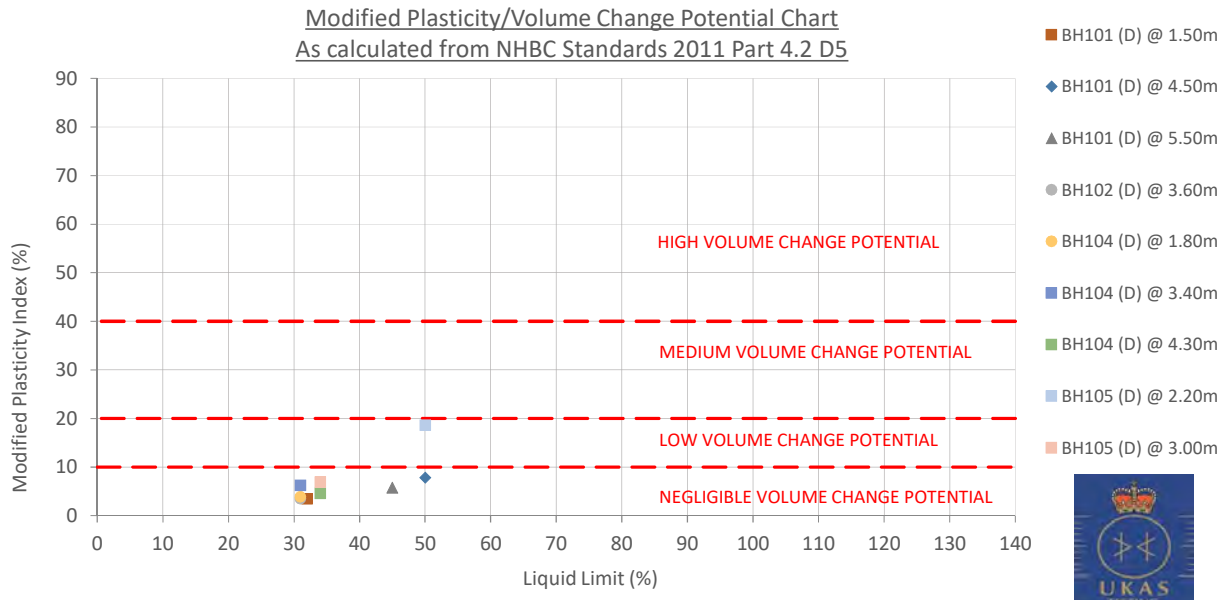
Unit 3 Brooklands,
Howden Road,
Tiverton,
Devon
EX16 5HW

Project No.	Project Name
10501	Watchet Harbour
Client Job No.	**Client**
-	Internal Job



Sample ID	Plasticity Index (%)	Modified Plasticity Index (%)
BH101 (D) @ 1.50m	10	4
BH101 (D) @ 4.50m	27	8
BH101 (D) @ 5.50m	23	6
BH102 (D) @ 3.60m	12	3
BH104 (D) @ 1.80m	12	4
BH104 (D) @ 3.40m	13	6
BH104 (D) @ 4.30m	14	5
BH105 (D) @ 2.20m	27	19
BH105 (D) @ 3.00m	16	7
-	-	-

The Modified Plasticity Index (I'p) is defined as the Plasticity Index (Ip) of the soil multiplied by the percentage of particles less than 425µm.
ie. I'p x % less than 425um/100%



KL001a Index Graphical Summary	Approved By	Date	Page No.
	Nick W-Williams - Quality Manager	10/12/2018 17:12	1

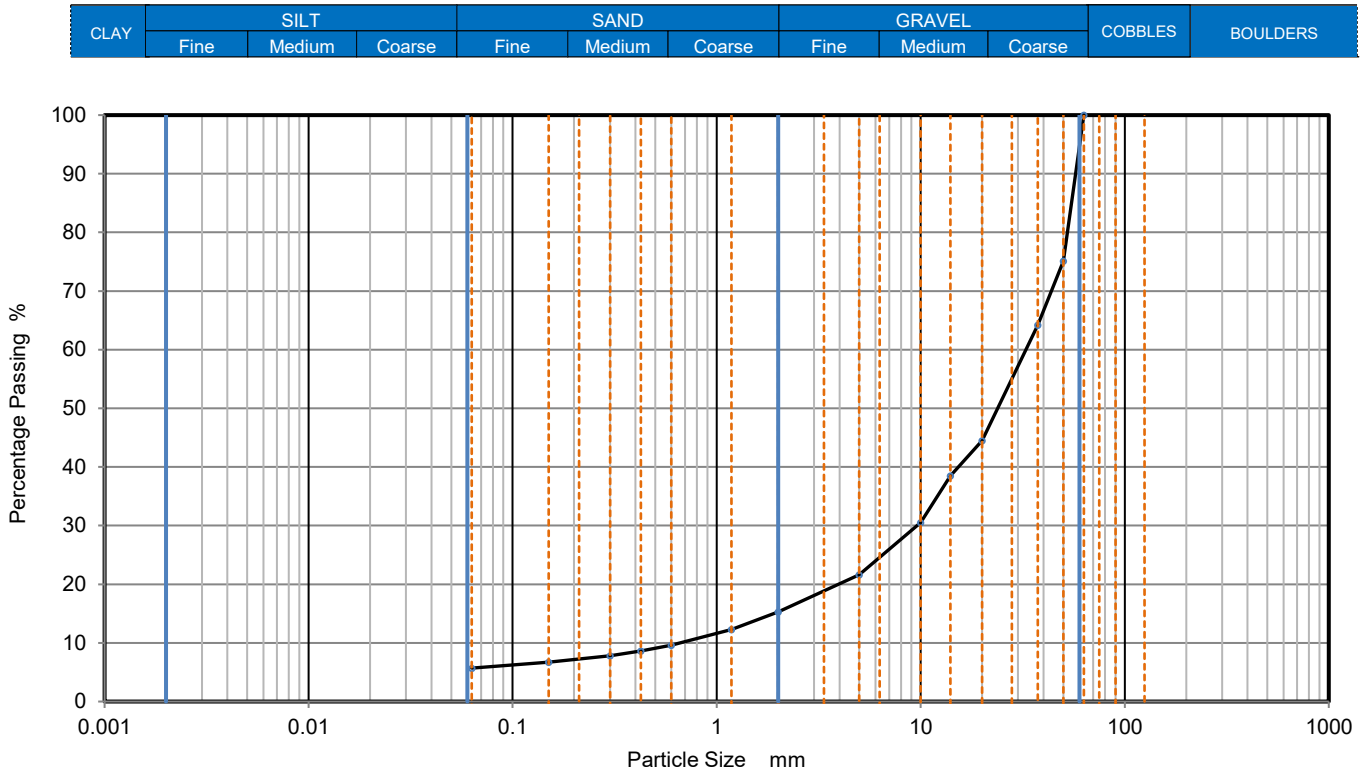
8260
Accredited to ISO/IEC 17025:2005

Unit 3 Brooklands, Howden Road, Tiverton, Devon, EX16 5HW

Particle Size Distribution

BS1377:Part 2:1990, clause 9.2

Project No.	10501				
Borehole/Pit No.	BH101				
Project Name	Watchet Harbour			Sample No.	-
Soil Description	Grey and reddish brown sandy silty GRAVEL			Depth, m	2.70 - 3.60
Client Job No.	10501	Specimen Depth	2.70 m	Sample Type	B
Client	Internal				



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	-	-	-
75	-	-	-
63	100	-	-
50	75		
37.5	64		
20	45		
14	39		
10	31		
5	22		
2	15		
1.18	12		
0.6	10		
0.425	9		
0.3	8		
0.15	7		
0.063	6		

Dry Mass of sample, g	4550

Sample Proportions	% dry mass
Very coarse	0
Gravel	85
Sand	10
Fines <0.063mm	6

Grading Analysis		
D100	mm	63
D60	mm	32.8
D30	mm	9.65
D10	mm	0.665
Uniformity Coefficient		49
Curvature Coefficient		4.3

Sedimentation pre-teatment
N/A

Remarks

Preparation and testing in accordance with BS1377 - Deviation to standard as insufficient material provided in order to meet the minimum mass requirement

Page No.	1	Date	Approved
Sheet ID: KL002R PSD		10/12/2018 16:58	Nick W-W - QM

8260
Accredited to
ISO/IEC
17025:2005

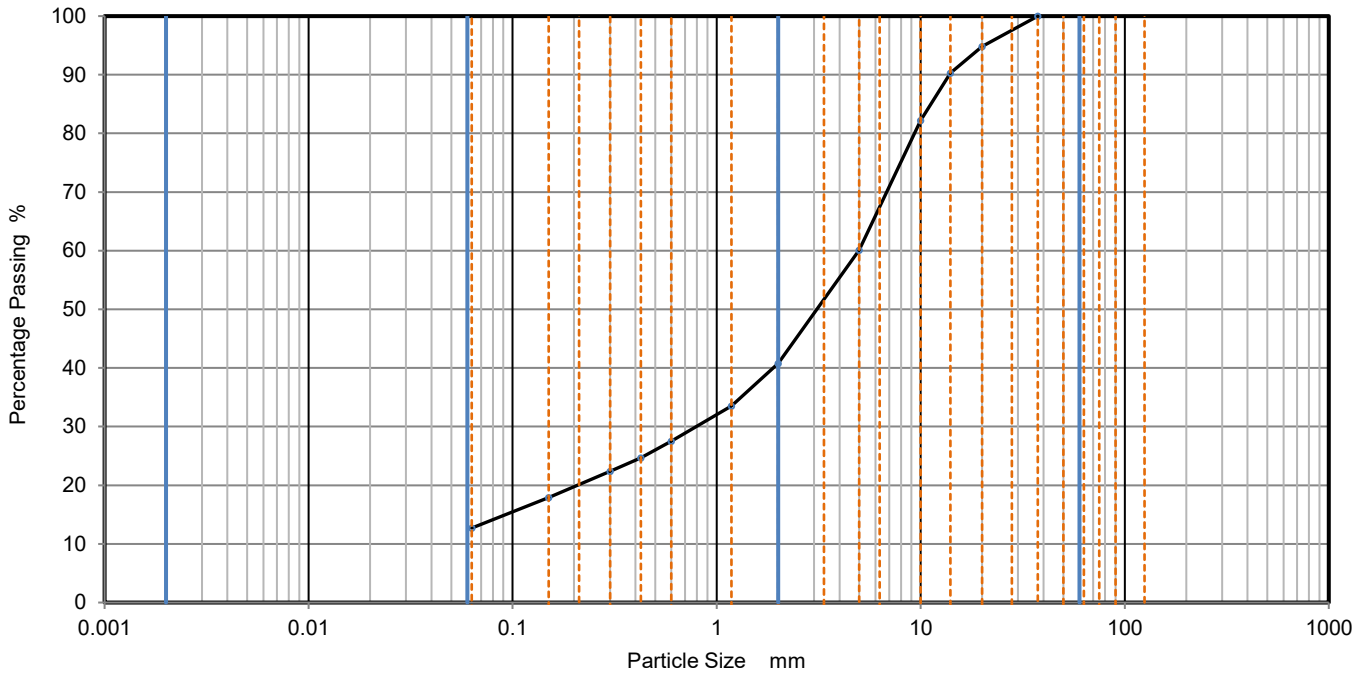
Unit 3 Brooklands, Howden Road, Tiverton, Devon, EX16 5HW

Particle Size Distribution

BS1377:Part 2:1990, clause 9.2

Project No.	10501				
Borehole/Pit No.	BH102				
Project Name	Watchet Harbour			Sample No.	-
Soil Description	Black silty very sandy GRAVEL			Depth, m	1.40 - 2.70
Client Job No.	10501	Specimen Depth	1.40 m	Sample Type	B
Client	Internal				

CLAY	SILT			SAND			GRAVEL			COBBLES	BOULDERS
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse		



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	-	-	-
75	-	-	-
63	-	-	-
50	-		
37.5	100		
20	95		
14	90		
10	82		
5	60		
2	41		
1.18	34		
0.6	28		
0.425	25		
0.3	22		
0.15	18		
0.063	13		

Dry Mass of sample, g	1064

Sample Proportions	% dry mass
Very coarse	0
Gravel	59
Sand	28
Fines <0.063mm	13

Grading Analysis		
D100	mm	37.5
D60	mm	4.99
D30	mm	0.795
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Sedimentation pre-teatment
N/A

