

# PHASE 2 GROUND INVESTIGATION

Lidl Great Britain Ltd

Former Severn Bridge Club, Chepstow

Client: Lidl Great Britain Ltd

*Remada Ltd*  
[www.remada.co.uk](http://www.remada.co.uk)

799.02.02  
July 2021



## **Executive Summary**

Remada Ltd was commissioned by Lidl Great Britain Ltd to conduct a Phase 2 Ground Investigation at the former Severn Bridge Club, Bulwark Road, Bulwark, Chepstow, NP16 5QZ. This report follows a Phase 1 Preliminary Risk Assessment (Remada report reference 799.01.01 dated December 2020, reissued in July 2021 with reference 799.01.02).

### Summary of Phase 1 Desk Study

The earliest available historic mapping of 1881 indicates the site to be occupied by a residential property 'Fairfield Lodge' with associated garden, woodland and fields. By 1901 the site was being referred to as Fairfield Farm. By 1921, the former field in the eastern margin of the site had been redeveloped by housing blocks of the wider Bulwark Village, which remained until their demolition between 1971 and 1977. The existing Severn Bridge Social Club was developed between 1955 and 1966.

### Intrusive Investigation

The investigation comprised the drilling of eight (8 No) window sample holes (WS1 – WS8) and execution of four (4 No) CBR tests at locations indicated on **Figure 2** between 30th November and 1st December 2020. Due to the nature of the encountered ground conditions, Remada returned to site on Monday 4th January 2021 to undertake additional investigation. This comprised the drilling of two (2 No) rotary boreholes (BH101 and BH102) within the proposed building footprint.

Made Ground was encountered within all ten exploratory holes on-site (WS1 – WS8 and BH101 – 102) and was typically a thin veneer less than 1.0m thick. The maximum thickness of made ground of 1.55m was recorded in WS5 in the southern area of the site.

The published geology indicates the site is directly underlain by Mercia Mudstone Group bedrock, with limestone and dolostone geological units being located off-site to the north. During the window sampling on-site, all the eight boreholes refused within a light brown clayey sandy limestone gravel at depths of between 1.0m and 1.7m bgl.

Subsequent rotary drilling by Remada identified the site to be underlain by yellowish brown limestone bedrock, which was cored to a depth of 4.5m in two locations under the building footprint. The bedrock was recorded as being strong to very strong during field tests, as it required multiple blows of a geological hammer to fracture. The limestone bedrock underlying the site is considered to be representative of the Gully Oolite Formation or Llanelli Formation units recorded to the north and north-east respectively.

### Human Health Assessment

The results of soil chemical analysis were compared to Human Health Generic Assessment Criteria for commercial land use. Dibenz(ah)anthracene was identified in the made ground sample from WS6 at 0.2 – 0.5m bgl at a concentration of 3.8mg/kg however the 95 percentile value is less than the applicable GAC of 3.6 mg/kg. Chrysotile asbestos cement was identified in the sample from WS8 at 0.1 – 0.6m bgl, recording a total concentration of 0.059%.

It is recommended that an asbestos risk assessment is undertaken prior to the commencement of redevelopment works.

### Water Resources Assessment

The results of the soil chemical analysis undertaken has identified that concentrations of metals and inorganic contaminants are within the range of typical made ground. Detectable concentrations of TPH and PAHs were encountered in some samples. However, the contaminants identified are of low solubility and mobility and as such are unlikely to present a risk to groundwater beneath the site. In addition, it should be noted that the site will be predominantly covered with the building and areas of hardstanding. Therefore, the risk of leaching of contaminants as a result of infiltration of groundwater is likely to be limited and does not warrant further consideration.



### Waste Classification

*In general, the results of the chemical analysis indicates that the material would be classified as non-hazardous waste. While Waste Acceptance Criteria (WAC) analysis has not been undertaken, four of the five samples selected for analysis exceeded this TOC limit for disposal in an inert landfill. Therefore, it is considered that the waste should be classified as non-hazardous. WAC testing is not required for disposal of non-hazardous waste to landfill.*

*Two samples of bituminous surfacing was analysed for concentrations of PAH compounds. The results indicated that the concentrations of PAHs were very low (sum <2.0 mg/kg) and benzo(a)pyrene <0.1mg/kg was below the 50mg/kg limit defined in WM3. Therefore, the bituminous surfacing represented by this sample would be classified as non-hazardous waste.*

### Geotechnical Assessment

*It was anticipated that the site would directly underlain by Mercia Mudstone however the window sample rig proved N values of greater than 50 were proven at 1.0 to 1.7m bgl. Consequently, two rotary core holes were bored at two locations within the proposed store footprint and recovered a yellowish-brown limestone bedrock to a depth of 4.5m. Point load testing of recovered samples from the shallow bedrock corresponded with published values for carbonate siltstone/sandstone.*

*Either pad foundation or stiffened raft down stands bearing directly on the limestone of  $N > 50$  and encountered at circa one metre depth is considered a suitable foundation solution. Removal and recompaction of the existing shallow made ground as observed outside the existing footprint may provide a suitable formation for a ground bearing floor slab if correctly engineered. In the event that deeper made ground is encountered following demolition of the existing building, proposed foundations should be deepened as necessary to bear on the underlying bedrock.*

*Finished floor levels are not known at the time of writing this report and it is assumed that these will be close to existing levels. It is important that any voids resulting from the removal of existing foundations are compacted to an appropriate engineering standard prior to the construction of the raft foundation or ground bearing floor slab.*

*A Design Sulphate Class DS-1 is considered appropriate for buried concrete and an ACEC Class of AC-1 is considered appropriate for the location.*

*Shallow limestone bedrock that was encountered will require a 360 tracked excavator (or similar) to break out.*

### Ground Gas & Radon

*The results of four rounds of gas monitoring visits placed the site into Characteristic Situation 1 and therefore ground gas protection measures will not be required within the proposed buildings. However, basic radon protection measures are required. A radon / ground gas membrane will need to be installed and verified in accordance with CIRIA C735 Good Practice on the Testing & Verification of Protection Systems for Buildings Against Hazardous Ground Gases (2014) which sets out industry good practice.*



<b>1</b>	<b>INTRODUCTION</b>	<b>5</b>
1.1	OBJECTIVES	5
1.2	SCOPE OF WORK	5
1.3	PREVIOUS REPORTS	5
1.4	LIMITATIONS	6
<b>2</b>	<b>SUMMARY OF PHASE 1 DESK STUDY</b>	<b>7</b>
<b>3</b>	<b>ENVIRONMENTAL &amp; GEOTECHNICAL INVESTIGATION METHODOLOGY</b>	<b>9</b>
3.1	INVESTIGATION STRATEGY	9
3.2	INTRUSIVE INVESTIGATION	9
3.3	SOIL SAMPLING	10
3.4	GAS AND GROUNDWATER MONITORING	10
3.5	QUALITY ASSURANCE AND QUALITY CONTROL	10
3.6	LABORATORY TESTING	11
<b>4</b>	<b>GEOTECHNICAL &amp; ENVIRONMENTAL INVESTIGATION FINDINGS</b>	<b>12</b>
4.1	GROUND CONDITIONS	12
4.2	IN-SITU TESTING	13
4.3	SOIL OBSERVATIONS	13
4.4	GROUNDWATER OBSERVATIONS	13
4.5	CHEMICAL ANALYSIS	13
4.6	GEOTECHNICAL TESTING	14
4.7	GROUND GAS MONITORING RESULTS	15
<b>5</b>	<b>GENERIC QUANTITATIVE RISK ASSESSMENT</b>	<b>16</b>
5.1	HUMAN HEALTH RISK ASSESSMENT	16
5.2	COMPARISON OF SOIL ANALYSIS RESULTS WITH HUMAN HEALTH GAC	16
5.3	CONTROLLED WATERS RISK ASSESSMENT	17
5.4	GROUND GAS ASSESSMENT	17
5.5	REVISED CONCEPTUAL SITE MODEL	17
5.6	WASTE CLASSIFICATION	18
5.7	HEALTH & SAFETY CONSIDERATIONS	18
<b>6</b>	<b>GEOTECHNICAL SITE ASSESSMENT:</b>	<b>20</b>
6.1	GEOTECHNICAL CONSIDERATIONS	20
6.2	FOUNDATIONS	20
6.3	IMPORTED FILL	20
6.4	EXCAVATIONS AND TEMPORARY WORKS	20
6.5	EXISTING CAR PARK SURFACING	20
6.6	PROTECTION OF BURIED CONCRETE	21
6.7	GENERAL CONSTRUCTION ADVICE	21
<b>7</b>	<b>CONCLUSIONS &amp; RECOMENDATIONS</b>	<b>22</b>
7.1	CONCLUSIONS	22
7.2	RECOMMENDATIONS	23
7.3	GROUND GAS	23
	<b>REFERENCES &amp; GUIDANCE</b>	<b>24</b>
	<b>STUDY LIMITATIONS</b>	<b>25</b>

## TABLES

Table 1	Outline Conceptual Site Model
Table 2	Monitoring Well Installation Details
Table 3	Gas & Groundwater Monitoring Data
Table 4	Comparison of Soil Chemical Analyses with GAC



Table 5 Refined Conceptual Site Model

**GRAPHS**

Graph 1 Plot of Corrected SPT N60 Values vs Depth

**FIGURES**

Figure 1 Site Location Plan  
Figure 2 Exploratory Hole Location Plan  
Figure 3 Proposed Site Layout Plan

**EXPLORATORY LOGS**

**APPENDICES**

Appendix A Dynamic Cone Penetrometer Test Results  
Appendix B Laboratory Chemical Analyses  
Appendix C Laboratory Geotechnical Tests  
Appendix D SPT Hammer Calibration

Issue No	Date	Prepared By	Technical Review	Authorised
01	01.02.2021	P Dickinson <i>P.Dickinson</i>	G Jones <i>G Jones</i>	G Jones <i>G Jones</i>
02 – Revised Layout	13.07.2021	P Dickinson <i>P.Dickinson</i>	G Jones <i>G Jones</i>	G Jones <i>G Jones</i>



## 1 INTRODUCTION

Remada Ltd was commissioned by Lidl Great Britain Ltd to conduct a Phase 2 Ground Investigation at the former Severn Bridge Club, Bulwark Road, Bulwark, Chepstow, NP16 5QZ, at the location indicated in **Figure 1**.

### 1.1 Objectives

The objectives of this assessment are as follows:

- to examine whether there have been any potentially contaminative uses on the site or nearby land;
- to develop a conceptual model of the site to identify plausible pollutant linkages;
- to assess ground conditions in relation to the proposed development in relation to construction design issues including the presence, nature, likely severity and extent of soil and groundwater contamination, which may be present, its potential environmental impact and likely requirement for further work; and
- Provide preliminary foundation design recommendations for the proposed development.

### 1.2 Scope of Work

The scope of the investigation is generally in accordance with BS10175:2011+A2 2017 and layout of this report has been designed in mind of the Environment Agency's Land Contamination Risk Management guidance for land contamination reports.

The scope of work comprised:

- 4 No window sample boreholes to target depths of 6m including SPTs;
- 4 No window sample boreholes to target depths of 3m including SPTs;
- 3 No combined groundwater and gas monitoring standpipes installed with window sample boreholes;
- 4 No California Bearing Ratio (CBR) tests;
- Suite of geotechnical classification and strength tests;
- 5 No soil sample suites for chemical analysis of CLEA metals, asbestos, speciated hydrocarbons, cyanide and phenols to further delineate soil contamination;
- 4 No ground gas and groundwater monitoring visits to satisfy planning requirements; and
- Combined Factual & Interpretative Geoenvironmental Report.

Four plate bearing tests were proposed but in agreement with the client these were not carried out to prevent damage to the operational car park. Alternatively, a supplementary phase of intrusive ground investigation was carried in January 2021 that comprised:

- 2 No rotary boreholes to target depths of circa 5.0m including SPTs to determine the nature/composition of the strata below 1.0m bgl.
- Update to the Combined Factual & Interpretative Geoenvironmental Report.

### 1.3 Previous Reports

The following Phase 1 Desk Study had been previously prepared for the site:



- Phase 1 Site Investigation & Preliminary Risk Assessment. Remada Ltd Report ref: 799.01.02, July 2021.

#### **1.4 Limitations**

The comments given in this report and the opinions expressed are based on the information reviewed and observations during site work. However, there may be conditions pertaining to the site that have not been disclosed by this assessment and therefore could not be taken into account.



## 2 SUMMARY OF PHASE 1 DESK STUDY

The Executive Summary and Conceptual Site Model presented within the Phase 1 Desk Study are reproduced below:

### **Site Setting**

*The site occupies a rectangular shaped plot of land, located within the north-west corner of Bulwark Industrial Estate, off Bulwark Road, and is situated approximately 1 km south of Chepstow Town Centre.*

*The site is currently occupied by the former Severn Bridge Club building and surrounding car park, and the adjacent Malvern Tyres. The southern and south-western site boundaries are delineated by wire mesh fencing, with part of the western boundary comprising wooden fencing. Hedgerows delineate part of the northern boundary. Metal fencing currently separates the Severn Bridge Club and Malvern Tyres.*

### **Site History**

*The earliest available historic mapping of 1881 indicates the site to be occupied by a residential property 'Fairfield Lodge' with associated garden, woodland and fields. By 1901 the site was being referred to as Fairfield Farm. By 1921, the former field in the eastern margin of the site had been redeveloped by housing blocks of the wider Bulwark Village, which remained until their demolition between 1971 and 1977. The existing Severn Bridge Social Club was developed between 1955 and 1966.*

### **Geology / Hydrogeology**

*Published geological maps record that the site is directly underlain by the Mercia Mudstone Group, designated as a Principal Aquifer.*

### **Mining**

*The site is not located within an area which may be affected by coal mining activity.*

### **Environmental Risk Assessment**

*The desk study has identified a number of on-site and off-site potential sources of contamination that would require further investigation. The following is recommended:*

- *Investigation of the lateral and vertical extent of made ground beneath the site;*
- *Collection of soil and groundwater samples from the areas identified above for contaminants of concern; and*
- *Ground gas monitoring.*

### **Geotechnical Assessment**

*It is recommended that a ground investigation is undertaken to enable preliminary foundation design.*





Potential Source Areas	Potential Contaminant of Concern	Pathways	Potential Receptor	Exposure Route (Human unless otherwise stated)	Potential Identified Linkage (unmitigated)	Findings of Ground investigation	Risk (Unmitigated)	Proposed Remediation (Mitigation) Measures	Residual Risk Estimation	
<b>On-site Sources</b>										
<b>General Made Ground</b>	Asbestos / Metals As, Be, Cd, Cu, Cr (VI), Cr (III) Hg, Ni, Se, Va, Zn, Boron, TPH /PAH, PCBs	Disturbance due to construction plant causing direct contact, dusts, vapours.	Occupants of the development / building fabric	• Direct Soil Ingestion	Yes	To be assessed (TBA)	Potential risk	(To be assessed (TBA)	(To be assessed (TBA)	
• Indoor Dust ingestion				Yes	As above	Potential risk	TBA	TBA		
• Skin Contact with Soils				Yes	As above	Potential risk	TBA	TBA		
<b>Off-site Sources</b>										
<b>Made Ground</b>		Direct Contact with occupants of the proposed development	Inhalation of fibres / vapours / gases by occupants of proposed development	Adjacent residents during construction	• Skin Contact with Dust	Yes	As above	Potential risk	TBA	TBA
<b>Builders Yard</b>					• Inhalation of Outdoor Dust	Yes	As above	Potential risk	TBA	TBA
<b>Tyre Depot</b>					• Inhalation of Outdoor Vapours	Yes	As above	Potential risk	TBA	TBA
<b>Bus Depot</b>					• Inhalation of ground gas	Yes	As above	Potential risk	TBA	TBA
<b>Electricity Sub-Station</b>					• Inhalation of radon gas	Yes	Intermediate Probability Radon Area	Potential Risk	Basic Radon Protection Measures	Low
<b>Tanks</b>					• Inhalation of Indoor Vapours	Yes	As above	Potential risk	TBA	TBA
<b>Various works, factories and warehouses</b>					• Ingestion via permeated water supply pipework	Yes	As above	Potential risk	TBA	TBA
<b>Residential premises</b>					• Inhalation of ground gas	Yes	As above	Potential risk	TBA	TBA
					• Leaching to Principal Aquifers in Bedrock deposits	Yes	As above	Potential risk	TBA	TBA
	Leachate				Principal Aquifers					

**Table 1: Outline Conceptual Site Model**

Direct contact with subsurface soil and/or groundwater during redevelopment works are not assessed as part of the CSM. It is considered that risks to workers will be managed as part of any the redevelopment works at the site through the application of health and safety procedures, where required.



### 3 ENVIRONMENTAL & GEOTECHNICAL INVESTIGATION METHODOLOGY

#### 3.1 Investigation Strategy

In accordance with Lidl Ground Investigation standard 04.2018, four (4 No). window sample holes were required beneath the proposed store footprint to a depth of 6m or refusal, and four (4 No) beneath the delivery bay, HGV access and car park. Four (4 No) CBR tests were conducted in the proposed car park. Four (4 No) ground gas monitoring visits were scheduled for the site to provide the minimum required by C665.

The investigation comprised the drilling of eight (8 No) window sample holes (WS1 – WS8) and execution of four (4 No) CBR tests at locations indicated on **Figure 2** between 30th November and 1st December 2020.

Due to the nature of the encountered ground conditions, Remada returned to site on Monday 4th January 2021 to undertake additional investigation. This comprised the drilling of two (2 No) rotary boreholes (BH101 and BH102) within the proposed building footprint at the locations indicated on **Figure 2**.

All exploratory holes were logged by a suitably qualified Geo-environmental Engineer in general accordance with the recommendations of BS5930:2015. Detailed descriptions, together with relevant comments, are given in the Exploratory Hole Logs.

#### 3.2 Intrusive Investigation

##### 3.2.1 Window Sample Holes

Four of the window samples were advanced to a target depth of 6m and four to a target depth of 3m. However, as SPT refusals were encountered at relatively shallow depths, all window sample holes were advanced only to depths of between 1.0m and 1.7m below ground level (bgl). Combined Groundwater and Ground Gas monitoring standpipes were installed in WS1, WS3 and WS4.

Standard Penetration Tests (SPTs) in the window samples were carried out at 1.0m intervals as recorded on the borehole logs to assess the relative density and consistency of soils.

SPTs were conducted in accordance with BS EN ISO 22476-3 and the recorded SPT N-values are summarised on the borehole logs.

##### 3.2.2 Rotary Boreholes

Two rotary boreholes were advanced to a target depth of circa. 5.0m using a Commachio GEO205 drilling rig. Both boreholes were backfilled with bentonite upon completion and the asphalt surfacing reinstated.

Standard Penetration Tests (SPTs) in these rotary boreholes were carried out at 1.5m intervals as recorded on the borehole logs to assess the relative density and consistency of recovered soils/rock.

SPTs were conducted in accordance with BS EN ISO 22476-3 and the recorded SPT N-values are summarised on the borehole logs.

##### 3.2.3 Dynamic Cone Penetrometer (DCP) Tests

The DCP tests were conducted in order to determine California Bearing Ratio (CBR) values for near surface soils. A known mass is dropped through a known distance to drive a cone into the ground. The penetration distance per blow is recorded in order to enable the CBR value to be calculated. The results of the DCP tests are presented in **Appendix A**.



### 3.3 Soil Sampling

#### 3.3.1 Environmental

Made ground and natural soils were selected by visual and olfactory means for subsequent analysis. Samples for chemical laboratory testing purposes were collected in amber glass jars, amber glass vials and plastic tubs and retained in a cool box for transport to the laboratory.

#### 3.3.2 Geotechnical

Geotechnical samples were collected at depths indicated on the trial pit and window sample logs with samples retrieved either from the excavator bucket or from within a sleeve line. The disturbed samples were placed in sealed and correctly labelled plastic tubs or bags as appropriate. All geotechnical samples were dispatched to the laboratory for testing with a completed chain of custody.