Remarks

Preparation and testing in accordance with BS1377: Part 1: 1990 CL7.3 & 7.4.5

UKAS TESTING

8260
Accredited to ISO/IEC 17025:2005

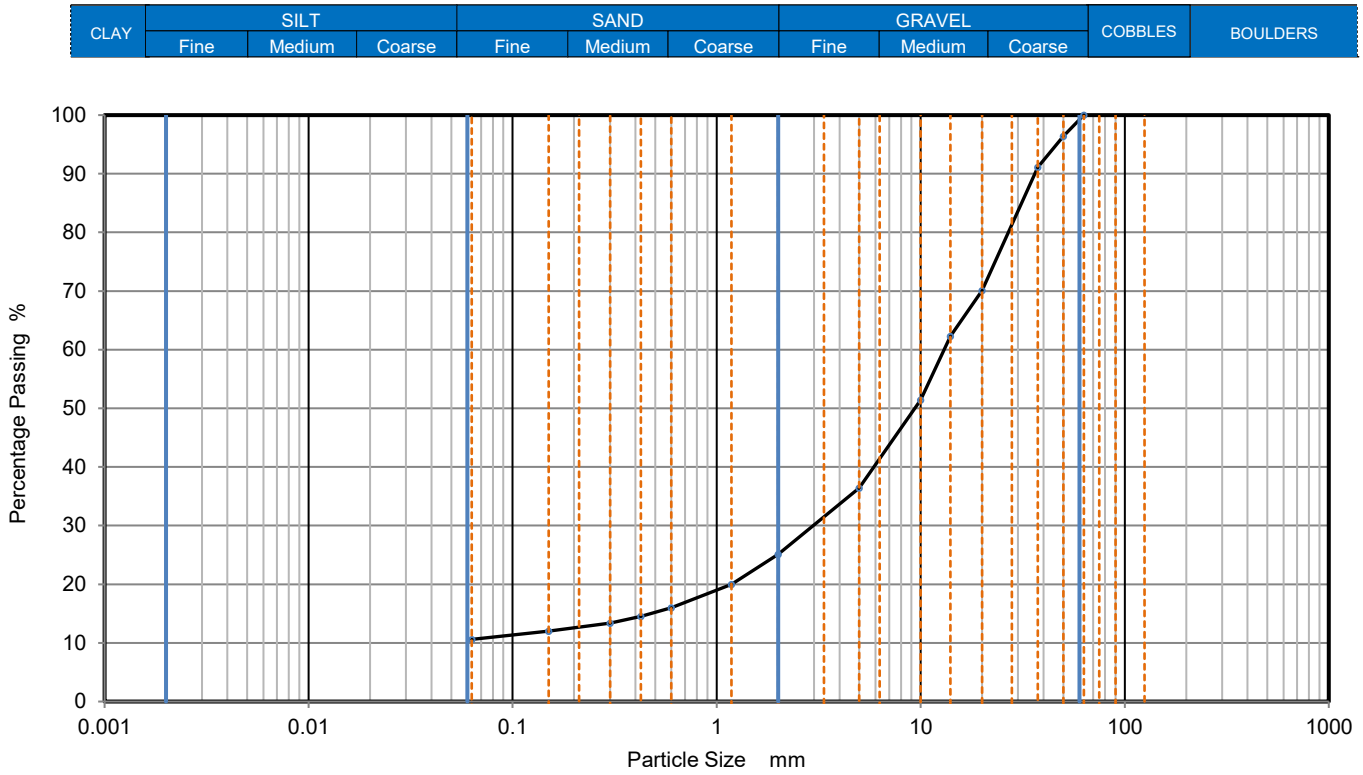
Page No.	2	Date	Approved
Sheet ID: KL002R PSD		10/12/2018 16:58	Nick W-W - QM

Unit 3 Brooklands, Howden Road, Tiverton, Devon, EX16 5HW

Particle Size Distribution

BS1377:Part 2:1990, clause 9.2

Project No.	10501					
Borehole/Pit No.	BH102					
Project Name	Watchet Harbour			Sample No.	-	
Soil Description	Brown sandy clayey GRAVEL			Depth, m	5.30	- 5.90
Client Job No.	10501	Specimen Depth	5.30 m	Sample Type	B	
Client	Internal					



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	-	-	-
75	-	-	-
63	100	-	-
50	96		
37.5	91		
20	70		
14	62		
10	51		
5	36		
2	25		
1.18	20		
0.6	16		
0.425	15		
0.3	13		
0.15	12		
0.063	11		

Dry Mass of sample, g	5089

Sample Proportions	% dry mass
Very coarse	0
Gravel	75
Sand	15
Fines <0.063mm	11

Grading Analysis		
D100	mm	63
D60	mm	13
D30	mm	2.97
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Sedimentation pre-teatment
N/A

Remarks

Preparation and testing in accordance with BS1377: Part 1: 1990 CL7.3 & 7.4.5

Page No.	3	Date	Approved
Sheet ID: KL002R PSD		10/12/2018 16:58	Nick W-W - QM

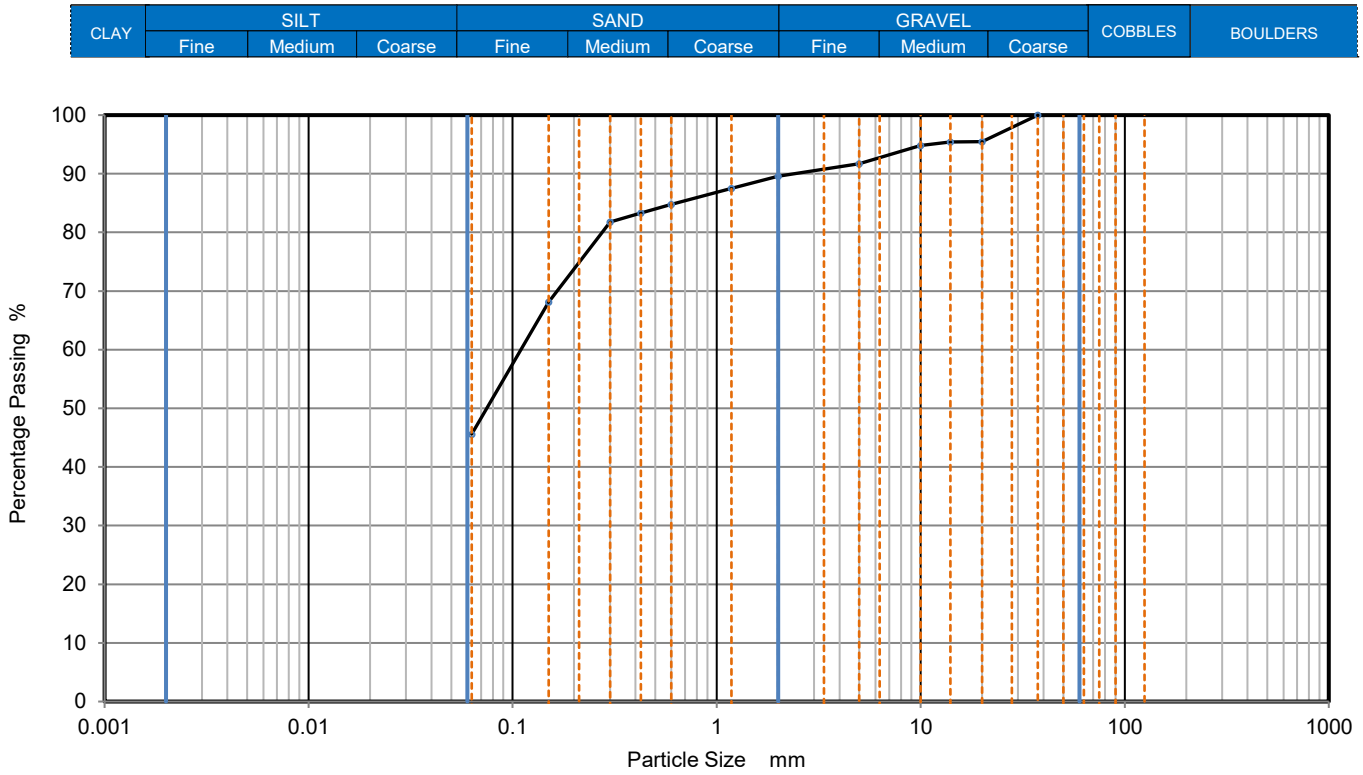
8260
Accredited to ISO/IEC 17025:2005

Unit 3 Brooklands, Howden Road, Tiverton, Devon, EX16 5HW

Particle Size Distribution

BS1377:Part 2:1990, clause 9.2

Project No.	10501				
Borehole/Pit No.	BH103				
Project Name	Watchet Harbour			Sample No.	-
Soil Description	Reddish brown and brown slightly gravelly sandy silty CLAY			Depth, m	2.80 - 3.10
Client Job No.	10501	Specimen Depth	2.80 m	Sample Type	B
Client	Internal				



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	-	-	-
75	-	-	-
63	-	-	-
50	-		
37.5	100		
20	96		
14	95		
10	95		
5	92		
2	90		
1.18	88		
0.6	85		
0.425	83		
0.3	82		
0.15	68		
0.063	46		

Dry Mass of sample, g	2023

Sample Proportions	% dry mass
Very coarse	0
Gravel	10
Sand	44
Fines <0.063mm	46

Grading Analysis		
D100	mm	37.5
D60	mm	0.11
D30	mm	
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Sedimentation pre-teatment
N/A

Remarks

Preparation and testing in accordance with BS1377: Part 1: 1990 CL7.3 & 7.4.5

Page No.	4	Date	Approved
Sheet ID: KL002R PSD		10/12/2018 16:58	Nick W-W - QM

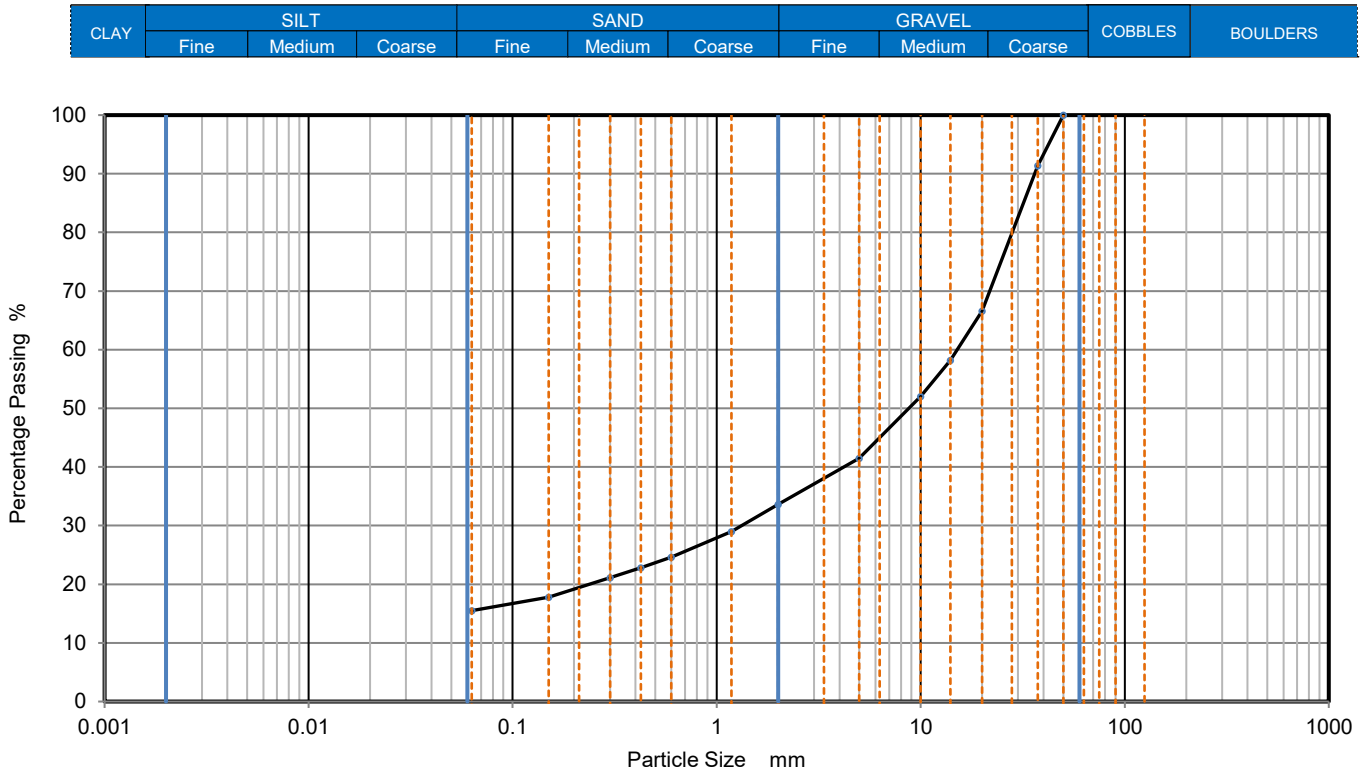
8260
Accredited to ISO/IEC 17025:2005

Unit 3 Brooklands, Howden Road, Tiverton, Devon, EX16 5HW

Particle Size Distribution

BS1377:Part 2:1990, clause 9.2

Project No.	10501				
Borehole/Pit No.	BH103				
Project Name	Watchet Harbour			Sample No.	-
Soil Description	Grey sandy clayey GRAVEL			Depth, m	4.60 - 5.70
Client Job No.	10501	Specimen Depth	4.60 m	Sample Type	B
Client	Internal				



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	-	-	-
75	-	-	-
63	-	-	-
50	100		
37.5	91		
20	67		
14	58		
10	52		
5	42		
2	34		
1.18	29		
0.6	25		
0.425	23		
0.3	21		
0.15	18		
0.063	16		

Dry Mass of sample, g	6216

Sample Proportions	% dry mass
Very coarse	0
Gravel	66
Sand	18
Fines <0.063mm	16

Grading Analysis		
D100	mm	50
D60	mm	15.1
D30	mm	1.32
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Sedimentation pre-teatment
N/A

Remarks

Preparation and testing in accordance with BS1377: Part 1: 1990 CL7.3 & 7.4.5

Page No.	5	Date	Approved
Sheet ID: KL002R PSD		10/12/2018 16:58	Nick W-W - QM

8260
Accredited to ISO/IEC 17025:2005

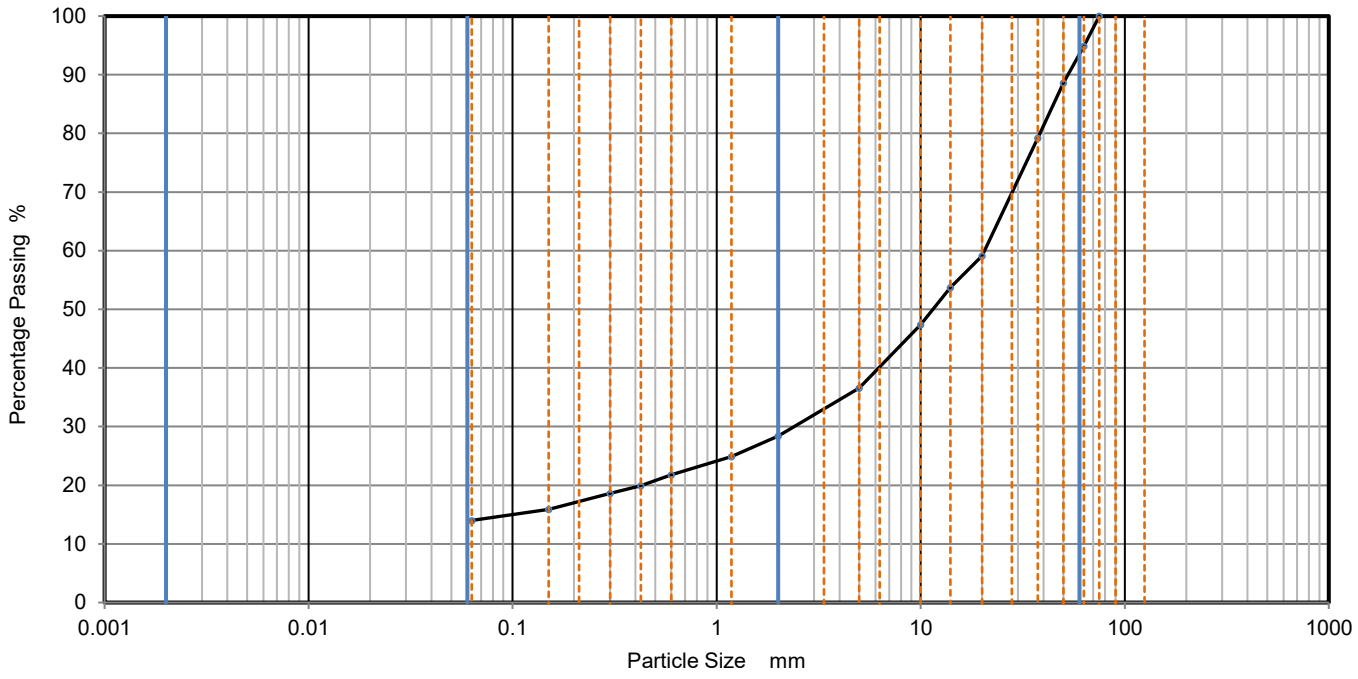
Unit 3 Brooklands, Howden Road, Tiverton, Devon, EX16 5HW

Particle Size Distribution

BS1377:Part 2:1990, clause 9.2

Project No.	10501					
Borehole/Pit No.	BH104					
Project Name	Watchet Harbour			Sample No.	-	
Soil Description	Grey sandy clayey GRAVEL			Depth, m	5.20	- 6.20
Client Job No.	10501	Specimen Depth	5.20 m	Sample Type	B	
Client	Internal					

CLAY	SILT			SAND			GRAVEL			COBBLES	BOULDERS
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse		



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	-	-	-
75	100	-	-
63	95	-	-
50	89		
37.5	79		
20	59		
14	54		
10	47		
5	37		
2	28		
1.18	25		
0.6	22		
0.425	20		
0.3	19		
0.15	16		
0.063	14		

Dry Mass of sample, g	9566

Sample Proportions	% dry mass
Very coarse	5
Gravel	67
Sand	14
Fines <0.063mm	14

Grading Analysis		
D100	mm	75
D60	mm	20.5
D30	mm	2.4
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Sedimentation pre-teatment
N/A

Remarks

Preparation and testing in accordance with BS1377 - Deviation to standard as insufficient material provided in order to meet the minimum mass requirement

Page No.	6	Date	Approved
Sheet ID: KL002R PSD		10/12/2018 16:58	Nick W-W - QM

8260
Accredited to ISO/IEC 17025:2005

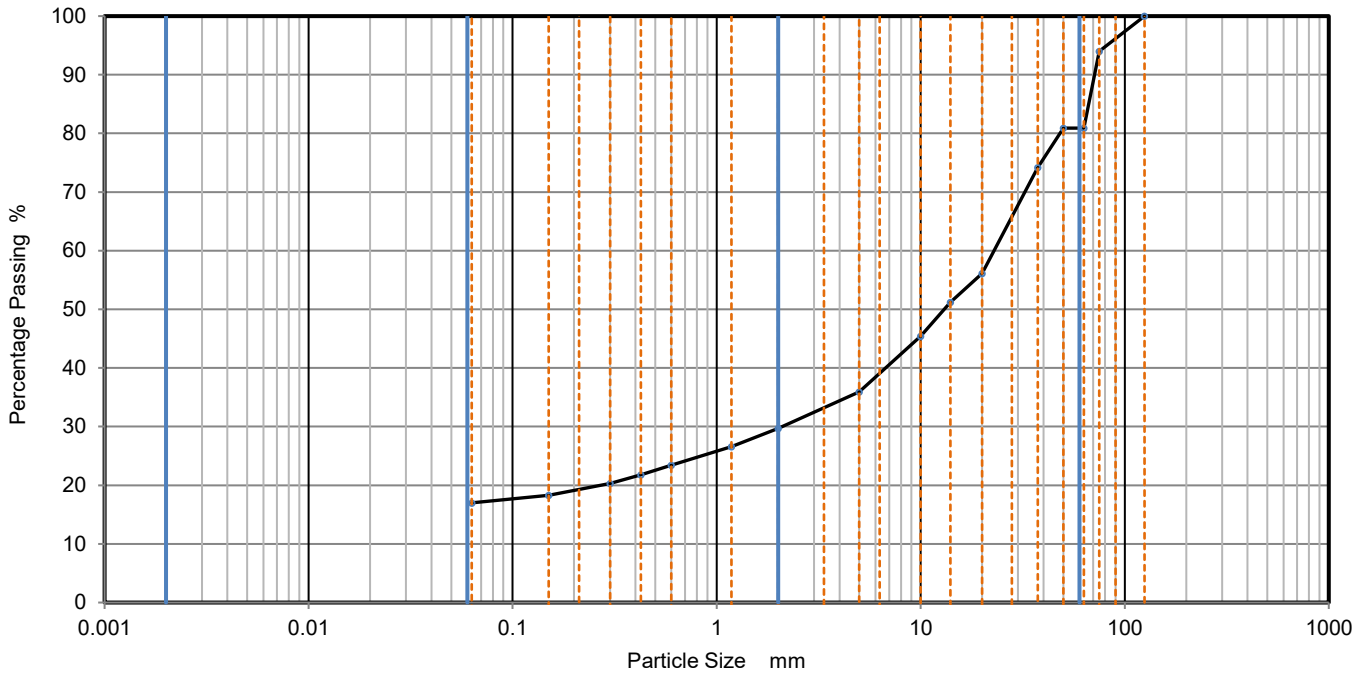
Unit 3 Brooklands, Howden Road, Tiverton, Devon, EX16 5HW

Particle Size Distribution

BS1377:Part 2:1990, clause 9.2

Project No.	10501					
Borehole/Pit No.	BH105					
Project Name	Watchet Harbour			Sample No.	-	
Soil Description	Grey sandy clayey GRAVEL			Depth, m	3.30	- 4.80
Client Job No.	10501	Specimen Depth	3.30 m	Sample Type	B	
Client	Internal					

CLAY | SILT: Fine, Medium, Coarse | SAND: Fine, Medium, Coarse | GRAVEL: Fine, Medium, Coarse | COBBLES | BOULDERS



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	-	-
75	94	-	-
63	81	-	-
50	81		
37.5	74		
20	56		
14	51		
10	45		
5	36		
2	30		
1.18	27		
0.6	23		
0.425	22		
0.3	20		
0.15	18		
0.063	17		

Dry Mass of sample, g	7873

Sample Proportions	% dry mass
Very coarse	19
Gravel	51
Sand	13
Fines <0.063mm	17

Grading Analysis		
D100	mm	125
D60	mm	22.9
D30	mm	2.09
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Sedimentation pre-teatment
N/A

Remarks

Preparation and testing in accordance with BS1377 - Deviation to standard as insufficient material provided in order to meet the minimum mass requirement

UKAS TESTING

8260
Accredited to ISO/IEC 17025:2005

Page No.	7	Date	Approved
Sheet ID: KL002R PSD		10/12/2018 16:58	Nick W-W - QM

Determination of Shear Strength using the Small Direct Shearbox Apparatus

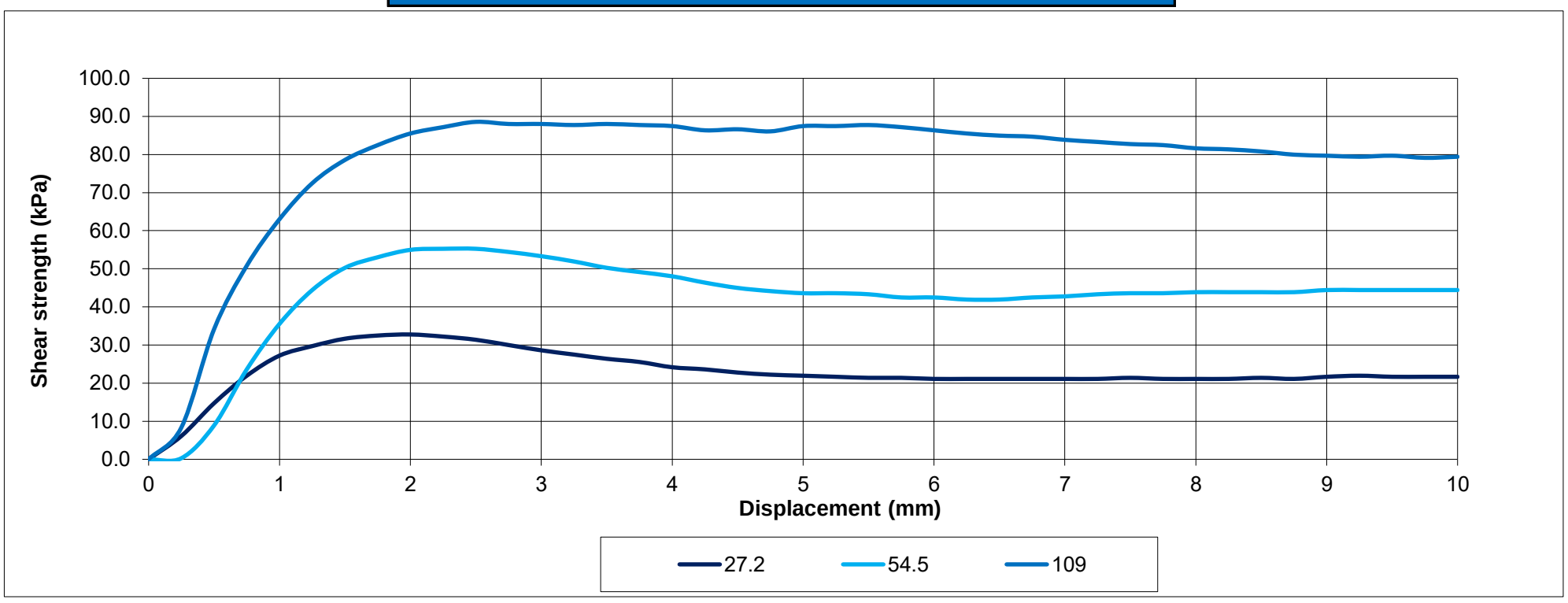
Unit 3 Brooklands,
Howden Road,
Tiverton,
Devon
EX16 5HW

Project Name	Watchet Harbour	**Project No.**	10501
Client:	Pick Everard	**Borehole / Pit No.**	BH102
Soil Description	Black silty very sandy GRAVEL	**Client Job No:**	-
Specimen Description	Black silty SAND	**Depth (m)**	1.40 - 2.70
Test Method	Tests carried out in accordance with Clause 4 of BS1377: 1990: Part 7: CL 4.5.4 (Single Stage) using the fraction passing a 2.0mm sieve	**Sample No.**	-
Sample Type	Bulk Sample	**Date of test**	03/12/2018
Preparation Details	Test prepared in accordance with BS1377:1990:Part 7: CL4.4.3.5	**Assumed Particle Density (Mg/m3)**	2.65