### 3.4 Gas and Groundwater Monitoring

#### 3.4.1 Installations

Combined ground gas and groundwater monitoring standpipes were installed in three of the window sample boreholes. The standpipes consisted of high-density polyethylene (HDPE) pipe. A bentonite seal was made around the plain pipe and a clean gravel pack was placed around the slotted pipe. A summary of the installation construction is tabulated below:

Location and Depth	Internal Diameter Pipe	Response Zone (m bgl)	Targeted Strata
WS1 – 1.0m bgl	50mm HDPE	0.5 – 1.0	Natural Sand
WS3 – 1.0m bgl	50mm HDPE	0.5 – 1.0	Natural Sand & Sandy Clay
WS4 – 1.0m bgl	50mm HDPE	0.5 – 1.0	MADE GROUND & Natural CLAY

**Table 2: Monitoring Well Installation Details**

#### 3.4.2 Monitoring

Ground gas monitoring was undertaken using Geotech GA5000 gas analyser for the parameters reported below. Groundwater levels were measured with a GeoSense OWP30 oil water interface probe.

Permanent ground gas monitoring involved the measurement of the following in the prescribed order:

- Pressure difference between the monitoring well and the atmosphere,
- Peak and steady flow rates of gas into or out of the monitoring well;
- Peak and steady concentrations of carbon dioxide, methane, oxygen (minimum and steady recorded), carbon monoxide, hydrogen sulphide; and
- Depth to groundwater.

In total four monitoring visits were undertaken between 10th December 2020 and 12th January 2021. The results are presented on **Table 3**.

### 3.5 Quality Assurance and Quality Control

All samples were submitted to a United Kingdom Accredited Laboratory (UKAS) under a completed chain of custody. The laboratory carried out its own QA/QC programme to ensure that the quality of the analytical data conformed to the appropriate test method protocols.



### 3.6 Laboratory Testing

#### 3.6.1 Soil Chemical Analysis

Five (5 No) soil samples were scheduled for the analysis of asbestos, arsenic, barium, beryllium, cadmium, chromium (III & VI), copper, mercury, nickel, lead, selenium, zinc, fraction of organic carbon, Total Petroleum Hydrocarbons (TPHCWG), Polyaromatic Hydrocarbons (PAH), BTEX compounds (benzene, toluene, ethylbenzene and xylene) and phenols.

In addition, two (2 No) samples of bituminous surfacing were analysed for PAH compounds. One (1 No) granular soil sample of suspected limestone was analysed for calcium and magnesium only.

The results of laboratory chemical analyses are presented at **Appendix B**.

#### 3.6.2 Geotechnical

Samples recovered from the boreholes were submitted to an accredited laboratory for the following analyses in general accordance with BS1377:1990:

- 5 No Natural Moisture Contents
- 5 No Plasticity Indices
- 5 No Particle Size Distribution tests
- 3 No Quick Undrained Shear Box Tests
- 4 No BRE SD1 suites; and
- 3 No. Point Load Test

The results of the geotechnical testing are presented at **Appendix C**.



## 4 GEOTECHNICAL & ENVIRONMENTAL INVESTIGATION FINDINGS

### 4.1 Ground Conditions

A brief description of the published geology is provided together with a summary of the ground conditions encountered during the intrusive investigation. Exploratory logs are presented at the end of the report.

#### 4.1.1 Made Ground

Made Ground was encountered within all ten exploratory holes on-site (WS1 – WS8 and BH101 – 102) and was typically a thin veneer less than 1.0m thick. The maximum thickness of made ground of 1.55m was recorded in WS5 in the southern area of the site.

Asphalt surfacing was encountered within nine of the exploratory holes (all except WS6) and was recorded between 0.05m and 0.15m thick. A sub-base material comprising sandy gravel of mudstone and shale was identified underlying this surfacing within five of the boreholes (WS2, WS5, WS8, BH101 and BH102) but was only between 0.05m and 0.1m thick.

Within WS6 in the western area of the site, brown sand topsoil was encountered to a depth of 0.2m bgl. For the purpose of this assessment, topsoil is defined as the upper darker and more fertile layer of the soil profile, which is a product of natural chemical, physical, biological and environmental processes. This does not imply compliance with BS 3882:2015.

The made ground underlying the topsoil, asphalt surfacing and subbase was typically heterogeneous, comprising soft to firm locally sandy, silty and gravelly clay, with some localised deposits of gravelly sand (as in WS6). Gravel was generally angular to subangular, of brick fragments, coal, quartz, limestone and rare clinker.

#### 4.1.2 Superficial Deposits

According to the published geology superficial deposits are not present beneath the site, although they are present in the local area. However, several of the exploratory holes encountered a material that has been interpreted as potentially superficial in origin.

The material was generally described as a soft to stiff brown locally gravelly clay, where the gravel comprised subangular limestone.

#### 4.1.3 Bedrock

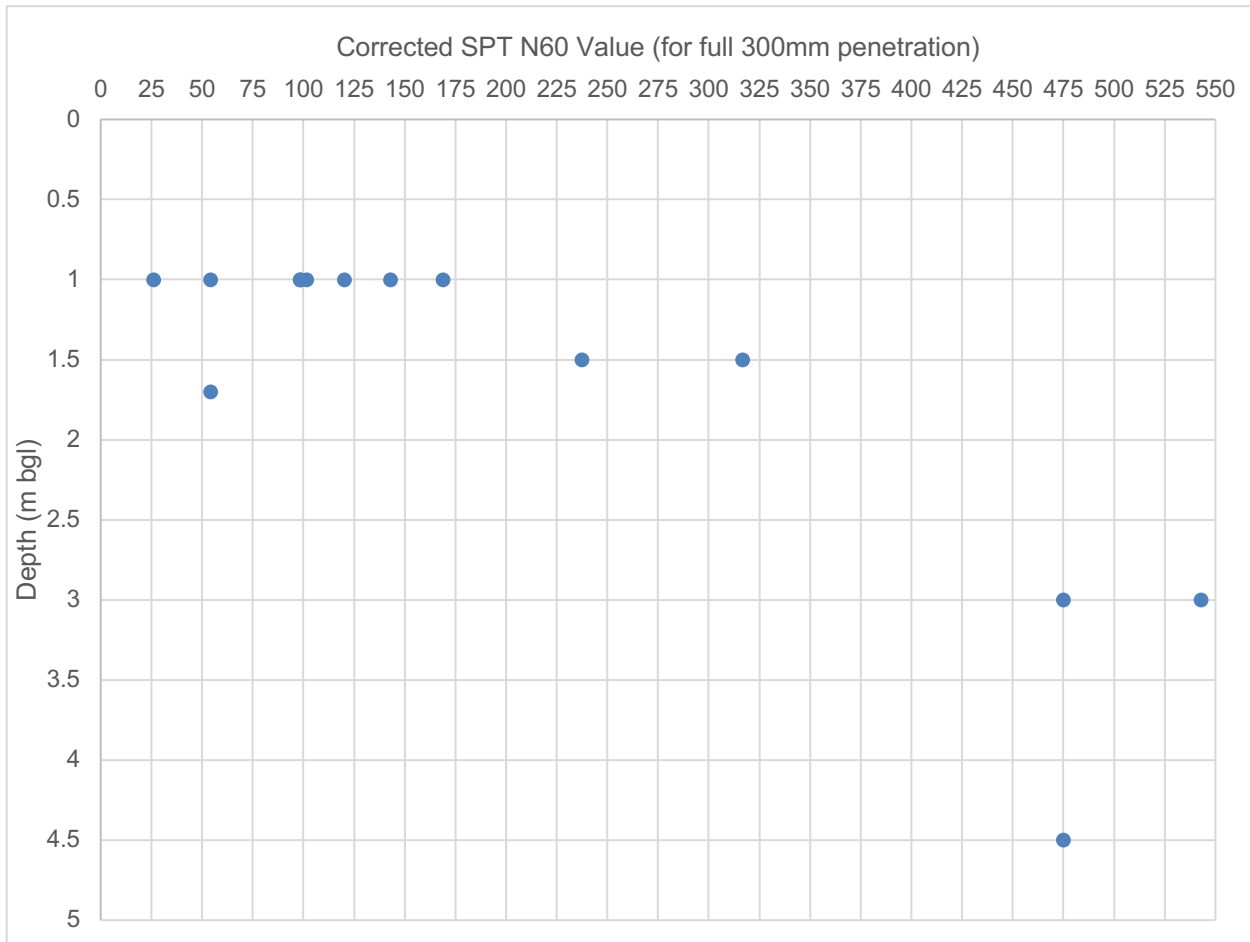
The published geology indicates the site is directly underlain by Mercia Mudstone Group bedrock, with limestone and dolostone geological units being located off-site to the north. During the window sampling on-site, all the eight boreholes refused within a light brown clayey sandy limestone gravel at depths of between 1.0m and 1.7m bgl. Due to the percussive window sampling method, the recovered material within the window sample liners was consequently analogous of a potential engineered fill material e.g., MOT Type subbase.

Subsequent rotary core drilling by Remada identified the site to be underlain by yellowish brown limestone bedrock, which was cored to a depth of 4.5m in two locations under the building footprint. The bedrock was recorded as being strong to very strong during field tests, as it required multiple blows of a geological hammer to fracture.

The limestone bedrock underlying the site is considered to be representative of the Gully Oolite Formation or Llanelli Formation units recorded to the north and north-east respectively.

## 4.2 In-situ Testing

In-situ SPTs were undertaken to assist with the interpretation of strata encountered. The SPT N-values have been corrected based on the Energy Ratio of 65% for the SPT hammer on the window sampling rig and 76% on the rotary rig. The SPT Hammer Energy Test Reports, undertaken in accordance with BS EN ISO 22476-3:2005 are included in **Appendix D**. The results of corrected N-values versus depth are plotted in the graph below:



**Graph 1: Plot of Corrected SPT N-Values Versus Depth**

## 4.3 Soil Observations

Made Ground was recovered at all locations as heterogeneous cohesive and granular materials, containing a variety of man-made materials including brick, ash and clinker.

There were no visible indicators of contamination including asbestos within the sampled soils.

## 4.4 Groundwater Observations

No groundwater was encountered within any of the exploratory during the intrusive investigation.

## 4.5 Chemical Analysis

Results of the soil chemical analysis are presented in **Table 4** at the end of the report and full laboratory certificates are presented in **Appendix B**. Results of the chemical analyses are summarised as follows.



The average FOC and pH were 0.04 and 9.2 respectively. Chrysotile asbestos cement was identified in the sample from WS8 at 0.1 – 0.6m bgl, recording a total concentration of 0.059%. Detectable concentrations of metals were identified, although these are generally within the range that would typically be expected for made ground.

Concentrations of TPH were detected above method detection limit (MDL) in three of the samples analysed (from WS2, WS6 and WS8). The hydrocarbons were generally heavy end hydrocarbons within the range C16 to C35 carbon range. There was no visual or olfactory evidence of contamination. No detectable concentrations of BTEX compounds were identified within the five samples analysed.

Concentrations of PAHs were generally low, with the maximum concentration (excluding bituminous surfacing sample) of 170 mg/kg was encountered in WS6 at 0.2 – 0.5m.

A crushed sample of the calcareous gravel from within WS1 at 0.55 – 0.95m contained 650 mg/l of calcium and only 36mg/l of extractable magnesium.

#### 4.6 Geotechnical Testing

Results of the geotechnical testing are summarised as follows and full laboratory certificates are presented in **Appendix C**.

Laboratory test results produced:

Five plasticity tests were undertaken on the recovered shallow cohesive strata from the window sample boreholes. The tests indicated that in four of the samples the natural strata to be of low plasticity, with plasticity indices of between 13% and 16%. The sample from WS8 between 0.9m – 1.1m was recorded as being non-plastic.

The PSD tests revealed the following:

- Natural deposits in WS1 at 0.55 – 0.95m comprised very sandy very clayey GRAVEL.
- Natural deposits in WS2 at 0.85 – 1.10m comprised very sandy very clayey GRAVEL.
- Natural deposits in WS4 at 1.10 – 1.40m comprised slightly gravelly very sandy and silty CLAY.
- Natural deposits in WS5 at 1.55 – 2.0m comprised very gravelly sandy CLAY.
- Made ground deposits in WS6 at 0.20 – 0.6m comprised slightly silty/clayey very sandy GRAVEL.

The consolidated drained peak shear box tests revealed the following:

- WS1 at 0.55 – 0.95m depth a peak angle of shearing resistance of 33° and effective cohesion of 10kPa was calculated.
- WS2 at 0.85 – 1.10m depth a peak angle of shearing resistance of 34° and effective cohesion of 7kPa was calculated.
- WS3 at 0.6 – 1.20m depth a peak angle of shearing resistance of 30° and effective cohesion of 8kPa was calculated.

The water soluble sulphate contents varied from <0.01 to 0.11 g/l in all four soil samples analysed with pH varying from 8.1 to 8.7. The total sulphur content varied from 0.022 to 0.13% and acid soluble sulphate varied from 0.029 to 0.079%.

Point load testing undertaken on three samples of limestone bedrock revealed the following:

- BH101 at 4.15m recorded a point load index ( $I_{s(50)}$ ) of 0.44MPa in perpendicular orientation.



- BH102 at 1.5m recorded a point load index of ( $I_{s(50)}$ ) of 1.0MPa in perpendicular orientation.
- BH102 at 2.66m recorded a point load index of ( $I_{s(50)}$ ) of 0.81MPa in perpendicular orientation.

#### 4.7 Ground Gas Monitoring Results

Ground gas monitoring was undertaken on 10th and 16th December 2020 and 7th and 12th January 2021, at the standpipes installed within WS1, WS3 and WS4. Results are presented in **Table 3** and summarised below:

- Methane concentrations were recorded below the instrument detection limit of <0.1 % v/v in all the monitoring wells on all four occasions;
- Peak carbon dioxide concentrations were recorded at a maximum of 0.7% v/v in WS1 during the first monitoring visit. The maximum steady state concentration of carbon dioxide was 0.5% v/v and recorded in the same standpipe during the first visit.
- Oxygen concentrations were recorded at a minimum concentration of 14.4 % v/v in WS4 on 7th January 2021;
- Ground gas flow rates were recorded at a maximum of 1.0 litres per hour (l/hr) within all three standpipes over the course of the monitoring programme.
- No groundwater was detected within any of the standpipes over the course of the monitoring programme.
- Atmospheric pressure at the time of sampling varied between a high of 1019 millibar (mbar) on 12<sup>th</sup> January 2021 and a low of 993 mbar on 10th December 2020. The monitoring visits were undertaken during periods of rising and falling pressure trends over the preceding 48 hours.





## 5 GENERIC QUANTITATIVE RISK ASSESSMENT

### 5.1 Human Health Risk Assessment

In order to provide an up to date assessment of the risks to human health, Remada has adopted the most recent Generic Assessment Criteria (GAC) published by LQM/CIEH (S4ULs) and CL:AIRE/EIC/AGS for the assessment of potential risks to human health. The derivation of GAC, methodology, input parameters and technical guidance (CLEA) may be obtained upon request.

The proposed site layout retail store and car park is presented and **Figure 3**. Default parameters have been adopted for sandy loam of pH 7 and commercial land use. FOC ranged from 0.0013 to 0.063 giving a Soil Organic Matter (SOM) content range of between 0.2 to 10.8% with an average result of 7.6%. In order to present a conservative assessment, the SOM content of 6% has been adopted for the assessment.

The depth to potential sources of contamination for indoor air pathways has been assumed to be 0.5m below building foundation level. The source has been conservatively assumed to be at ground level for outdoor air and direct contact pathways.

For commercial land use the CLEA version 1.06 critical receptor is conservatively modelled as a female working adult with an exposure duration of 49 years. In accordance with the default parameters it was assumed that employees spend most of their time indoors and that 80% of outdoor area is covered by hardstanding. As such, the potential exposure pathways have been assumed to be:

- Direct Soil and Indoor Dust Ingestion;
- Skin contact with soils and dusts;
- Inhalation of indoor and outdoor dusts and vapours.

Where GAC values for individual TPH fractions are not exceeded, the potential additive effect has been assessed by calculating overall TPH hazard index for each sample.

### 5.2 Comparison of Soil Analysis Results with Human Health GAC

A comparison of soil chemical analysis with GAC is presented as **Table 4**.

#### TPH, PAH & BTEX

Dibenz(ah)anthracene was identified in the made ground sample from WS6 at 0.2 – 0.5m bgl at a concentration of 3.8mg/kg, which marginally exceeded the human health GAC of 3.6mg/kg protective of on-site workers. The 95 percentile value for Dibenz(ah)anthracene is 3.47 and less the applicable GAC of 3.6 mg/kg.

#### Metals & Inorganics Excluding Asbestos

None of the analytes tested were detected at concentrations that exceeded the human health GAC protective of on-site workers.

#### Asbestos

Chrysotile asbestos cement was identified in the sample from WS8 at 0.1 – 0.6m bgl, recording a total concentration of 0.059%. The sample was obtained from made ground comprising brown sandy clayey gravel with brick and coal fragments.



### 5.3 Controlled Waters Risk Assessment

The site is not located within a designated Groundwater Source Protection Zone. The intrusive investigation has revealed that the site is directly underlain by limestone bedrock, rather than the Mercia Mudstone Group bedrock (a Principal Aquifer) indicated on the geological mapping.

The results of the soil chemical analysis undertaken has identified that concentrations of metals and inorganic contaminants are within the range of typical made ground. Detectable concentrations of TPH and PAHs were encountered in some samples. However, the contaminants identified are of low solubility and mobility and as such are unlikely to present a risk to groundwater beneath the site. In addition, it should be noted that the site will be predominantly covered with the building and areas of hardstanding. Therefore, the risk of leaching of contaminants as a result of infiltration of groundwater is likely to be limited. Therefore, the risk to groundwater from contaminants within the made ground at the site is considered to be low and does not warrant further consideration.

### 5.4 Ground Gas Assessment

In order to understand the gassing regime at the site, a Characteristic Situation (as defined in CIRIA C665 and BS8576:2013) is determined for the site. CIRIA C665 and BS8576 provides definitions for each Characteristic Situation based on Gas Screening Values (GSV) which are calculated as follows:

- $GSV = \text{Gas Concentration (\% v/v)} \times \text{Measured Borehole Flow Rate (l/hr)}$

BS8576 makes a distinction between the GSV and the Hazardous Gas Flow Rate ( $Q_{hg}$ ) which is also calculated using the above calculation. BS8576 states that  $Q_{hg}$  is calculated for each individual borehole for each monitoring visit, whereas the GSV is taken as the representative value for the site or site zone.

As a worst-case assessment, the GSV for the site is therefore taken as the maximum steady state carbon dioxide/methane concentration recorded in the boreholes which is multiplied by the maximum flow rate recorded during the same monitoring event.

- Methane GSV =  $0.1\% \times 1.0 \text{ l/hr} = 0.001 \text{ l/hr}$  (methane concentration taken as equal to the instrument detection limit of 0.1%).
- Carbon Dioxide GSV =  $0.5\% \times 1.0 \text{ l/hr} = 0.005 \text{ l/hr}$

The calculated GSV for methane and carbon dioxide places the site into Characteristic Situation 1. BS8485 states that for Characteristic Situation 1 the methane concentration would typically be less than 1% and carbon dioxide less than 5% and that if concentrations are above these limits then consideration should be given to placing the site into Characteristic Situation 2. As the concentrations of methane and carbon dioxide were both within these typical limits it is considered that the Characteristic Situation 1 classification is appropriate for the site. Therefore, gas protection measures are not deemed necessary for the proposed development.

Whilst ground gas protection measures are not deemed necessary, the site is located within an Intermediate Probability Radon Area and as such, basic radon protection measures are required. A radon / ground gas membrane will need to be installed and verified in accordance with CIRIA C735 Good Practice on the Testing & Verification of Protection Systems for Buildings Against Hazardous Ground Gases (2014) which sets out industry good practice.

### 5.5 Revised Conceptual Site Model

A revised Conceptual Site Model is presented as **Table 5** below.



## 5.6 Waste Classification

In general, the results of the chemical analysis indicates that the material would be classified as non-hazardous waste. While Waste Acceptance Criteria (WAC) analysis has not been undertaken, the assessment has included determination of the fraction of organic carbon (foc) which can be converted to TOC by multiplying the result by 100. A TOC limit of 3% is placed on waste destined for disposal in an inert landfill. As four of the five samples selected for analysis exceeded this limit it is considered that the waste should be classified as non-hazardous. WAC testing is not required for disposal of non-hazardous waste to landfill.