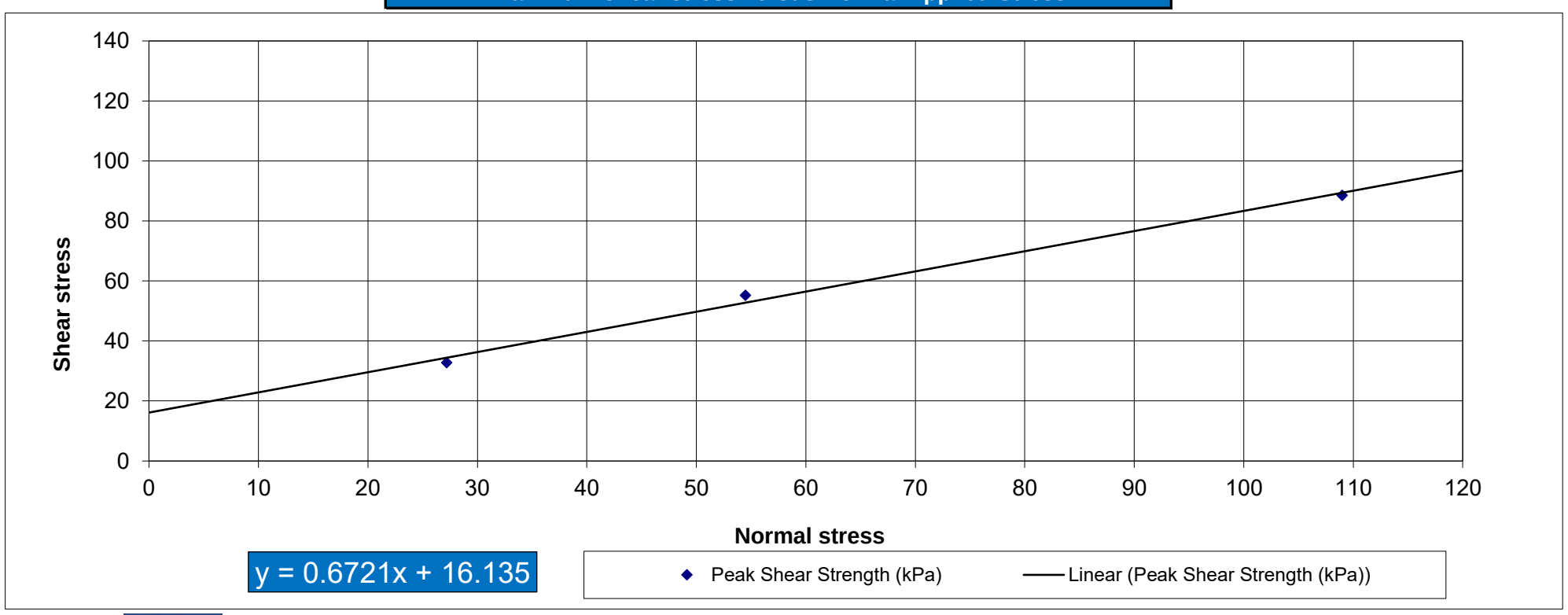
Rate of displacement (mm/min)	Test Dry or Submerged	Load Stage (kPa)	Initial Moisture Content %	Initial Height (mm)	Initial Bulk Density (Mg/m3)	Initial Dry Density (Mg/m3)	Specimen Width (mm)	Specimen Length (mm)	Consolidated Height (mm)	Peak Shear Strength (kPa)	Horizontal Displacement At Peak
0.10861	Submerged	27.2	28	20.10	1.34	1.05	60.01	60.02	19.92	33	2.00mm
		54.5		20.10	1.33	1.04			19.85	55	2.25mm
		109		20.11	1.32	1.04			19.81	89	2.50mm

Angle of friction (Peak) °	34	**Peak Cohesion (kPa)**	16	**Angle of friction (Residual) °**	-	**Residual Cohesion (kPa)**	-

Shear stress versus Horizontal Displacement



Maximum shear stress versus Normal Applied Stress



Accredited to ISO/IEC 17025:2005

Remarks:

Approved by	Date Approved
Dan Ayre - Deputy Quality Manager	06/12/2018 09:41

Unit 3 Brooklands,
Howden Road,
Tiverton,
Devon EX16 5HW

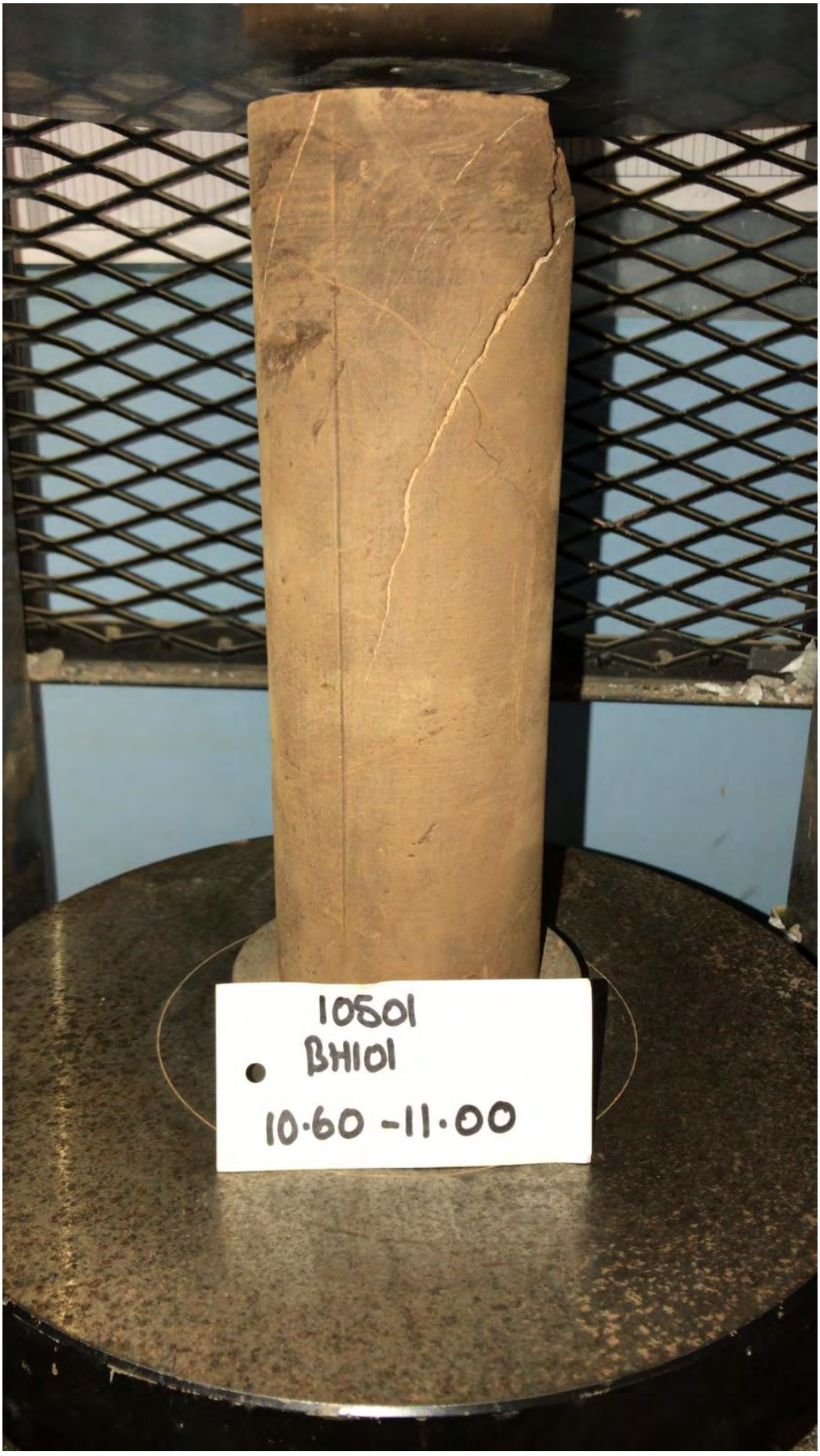
Summary of Rock Testing

ISRM: 1981: Part 2 Suggested Methods - Uniaxial Compressive Strength of Rock materials

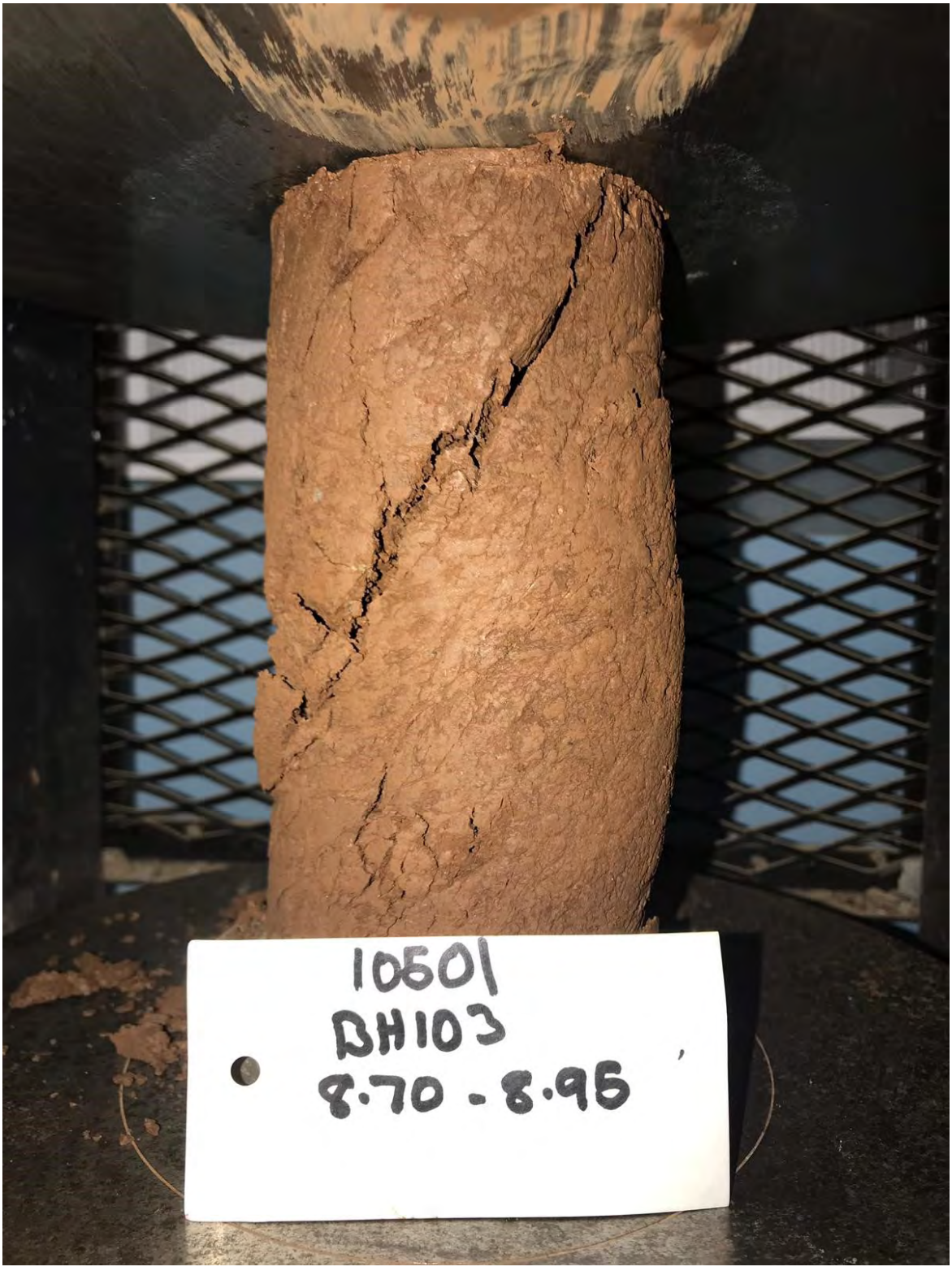
		Date of test	03/12/18
Project Name	Watchet Harbour	**Project No.**	10501
Client	Internal Job	**Client Job No.**	-

Sample Details				Density			Uniaxial Compressive Strength				
Borehole No.	Sample Reference	Depth (m)	Description	Water Content (%)	Bulk (Mg/m3)	Dry (Mg/m3)	Diameter (mm)	Height (mm)	H/D Ratio	Load at Failure (kN)	UCS (Mpa)
BH101		10.60 - 11.00	Brown MUDSTONE	3.9	2.55	2.46	79.08	238.00	3.0	18.5	3.8
BH102		8.00 - 8.30	Brown MUDSTONE	5.1	2.53	2.40	79.48	197.00	2.5	25.7	5.2
BH103		8.70 - 8.95	Brown MUDSTONE	13	2.26	2.00	76.66	187.67	2.4	3.5	0.8
BH105		7.50 - 7.90	Grey with white veins LIMESTONE	0.75	2.71	2.69	79.25	198.00	2.5	309.3	62.7

KL037 - Uniaxial Compressive Strength of Rock	Remarks	Approved By	Date	Page No.
		Daniel Ayre - Deputy Quality Manager	04/12/2018 11:21	**1**


10501
BH101
10.60 -11.00


10501
BH102
8.00 - 8.30


10501
BH103
8.70 - 8.96


BH105
7.50 - 7.90
10501

Point Load Results Summary Sheet

Unit 3 Brooklands,
Howden Road,
Tiverton,
Devon
EX16 5HW

Project No.	Project Name
10501	Watchet Harbour
Client Job No.	**Client**
10501	Internal