Two samples of bituminous surfacing was analysed for concentrations of PAH compounds. The purpose of this analysis was to determine if the sample contained coal tar as this would result in a hazardous waste classification. The Environment Agency Technical Guidance document WM3 states that *“where the concentration of benzo(a)pyrene is at or above 50ppm (mg/kg) in the black top alone (excluding other material) then the amount of coal tar should be considered to be sufficient (0.1% or more) for the material to be hazardous”*.

The results indicated that while the concentrations of PAHs were very low (total PAH concentration <2.0 mg/kg), whilst the concentration of benzo(a)pyrene of <0.1mg/kg was below the 50mg/kg limit defined in WM3. Therefore, the bituminous surfacing represented by this sample would be classified as non-hazardous waste and assigned the List of Wastes code 17 03 02 for bituminous mixtures other than those mentioned in 17 03 01.

## 5.7 Health & Safety Considerations

To ensure direct exposure of construction workers involved in the site redevelopment to any impacted contaminated shallow soils is minimised, the guidance stated in HSG 66 “Protection of Workers and the General Public During Redevelopment of Contaminated Land” should be followed.



Potential Source Areas	Potential Contaminant of Concern	Pathways	Potential Receptor	Exposure Route (Human unless otherwise stated)	Potential Identified Linkage (unmitigated)	Findings of Ground investigation	Risk (Unmitigated)	Proposed Remediation (Mitigation) Measures	Residual Risk Estimation	
<b>On-site Sources</b>	Asbestos / Metals As, Be, Cd, Cu, Cr (VI), Cr (III) Hg, Ni, Se, Va, Zn, Boron, TPH /PAH, PCBs	Disturbance due to construction plant causing direct contact, dusts, vapours.	Occupants of the development / building fabric	• Direct Soil Ingestion	Yes	< GAC	Negligible	Negligible	Negligible	
<b>General Made Ground</b>				• Indoor Dust ingestion	Yes	< GAC	Negligible	As above	Negligible	
<b>Severn Bridge Club</b>				• Skin Contact with Soils	Yes	< GAC	Negligible	As above	Negligible	
<b>Off-site Sources</b>				• Skin Contact with Dust	Yes	< GAC	Negligible	As above	Negligible	
<b>Made Ground</b>		Direct Contact with occupants of the proposed development		Adjacent residents during construction	• Inhalation of Outdoor Dust	Yes	Made Ground 0.0059% chrysotile @ WS8	TBC	Asbestos Risk Assessment for excavations / disturbance	TBC
<b>Builders Yard</b>					• Inhalation of Outdoor Vapours	Yes	< GAC	Negligible	As above	Negligible
<b>Tyre Depot</b>		Inhalation of fibres / vapours / gases by occupants of proposed development		Adjacent residents during construction	• Inhalation of ground gas	Yes	< GAC	Negligible	As above	Negligible
<b>Bus Depot</b>					• Inhalation of radon gas	Yes	Intermediate Probability Radon Area	Potential Risk	Basic Radon Protection Measures	Negligible
<b>Electricity Sub-Station</b>					• Inhalation of Indoor Vapours	Yes	< GAC	Negligible	Negligible	Negligible
<b>Tanks</b>		Permeation of water supply pipework		Adjacent residents during construction	• Ingestion via permeated water supply pipework	Yes	< GAC	Negligible	Negligible	Negligible
<b>Various works, factories and warehouses</b>					• Inhalation of ground gas	Yes	<GSV	Negligible	Negligible	Negligible
<b>Residential premises</b>		Leachate		Principal Aquifers	• Leaching to Principal Aquifers in Bedrock deposits	Yes	< GAC	Negligible	Negligible	Negligible

**Table 5: Refined Conceptual Site Model**

Direct contact with subsurface soil and/or groundwater during redevelopment works are not assessed as part of the CSM. It is considered that risks to workers will be managed as part of any the redevelopment works at the site through the application of health and safety procedures, where required.



## 6 GEOTECHNICAL SITE ASSESSMENT:

### 6.1 Geotechnical Considerations

The proposed layout at **Figure 3** indicates that the store footprint will occupy the existing car park in the central and eastern zones of the site. It was anticipated that the site would directly underlain by Mercia Mudstone however the window sample rig proved N values of greater than 50 were proven at 1.0 to 1.7m bgl. Consequently, two rotary core holes were bored at two locations within the proposed store footprint and recovered a yellowish-brown limestone bedrock to a depth of 4.5m.

Representative core samples were recovered from the shallow bedrock and produced point load tests  $I_{s(50)}$  values of between 0.44 and 1.0MPa. The average  $I_{s(50)}$  value is 0.75MPa, which compares with published values for carbonate siltstone/sandstone in Tomlinson (2001).

Details of the proposed permanent and variable design loads (actions) are not currently known although an indicative column load of 400kN has been provided.

### 6.2 Foundations

Either pad foundation or stiffened raft down stands bearing directly on the limestone of  $N > 50$  and encountered at circa. one metre depth is considered a suitable foundation solution. Removal and recompaction of the existing shallow made ground as observed outside the existing footprint may provide a suitable formation for a ground bearing floor slab if correctly engineered. In the event that deeper made ground is encountered following demolition of the existing building, proposed foundations should be deepened as necessary to bear on the underlying bedrock.

Finished floor levels are not known at the time of writing this report and it is assumed that these will be close to existing levels. It is important that any voids resulting from the removal of existing foundations are compacted to an appropriate engineering standard prior to the construction of the raft foundation or ground bearing floor slab.

### 6.3 Imported Fill

Any imported material should comply with an earthworks specification to be prepared by the engineer and not contain concentrations of contaminants at greater than the Generic Assessment Criteria (GAC) presented in **Table 3**.

### 6.4 Excavations and Temporary Works

Shallow limestone bedrock was encountered underlying the site, which will require a 360 tracked excavator (or similar) to penetrate into.

No groundwater was encountered during the intrusive works, or during the subsequent monitoring programme.

### 6.5 Existing Car Park Surfacing

Bituminous hardstanding was encountered at ground level in nine of the exploratory holes on-site; ranging in thickness between 0.05m and 0.15m.

Lidl standard detail LD(14)-SP-04 Rev 1 provides separate details for 3-layer HGV access roads and 2-layer car park areas. The overall bituminous construction is significantly less than the 200mm required by Lidl for a HGV route, and in several instances is less than the 90mm required for car parking only.

Due to the demolition of the existing building on-site and the associated reprofiling of the car parking on-site, the existing car park surfacing is likely to be removed as part of the site's redevelopment.



## 6.6 Protection of Buried Concrete

In accordance with BRE SD1 for buried concrete in a brownfield site with mobile groundwater, analysis of selected samples for water soluble sulphate returned values of up to 0.11 g/l and pH >8.1. Therefore a Design Sulphate Class DS-1 is considered appropriate for buried concrete and an ACEC Class of AC-1 is considered appropriate for the location.

## 6.7 General Construction Advice

All formations should be cleaned, and subsequently inspected, by a suitably qualified engineer prior to placing concrete. Should any soft, compressible or otherwise unsuitable materials be encountered they should be removed and replaced by blinding concrete.

Foundation concrete, or alternatively, a blinding layer of concrete, should be placed immediately after excavation and inspection in order to protect the formation against softening and disturbance.

Generally, all formations should be placed wholly within the same material type, unless specific geotechnical inspection and assessment have been undertaken.

Where applicable ground beneath the proposed building footprint and potentially car parking may require to be stripped to reveal localised areas of made ground and structures. Excavations should be backfilled with suitably re-compacted materials to achieve formation level.

During foundation excavation works arisings should be constantly monitored for the presence of contamination.



## 7 CONCLUSIONS & RECOMENDATIONS

### 7.1 Conclusions

The following conclusions have been made based on the findings of this investigation.

#### 7.1.1 Phase 2 Site Investigation

The earliest available historic mapping of 1881 indicates the site to be occupied by a residential property 'Fairfield Lodge' with associated garden, woodland and fields. By 1901 the site was being referred to as Fairfield Farm. By 1921, the former field in the eastern margin of the site had been redeveloped by housing blocks of the wider Bulwark Village, which remained until their demolition between 1971 and 1977. The existing Severn Bridge Social Club was developed between 1955 and 1966.

The published geology indicates the site is directly underlain by Mercia Mudstone Group bedrock, with limestone and dolostone geological units being located off-site to the north. During the window sampling on-site, all the eight boreholes refused within a light brown clayey sandy limestone gravel at depths of between 1.0m and 1.7m bgl. Chemical analysis of the gravel indicated it to be depleted in magnesium in comparison to calcium, indicating the rock to be limestone rather than dolostone.

Subsequent rotary drilling by Remada identified the site to be underlain by yellowish brown limestone bedrock, which was cored to a depth of 4.5m in two locations under the building footprint. The bedrock was recorded as being strong to very strong during field tests, as it required multiple blows of a geological hammer to fracture. The limestone bedrock underlying the site is considered to be representative of the Gully Oolite Formation or Llanelli Formation units recorded to the north and north-east respectively.

#### 7.1.2 Human Health Risk Assessment Retail Zone

The results of soil chemical analysis were compared to Human Health Generic Assessment Criteria for commercial land use. Dibenz(ah)anthracene was identified in the made ground sample from WS6 at 0.2 – 0.5m bgl at a concentration of 3.8mg/kg however the 95-percentile value is less the applicable GAC of 3.6 mg/kg.

Chrysotile asbestos cement was identified in the sample from WS8 at 0.1 – 0.6m bgl, recording a total concentration of 0.059%.

#### 7.1.3 Water Resources Risk Assessment

The results of the soil chemical analysis undertaken has identified that concentrations of metals and inorganic contaminants are within the range of typical made ground. Detectable concentrations of TPH and PAHs were encountered in some samples. However, the contaminants identified are of low solubility and mobility and as such are unlikely to present a risk to groundwater beneath the site. In addition, it should be noted that the site will be predominantly covered with the building and areas of hardstanding. Therefore, the risk of leaching of contaminants as a result of infiltration of groundwater is likely to be limited. Therefore, the risk to groundwater from contaminants within the made ground at the site is considered to be low and does not warrant further consideration.

#### 7.1.4 Waste Classification

In general, the results of the chemical analysis indicates that the material would be classified as non-hazardous waste. While Waste Acceptance Criteria (WAC) analysis has not been undertaken, four of the five samples selected for analysis exceeded this TOC limit for disposal in an inert landfill. Therefore, it is considered that the waste should be classified as non-hazardous. WAC testing is not required for disposal of non-hazardous waste to landfill.

Two samples of bituminous surfacing were analysed for concentrations of PAH compounds. The results indicated that while the concentrations of PAHs were very low (total PAH concentration <2.0 mg/kg), whilst



the concentration of benzo(a)pyrene of <0.1mg/kg was below the 50mg/kg limit defined in WM3. Therefore, the bituminous surfacing represented by this sample would be classified as non-hazardous waste and assigned the List of Wastes code 17 03 02 for bituminous mixtures other than those mentioned in 17 03 01.

### 7.1.5 Geotechnical Considerations

It was anticipated that the site would directly underlain by Mercia Mudstone however the window sample rig proved N values of greater than 50 were proven at 1.0 to 1.7m bgl. Consequently, two rotary core holes were bored at two locations within the proposed store footprint and recovered a yellowish-brown limestone bedrock to a depth of 4.5m. Point load testing of recovered samples from the shallow bedrock corresponded with published values for carbonate siltstone/sandstone.

## 7.2 Recommendations

Either pad foundation or stiffened raft down stands bearing directly on the limestone of  $N > 50$  and encountered at circa. one metre depth is considered a suitable foundation solution. Removal and recompaction of the existing shallow made ground as observed outside the existing footprint may provide a suitable formation for a ground bearing floor slab if correctly engineered. In the event that deeper made ground is encountered following demolition of the existing building, proposed foundations should be deepened as necessary to bear on the underlying bedrock.

Finished floor levels are not known at the time of writing this report and it is assumed that these will be close to existing levels. It is important that any voids resulting from the removal of existing foundations are compacted to an appropriate engineering standard prior to the construction of the raft foundation or ground bearing floor slab.

A Design Sulphate Class DS-1 is considered appropriate for buried concrete and an ACEC Class of AC-1 is considered appropriate for the location.

Shallow limestone bedrock was encountered underlying the site, which will require a 360 tracked excavator (or similar) to penetrate into.

Due to the identification of chrysotile asbestos cement at a concentration of 0.059% in made ground at WS8 it is recommended that an asbestos risk assessment is undertaken prior to the commencement of redevelopment works.

## 7.3 Ground Gas

The results of four rounds of gas monitoring visits placed the site into Characteristic Situation 1 and therefore ground gas protection measures will not be required within the proposed buildings.

The site is located within an Intermediate Probability Radon Area and as such, basic radon protection measures are required. A radon / ground gas membrane will need to be installed and verified in accordance with CIRIA C735 Good Practice on the Testing & Verification of Protection Systems for Buildings Against Hazardous Ground Gases (2014) which sets out industry good practice.





## REFERENCES & GUIDANCE

- AGS, *Guidance on the Waste Classification for Soils – A Practitioners' Guide* 2019.
- Barnes, G. 2010, *Soil Mechanics Principles and Practice*. 3rd Edition.
- BRE, *Special Digest 1:2005 (3rd Edition), Concrete in Aggressive Ground*. 2005.
- BS 10175:2011+A1:2013, *Investigation of potentially contaminated sites: Code of practice*.
- BS 1377:1999. *Methods of test for soils for civil engineering purposes*.
- BS 5930:2015, *Code of practice for site investigations*.
- BS 8485:2015, *Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings*.
- BS 8576:2013, *Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds (VOCs)*.
- BS EN ISO 22476-3:2005, *Geotechnical investigation and testing: Field testing - Standard penetration test*.
- CIRIA, C504, *Engineering in glacial tills*, 1999.
- CIRIA, C665, *Assessing risks posed by hazardous ground gases to buildings*, 2007.
- CIRIA, C682, *The VOCs Handbook: Investigating, assessing and managing risks from inhalation of VOCs at land affected by contamination*, 2009.
- CIRIA, C716, *Remediating and mitigating risks from volatile organic compound (VOC) vapours from land affected by contamination*, 2012.
- CIRIA C733, *Asbestos in Soil and Made Ground: A Guide to Understanding & Managing Risks*.
- CL:AIRE/EIC/AGS, *The Soil Generic Assessment Criteria for Human Health Risk Assessment*, 2009.
- CL:AIRE, SP1010, *Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination -Final Project Report*. 2013.
- CL:AIRE, *The Definition of Waste: Development Industry Code of Practice Version 2*
- DEFRA, Circular 01/2006, *Contaminated Land Environmental Protection Act 1990, Part 2A*. 2006.
- DEFRA, SP1010, *Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document*. March 2014.
- Environment Agency, *Model Procedures for the Management of Land Contamination*, CLR 11, 2004.
- Environment Agency, *Verification of Remediation of Land Contamination Science Report – NC/00/38/SR*
- Environment Agency, *Waste Classification, Guidance on the classification and assessment of waste (1<sup>st</sup> Edition V1.1) Technical Guidance WM3*.
- Health & Safety Executive, HSG 66, *Protection of Workers and the General Public During Redevelopment of Contaminated Land*. 1991.
- Highways Agency, IAN 73/06 Rev 1, *Design of Pavement Foundations*, 2009.
- Land Contamination Risk Management [www.gov.uk](http://www.gov.uk) 08.10.2020.
- LCM/CIEH, *The LQM/CIEH S4ULs for Human Health Risk Assessment*. Land Quality Press, S4UL3146, 2015.
- NHBC Standards, 2019.
- Tomlinson, M.J., 2001, *Foundation Design and Construction*, 7th Edition.
- The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015
- The Definition of Waste: Development Industry Code of Practice, CL:AIRE 2011.
- Guidance on the classification and assessment of waste (1st Edition v1.1 ) Technical Guidance WM3 2018.



## STUDY LIMITATIONS

**IMPORTANT.** This section should be read before reliance is placed on any of the information, opinions, advice, recommendations or conclusions contained in this report.

1. This report has been prepared by Remada, Ltd with all reasonable skill, care and diligence within the terms of the Appointment and with the resources and manpower agreed with (the 'Client'). Remada does not accept responsibility for any matters outside the agreed scope.

2. This report has been prepared for the sole benefit of the Client unless agreed otherwise in writing.

3. Unless stated otherwise, no consultations with authorities or funders or other interested third parties have been carried out. Remada is unable to give categorical assurance that the findings will be accepted by these third parties as such bodies may have published, more stringent objectives. Further work may be required by these parties.

4. All work carried out in preparing this report has used, and is based on, Remada' professional knowledge and understanding of current relevant legislation. Changes in legislation or regulatory guidance may cause the opinion or advice contained in this report to become inappropriate or incorrect. In giving opinions and advice pending changes in legislation, of which Remada is aware, have been considered. Following delivery of the report Remada has no obligation to advise the Client or any other party of such changes or their repercussions.

5. This report is only valid when used in its entirety. Any information or advice included in the report should not be relied upon until considered in the context of the whole report.

6. Whilst this report and the opinions made are to the best of Remada' belief, Remada cannot guarantee the accuracy or completeness of any information provided by third parties.

7. This report has been prepared based on the information reasonably available during the project programme. All information relevant to the scope may not have received.

8. This report refers, within the limitations stated, to the condition of the site at the time of the inspections. No warranty is given as to the possibility of changes in the condition of the site since the time of the investigation.

9. The content of this report represents the professional opinion of experienced environmental consultants. Remada does not provide specialist legal or other professional advice. The advice of other professionals may be required.

10. Where intrusive investigation techniques have been employed they have been designed to provide a reasonable level of assurance on the conditions. Given the discrete nature of sampling, no investigation technique is capable of identifying all conditions present in all areas. In some cases the investigation is further limited by site operations, underground obstructions and above ground structures. Unless otherwise stated, areas beyond the boundary of the site have not been investigated.

11. If below ground intrusive investigations have been conducted as part of the scope, service tracing for safe location of exploratory holes has been carried out. The location of underground services shown on any drawing in this report has been determined by visual observations and electromagnetic techniques. No guarantee can be given that all services have been identified. Additional services, structures or other below ground obstructions, not indicated on the drawing, may be present on site.

12. Unless otherwise stated the report provides no comment on the nature of building materials, operational integrity of the facility or on any regulatory compliance issues.

13. Unless otherwise stated, samples from the site (soil, groundwater, building fabric or other samples) have NOT been analysed or assessed for waste classification purposes.



# TABLES

Table 3: Gas Groundwater Monitoring Data

GAS & GROUNDWATER MONITORING DATA														Remada					
SITE		Bulwark Road, Chepstow, NP16 5JN																	
PROJECT No.		799.02		Atmospheric & Ground Conditions															
Carried Out by:		Idris Shafqat		Atmospheric Pressure Variations During Visit						Ground Surface Conditions									
Date:		10.12.2020		993mb						Wet									
Instrument Details		GA 5000 G501261		Atmospheric Pressure Trend Over Previous 48hrs						Weather Conditions									
				Falling						Cold, windy, cloudy, light rain									
Well No.	Cover Height (m AOD)	Well Diameter (mm)	CH <sub>4</sub> (% v/v)		CH <sub>4</sub> Steady LEL (%)	CO <sub>2</sub> (% v/v)		O <sub>2</sub> (% v/v)		Duration (secs) <sup>^</sup>	Flow Rate (l/hr)	Relative Pressure (Pa)	PID (ppm)		Atmospheric Pressure (mb)	Water Level (m bgl)	Water Level (m AoD)	Depth of Pipe (m bgl)	Comments
			Peak	Steady		Peak	Steady	Minimum	Steady				Peak	Steady					
WS1		50	0.0	0.0	0.0	0.7	0.5	19.5	19.8	60	0.9	-0.59	-	-	993	DRY	-	1.000	
WS3		50	0.0	0.0	0.0	0.1	0.1	20.6	20.6	60	0.8	-0.49	-	-	993	DRY	-	1.000	
WS4		50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Not Accessible

Notes: NR = Not Recorded      ^ For measurement of gas concentrations      > = Above LEL      WST = Water Sample Taken      GL = Ground Level

GAS & GROUNDWATER MONITORING DATA														Remada					
SITE		Bulwark Road, Chepstow, NP16 5JN																	
PROJECT No.		799.02		Atmospheric & Ground Conditions															
Carried Out by:		Idris Shafqat		Atmospheric Pressure Variations During Visit						Ground Surface Conditions									
Date:		16.12.2020		994mb						Wet									
Instrument Details		GA 5000 G501261		Atmospheric Pressure Trend Over Previous 48hrs						Weather Conditions									
				Rising						Cold, windy, light rain									
Well No.	Cover Height (m AOD)	Well Diameter (mm)	CH <sub>4</sub> (% v/v)		CH <sub>4</sub> Steady LEL (%)	CO <sub>2</sub> (% v/v)		O <sub>2</sub> (% v/v)		Duration (secs) <sup>^</sup>	Flow Rate (l/hr)	Relative Pressure (Pa)	PID (ppm)		Atmospheric Pressure (mb)	Water Level (m bgl)	Water Level (m AoD)	Depth of Pipe (m bgl)	Comments
			Peak	Steady		Peak	Steady	Minimum	Steady				Peak	Steady					
WS1		50	0.0	0.0	0.0	0.4	0.3	17.0	17.1	60	0.8	0.52	-	-	994	DRY	-	1.000	
WS3		50	0.0	0.0	0.0	0.2	0.0	20.0	20.4	60	0.7	0.46	-	-	994	DRY	-	1.000	
WS4		50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Not Accessible

Notes: NR = Not Recorded      ^ For measurement of gas concentrations      > = Above LEL      WST = Water Sample Taken      GL = Ground Level

GAS & GROUNDWATER MONITORING DATA														Remada					
SITE		Bulwark Road, Chepstow, NP16 5JN																	
PROJECT No.		799.02		Atmospheric & Ground Conditions															
Carried Out by:		Idris Shafqat		Atmospheric Pressure Variations During Visit						Ground Surface Conditions									
Date:		07.01.2020		1011mb						Dry									
Instrument Details		GA 5000 G501261		Atmospheric Pressure Variations During Visit						Weather Conditions									
				Falling						Cloudy, cold, windy									
Well No.	Cover Height (m AOD)	Well Diameter (mm)	CH <sub>4</sub> (% v/v)		CH <sub>4</sub> Steady LEL (%)	CO <sub>2</sub> (% v/v)		O <sub>2</sub> (% v/v)		Duration (secs) <sup>^</sup>	Flow Rate (l/hr)	Relative Pressure (Pa)	PID (ppm)		Atmospheric Pressure (mb)	Water Level (m bgl)	Water Level (m AoD)	Depth of Pipe (m bgl)	Comments
			Peak	Steady		Peak	Steady	Minimum	Steady				Peak	Steady					
WS1		50	0.0	0.0	0.0	0.2	0.0	17.3	17.6	60	0.9	-0.59	-	-	1011	DRY	-	1.000	
WS3		50	0.0	0.0	0.0	0.6	0.0	17.5	17.8	60	1.0	-0.51	-	-	1011	DRY	-	1.000	
WS4		50	0.0	0.0	0.0	0.6	0.3	14.4	14.6	60	1.0	-0.54	-	-	1011	DRY	-	1.000	

Notes: NR = Not Recorded      ^ For measurement of gas concentrations      > = Above LEL      WST = Water Sample Taken      GL = Ground Level

GAS & GROUNDWATER MONITORING DATA														Remada					
SITE		Bulwark Road, Chepstow, NP16 5JN																	
PROJECT No.		799.02		Atmospheric & Ground Conditions															
Carried Out by:		Idris Shafqat		Atmospheric Pressure Variations During Visit						Ground Surface Conditions									
Date:		12.01.2020		1019mb						Wet									
Instrument Details		GA 5000 G501261		Atmospheric Pressure Trend Over Previous 48hrs						Weather Conditions									
				Rising						Light rain, cloudy, cold, windy									
Well No.	Cover Height (m AOD)	Well Diameter (mm)	CH <sub>4</sub> (% v/v)		CH <sub>4</sub> Steady LEL (%)	CO <sub>2</sub> (% v/v)		O <sub>2</sub> (% v/v)		Duration (secs) <sup>^</sup>	Flow Rate (l/hr)	Relative Pressure (Pa)	PID (ppm)		Atmospheric Pressure (mb)	Water Level (m bgl)	Water Level (m AoD)	Depth of Pipe (m bgl)	Comments
			Peak	Steady		Peak	Steady	Minimum	Steady				Peak	Steady					
WS1		50	0.0	0.0	0.0	0.0	0.0	17.3	19.0	60	1.0	-0.45	-	-	1019	DRY	-	1.000	
WS3		50	0.0	0.0	0.0	0.3	0.0	15.9	17.2	60	0.9	-0.32	-	-	1019	DRY	-	1.000	
WS4		50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Not Accessible

Notes: NR = Not Recorded      ^ For measurement of gas concentrations      > = Above LEL      WST = Water Sample Taken      GL = Ground Level

Table 2: Gas and Groundwater Monitoring Data

Table 4: Comparison of Soil Chemical Analyses with GAC

Laboratory ID	Client Sample ID:				20-33135	20-33135	20-33135	20-33135	20-33135
Sample ID	Sample Location:				1107853	1107856	1107857	1107858	1107859
Borehole	Top Depth (m):				WS2	WS5	WS6	WS7	WS8
Depth	Date Sampled (S):				0.20 - 0.70	0.10 - 1.0	0.20 - 0.50	0.05 - 0.50	0.10 - 0.60
Sample Date	LQM / CIEH Commercial GAC 6% SOM				30-Nov-2020	30-Nov-2020	30-Nov-2020	30-Nov-2020	30-Nov-2020
Determinand	Accred.	SOP	Units	LOD	[mg/kg unless stated]				
ACM Type	U	2192		N/A	-	-	-	-	-
Asbestos Identification	U	2192	%	0.001	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	Cement Chrysotile
ACM Detection Stage	U	2192		N/A	-	-	-	-	Stereo Microscopy
Asbestos by Gravimetry									0.059
Total Asbestos									0.059
Moisture	N	2030	%	0.020	6.8	15	14	17	6.2
pH	M	2010		N/A	8.7	8.1	9.2	8.4	11.5
Arsenic	M	2450	mg/kg	1.0	640	17.0	20.0	18.0	24
Beryllium	U	2450	mg/kg	1.0	12	< 1.0	< 1.0	< 1.0	< 1.0
Cadmium	M	2450	mg/kg	0.10	190	0.25	0.54	0.82	0.61
Copper	M	2450	mg/kg	0.50	68000	13	36	32	41
Mercury	M	2450	mg/kg	0.10	58 <sup>app</sup> (25.8)	< 0.10	0.3	0.46	< 0.10
Nickel	M	2450	mg/kg	0.50	980	11	22	18	21
Lead	M	2450	mg/kg	0.50	2300	22.0	120	180	150.0
Selenium	M	2450	mg/kg	0.20	12000	< 0.20	0.31	0.25	< 0.20
Vanadium	U	2450	mg/kg	5.0	9000	15.0	21	16	20
Zinc	M	2450	mg/kg	0.50	730000	51	170	250	180
Chromium (Trivalent)	N	2490	mg/kg	1.0	8600	10	14	10	14
Chromium (Hexavalent)	N	2490	mg/kg	0.50	33	< 0.50	< 0.50	< 0.50	< 0.50
Fraction of Organic Carbon	M	2625		0.0010	0.0560	0.0540	0.0460	0.0630	0.0013
Calculated SOM from FOC					9.655	9.310	7.931	10.862	0.224
Calculated TOC from FOC					5.600	5.400	4.600	6.300	0.130
Aliphatic TPH >C5-C6	N	2680	mg/kg	1.0	12000sol (1150)	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C6-C8	N	2680	mg/kg	1.0	4000sol (736)	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C8-C10	M	2680	mg/kg	1.0	11000vap (451)	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C10-C12	M	2680	mg/kg	1.0	47000vap (283)	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C12-C16	M	2680	mg/kg	1.0	9000sol (142)	10	< 1.0	9.6	< 1.0
Aliphatic TPH >C16-C21	M	2680	mg/kg	1.0	1800000	< 1.0	< 1.0	14	< 1.0
Aliphatic TPH >C21-C35	M	2680	mg/kg	1.0		100	< 1.0	85	< 1.0
Total Aliphatic Hydrocarbons:	N	2680	mg/kg	5.0		110	< 5.0	110	< 5.0
Aromatic TPH >C5-C7	N	2680	mg/kg	1.0	86000sol (4710)	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C7-C8	N	2680	mg/kg	1.0	18000vap (4360)	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C8-C10	M	2680	mg/kg	1.0	17000vap (3580)	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C10-C12	M	2680	mg/kg	1.0	34000sol (2150)	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C12-C16	M	2680	mg/kg	1.0	38000	12	< 1.0	< 1.0	< 1.0
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0	28000	< 1.0	< 1.0	84	< 1.0
Aromatic TPH >C21-C35	M	2680	mg/kg	1.0	28000	410	< 1.0	600	< 1.0
Total Aromatic Hydrocarbons	N	2680	mg/kg	5.0		490	< 5.0	730	< 5.0
Total Petroleum Hydrocarbons	N	2680	mg/kg	10.0		600	< 10	840	< 10
Naphthalene	M	2700	mg/kg	0.10	1100sol (432)	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthylene	M	2700	mg/kg	0.10	100000	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthene	M	2700	mg/kg	0.10	100000	< 0.10	< 0.10	< 0.10	< 0.10
Fluorene	M	2700	mg/kg	0.10	71000	< 0.10	< 0.10	< 0.10	< 0.10
Phenanthrene	M	2700	mg/kg	0.10	23000	< 0.10	0.58	7.6	< 0.10
Anthracene	M	2700	mg/kg	0.10	540000	< 0.10	0.14	3.4	< 0.10
Fluoranthene	M	2700	mg/kg	0.10	23000	0.44	1.1	27	7.3
Pyrene	M	2700	mg/kg	0.10	54000	0.53	1.2	26	8.1
Benzo[a]anthracene	M	2700	mg/kg	0.10	180	< 0.10	0.84	14	4.2
Chrysene	M	2700	mg/kg	0.10	350	< 0.10	1	14	3.6
Benzo[b]fluoranthene	M	2700	mg/kg	0.10	45	< 0.10	1	23	4.5
Benzo[k]fluoranthene	M	2700	mg/kg	0.10	1200	< 0.10	0.58	8.7	2.5
Benzo[a]pyrene	M	2700	mg/kg	0.10	36	< 0.10	0.88	18	4.8
Indeno(1,2,3-c,d)Pyrene	M	2700	mg/kg	0.10	510	< 0.10	0.44	13	3.7
Dibenz(a,h)Anthracene	M	2700	mg/kg	0.10	3.6	< 0.10	0.27	3.8	1.6
Benzo(g,h,i)perylene	M	2700	mg/kg	0.10	4000	< 0.10	1.5	12	3.9
Total Of 16 PAH's	M	2700	mg/kg	2.0		< 2.0	10	170	< 2.0
Benzene	M	2760	µg/kg	1.0	90	< 0.001	< 0.001	< 0.001	< 0.001
Toluene	M	2760	µg/kg	1.0	18000vap (4360)	< 0.001	< 0.001	< 0.001	< 0.001
Ethylbenzene	M	2760	µg/kg	1.0	27000vap (2840)	< 0.001	< 0.001	< 0.001	< 0.001
m-Xylene	M	2760	µg/kg	1.0	33000sol (2620)	< 0.001	< 0.001	< 0.001	< 0.001
p-Xylene	M	2760	µg/kg	1.0	31000vap (3460)	< 0.001	< 0.001	< 0.001	< 0.001
o-Xylene	M	2760	µg/kg	1.0	30000sol (3170)	< 0.001	< 0.001	< 0.001	< 0.001
Total Phenols	M	2920	mg/kg	0.30	1300dir (34000)	< 0.30	< 0.30	< 0.30	< 0.30

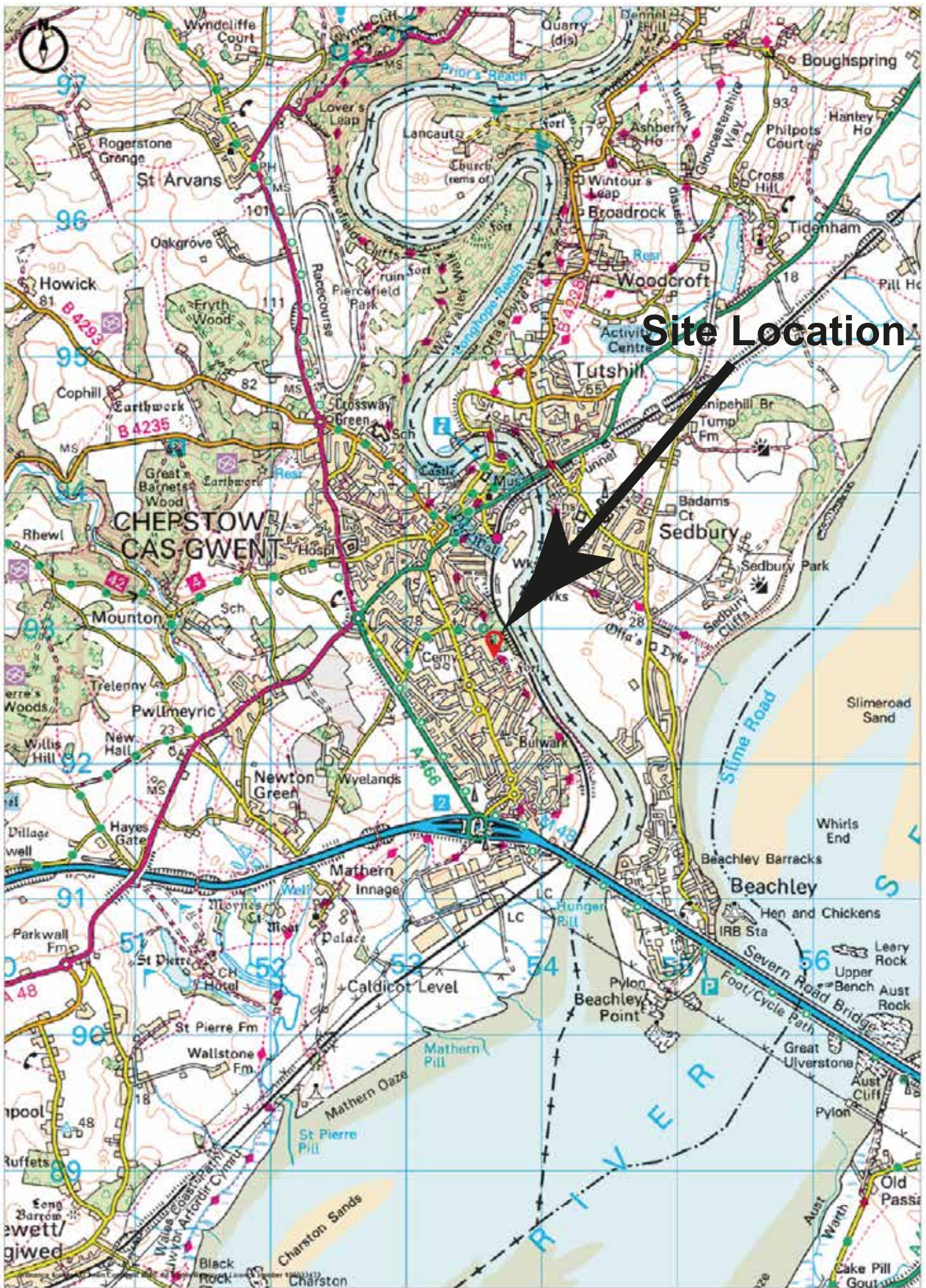


Determinand concentration below the GAC  
 Determinand concentration in excess of GAC  
 Determinand concentration in excess of the vapour/solubility saturation limit.

NC: No published criteria  
 vap: Screening criteria presented exceed the vapour saturation limit, which is presented in brackets.  
 sol: Screening criteria presented exceed the solubility saturation limit, which is presented in brackets.  
 dir: Screening criteria based on threshold protective of direct skin contact (guideline in brackets based on health effects following long term exposure provided for illustration only).  
 (1): For assessment based on the use of the surrogate marker approach the GAC for Coal Tar must be used instead of benzo(a)pyrene.



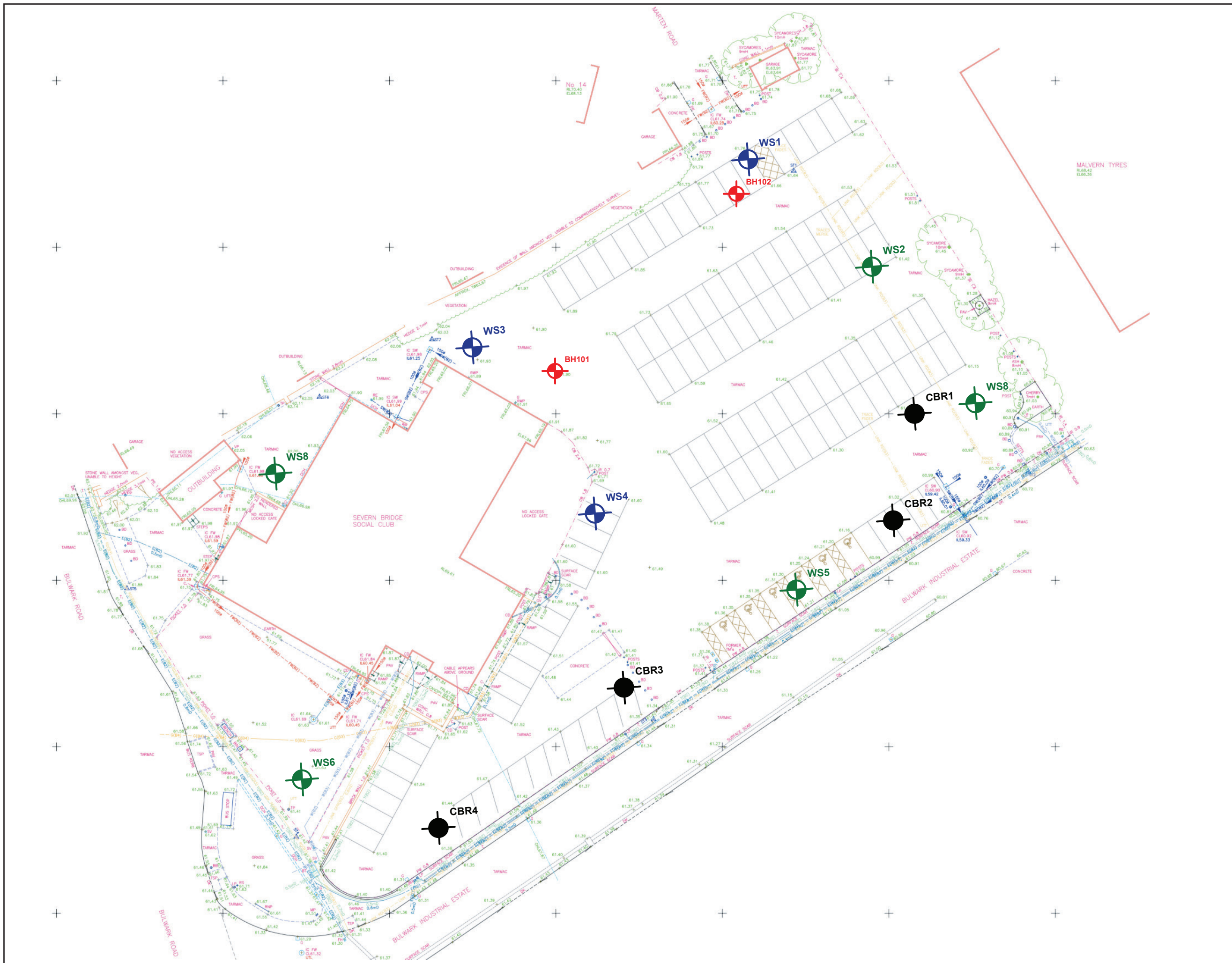
# FIGURES




Notes

Project Title	Scale	Drawn	Size
Chepstow	as shown	GJ	A4
Drawing Title	Date	Job No.	Drawing / Rev No.
Site Location Plan	01.12.20	799	Fig1
Client			
Lidl Great Britain Ltd	 		