Hole No.	Sample				Specimen Depth	Axial / Diametral / Irregular	THICKNESS (mm) - D	WIDTH (mm) - W	DIAMETER (mm) - D	BREAKING LOAD (kN) - P	D^2_e (mm^2)	Is (MPa)	De	De/50	k_{PLT}	Is 50 (MPa)	Sample Description
	Ref.	Top	Base	Type													
BH101	-	10.6	10.7	C		A	76.80	79.12		1.2	7736.73	0.16	87.96	1.76	1.29	0.20	Brown MUDSTONE
BH101	-	11.5	11.6	C		D			79.84	0.3	6373.89	0.05	79.84	1.60	1.23	0.06	Brown MUDSTONE
BH102	-	8.6	8.7	C		D			78.94	4.4	6231.00	0.71	78.94	1.58	1.23	0.87	Brown MUDSTONE
BH103	-	9.3	9.4	C		A	78.01	109.52		0	10877.79	0.00	104.30	2.09	1.39	0.00	Brown MUDSTONE (X)
BH104	-	9.4	9.55	C		A	88.15	79.69		3.2	8944.09	0.36	94.57	1.89	1.33	0.48	Dark grey MUDSTONE
BH104	-	10.1	10.2	C		D			79.93	0	6388.27	0.00	79.93	1.60	1.24	0.00	Dark grey MUDSTONE (X)
BH104	-	11.8	11.9	C		D			79.66	0	6346.25	0.00	79.66	1.59	1.23	0.00	Dark grey MUDSTONE (X)
BH105	-	6.05	6.15	C		D			79.16	5.2	6266.83	0.83	79.16	1.58	1.23	1.02	Grey MUDSTONE
BH105	-	6.4	6.5	C		I	170.60	74.76		4.7	16238.24	0.29	127.43	2.55	1.52	0.44	Grey MUDSTONE
BH105	-	9.6	9.7	C		I	30.75	77.35		0	3028.74	0.00	55.03	1.10	1.04	0.00	Grey MUDSTONE (X)

Wylie and Mah (1991) Rock Slope Engineering

$I_s = P/D^2_e$ $\quad I_{s\,(50)} = I_s k_{PLT}$

$D^2_e = (4(WD))/p$ $\quad k_{PLT} = (D_e/50)^{0.45}$

$D_e = \sqrt{D^2_e}$

Where a description is followed by (X) this denotes a failure along an existing weakness

Samples tested in accordance with International Journal of Rock Mechanics and Mining.

Lab Sheet Reference: KL011R Point Load

Date	Approved By	Page No.
10/12/18	Nick W-W - QM	1

Appendix G

Geo-environmental Laboratory Test Result

Neil Forrow
South West Geotechnical Ltd
Unit 3 Brooklands
Howden Road
Tiverton
Devon
EX16 5HW

DETS Ltd
Unit 1
Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Kent
ME17 2JN
t: 01622 850410
russell.jarvis@dets.co.uk

4480

DETS Report No: 18-85076

Site Reference:	Watchet Harbour
Project / Job Ref:	10501/T4026A
Order No:	None Supplied
Sample Receipt Date:	13/11/2018
Sample Scheduled Date:	13/11/2018
Report Issue Number:	2
Reporting Date:	07/12/2018

Authorised by:

Russell Jarvis
Associate Director of Client Services

This report supersedes 18-85076.

DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

4480

Soil Analysis Certificate							
DETS Report No: 18-85076	Date Sampled	06/11/18	07/11/18				
South West Geotechnical Ltd	Time Sampled	None Supplied	None Supplied				
Site Reference: Watchet Harbour	TP / BH No	BH101	BH102				
Project / Job Ref: 10501/T4026A	Additional Refs	None Supplied	None Supplied				
Order No: None Supplied	Depth (m)	0.40	0.80				
Reporting Date: 07/12/2018	DETS Sample No	371998	371999				

Determinand	Unit	RL	Accreditation					
Asbestos Screen (S)	N/a	N/a	ISO17025	Not Detected	Not Detected			
pH	pH Units	N/a	MCERTS	8.4	7.8			
Total Cyanide	mg/kg	< 2	NONE	< 2	< 2			
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	MCERTS	56	1420			
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	MCERTS	0.06	1.42			
Organic Matter	%	< 0.1	MCERTS	1.8	7.2			
Arsenic (As)	mg/kg	< 2	MCERTS	8	16			
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	0.3	0.3			
Chromium (Cr)	mg/kg	< 2	MCERTS	14	15			
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2			
Copper (Cu)	mg/kg	< 4	MCERTS	28	138			
Lead (Pb)	mg/kg	< 3	MCERTS	43	284			
Mercury (Hg)	mg/kg	< 1	NONE	< 1	1.8			
Nickel (Ni)	mg/kg	< 3	MCERTS	16	31			
Selenium (Se)	mg/kg	< 3	NONE	< 3	< 3			
Zinc (Zn)	mg/kg	< 3	MCERTS	61	166			

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C
Subcontracted analysis (S)

DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

4480

Soil Analysis Certificate - Speciated PAHs							
DETS Report No: 18-85076	Date Sampled	06/11/18	07/11/18			
South West Geotechnical Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Watchet Harbour	TP / BH No	BH101	BH102			
Project / Job Ref: 10501/T4026A	Additional Refs	None Supplied	None Supplied			
Order No: None Supplied	Depth (m)	0.40	0.80			
Reporting Date: 07/12/2018	DETS Sample No	371998	371999			

Determinand	Unit	RL	Accreditation					
Naphthalene	mg/kg	< 0.1	MCERTS	0.14	0.17			
Acenaphthylene	mg/kg	< 0.1	MCERTS	0.12	< 0.1			
Acenaphthene	mg/kg	< 0.1	MCERTS	0.23	< 0.1			
Fluorene	mg/kg	< 0.1	MCERTS	0.23	< 0.1			
Phenanthrene	mg/kg	< 0.1	MCERTS	1.19	0.32			
Anthracene	mg/kg	< 0.1	MCERTS	0.34	< 0.1			
Fluoranthene	mg/kg	< 0.1	MCERTS	1.52	0.26			
Pyrene	mg/kg	< 0.1	MCERTS	1.50	0.25			
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	1.02	0.42			
Chrysene	mg/kg	< 0.1	MCERTS	0.70	0.13			
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	1.60	0.47			
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	0.45	< 0.1			
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	1.11	0.24			
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	1.12	0.42			
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	0.42	< 0.1			
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	0.83	0.24			
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	12.5	2.9			

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

4480

Soil Analysis Certificate - TPH CWG Banded							
DETS Report No: 18-85076	Date Sampled	06/11/18	07/11/18				
South West Geotechnical Ltd	Time Sampled	None Supplied	None Supplied				
Site Reference: Watchet Harbour	TP / BH No	BH101	BH102				
Project / Job Ref: 10501/T4026A	Additional Refs	None Supplied	None Supplied				
Order No: None Supplied	Depth (m)	0.40	0.80				
Reporting Date: 07/12/2018	DETS Sample No	371998	371999				

Determinand	Unit	RL	Accreditation					
Aliphatic >C5 - C6	mg/kg	< 0.01	NONE	< 0.01	< 0.01			
Aliphatic >C6 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05			
Aliphatic >C8 - C10	mg/kg	< 2	MCERTS	< 2	< 2			
Aliphatic >C10 - C12	mg/kg	< 2	MCERTS	< 2	< 2			
Aliphatic >C12 - C16	mg/kg	< 3	MCERTS	< 3	< 3			
Aliphatic >C16 - C21	mg/kg	< 3	MCERTS	5	< 3			
Aliphatic >C21 - C34	mg/kg	< 10	MCERTS	202	< 10			
Aliphatic (C5 - C34)	mg/kg	< 21	NONE	207	< 21			
Aromatic >C5 - C7	mg/kg	< 0.01	NONE	< 0.01	< 0.01			
Aromatic >C7 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05			
Aromatic >C8 - C10	mg/kg	< 2	MCERTS	< 2	< 2			
Aromatic >C10 - C12	mg/kg	< 2	MCERTS	< 2	< 2			
Aromatic >C12 - C16	mg/kg	< 2	MCERTS	< 2	< 2			
Aromatic >C16 - C21	mg/kg	< 3	MCERTS	13	< 3			
Aromatic >C21 - C35	mg/kg	< 10	MCERTS	462	< 10			
Aromatic (C5 - C35)	mg/kg	< 21	NONE	474	< 21			
Total >C5 - C35	mg/kg	< 42	NONE	681	< 42			

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

Soil Analysis Certificate - BTEX / MTBE							
DETS Report No: 18-85076	Date Sampled	06/11/18	07/11/18			
South West Geotechnical Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Watchet Harbour	TP / BH No	BH101	BH102			
Project / Job Ref: 10501/T4026A	Additional Refs	None Supplied	None Supplied			
Order No: None Supplied	Depth (m)	0.40	0.80			
Reporting Date: 07/12/2018	DETS Sample No	371998	371999			

Determinand	Unit	RL	Accreditation					
Benzene	ug/kg	< 2	MCERTS	< 2	< 2			
Toluene	ug/kg	< 5	MCERTS	< 5	< 5			
Ethylbenzene	ug/kg	< 2	MCERTS	< 2	< 2			
p & m-xylene	ug/kg	< 2	MCERTS	6	< 2			
o-xylene	ug/kg	< 2	MCERTS	< 2	< 2			
MTBE	ug/kg	< 5	MCERTS	< 5	< 5			

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

mCERTS THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

UKAS TESTING 4480

Waste Acceptance Criteria Analytical Certificate - BS EN 12457/3

DETS Report No: 18-85076	Date Sampled	07/11/18	
South West Geotechnical Ltd	Time Sampled	None Supplied	
Site Reference: Watchet Harbour	TP / BH No	BH102	
Project / Job Ref: 10501/T4026A	Additional Refs	None Supplied	
Order No: None Supplied	Depth (m)	0.80	
Reporting Date: 07/12/2018	DETS Sample No	371999	

Determinand	Unit	MDL		Landfill Waste Acceptance Criteria Limits: Inert Waste Landfill	Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill	Hazardous Waste Landfill
TOC[MU]	%	< 0.1	4.2	3%	5%	6%
Loss on Ignition	%	< 0.01	16.50	--	--	10%
BTEX[MU]	mg/kg	< 0.05	< 0.05	6	--	--
Sum of PCBs	mg/kg	< 0.1	< 0.1	1	--	--
Mineral Oil[MU]	mg/kg	< 10	< 10	500	--	--
Total PAH[MU]	mg/kg	< 1.7	2.9	100	--	--
pH[MU]	pH Units	N/a	7.8	--	>6	--
Acid Neutralisation Capacity	mol/kg (+/-)	< 1	1.9	--	To be evaluated	To be evaluated

Eluate Analysis		2:1 mg/l	8:1 mg/l		Cumulative 10:1 mg/kg	Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg (mg/kg)		
Arsenic[U]		< 0.01	< 0.01		< 0.2	0.5	2	25
Barium[U]		0.05	0.05		0.5	20	100	300
Cadmium[U]		< 0.0005	< 0.0005		< 0.02	0.04	1	5
Chromium[U]		< 0.005	< 0.005		< 0.20	0.5	10	70
Copper[U]		< 0.01	< 0.01		< 0.5	2	50	100
Mercury[U]		< 0.005	< 0.005		< 0.01	0.01	0.2	2
Molybdenum[U]		0.028	0.010		0.1	0.5	10	30
Nickel[U]		< 0.007	< 0.007		< 0.2	0.4	10	40
Lead[U]		< 0.005	< 0.005		< 0.2	0.5	10	50
Antimony[U]		0.017	0.012		0.12	0.06	0.7	5
Selenium[U]		< 0.005	< 0.005		< 0.1	0.1	0.5	7
Zinc[U]		0.006	< 0.005		< 0.2	4	50	200
Chloride[U]		9	1		24	800	15000	25000
Fluoride[U]		< 0.5	< 0.5		< 1	10	150	500
Sulphate[U]		524	45		1079	1000	20000	50000
TDS		555	114		1722	4000	60000	100000
Phenol Index		< 0.01	< 0.01		< 0.5	1	-	-
DOC		4.6	7.1		67.9	500	800	1000

Leach Test Information						
Sample Mass (kg)			0.20			
Dry Matter (%)			87.8			
Moisture (%)			14			
Stage 1						
Volume Eluate L2 (litres)			0.33			
Filtered Eluate VE1 (litres)			0.23			

Results are expressed on a dry weight basis, after correction for moisture content where applicable
Stated limits are for guidance only and QTS Environmental cannot be held responsible for any discrepencies with current legislation
M Denotes MCERTS accredited test
U Denotes ISO17025 accredited test

DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

4480

Soil Analysis Certificate - Sample Descriptions	
DETS Report No: 18-85076	
South West Geotechnical Ltd	
Site Reference: Watchet Harbour	
Project / Job Ref: 10501/T4026A	
Order No: None Supplied	
Reporting Date: 07/12/2018	

DETS Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
371998	BH101	None Supplied	0.40	4.5	Brown sandy gravel with stones and concrete
371999	BH102	None Supplied	0.80	12.2	Black sandy clay with stones

Moisture content is part of procedure E003 & is not an accredited test

Insufficient Sample I/S

Unsuitable Sample U/S

DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

4480

Soil Analysis Certificate - Methodology & Miscellaneous Information
DETS Report No: 18-85076
South West Geotechnical Ltd
Site Reference: Watchet Harbour
Project / Job Ref: 10501/T4026A
Order No: None Supplied
Reporting Date: 07/12/2018