Note:  
 Existing topographic and layout drawing reproduced from EDI Survey Ltd's Topographic & Services Survey, drawing No. 19190/T/01-01, issued in November 2020



Project Title		
Bulwark Road, Chepstow		
Drawing Title		
Figure 2: Existing Layout & Exploratory Locations		
Client		
Lidl Great Britain Ltd 		
Scale	Drawn	Size
NTS	GJ	A3
Date	Job No.	Drawing / Rev No.
05.01.21	799	01

**Remada**







# EXPLORATORY LOGS

# Percussion Drilling Log

Project Name: Bulwark Road		Client: Lidl Great Britain Ltd		Date: 30/11/2020	
Location: Chepstow		Contractor:			
Project No. : 799.02		Crew Name:		Drilling Equipment:	
Borehole Number WS1	Hole Type WS	Level 61.73m AoD	Logged By JM	Scale 1:25	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.15 - 0.40	ES		0.04 0.10 0.15	61.69 61.63 61.58	MADE GROUND: Asphalt MADE GROUND: Asphalt MADE GROUND: Brown grey slightly sandy angular to subangular medium to coarse gravel of mudstone and shale		
		0.55 - 0.95	B		0.55	61.18	Soft to firm brown slightly sandy silty gravelly CLAY. Gravel is angular medium predominantly of quartz and limestone.		
		0.55 - 0.95	ES		0.75	60.98	Firm friable light brown slightly sandy gravelly silty CLAY. Gravel is angular medium predominantly of quartz and limestone		
		1.00	SPT	78 (4, 18/78 for 150mm)	1.30	60.43	Very stiff friable light brown sandy gravelly silty CLAY. Sand is fine to medium. Gravel is angular to sub angular fine to medium of Limestone.	1	
							End of Borehole at 1.300m	2 3 4 5	

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

**Remarks**  
 1. No groundwater encountered.  
 2. Installed to 1.0m bgl. 0.5m plain pipe, 0.5m slotted pipe.



# Percussion Drilling Log

Project Name: Bulwark Road		Client: Lidl Great Britain Ltd		Date: 30/11/2020	
Location: Chepstow		Contractor:			
Project No. : 799.02		Crew Name:		Drilling Equipment:	
Borehole Number WS2	Hole Type WS	Level 61.42m AoD	Logged By JM	Scale 1:25	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.10	61.32		MADE GROUND: Asphalt.	
		0.20 - 0.70	ES		0.20	61.22		MADE GROUND: Brown grey slightly sandy angular to subangular medium to coarse gravel of mudstone and shale	
					0.70	60.72		MADE GROUND: Soft to firm dark brown mottled dark grey sandy gravelly clay. Gravel is angular to subangular medium to coarse predominantly of coal and brick fragments	
		0.85 - 1.10	B		0.85	60.57		<i>Becoming very sandy with ash and clinker</i> Firm brown silty CLAY.	
		1.00	SPT	N=50 (8,8/13,12,12,13)				Very stiff yellowish brown mottled brown clayey sandy angular to sub angular fine to coarse GRAVEL of Limestone.	1
					1.45	59.97		End of Borehole at 1.450m	2
									3
									4
									5

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

**Remarks**  
 1. No groundwater encountered.  
 2. Installed to 1.0m bgl. 0.5m plain pipe, 0.5m slotted pipe.



# Percussion Drilling Log

Project Name: Bulwark Road		Client: Lidl Great Britain Ltd		Date: 30/11/2020	
Location: Chepstow		Contractor:			
Project No. : 799.02		Crew Name:		Drilling Equipment:	
Borehole Number WS3	Hole Type WS	Level 61.93m AoD	Logged By JM	Scale 1:25	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.05 - 0.60	ES		0.05	61.88		MADE GROUND: Asphalt. Soft becoming firm brown silty CLAY.	
		0.60 - 1.20	B		0.60	61.33		Very stiff light brown silty gravelly CLAY. Gravel is angular to sub angular fine to coarse of Limestone.	
		1.00	SPT	50 (8,13/50 for 165mm)	1.32	60.62		End of Borehole at 1.320m	1
									2
									3
									4
									5

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

**Remarks**  
 1. No groundwater encountered.  
 2. Installed to 1.0m bgl. 0.5m plain pipe, 0.5m slotted pipe.



# Percussion Drilling Log

Project Name: Bulwark Road		Client: Lidl Great Britain Ltd		Date: 30/11/2020	
Location: Chepstow		Contractor:			
Project No. : 799.02		Crew Name:		Drilling Equipment:	
Borehole Number WS4	Hole Type WS	Level 61.60m AoD	Logged By JM	Scale 1:25	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
		0.10 - 0.25	ES	50 (2,8/50 for 135mm)	0.10	61.50		MADE GROUND: Asphalt.	1	
		1.00	SPT		0.25	61.35		MADE GROUND: Very soft dark grey and black slightly sandy silty clay. Sand is fine to coarse.		
					1.10 - 1.29	B				Soft brown mottled light brown slightly sandy silty CLAY. Sand is fine to coarse, recovered as angular fine to medium gravel of limestone and quartz.
										Limestone cobble.
					0.80	60.80		Firm to stiff brown slightly sandy silty CLAY. Sand is fine to medium.		
		1.10	60.50		Very stiff light yellowish brown silty, sandy gravelly CLAY. Gravel is angular to sub angular fine to coarse of Limestone.					
		1.29	60.31				End of Borehole at 1.290m	2		
								3		
								4		
								5		

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks

- No groundwater encountered.
- Installed to 1.0m bgl. 0.5m plain pipe, 0.5m slotted pipe.



# Percussion Drilling Log

Project Name: Bulwark Road		Client: Lidl Great Britain Ltd		Date: 30/11/2020	
Location: Chepstow		Contractor:			
Project No. : 799.02		Crew Name:		Drilling Equipment:	
Borehole Number WS5	Hole Type WS	Level 61.30m AoD	Logged By JM	Scale 1:25	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10 - 1.00	ES		0.05 0.10	61.25 61.20	MADE GROUND: Asphalt. MADE GROUND: Brown grey slightly sandy angular to subangular medium to coarse gravel of mudstone and shale MADE GROUND: Soft to firm dark grey sandy gravelly silty clay. Sand is fine to coarse. Gravel is angular to sub angular fine to medium of mixed lithologies including clinker and brick.		
		1.00	SPT	N=24 (4,5/6,5,6,7)	1.00	60.30	MADE GROUND: Stiff brown mottled dark brown sandy gravelly silty clay. Sand is medium to coarse. Gravel is angular fine to medium of mixed lithologies including brick.	1	
		1.55 - 2.15	B		1.55	59.75	Very stiff yellowish brown mottled brown sandy very gravelly CLAY. gravel is angular to sub angular fine to coarse of limestone.		
		1.70	SPT	N=50 (8,8/13,12,13,12)				2	
					2.15	59.15	End of Borehole at 2.150m		

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

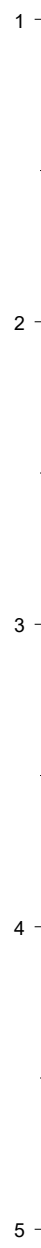
**Remarks**  
 1. No groundwater encountered.  
 2. Installed to 1.0m bgl. 0.5m plain pipe, 0.5m slotted pipe.



# Percussion Drilling Log

Project Name: Bulwark Road		Client: Lidl Great Britain Ltd		Date: 01/12/2020	
Location: Chepstow		Contractor:			
Project No. : 799.02		Crew Name:		Drilling Equipment:	
Borehole Number WS6	Hole Type WS	Level 61.51m AoD	Logged By JM	Scale 1:25	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
[Pattern]		0.20 - 0.50	ES B	66 (10,7/66 for 150mm)	0.20	61.31	[Pattern]	MADE GROUND: Topsoil.
		0.20 - 0.60			0.50	61.01	[Pattern]	MADE GROUND: Dark brown slightly clayey gravelly fine to coarse sand. Gravel is angular to sub angular fine to coarse of limestone and occasional brick fragments.
		1.00	SPT		0.70	60.81	[Pattern]	MADE GROUND: Soft to firm dark brown sandy silty very gravelly clay. Sand is medium to coarse. Gravel is angular to sub angular fine to coarse of mixed lithologies including brick and limestone
					1.30	60.21	[Pattern]	Very stiff yellowish brown silty very gravelly CLAY. Gravel is angular fine to medium of limestone.
							End of Borehole at 1.300m	



Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

**Remarks**  
 1. No groundwater encountered.  
 2. Installed to 1.0m bgl. 0.5m plain pipe, 0.5m slotted pipe.





# Percussion Drilling Log

Project Name: Bulwark Road		Client: Lidl Great Britain Ltd		Date: 01/12/2020	
Location: Chepstow		Contractor:			
Project No. : 799.02		Crew Name:		Drilling Equipment:	
Borehole Number WS7	Hole Type WS	Level 61.98m AoD	Logged By JM	Scale 1:25	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
Water Strikes		0.05 - 0.50	ES		0.05	61.93		MADE GROUND: Asphalt.	1
					0.30	61.68		MADE GROUND: Soft grey slightly sandy gravelly silty clay. Sand is fine to coarse. Gravel is angular medium coal.	
		0.50 - 1.20	B		0.50	61.48		MADE GROUND: Soft to firm yellowish brown mottled grey silty very gravelly clay. Gravel is angular medium coal.	
								Very stiff yellowish brown silty very gravelly CLAY. Gravel is angular to sub angular fine to medium of Limestone.	
	1.00	SPT	50 (5,9/50 for 165mm)	1.32	60.66		End of Borehole at 1.320m	2	
								3	
								4	
								5	

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

**Remarks**  
 1. No groundwater encountered.  
 2. Installed to 1.0m bgl. 0.5m plain pipe, 0.5m slotted pipe.



# Percussion Drilling Log

Project Name: Bulwark Road		Client: Lidl Great Britain Ltd		Date: 01/12/2020	
Location: Chepstow		Contractor:			
Project No. : 799.02		Crew Name:		Drilling Equipment:	
Borehole Number WS8	Hole Type WS	Level 60.90m AoD	Logged By JM	Scale 1:25	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10 - 0.90	ES		0.05 0.10	60.85 60.80	MADE GROUND: Asphalt. MADE GROUND: Brown grey slightly sandy angular to subangular medium to coarse gravel of mudstone and shale MADE GROUND: Brown mottled grey sandy clayey angular fine to coarse gravel of mixed lithologies including coal and brick.		
		0.90 - 1.10	B		0.60	60.30	MADE GROUND: Multicoloured fine to medium sand.		
		1.00	SPT	50 (8,15/50 for 160mm)	0.75 0.90	60.15 60.00	Multicoloured sandy angular to sub angular fine to coarse GRAVEL of mixed lithologies including quartz, limestone and coal. Very stiff yellowish brown mottled brown silty gravelly CLAY. Gravel is angular medium of limestone.	1	
					1.31	59.59	End of Borehole at 1.310m		

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

**Remarks**  
 1. No groundwater encountered.  
 2. Installed to 1.0m bgl. 0.5m plain pipe, 0.5m slotted pipe.



# Rotary Core Log

Project Name: Bulwark Road		Client: Lidl Great Britain Ltd		Date:	
Location: Chepstow		Contractor:			
Project No. : 799.02		Crew Name:		Drilling Equipment:	
Borehole Number BH101	Hole Type RC	Level	Logged By	Scale 1:25	Page Number Sheet 1 of 1

Well	Water	Depth (m)	Type /FI	Coring			Diameter Recovery (SPT)	Depth (m)	Level (m)	Legend	Stratum Description	
				TCR	SCR	RQD						
		4.15 - 4.31	C					0.09			MADE GROUND: Asphalt	
								0.15			MADE GROUND: Brown grey slightly sandy angular to subangular medium to coarse gravel of mudstone and shale	
											Firm brown slightly gravelly silty CLAY. Gravel is subangular fine to coarse of mixed lithologies including limestone and rare coal fragments.	
								1.00			Yellowish brown LIMESTONE. Assessed as being strong to very strong as requires multiple blows of a geological hammer to fracture.	1
												2
												3
												4
								4.50				5

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation				Drilling Flush					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation	Depth Top	Depth Base	Type	Colour	Min (%)	Max (%)

Remarks



# Rotary Core Log

Project Name: Bulwark Road		Client: Lidl Great Britain Ltd		Date:	
Location: Chepstow		Contractor:			
Project No. : 799.02		Crew Name:		Drilling Equipment:	
Borehole Number BH102	Hole Type RC	Level	Logged By	Scale 1:25	Page Number Sheet 1 of 1

Well	Water	Depth (m)	Type /FI	Coring			Diameter Recovery (SPT)	Depth (m)	Level (m)	Legend	Stratum Description				
				TCR	SCR	RQD									
[Redacted]		1.50 - 1.64	C					0.04		[Pattern]	MADE GROUND: Asphalt	1			
								0.10		[Pattern]	MADE GROUND: Asphalt				
								0.15		[Pattern]	MADE GROUND: Brown grey slightly sandy angular to subangular medium to coarse gravel of mudstone and shale				
								0.45		[Pattern]	Firm brown slightly gravelly silty CLAY. Gravel is subangular fine to coarse of mixed lithologies including limestone and rare coal fragments				
								0.70		[Pattern]	Firm to stiff yellowish brown gravelly CLAY. Gravel is subangular fine to coarse of limestone.				
[Redacted]		4.15 - 4.31	C							[Pattern]	Yellowish brown LIMESTONE. Assessed as being strong to very strong as requires multiple blows of a geological hammer to fracture.	2			
													[Pattern]		
														[Pattern]	
														[Pattern]	
														[Pattern]	
														[Pattern]	
														[Pattern]	
														[Pattern]	
														[Pattern]	
														[Pattern]	
[Redacted]		4.50										3			
[Redacted]												4			
[Redacted]												5			

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation				Drilling Flush					
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation	Depth Top	Depth Base	Type	Colour	Min (%)	Max (%)

Remarks





---

# APPENDIX A

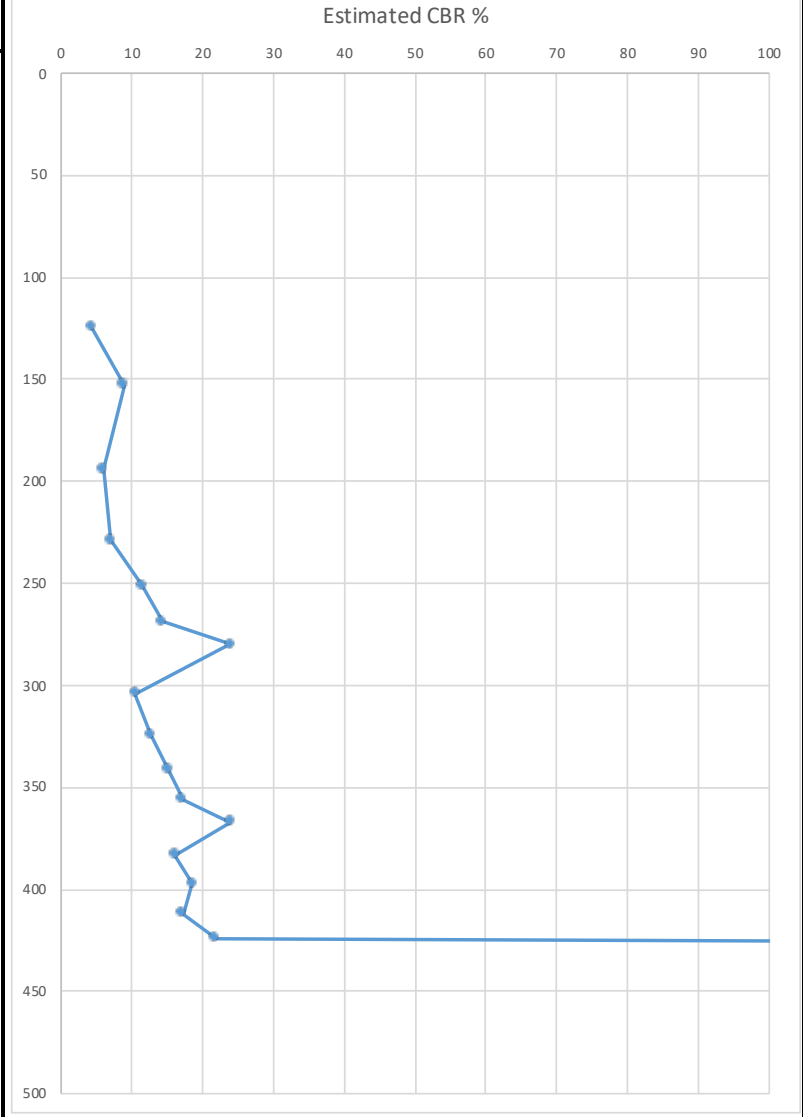
## Dynamic Cone Penetrometer Test Results

TRL Dynamic Cone Penetrometer Test Results

Remada

<b>Client:</b>	Lidl Great Britain Ltd	<b>Struct' Eng':</b>		<b>Test No:</b>	CBR1	<b>Location:</b>	
<b>Project No:</b>	799.01	<b>Date:</b>	04.01.2021	<b>Start Depth:</b>	Surfacing	<b>Test Strata:</b>	Made Ground & Sub-base
$Log_{10}(CBR) = 2.480 - 1.057 \times Log_{10}(mm/blow)$						<b>Weather:</b>	Dry Sunny

No of Blows	Depth Reading mm	Penetration /Blow mm	CBR %
0	70	0	
1	125	55.0	4.4
2	153	28.0	8.9
3	194	41.0	6.0
4	229	35.0	7.0
5	251	22.0	11.5
6	269	18.0	14.2
7	280	11.0	23.9
8	304	24.0	10.5
9	324	20.0	12.7
10	341	17.0	15.1
11	356	15.0	17.3
12	367	11.0	23.9
13	383	16.0	16.1
14	397	14.0	18.6
15	412	15.0	17.3
16	424	12.0	21.8
17	426	2.0	145.1
18	427	1.0	302.0
19	428	1.0	302.0
20	429	1.0	302.0
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			
38			
39			
40			



Notes:

Tested by P Dickinson  
 Date: 04.01.2021  
 Checked by: G Jones  
 Date: 06.01.2021