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 – C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10 C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received

Neil Forrow
South West Geotechnical Ltd
Unit 3 Brooklands
Howden Road
Tiverton
Devon
EX16 5HW

DETS Ltd
Unit 1
Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Kent
ME17 2JN
t: 01622 850410
russell.jarvis@dets.co.uk

4480

DETS Report No: 18-85540

Site Reference:	Watchet Harbour
Project / Job Ref:	10501 / T4026B
Order No:	None Supplied
Sample Receipt Date:	22/11/2018
Sample Scheduled Date:	22/11/2018
Report Issue Number:	1
Reporting Date:	28/11/2018

Authorised by:

Dave Ashworth
Deputy Quality Manager

Authorised by:

DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

Soil Analysis Certificate							
DETS Report No: 18-85540	Date Sampled	08/11/18	08/11/18	09/11/18	09/11/18	13/11/18	
South West Geotechnical Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied	
Site Reference: Watchet Harbour	TP / BH No	BH102	BH102	BH103	BH103	BH104	
Project / Job Ref: 10501 / T4026B	Additional Refs	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied	
Order No: None Supplied	Depth (m)	1.40 - 2.70	4.60	0.50	3.20	3.20 - 4.20	
Reporting Date: 28/11/2018	DETS Sample No	374058	374059	374061	374062	374063	
Determinand	Unit	RL	Accreditation				
Asbestos Screen (S)	N/a	N/a	ISO17025			Not Detected	
pH	pH Units	N/a	MCERTS	7.8	8.0	10.0	8.6	8.8
Total Cyanide	mg/kg	< 2	NONE			< 2		
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	MCERTS	775	609	47	295	251
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	MCERTS	0.77	0.61	0.05	0.30	0.25
Organic Matter	%	< 0.1	MCERTS			0.5		
Arsenic (As)	mg/kg	< 2	MCERTS			17		
Cadmium (Cd)	mg/kg	< 0.2	MCERTS			< 0.2		
Chromium (Cr)	mg/kg	< 2	MCERTS			18		
Chromium (hexavalent)	mg/kg	< 2	NONE			< 2		
Copper (Cu)	mg/kg	< 4	MCERTS			23		
Lead (Pb)	mg/kg	< 3	MCERTS			10		
Mercury (Hg)	mg/kg	< 1	NONE			< 1		
Nickel (Ni)	mg/kg	< 3	MCERTS			26		
Selenium (Se)	mg/kg	< 3	NONE			< 3		
Zinc (Zn)	mg/kg	< 3	MCERTS			36		

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C
Subcontracted analysis (S)

DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

Soil Analysis Certificate							
DETS Report No: 18-85540	Date Sampled	13/11/18	14/11/18				
South West Geotechnical Ltd	Time Sampled	None Supplied	None Supplied				
Site Reference: Watchet Harbour	TP / BH No	BH104	BH105				
Project / Job Ref: 10501 / T4026B	Additional Refs	None Supplied	None Supplied				
Order No: None Supplied	Depth (m)	4.50	1.00				
Reporting Date: 28/11/2018	DETS Sample No	374064	374065				

Determinand	Unit	RL	Accreditation					
Asbestos Screen (S)	N/a	N/a	ISO17025	Not Detected	Not Detected			
pH	pH Units	N/a	MCERTS	9.0	5.7			
Total Cyanide	mg/kg	< 2	NONE	< 2	< 2			
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	MCERTS	240	27			
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	MCERTS	0.24	0.03			
Organic Matter	%	< 0.1	MCERTS	1.5	1.2			
Arsenic (As)	mg/kg	< 2	MCERTS	7	13			
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	1.4	0.3			
Chromium (Cr)	mg/kg	< 2	MCERTS	10	14			
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2			
Copper (Cu)	mg/kg	< 4	MCERTS	22	23			
Lead (Pb)	mg/kg	< 3	MCERTS	16	36			
Mercury (Hg)	mg/kg	< 1	NONE	< 1	< 1			
Nickel (Ni)	mg/kg	< 3	MCERTS	15	22			
Selenium (Se)	mg/kg	< 3	NONE	< 3	< 3			
Zinc (Zn)	mg/kg	< 3	MCERTS	222	96			

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C
Subcontracted analysis (S)

DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

Soil Analysis Certificate - Speciated PAHs							
DETS Report No: 18-85540	Date Sampled	09/11/18	13/11/18	14/11/18		
South West Geotechnical Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: Watchet Harbour	TP / BH No	BH103	BH104	BH105		
Project / Job Ref: 10501 / T4026B	Additional Refs	None Supplied	None Supplied	None Supplied		
Order No: None Supplied	Depth (m)	0.50	4.50	1.00		
Reporting Date: 28/11/2018	DETS Sample No	374061	374064	374065		

Determinand	Unit	RL	Accreditation					
Naphthalene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Acenaphthylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Acenaphthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Fluorene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Phenanthrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Fluoranthene	mg/kg	< 0.1	MCERTS	0.11	< 0.1	< 0.1		
Pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Chrysene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	0.12	< 0.1	< 0.1		
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	0.17	< 0.1	< 0.1		
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1		
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	0.20	< 0.1	< 0.1		
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	< 1.6	< 1.6	< 1.6		

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

Soil Analysis Certificate - TPH CWG Banded							
DETS Report No: 18-85540	Date Sampled	09/11/18	13/11/18	14/11/18			
South West Geotechnical Ltd	Time Sampled	None Supplied	None Supplied	None Supplied			
Site Reference: Watchet Harbour	TP / BH No	BH103	BH104	BH105			
Project / Job Ref: 10501 / T4026B	Additional Refs	None Supplied	None Supplied	None Supplied			
Order No: None Supplied	Depth (m)	0.50	4.50	1.00			
Reporting Date: 28/11/2018	DETS Sample No	374061	374064	374065			

Determinand	Unit	RL	Accreditation					
Aliphatic >C5 - C6	mg/kg	< 0.01	NONE	< 0.01	< 0.01	< 0.01		
Aliphatic >C6 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05	< 0.05		
Aliphatic >C8 - C10	mg/kg	< 2	MCERTS	< 2	< 2	< 2		
Aliphatic >C10 - C12	mg/kg	< 2	MCERTS	< 2	< 2	< 2		
Aliphatic >C12 - C16	mg/kg	< 3	MCERTS	< 3	< 3	< 3		
Aliphatic >C16 - C21	mg/kg	< 3	MCERTS	< 3	< 3	< 3		
Aliphatic >C21 - C34	mg/kg	< 10	MCERTS	< 10	< 10	< 10		
Aliphatic (C5 - C34)	mg/kg	< 21	NONE	< 21	< 21	< 21		
Aromatic >C5 - C7	mg/kg	< 0.01	NONE	< 0.01	< 0.01	< 0.01		
Aromatic >C7 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05	< 0.05		
Aromatic >C8 - C10	mg/kg	< 2	MCERTS	< 2	< 2	< 2		
Aromatic >C10 - C12	mg/kg	< 2	MCERTS	< 2	< 2	< 2		
Aromatic >C12 - C16	mg/kg	< 2	MCERTS	< 2	< 2	< 2		
Aromatic >C16 - C21	mg/kg	< 3	MCERTS	< 3	< 3	< 3		
Aromatic >C21 - C35	mg/kg	< 10	MCERTS	< 10	< 10	< 10		
Aromatic (C5 - C35)	mg/kg	< 21	NONE	< 21	< 21	< 21		
Total >C5 - C35	mg/kg	< 42	NONE	< 42	< 42	< 42		

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

4480

Soil Analysis Certificate - BTEX / MTBE							
DETS Report No: 18-85540	Date Sampled	09/11/18	13/11/18	14/11/18			
South West Geotechnical Ltd	Time Sampled	None Supplied	None Supplied	None Supplied			
Site Reference: Watchet Harbour	TP / BH No	BH103	BH104	BH105			
Project / Job Ref: 10501 / T4026B	Additional Refs	None Supplied	None Supplied	None Supplied			
Order No: None Supplied	Depth (m)	0.50	4.50	1.00			
Reporting Date: 28/11/2018	DETS Sample No	374061	374064	374065			

Determinand	Unit	RL	Accreditation					
Benzene	ug/kg	< 2	MCERTS	< 2	< 2	< 2		
Toluene	ug/kg	< 5	MCERTS	< 5	< 5	< 5		
Ethylbenzene	ug/kg	< 2	MCERTS	< 2	< 2	< 2		
p & m-xylene	ug/kg	< 2	MCERTS	< 2	< 2	< 2		
o-xylene	ug/kg	< 2	MCERTS	< 2	< 2	< 2		
MTBE	ug/kg	< 5	MCERTS	< 5	< 5	< 5		

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

MCERTS THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME
UKAS TESTING 4480

Waste Acceptance Criteria Analytical Certificate - BS EN 12457/3

DETS Report No: 18-85540		Date Sampled	13/11/18				Landflll Waste Acceptance Criteria Limits		
South West Geotechnical Ltd		Time Sampled	None Supplied				Inert Waste Landfill	Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill	Hazardous Waste Landfill
Site Reference: Watchet Harbour		TP / BH No	BH104						
Project / Job Ref: 10501 / T4026B		Additional Refs	None Supplied						
Order No: None Supplied		Depth (m)	4.50						
Reporting Date: 28/11/2018		DETS Sample No	374064						
Determinand	Unit	MDL							
TOC[MU]	%	< 0.1	0.9				3%	5%	6%
Loss on Ignition	%	< 0.01	2.30				--	--	10%
BTEX[MU]	mg/kg	< 0.05	< 0.05				6	--	--
Sum of PCBs	mg/kg	< 0.1	< 0.1				1	--	--
Mineral Oil[MU]	mg/kg	< 10	< 10				500	--	--
Total PAH[MU]	mg/kg	< 1.7	< 1.7				100	--	--
pH[MU]	pH Units	N/a	9.0				--	>6	--
Acid Neutralisation Capacity	mol/kg (+/-)	< 1	2.5				--	To be evaluated	To be evaluated
Eluate Analysis			2:1 mg/l	8:1 mg/l		Cumulative 10:1 mg/kg	Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg (mg/kg)		
Arsenic[U]			< 0.01	< 0.01		< 0.2	0.5	2	25
Barium[U]			0.02	< 0.02		< 0.1	20	100	300
Cadmium[U]			< 0.0005	< 0.0005		< 0.02	0.04	1	5
Chromium[U]			< 0.005	< 0.005		< 0.20	0.5	10	70
Copper[U]			< 0.01	< 0.01		< 0.5	2	50	100
Mercury[U]			< 0.005	< 0.005		< 0.01	0.01	0.2	2
Molybdenum[U]			0.054	0.020		0.2	0.5	10	30
Nickel[U]			< 0.007	< 0.007		< 0.2	0.4	10	40
Lead[U]			< 0.005	< 0.005		< 0.2	0.5	10	50
Antimony[U]			< 0.005	< 0.005		< 0.06	0.06	0.7	5
Selenium[U]			< 0.005	< 0.005		< 0.1	0.1	0.5	7
Zinc[U]			< 0.005	< 0.005		< 0.2	4	50	200
Chloride[U]			675	75		1340	800	15000	25000
Fluoride[U]			1.2	0.6		6.6	10	150	500
Sulphate[U]			147	21		338	1000	20000	50000
TDS			1260	241		3409	4000	60000	100000
Phenol Index			< 0.01	< 0.01		< 0.5	1	-	-
DOC			5.7	10.4		99.2	500	800	1000
Leach Test Information									
Sample Mass (kg)			0.19						
Dry Matter (%)			92.3						
Moisture (%)			8.4						
Stage 1									
Volume Eluate L2 (litres)			0.34						
Filtered Eluate VE1 (litres)			0.17						

Results are expressed on a dry weight basis, after correction for moisture content where applicable
Stated limits are for guidance only and QTS Environmental cannot be held responsible for any discrepencies with current legislation
M Denotes MCERTS accredited test
U Denotes ISO17025 accredited test

DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

Soil Analysis Certificate - Sample Descriptions	
DETS Report No: 18-85540	
South West Geotechnical Ltd	
Site Reference: Watchet Harbour	
Project / Job Ref: 10501 / T4026B	
Order No: None Supplied	
Reporting Date: 28/11/2018	

DETS Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
$ 374058	BH102	None Supplied	1.40 - 2.70	12.6	Black sandy clay with stones
$ 374059	BH102	None Supplied	4.60	23.4	Brown clay with stones
$ 374061	BH103	None Supplied	0.50	7	Red sandy clay with stones
$ 374062	BH103	None Supplied	3.20	13.6	Red sandy clay with stones
374063	BH104	None Supplied	3.20 - 4.20	11.5	Brown sandy clay with stones
374064	BH104	None Supplied	4.50	7.7	Brown sandy clay with stones
374065	BH105	None Supplied	1.00	11	Brown sandy clay with stones

Moisture content is part of procedure E003 & is not an accredited test

Insufficient Sample I/S

Unsuitable Sample U/S

$ samples exceeded recommended holding times

DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

4480

Soil Analysis Certificate - Methodology & Miscellaneous Information
DETS Report No: 18-85540
South West Geotechnical Ltd
Site Reference: Watchet Harbour
Project / Job Ref: 10501 / T4026B
Order No: None Supplied
Reporting Date: 28/11/2018