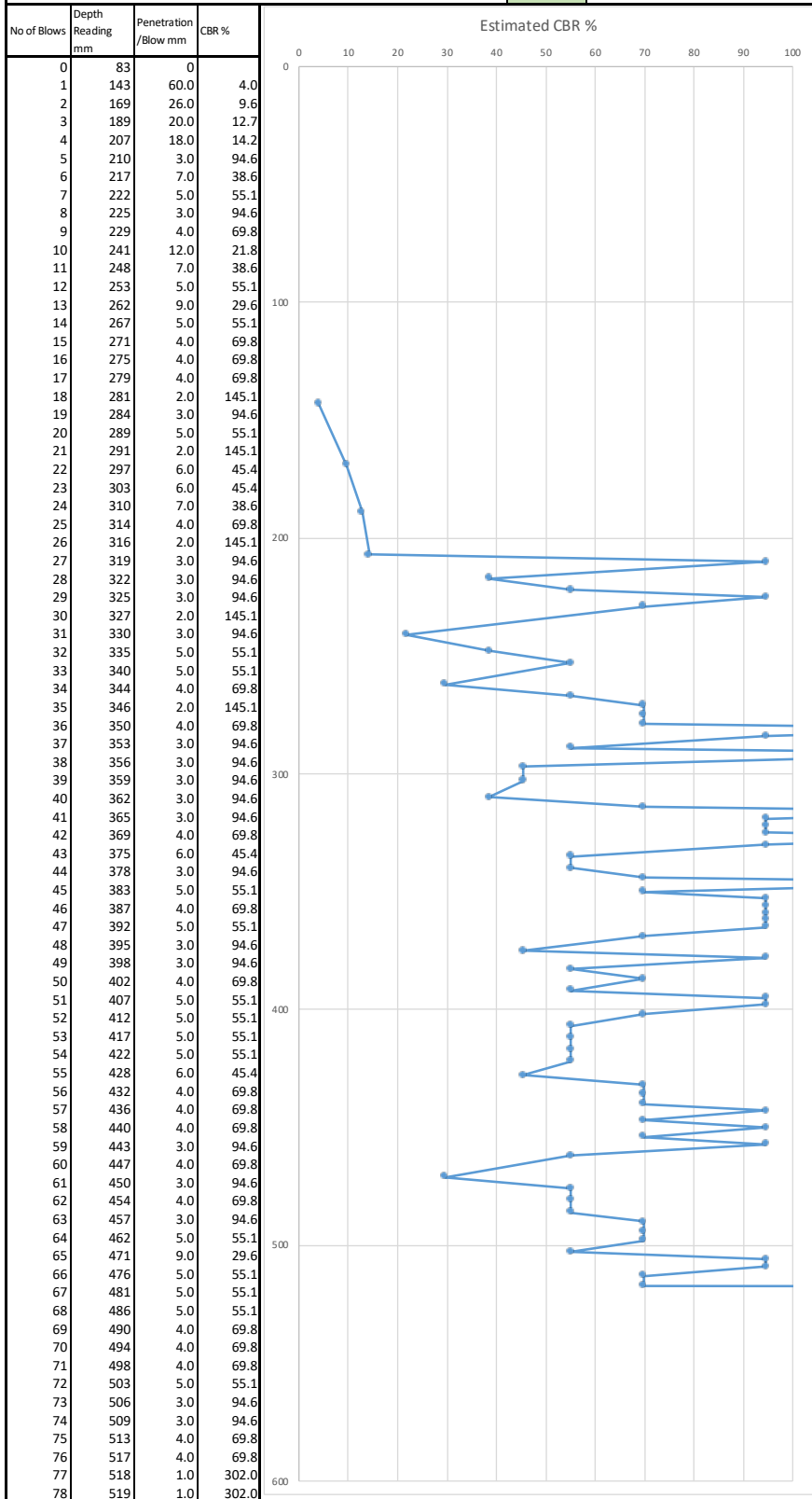
TRL Dynamic Cone Penetrometer Test Results

Remada

Client:	Lidl Great Britain Ltd	Struct' Eng':		Test No:	CBR1	Location:	
Project No:	799.01	Date:	04.01.2021	Start Depth:	Surfacing	Test Strata:	Made Ground & Sub-base

$Log10(CBR) = 2.480 - 1.057 \times Log10(mm/blow)$

Weather: Dry Sunny



Notes:

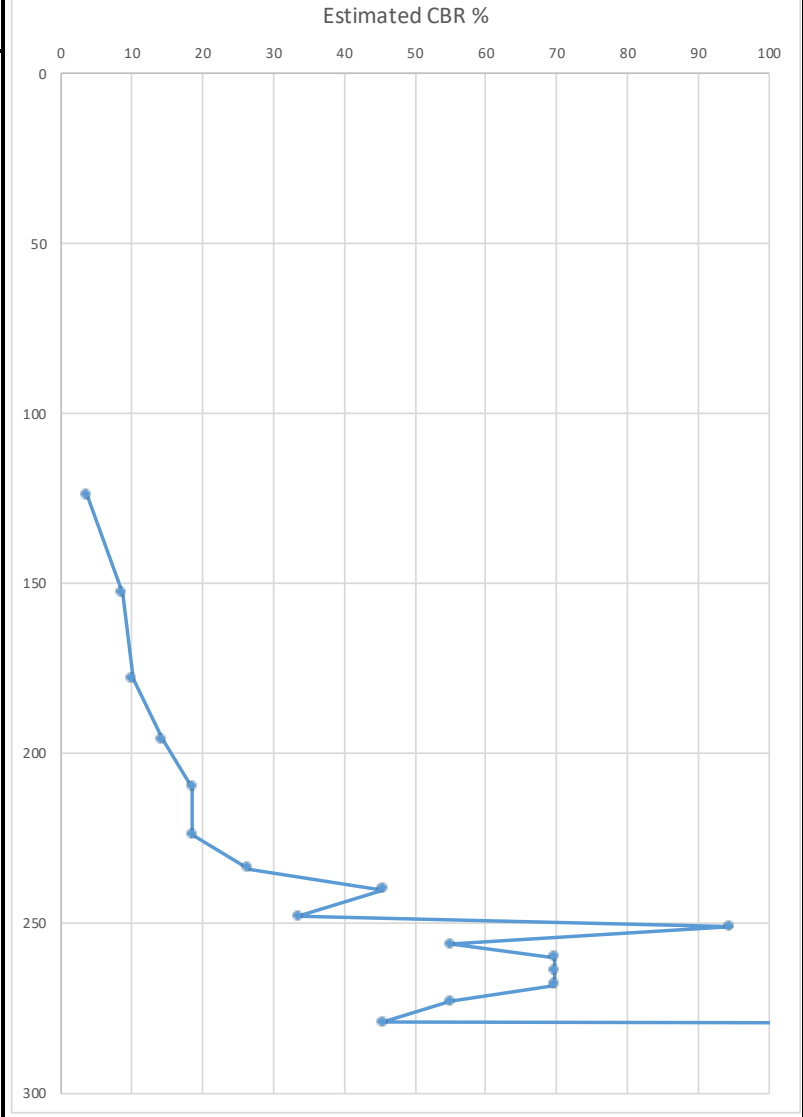
Tested by P Dickinson  
 Date: 04.01.2021  
 Checked by: G Jones  
 Date: 06.01.2021

TRL Dynamic Cone Penetrometer Test Results

Remada

<b>Client:</b>	Lidl Great Britain Ltd	<b>Struct' Eng':</b>		<b>Test No:</b>	CBR3	<b>Location:</b>	
<b>Project No:</b>	799.01	<b>Date:</b>	04.01.2021	<b>Start Depth:</b>	Surfacing	<b>Test Strata:</b>	Made Ground & Sub-base
$Log_{10}(CBR) = 2.480 - 1.057 \times Log_{10}(mm/blow)$						<b>Weather:</b>	Dry Sunny

No of Blows	Depth Reading mm	Penetration /Blow mm	CBR %
0	59	0	
1	124	65.0	3.7
2	153	29.0	8.6
3	178	25.0	10.1
4	196	18.0	14.2
5	210	14.0	18.6
6	224	14.0	18.6
7	234	10.0	26.5
8	240	6.0	45.4
9	248	8.0	33.5
10	251	3.0	94.6
11	256	5.0	55.1
12	260	4.0	69.8
13	264	4.0	69.8
14	268	4.0	69.8
15	273	5.0	55.1
16	279	6.0	45.4
17	280	1.0	302.0
18	281	1.0	302.0
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			
38			
39			
40			



Notes:

Tested by P Dickinson  
 Date: 04.01.2021  
 Checked by: G Jones  
 Date: 06.01.2021

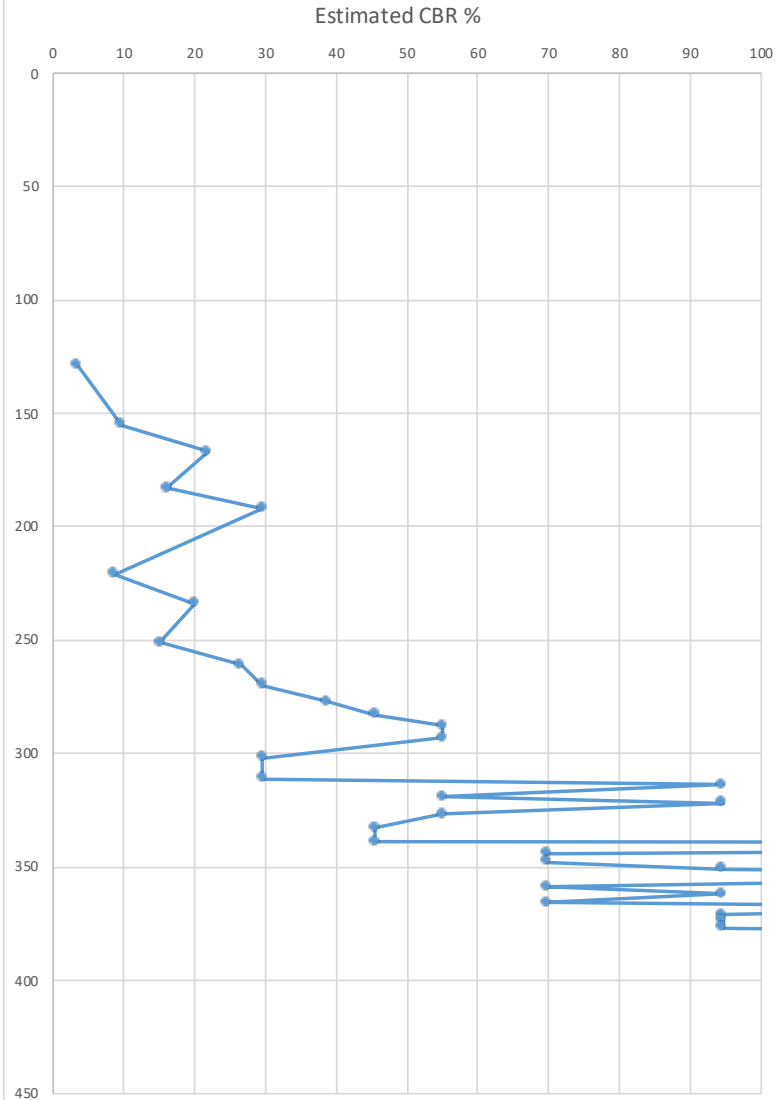


TRL Dynamic Cone Penetrometer Test Results

Remada

<b>Client:</b>	Lidl Great Britain Ltd	<b>Struct' Eng':</b>		<b>Test No:</b>	CBR4	<b>Location:</b>	
<b>Project No:</b>	799.01	<b>Date:</b>	04.01.2021	<b>Start Depth:</b>	Surfacing	<b>Test Strata:</b>	Made Ground & Sub-base
$Log_{10}(CBR) = 2.480 - 1.057 \times Log_{10}(mm/blow)$						<b>Weather:</b>	Dry Sunny

No of Blows	Depth Reading mm	Penetration /Blow mm	CBR %
0	61	0	
1	129	68.0	3.5
2	155	26.0	9.6
3	167	12.0	21.8
4	183	16.0	16.1
5	192	9.0	29.6
6	221	29.0	8.6
7	234	13.0	20.1
8	251	17.0	15.1
9	261	10.0	26.5
10	270	9.0	29.6
11	277	7.0	38.6
12	283	6.0	45.4
13	288	5.0	55.1
14	293	5.0	55.1
15	302	9.0	29.6
16	311	9.0	29.6
17	314	3.0	94.6
18	319	5.0	55.1
19	322	3.0	94.6
20	327	5.0	55.1
21	333	6.0	45.4
22	339	6.0	45.4
23	340	1.0	302.0
24	344	4.0	69.8
25	348	4.0	69.8
26	351	3.0	94.6
27	353	2.0	145.1
28	355	2.0	145.1
29	359	4.0	69.8
30	362	3.0	94.6
31	366	4.0	69.8
32	368	2.0	145.1
33	371	3.0	94.6
34	374	3.0	94.6
35	377	3.0	94.6
36	379	2.0	145.1
37	380	1.0	302.0
38	382	2.0	145.1
39	383	1.0	302.0
40	384	1.0	302.0



Notes:

Tested by P Dickinson  
 Date: 04.01.2021  
 Checked by: G Jones  
 Date: 06.01.2021



---

# Appendix B

## Laboratory Chemical Analyses



# Final Report

---

**Report No.:** 20-33135-1  
**Initial Date of Issue:** 09-Dec-2020  
**Client:** Remada Ltd  
**Client Address:** Forward House  
17 High Street  
Henley in Arden  
B95 5AA  
**Contact(s):** Greg Jones  
Peter Dickinson  
**Project:** 799.02 Bulwark Road, Chepstow  
**Quotation No.:** **Date Received:** 03-Dec-2020  
**Order No.:** **Date Instructed:** 03-Dec-2020  
**No. of Samples:** 7  
**Turnaround (Wkdays):** 5 **Results Due:** 09-Dec-2020  
**Date Approved:** 09-Dec-2020

**Approved By:**

**Details:** Glynn Harvey, Technical Manager

---

## Results - Soil

**Project: 799.02 Bulwark Road, Chepstow**

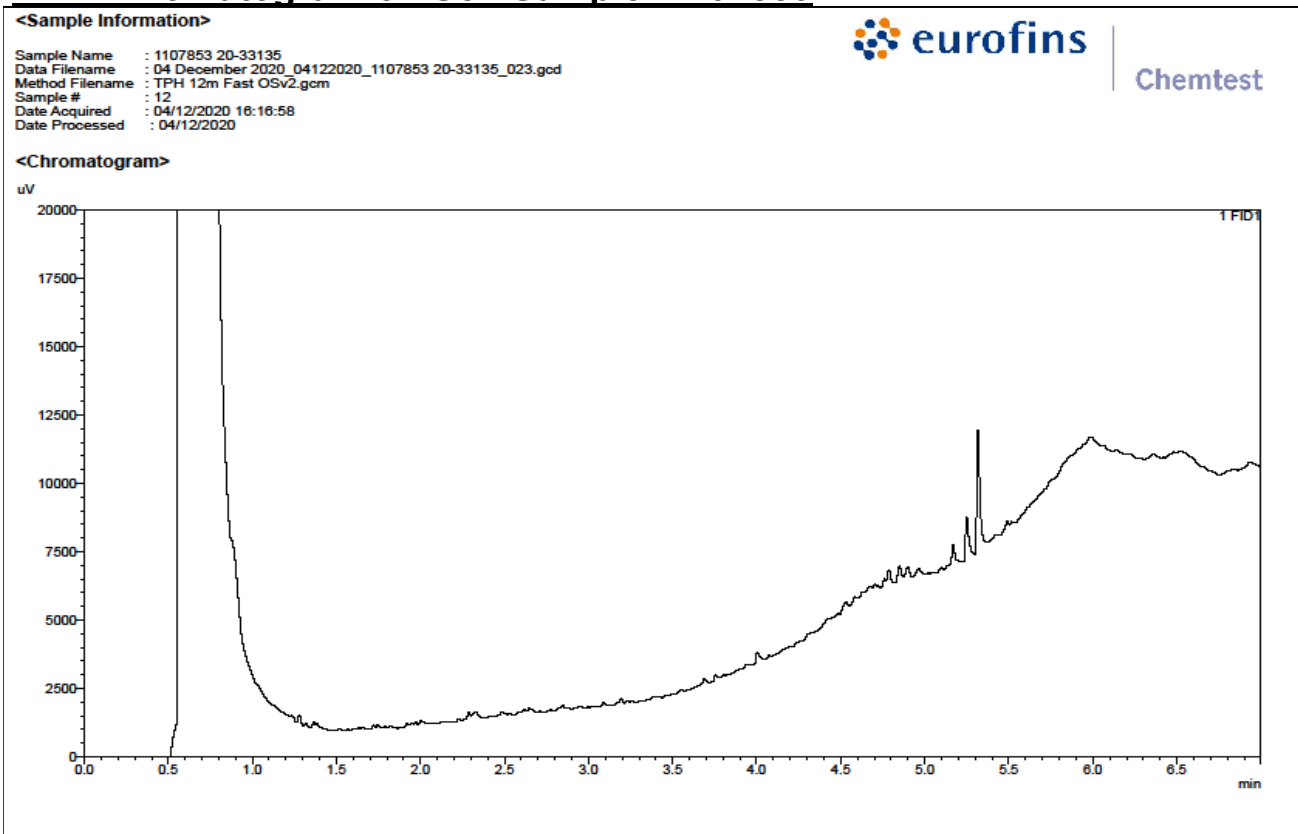
Client: Remada Ltd	Chemtest Job No.:		20-33135	20-33135	20-33135	20-33135	20-33135	20-33135	20-33135	20-33135	
Quotation No.:	Chemtest Sample ID.:		1107852	1107853	1107854	1107856	1107857	1107858	1107859		
	Sample Location:		WS1	WS2	WS3	WS5	WS6	WS7	WS8		
	Sample Type:		SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL		
	Top Depth (m):		0.15	0.20	0.15	0.10	0.20	0.05	0.10		
	Bottom Depth (m):		0.40	0.70	0.60	1.00	0.50	0.50	0.60		
	Date Sampled:		30-Nov-2020	30-Nov-2020	30-Nov-2020	30-Nov-2020	30-Nov-2020	30-Nov-2020	30-Nov-2020		
	Asbestos Lab:			COVENTRY		COVENTRY	COVENTRY	COVENTRY	COVENTRY		
Determinand	Accred.	SOP	Units	LOD							
ACM Type	U	2192		N/A		-		-	-	-	Cement
Asbestos Identification	U	2192		N/A		No Asbestos Detected		No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	Chrysotile
ACM Detection Stage	U	2192		N/A		-		-	-	-	Stereo Microscopy
Asbestos by Gravimetry	U	2192	%	0.001							0.059
Total Asbestos	U	2192	%	0.001							0.059
Moisture	N	2030	%	0.020	19	6.8	14	15	14	17	6.2
Chromatogram (TPH)	N			N/A		See Attached		See Attached	See Attached	See Attached	See Attached
pH	U	2010		4.0	8.3	8.7	8.4	8.1	9.2	8.4	11.5
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40		0.86		2.2	0.83	0.64	< 0.40
Magnesium (Water Soluble)	N	2120	g/l	0.010	< 0.010	0.014	< 0.010	< 0.010			
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	< 0.010	0.11	< 0.010	0.016			
Total Sulphur	U	2175	%	0.010	0.063	0.13	0.022	0.072			
Chloride (Water Soluble)	U	2220	g/l	0.010	0.18	0.041	0.015	0.027			
Nitrate (Water Soluble)	N	2220	g/l	0.010	< 0.010	< 0.010	< 0.010	< 0.010			
Ammonium (Water Soluble)	U	2120	g/l	0.01	< 0.01	< 0.01	< 0.01	< 0.01			
Sulphate (Acid Soluble)	U	2430	%	0.010	0.079	0.078	0.029	0.056			
Arsenic	U	2450	mg/kg	1.0		17		20	18	24	24
Beryllium	U	2450	mg/kg	1.0		< 1.0		< 1.0	< 1.0	< 1.0	< 1.0
Cadmium	U	2450	mg/kg	0.10		0.25		0.54	0.82	0.61	0.27
Copper	U	2450	mg/kg	0.50		13		36	32	41	10
Mercury	U	2450	mg/kg	0.10		< 0.10		0.27	0.46	0.46	< 0.10
Nickel	U	2450	mg/kg	0.50		11		22	18	21	11
Lead	U	2450	mg/kg	0.50		22		120	180	150	160
Selenium	U	2450	mg/kg	0.20		< 0.20		0.31	0.25	< 0.20	< 0.20
Vanadium	U	2450	mg/kg	5.0		15		21	16	20	16
Zinc	U	2450	mg/kg	0.50		51		170	250	210	180
Chromium (Trivalent)	N	2490	mg/kg	1.0		9.5		14	9.9	14	12
Chromium (Hexavalent)	N	2490	mg/kg	0.50		< 0.50		< 0.50	< 0.50	< 0.50	< 0.50
Fraction of Organic Carbon	U	2625		0.0010		0.056		0.054	0.046	0.063	0.0013
Aliphatic TPH >C5-C6	N	2680	mg/kg	1.0		< 1.0		< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C6-C8	N	2680	mg/kg	1.0		< 1.0		< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C8-C10	U	2680	mg/kg	1.0		< 1.0		< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C10-C12	U	2680	mg/kg	1.0		< 1.0		< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C12-C16	U	2680	mg/kg	1.0		10		< 1.0	9.6	< 1.0	< 1.0
Aliphatic TPH >C16-C21	U	2680	mg/kg	1.0		< 1.0		< 1.0	14	< 1.0	15
Aliphatic TPH >C21-C35	U	2680	mg/kg	1.0		100		< 1.0	85	< 1.0	220

## Results - Soil

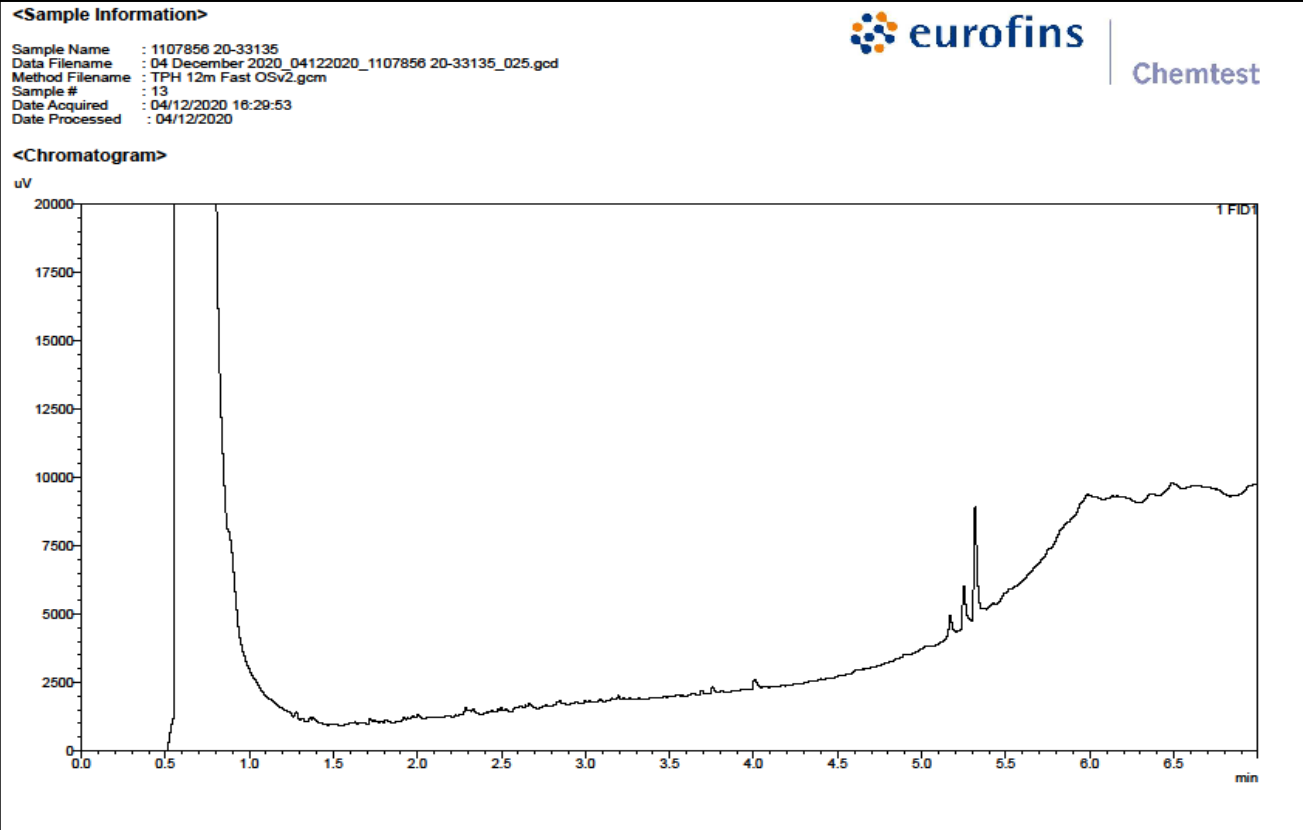
Project: 799.02 Bulwark Road, Chepstow

Client: Remada Ltd		Chemtest Job No.:		20-33135	20-33135	20-33135	20-33135	20-33135	20-33135	20-33135
Quotation No.:		Chemtest Sample ID.:		1107852	1107853	1107854	1107856	1107857	1107858	1107859
Sample Location:		WS1	WS2	WS3	WS5	WS6	WS7	WS8		
Sample Type:		SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL		
Top Depth (m):		0.15	0.20	0.15	0.10	0.20	0.05	0.10		
Bottom Depth (m):		0.40	0.70	0.60	1.00	0.50	0.50	0.60		
Date Sampled:		30-Nov-2020	30-Nov-2020	30-Nov-2020	30-Nov-2020	30-Nov-2020	30-Nov-2020	30-Nov-2020		
Asbestos Lab:			COVENTRY		COVENTRY	COVENTRY	COVENTRY	COVENTRY		
Determinand	Accred.	SOP	Units	LOD						
Aliphatic TPH >C35-C44	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Aliphatic Hydrocarbons	N	2680	mg/kg	5.0	110	< 5.0	110	< 5.0	230	
Aromatic TPH >C5-C7	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C7-C8	N	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C8-C10	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C10-C12	U	2680	mg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C12-C16	U	2680	mg/kg	1.0	12	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0	< 1.0	< 1.0	84	< 1.0	48	
Aromatic TPH >C21-C35	U	2680	mg/kg	1.0	410	< 1.0	600	< 1.0	1100	
Aromatic TPH >C35-C44	N	2680	mg/kg	1.0	68	< 1.0	48	< 1.0	270	
Total Aromatic Hydrocarbons	N	2680	mg/kg	5.0	490	< 5.0	730	< 5.0	1400	
Total Petroleum Hydrocarbons	N	2680	mg/kg	10.0	600	< 10	840	< 10	1600	
Naphthalene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthylene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluorene	U	2700	mg/kg	0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Phenanthrene	U	2700	mg/kg	0.10	< 0.10	0.58	7.6	2.7	< 0.10	
Anthracene	U	2700	mg/kg	0.10	< 0.10	0.14	3.4	1.0	< 0.10	
Fluoranthene	U	2700	mg/kg	0.10	0.44	1.1	27	7.3	< 0.10	
Pyrene	U	2700	mg/kg	0.10	0.53	1.2	26	8.1	< 0.10	
Benzo[a]anthracene	U	2700	mg/kg	0.10	< 0.10	0.84	14	4.2	< 0.10	
Chrysene	U	2700	mg/kg	0.10	< 0.10	1.0	14	3.6	< 0.10	
Benzo[b]fluoranthene	U	2700	mg/kg	0.10	< 0.10	1.0	23	4.5	< 0.10	
Benzo[k]fluoranthene	U	2700	mg/kg	0.10	< 0.10	0.58	8.7	2.5	< 0.10	
Benzo[a]pyrene	U	2700	mg/kg	0.10	< 0.10	0.88	18	4.8	< 0.10	
Indeno(1,2,3-c,d)Pyrene	U	2700	mg/kg	0.10	< 0.10	0.44	13	3.7	< 0.10	
Dibenz(a,h)Anthracene	U	2700	mg/kg	0.10	< 0.10	0.27	3.8	1.6	< 0.10	
Benzo[g,h,i]perylene	U	2700	mg/kg	0.10	< 0.10	1.5	12	3.9	< 0.10	
Total Of 16 PAH's	U	2700	mg/kg	2.0	< 2.0	9.5	170	48	< 2.0	
Benzene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
m & p-Xylene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-Xylene	U	2760	µg/kg	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Phenols	U	2920	mg/kg	0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30

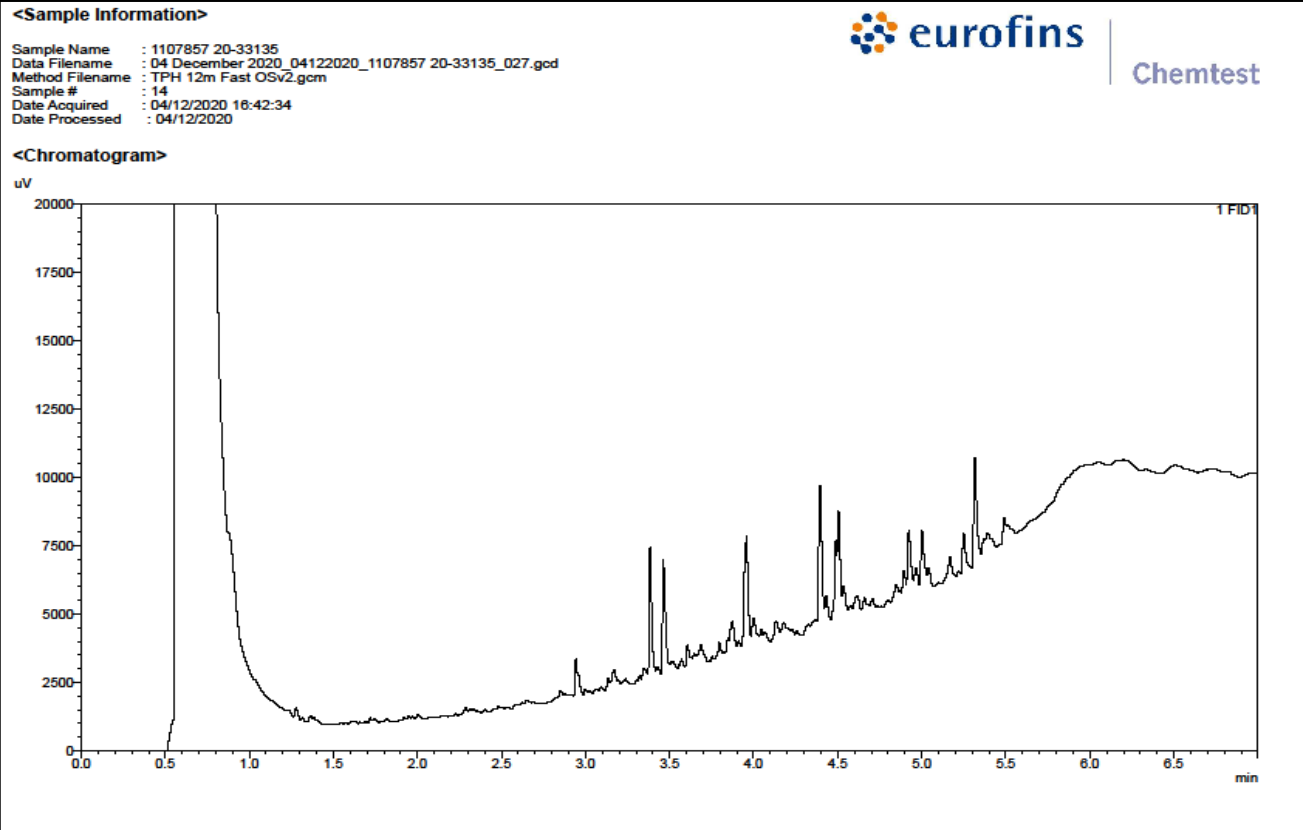
# TPH Chromatogram on Soil Sample: 1107853



# TPH Chromatogram on Soil Sample: 1107856

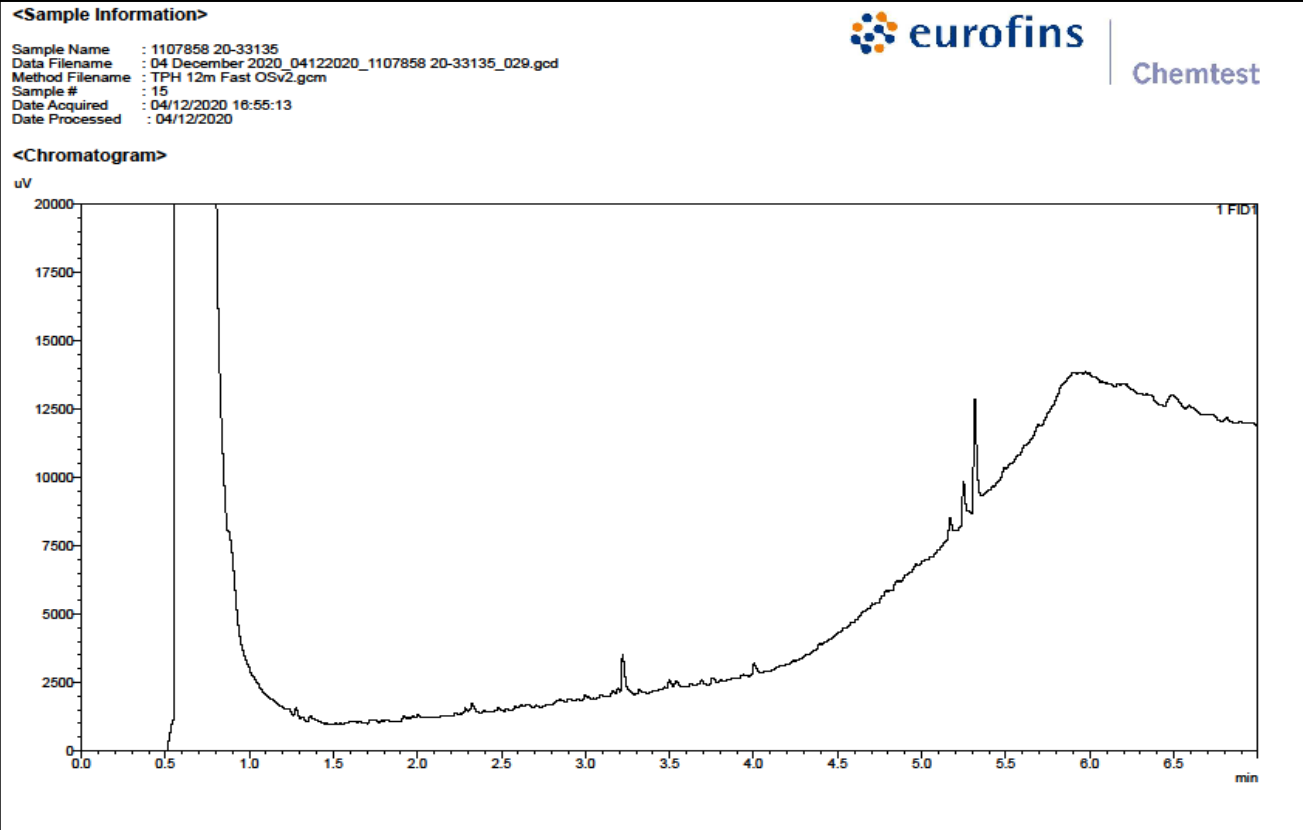


# TPH Chromatogram on Soil Sample: 1107857

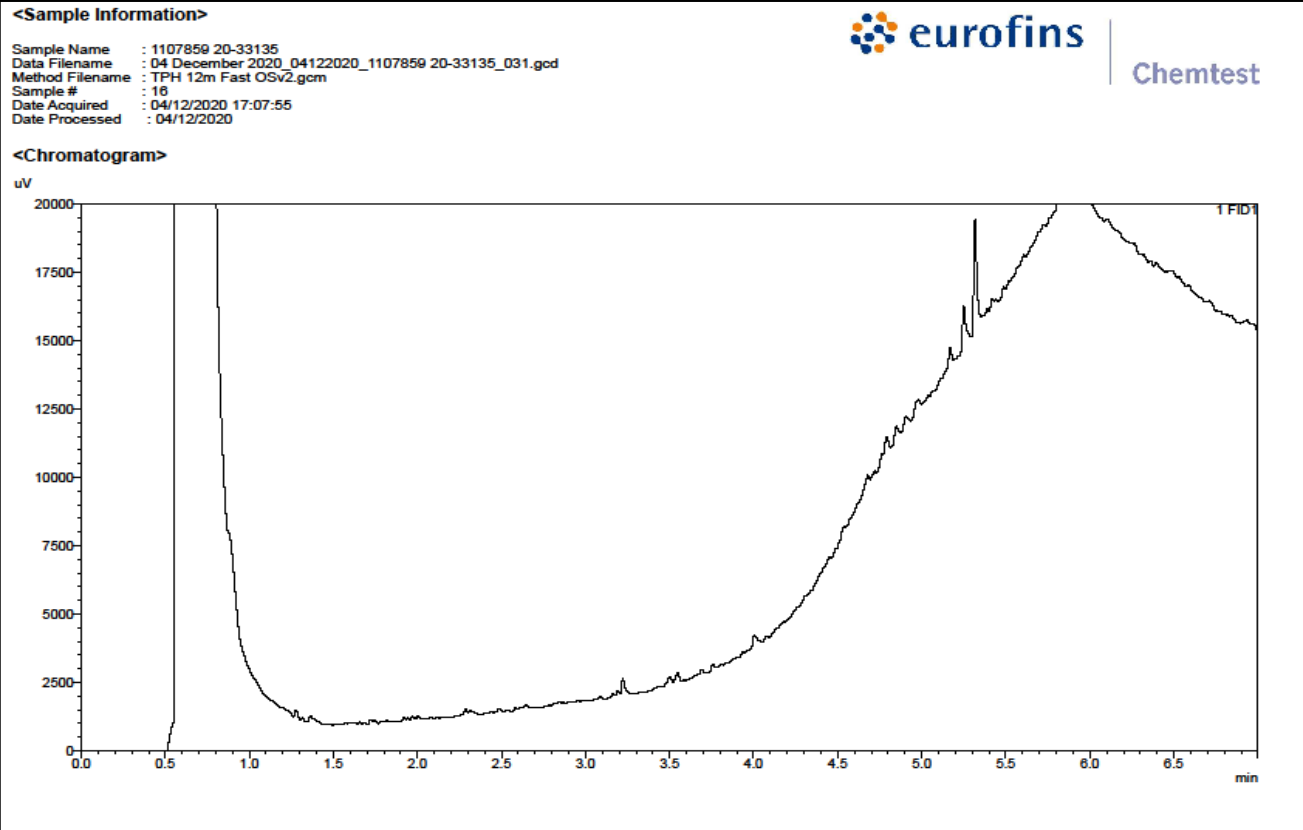




# TPH Chromatogram on Soil Sample: 1107858



# TPH Chromatogram on Soil Sample: 1107859



## Test Methods

SOP	Title	Parameters included	Method summary
2010	pH Value of Soils	pH	pH Meter
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2175	Total Sulphur in Soils	Total Sulphur	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2220	Water soluble Chloride in Soils	Chloride	Aqueous extraction and measurement by 'Aquakem 600' Discrete Analyser using ferric nitrate / mercuric thiocyanate.
2430	Total Sulphate in soils	Total Sulphate	Acid digestion followed by determination of sulphate in extract by ICP-OES.
2450	Acid Soluble Metals in Soils	Metals, including: Arsenic; Barium; Beryllium; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Vanadium; Zinc	Acid digestion followed by determination of metals in extract by ICP-MS.
2490	Hexavalent Chromium in Soils	Chromium [VI]	Soil extracts are prepared by extracting dried and ground soil samples into boiling water. Chromium [VI] is determined by 'Aquakem 600' Discrete Analyser using 1,5-diphenylcarbazine.
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2680	TPH A/A Split	Aliphatics: >C5-C6, >C6-C8,>C8-C10, >C10-C12, >C12-C16, >C16-C21, >C21-C35, >C35- C44Aromatics: >C5-C7, >C7-C8, >C8- C10, >C10-C12, >C12-C16, >C16- C21, >C21- C35, >C35- C44	Dichloromethane extraction / GCxGC FID detection
2700	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-FID	Acenaphthene; Acenaphthylene; Anthracene; Benzo[a]Anthracene; Benzo[a]Pyrene; Benzo[b]Fluoranthene; Benzo[ghi]Perylene; Benzo[k]Fluoranthene; Chrysene; Dibenz[ah]Anthracene; Fluoranthene; Fluorene; Indeno[123cd]Pyrene; Naphthalene; Phenanthrene; Pyrene	Dichloromethane extraction / GC-FID (GC-FID detection is non-selective and can be subject to interference from co-eluting compounds)
2760	Volatile Organic Compounds (VOCs) in Soils by Headspace GC-MS	Volatile organic compounds, including BTEX and halogenated Aliphatic/Aromatics.(cf. USEPA Method 8260)*please refer to UKAS schedule	Automated headspace gas chromatographic (GC) analysis of a soil sample, as received, with mass spectrometric (MS) detection of volatile organic compounds.
2920	Phenols in Soils by HPLC	Phenolic compounds including Resorcinol, Phenol, Methylphenols, Dimethylphenols, 1-Naphthol and TrimethylphenolsNote: chlorophenols are excluded.	60:40 methanol/water mixture extraction, followed by HPLC determination using electrochemical detection.