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 – C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10 C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received

Neil Forrow
South West Geotechnical Ltd
Unit 3 Brooklands
Howden Road
Tiverton
Devon
EX16 5HW

DETS Ltd
Unit 1
Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Kent
ME17 2JN
t: 01622 850410
russell.jarvis@dets.co.uk

4480

DETS Report No: 18-86156

Site Reference:	Watchet Harbour
Project / Job Ref:	10501 / T4026B
Order No:	None Supplied
Sample Receipt Date:	04/12/2018
Sample Scheduled Date:	04/12/2018
Report Issue Number:	1
Reporting Date:	10/12/2018

Authorised by:

Russell Jarvis
Associate Director of Client Services

DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

4480

Soil Analysis Certificate							
DETS Report No: 18-86156	Date Sampled	08/11/18	15/11/18				
South West Geotechnical Ltd	Time Sampled	None Supplied	None Supplied				
Site Reference: Watchet Harbour	TP / BH No	BH102	BH105				
Project / Job Ref: 10501 / T4026B	Additional Refs	None Supplied	None Supplied				
Order No: None Supplied	Depth (m)	9.30 - 9.40	6.60				
Reporting Date: 10/12/2018	DETS Sample No	376588	376589				

Determinand	Unit	RL	Accreditation					
pH	pH Units	N/a	MCERTS	8.7	8.0			
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	MCERTS	62	480			
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	MCERTS	0.06	0.48			

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C
Subcontracted analysis (S)

DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

4480

Soil Analysis Certificate - Sample Descriptions	
DETS Report No: 18-86156	
South West Geotechnical Ltd	
Site Reference: Watchet Harbour	
Project / Job Ref: 10501 / T4026B	
Order No: None Supplied	
Reporting Date: 10/12/2018	

DETS Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
$ 376588	BH102	None Supplied	9.30 - 9.40	4.6	Red sandy clay
$ 376589	BH105	None Supplied	6.60	4.5	Black sandy clay with stones

Moisture content is part of procedure E003 & is not an accredited test

Insufficient Sample I/S

Unsuitable Sample U/S

$ samples exceeded recommended holding times

DETS Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

4480

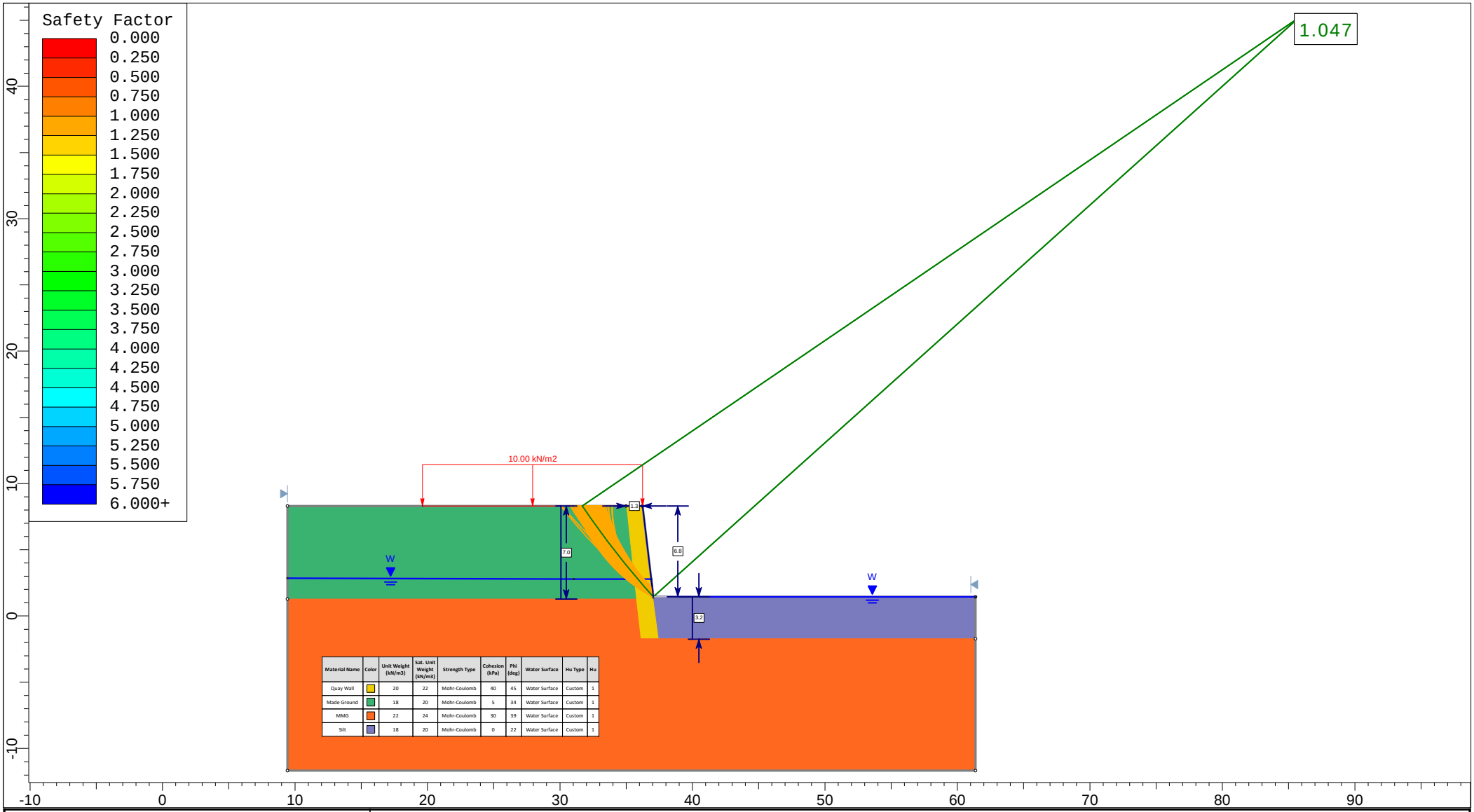
Soil Analysis Certificate - Methodology & Miscellaneous Information
DETS Report No: 18-86156
South West Geotechnical Ltd
Site Reference: Watchet Harbour
Project / Job Ref: 10501 / T4026B
Order No: None Supplied
Reporting Date: 10/12/2018

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 – C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10 C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received

Appendix H

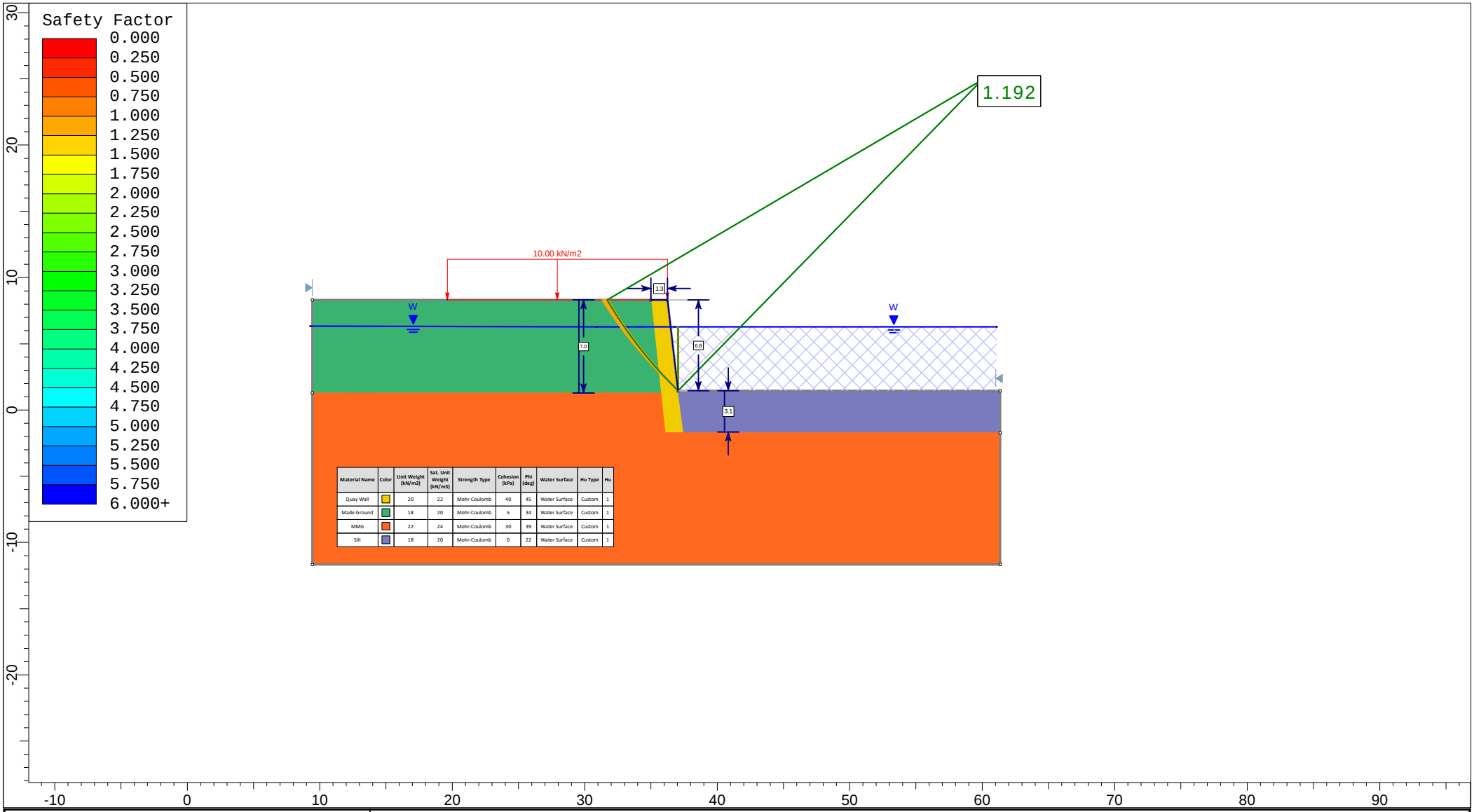
Stability Analysis Results



rocscience

SLIDEINTERPRET 8.020

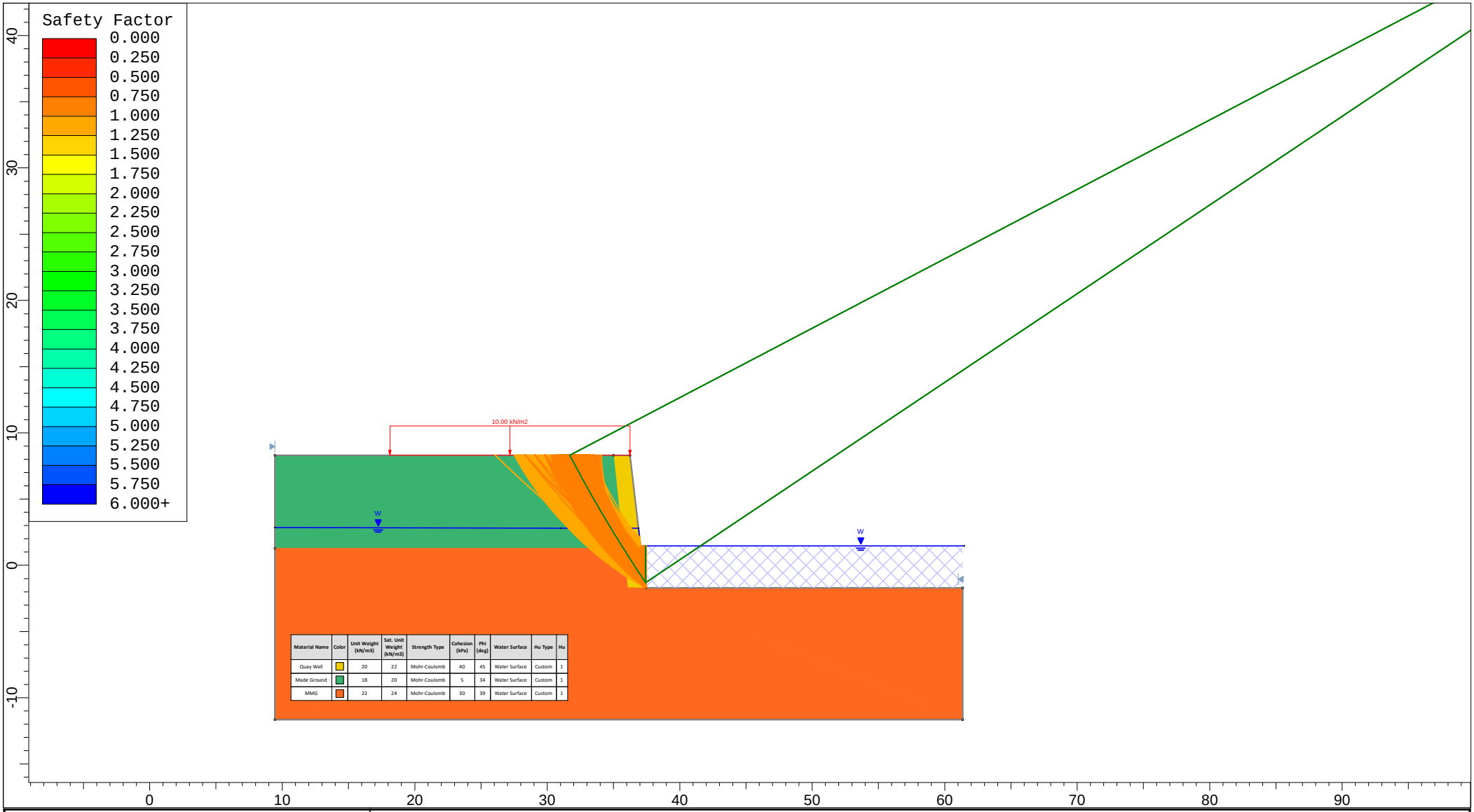
Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description	Section 1 BH101 Low Tide		
Drawn By		*Scale* 1:400	*Company*
Date	14/12/2018, 11:39:15		*File Name* 10501 BH101.slmd



rocscience

SLIDEINTERPRET 8.020

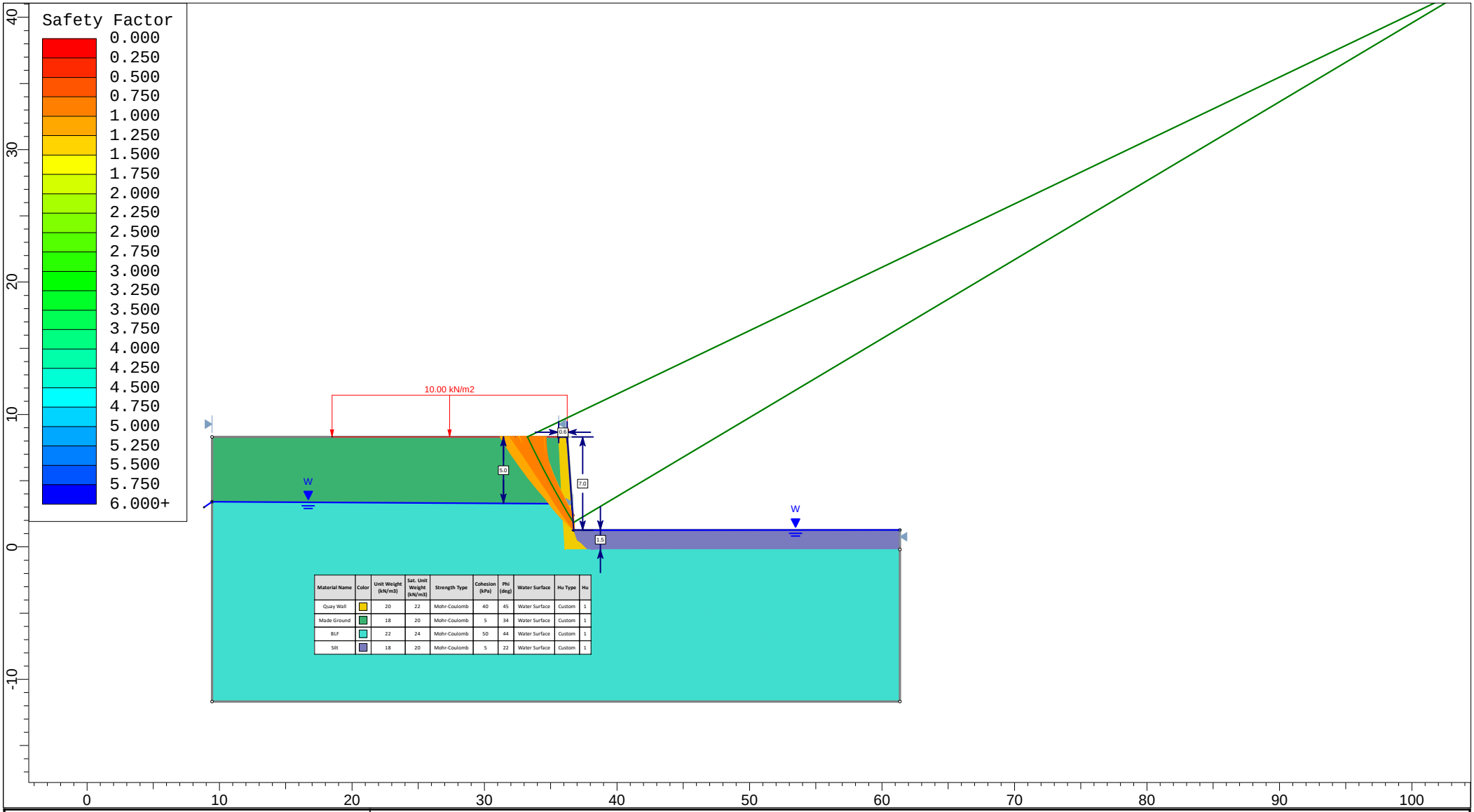
Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description	Section 1 BH101 High Tide		
Drawn By		*Scale* 1:400	*Company*
Date	14/12/2018, 11:39:15		*File Name* 10501 BH101 - High Tide.slmd



rocscience

SLIDEINTERPRET 8.020

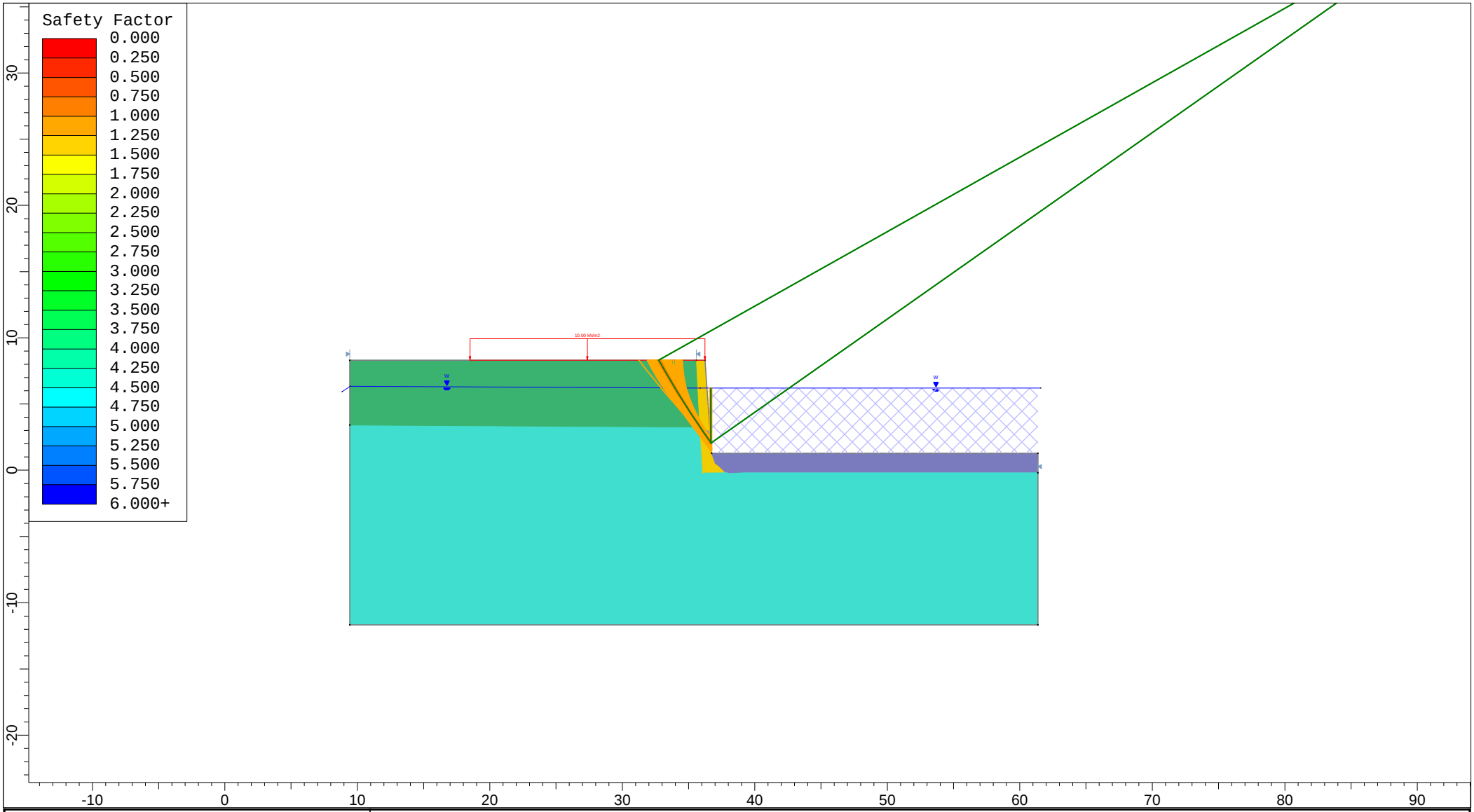
Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description	Section 1 BH1010 Silt Dredged		
Drawn By		*Scale* 1:400	*Company*
Date	14/12/2018, 11:39:15		*File Name* 10501 BH101 - No silt.slmd



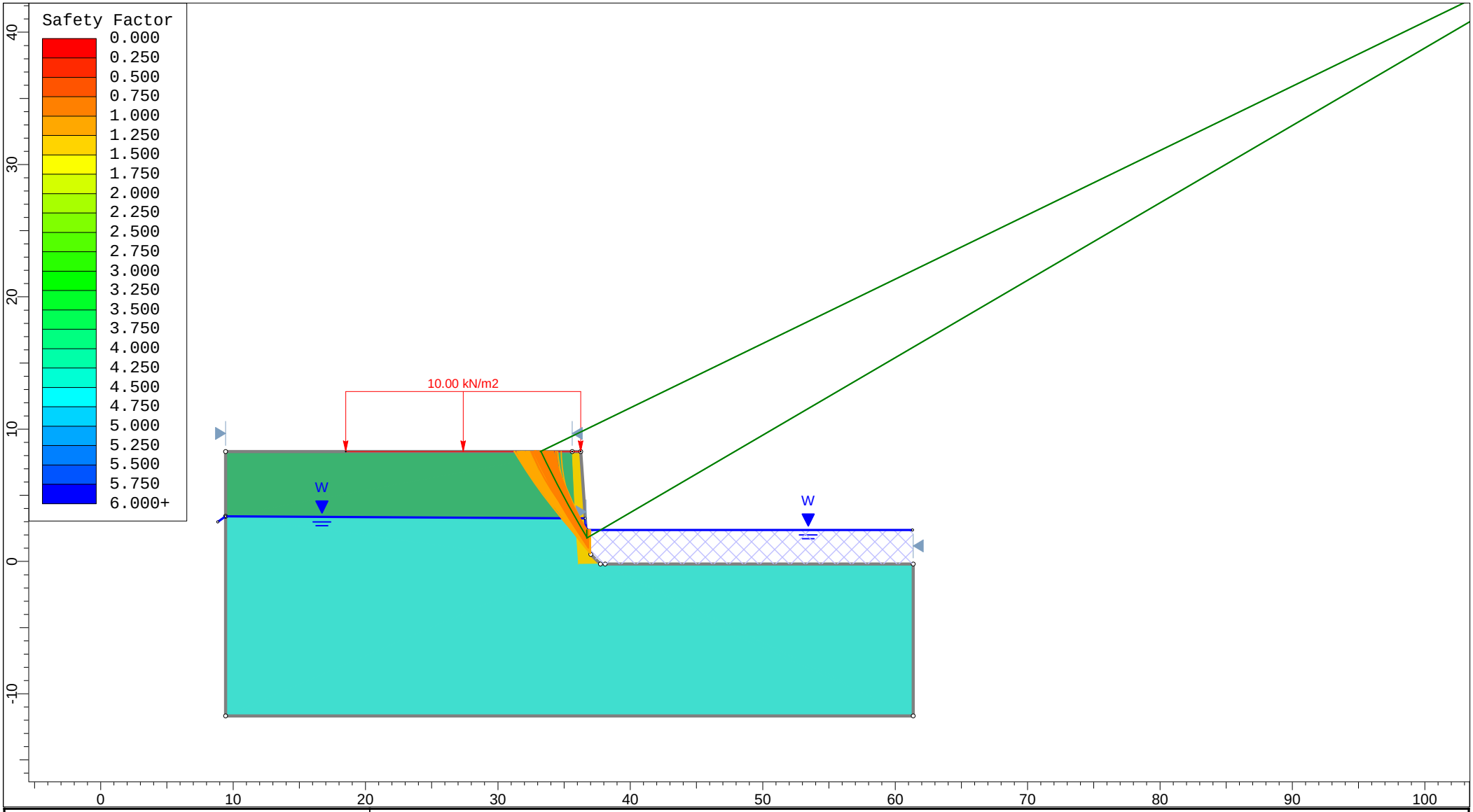
rocscience

SLIDEINTERPRET 8.020

Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description	Section 3 BH105 Low Tide		
Drawn By		*Scale* 1:400	*Company*
Date	14/12/2018, 11:39:15		*File Name* 10501 BH105.slmd



rocscience	*Project* SLIDE - An Interactive Slope Stability Program		
	Analysis Description Section 3 BH105 High Tide		
	Drawn By	*Scale* 1:400	*Company*
SLIDEINTERPRET 8.020	*Date* 14/12/2018, 11:39:15		*File Name* 10501 BH105 - High Tide.slmd



rocscience

SLIDEINTERPRET 8.020

Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description	Section 3 BH105 Dredged		
Drawn By		*Scale* 1:400	*Company*
Date	14/12/2018, 11:39:15		*File Name* 10501 BH105 - No silt.slmd