## **Report Information**

### **Key**

---

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis

All Asbestos testing is performed at the indicated laboratory

Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

### **Sample Deviation Codes**

---

- A - Date of sampling not supplied
- B - Sample age exceeds stability time (sampling to extraction)
- C - Sample not received in appropriate containers
- D - Broken Container
- E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

### **Sample Retention and Disposal**

---

All soil samples will be retained for a period of 45 days from the date of receipt

All water samples will be retained for 14 days from the date of receipt

Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:

[customerservices@chemtest.com](mailto:customerservices@chemtest.com)

# Final Report

---

**Report No.:** 20-33519-1  
**Initial Date of Issue:** 11-Dec-2020  
**Client:** Remada Ltd  
**Client Address:** Forward House  
17 High Street  
Henley in Arden  
B95 5AA  
**Contact(s):** Greg Jones  
Peter Dickinson  
**Project:** 799.02 Bulwark Road, Chepstow  
**Quotation No.:** **Date Received:** 07-Dec-2020  
**Order No.:** **Date Instructed:** 07-Dec-2020  
**No. of Samples:** 1  
**Turnaround (Wkdays):** 5 **Results Due:** 11-Dec-2020  
**Date Approved:** 11-Dec-2020

**Approved By:****Details:** Glynn Harvey, Technical Manager

## Results - Soil

**Project: 799.02 Bulwark Road, Chepstow**

<b>Client: Remada Ltd</b>	<b>Chemtest Job No.:</b>				20-33519
Quotation No.:	<b>Chemtest Sample ID.:</b>				1109483
	Sample Location:				WS1
	Sample Type:				SOIL
	Top Depth (m):				0.55
	Bottom Depth (m):				0.95
	Date Sampled:				30-Nov-2020
<b>Determinand</b>	<b>Accred.</b>	<b>SOP</b>	<b>Units</b>	<b>LOD</b>	
Moisture	N	2030	%	0.020	13
Magnesium (Water Soluble)	N	2120	g/l	0.010	< 0.010
Calcium	N	2400	mg/l	20	650
Magnesium (Extractable)	N	2400	mg/l	2.0	36

## Test Methods

<b>SOP</b>	<b>Title</b>	<b>Parameters included</b>	<b>Method summary</b>
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2400	Cations	Cations	ICP-MS

## **Report Information**

### **Key**

---

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis

All Asbestos testing is performed at the indicated laboratory

Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

### **Sample Deviation Codes**

---

- A - Date of sampling not supplied
- B - Sample age exceeds stability time (sampling to extraction)
- C - Sample not received in appropriate containers
- D - Broken Container
- E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

### **Sample Retention and Disposal**

---

All soil samples will be retained for a period of 45 days from the date of receipt

All water samples will be retained for 14 days from the date of receipt

Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:

[customerservices@chemtest.com](mailto:customerservices@chemtest.com)



# Final Report

---

<b>Report No.:</b>	20-34499-1		
<b>Initial Date of Issue:</b>	21-Dec-2020		
<b>Client</b>	Remada Ltd		
<b>Client Address:</b>	Forward House 17 High Street Henley in Arden B95 5AA		
<b>Contact(s):</b>	Peter Dickinson Greg Jones		
<b>Project</b>	799.02 Bulwark Road, Chepstow		
<b>Quotation No.:</b>		<b>Date Received:</b>	14-Dec-2020
<b>Order No.:</b>	799.02	<b>Date Instructed:</b>	15-Dec-2020
<b>No. of Samples:</b>	2		
<b>Turnaround (Wkdays):</b>	5	<b>Results Due:</b>	21-Dec-2020
<b>Date Approved:</b>	21-Dec-2020		

**Approved By:**

**Details:** Glynn Harvey, Technical Manager

## Results - Miscellaneous Solid

**Project: 799.02 Bulwark Road, Chepstow**

<b>Client: Remada Ltd</b>	<b>Chemtest Job No.:</b>		20-34499	20-34499		
Quotation No.:	<b>Chemtest Sample ID.:</b>		1114152	1114153		
Order No.: 799.02	Client Sample Ref.:		1	2		
	Sample Location:		WS1	WS2		
	Sample Type:		MISCSOLID	MISCSOLID		
	Top Depth (m):		0	0		
	Bottom Depth (m):		0.15	0.1		
	Date Sampled:		10-Dec-2020	10-Dec-2020		
<b>Determinand</b>	<b>Accred.</b>	<b>SOP</b>	<b>Units</b>	<b>LOD</b>		
Naphthalene	N	2700	mg/kg	0.10	< 0.10	< 0.10
Acenaphthylene	N	2700	mg/kg	0.10	< 0.10	< 0.10
Acenaphthene	N	2700	mg/kg	0.10	< 0.10	< 0.10
Fluorene	N	2700	mg/kg	0.10	< 0.10	< 0.10
Phenanthrene	N	2700	mg/kg	0.10	< 0.10	< 0.10
Anthracene	N	2700	mg/kg	0.10	< 0.10	< 0.10
Fluoranthene	N	2700	mg/kg	0.10	< 0.10	< 0.10
Pyrene	N	2700	mg/kg	0.10	< 0.10	< 0.10
Benzo[a]anthracene	N	2700	mg/kg	0.10	< 0.10	< 0.10
Chrysene	N	2700	mg/kg	0.10	< 0.10	< 0.10
Benzo[b]fluoranthene	N	2700	mg/kg	0.10	< 0.10	< 0.10
Benzo[k]fluoranthene	N	2700	mg/kg	0.10	< 0.10	< 0.10
Benzo[a]pyrene	N	2700	mg/kg	0.10	< 0.10	< 0.10
Indeno(1,2,3-c,d)Pyrene	N	2700	mg/kg	0.10	< 0.10	< 0.10
Dibenz(a,h)Anthracene	N	2700	mg/kg	0.10	< 0.10	< 0.10
Benzo[g,h,i]perylene	N	2700	mg/kg	0.10	< 0.10	< 0.10
Coronene	N	2700	mg/kg	0.10	< 0.10	< 0.10
Total Of 17 PAH's	N	2700	mg/kg	2.0	< 2.0	< 2.0
Moisture	N		%	0.10	< 0.10	< 0.10

## Test Methods

SOP	Title	Parameters included	Method summary
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
2700	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-FID	Acenaphthene; Acenaphthylene; Anthracene; Benzo[a]Anthracene; Benzo[a]Pyrene; Benzo[b]Fluoranthene; Benzo[ghi]Perylene; Benzo[k]Fluoranthene; Chrysene; Dibenz[ah]Anthracene; Fluoranthene; Fluorene; Indeno[123cd]Pyrene; Naphthalene; Phenanthrene; Pyrene	Dichloromethane extraction / GC-FID (GC-FID detection is non-selective and can be subject to interference from co-eluting compounds)

## **Report Information**

### **Key**

---

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis

All Asbestos testing is performed at the indicated laboratory

Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

### **Sample Deviation Codes**

---

- A - Date of sampling not supplied
- B - Sample age exceeds stability time (sampling to extraction)
- C - Sample not received in appropriate containers
- D - Broken Container
- E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

### **Sample Retention and Disposal**

---

All soil samples will be retained for a period of 45 days from the date of receipt

All water samples will be retained for 14 days from the date of receipt

Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:

[customerservices@chemtest.com](mailto:customerservices@chemtest.com)



---

# Appendix C

## Laboratory Geotechnical Analyses



# LABORATORY REPORT



4043

**Contract Number: PSL21/0345**

Report Date: 28 January 2021

Client's Reference: 799.02

Client Name: Remada Limited  
Forward House  
17 High Street  
Henley-in-Arden  
Warwickshire  
B95 5AA

**For the attention of: Peter Dickinson**

Contract Title: Chepstow

Date Received: 12/1/2021

Date Commenced: 12/1/2021

Date Completed: 28/1/2021

**Notes: Opinions and Interpretations are outside the UKAS Accreditation**

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced other than in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

A Watkins  
(Director)

R Berriman  
(Quality Manager)

S Royle  
(Laboratory Manager)

L Knight  
(Senior Technician)

  
S Eyre  
(Senior Technician)

H Daniels  
(Senior Technician)

5 – 7 Hexthorpe Road, Hexthorpe,  
Doncaster DN4 0AR  
tel: +44 (0)844 815 6641  
fax: +44 (0)844 815 6642  
e-mail: rberriman@prosoils.co.uk  
awatkins@prosoils.co.uk

Page 1 of









# LABORATORY REPORT



4043

**Contract Number: PSL20/7003**

Report Date: 18 December 2020

Client's Reference: 799.02

Client Name: Remada Ltd  
Forward House  
17 High Street  
Henley-in-Arden  
Warwickshire  
B95 5AA

**For the attention of: Peter Dickinson**

Contract Title: Bulwark Road, Chepstow

Date Received: 3/12/2020  
Date Commenced: 3/12/2020  
Date Completed: 18/12/2020

**Notes: Opinions and Interpretations are outside the UKAS Accreditation**

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced other than in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

H Daniels  
(Senior Technician)

A Watkins  
(Director)

R Berriman  
(Quality Manager)

S Royle  
(Laboratory Manager)

S Eyre  
(Senior Technician)

L Knight  
(Senior Technician)

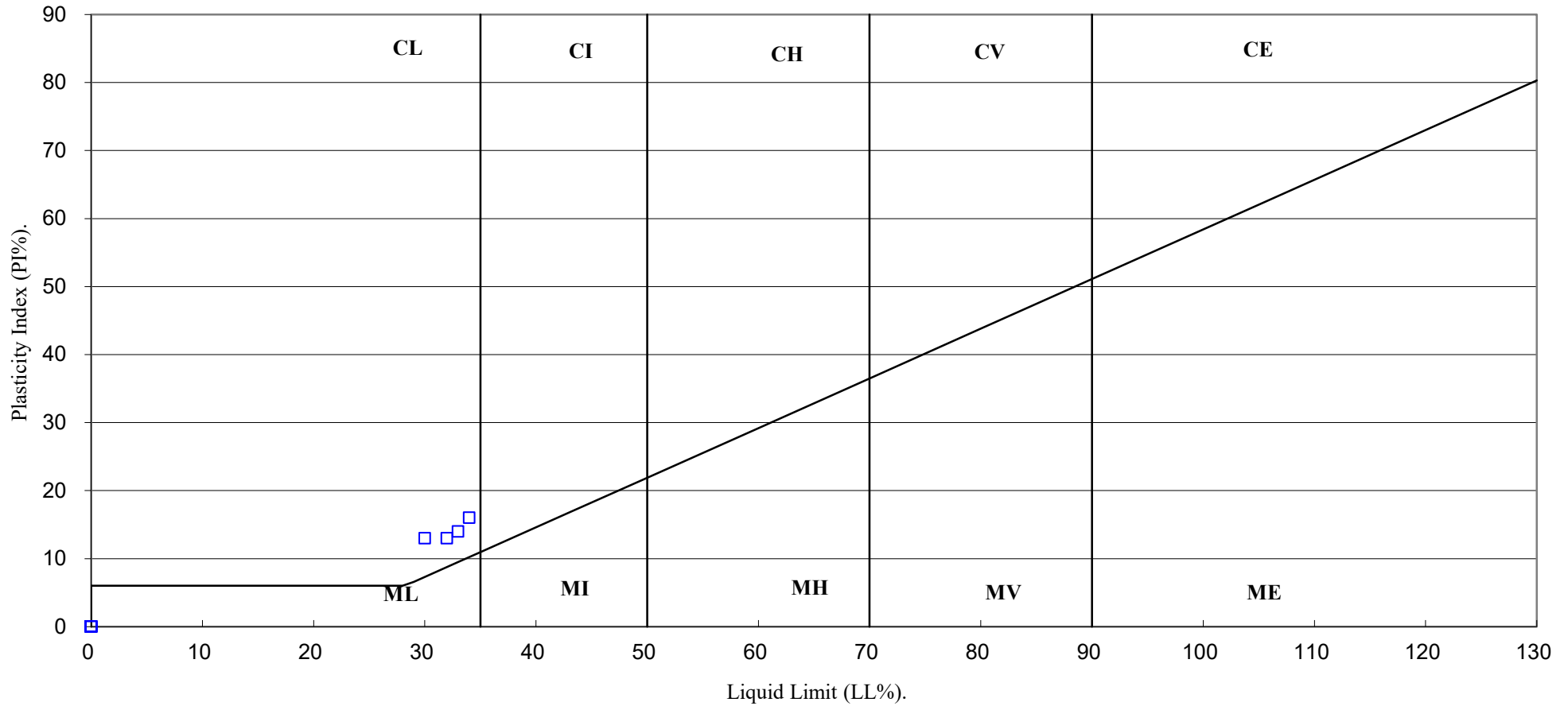
5 – 7 Hexthorpe Road, Hexthorpe,  
Doncaster DN4 0AR  
tel: +44 (0)844 815 6641  
fax: +44 (0)844 815 6642  
e-mail: [rgunson@prosoils.co.uk](mailto:rgunson@prosoils.co.uk)  
[awatkins@prosoils.co.uk](mailto:awatkins@prosoils.co.uk)

Page 1 of





# PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.



4043

**PSL**  
Professional Soils Laboratory

Bulwark Road, Chepstow

Contract No:

PSL20/7003

Client Ref:

799.02







# PARTICLE SIZE DISTRIBUTION TEST

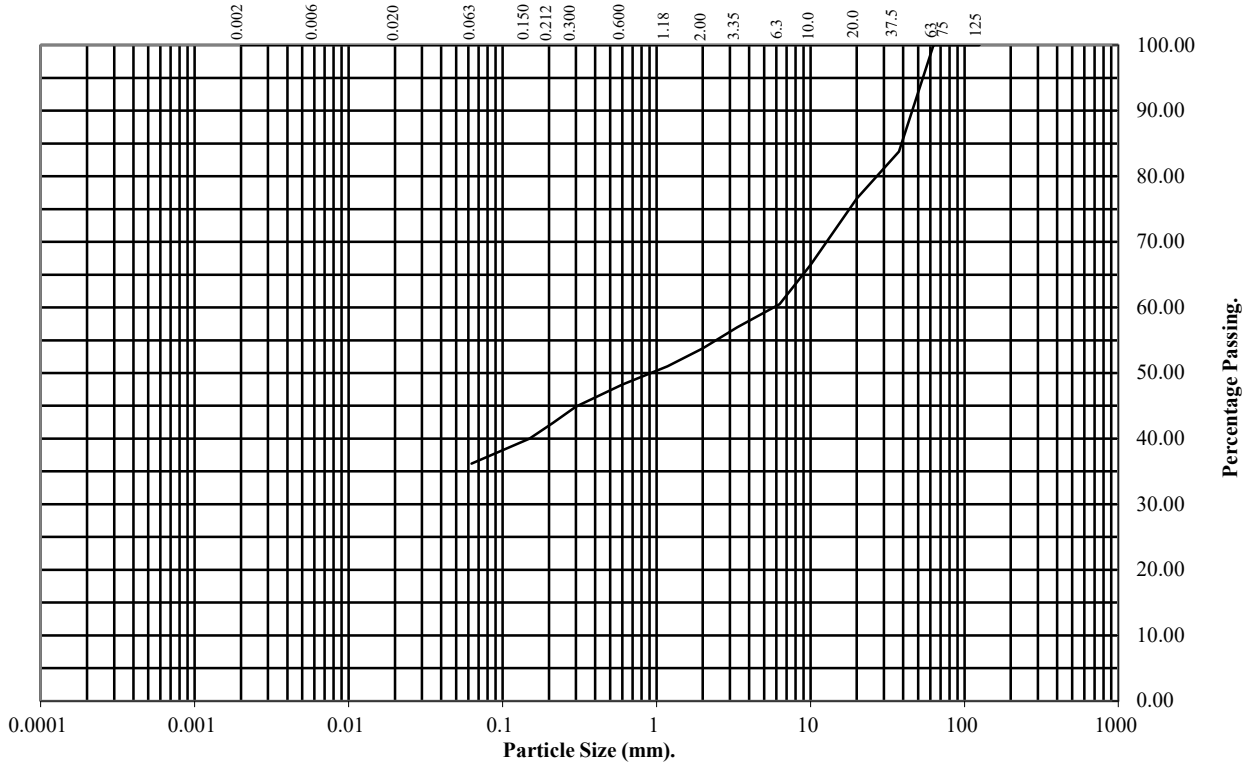
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **WS5** Top Depth (m): **1.55**

Sample Number: Base Depth(m): **2.00**

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	84
20	77
10	67
6.3	60
3.35	57
2	54
1.18	51
0.6	48
0.3	45
0.212	42
0.15	40
0.063	36

Soil Fraction	Total Percentage
Cobbles	0
Gravel	46
Sand	18
Silt/Clay	36

**Remarks:**  
See Summary of Soil Descriptions



Bulwark Road, Chepstow

Contract No:  
**PSL20/7003**  
Client Ref:  
**799.02**



# PARTICLE SIZE DISTRIBUTION TEST

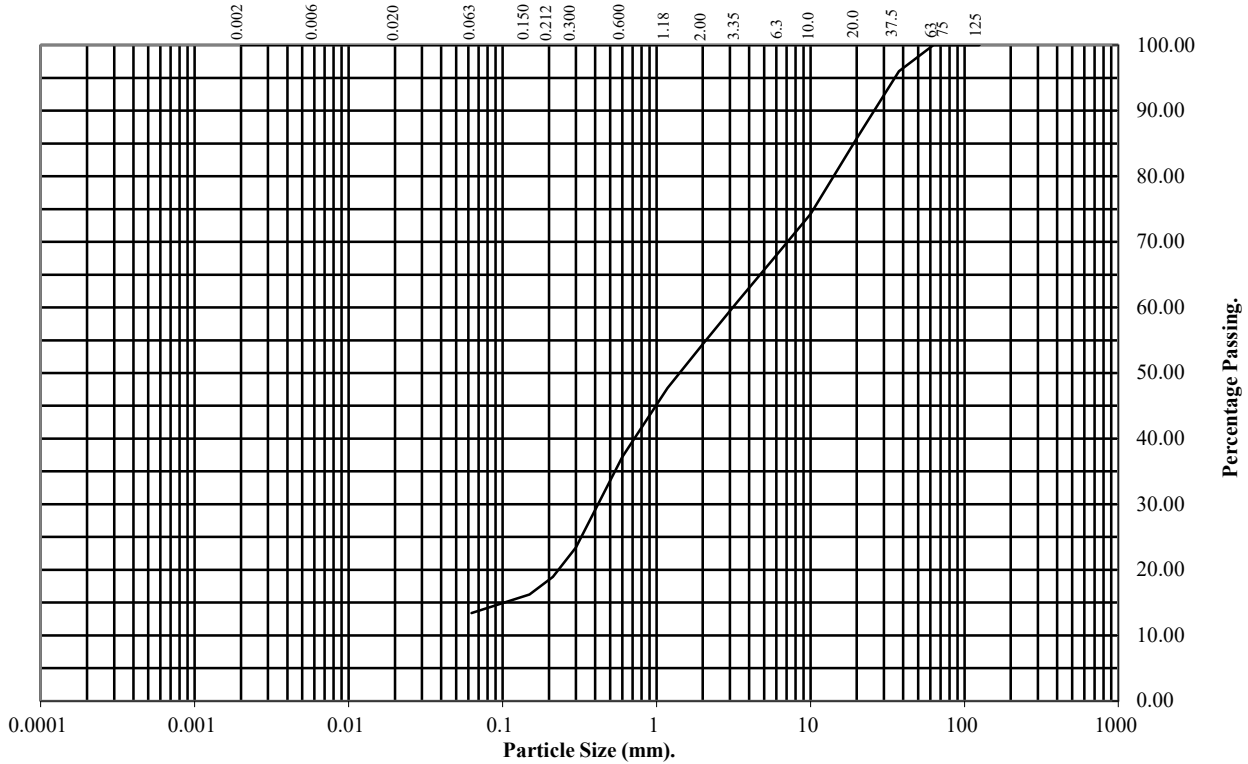
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **WS6** Top Depth (m): **0.20**

Sample Number: Base Depth(m): **0.60**

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	96
20	86
10	74
6.3	69
3.35	61
2	54
1.18	48
0.6	37
0.3	23
0.212	19
0.15	16
0.063	13

Soil Fraction	Total Percentage
Cobbles	0
Gravel	46
Sand	41
Silt/Clay	13

**Remarks:**  
See Summary of Soil Descriptions



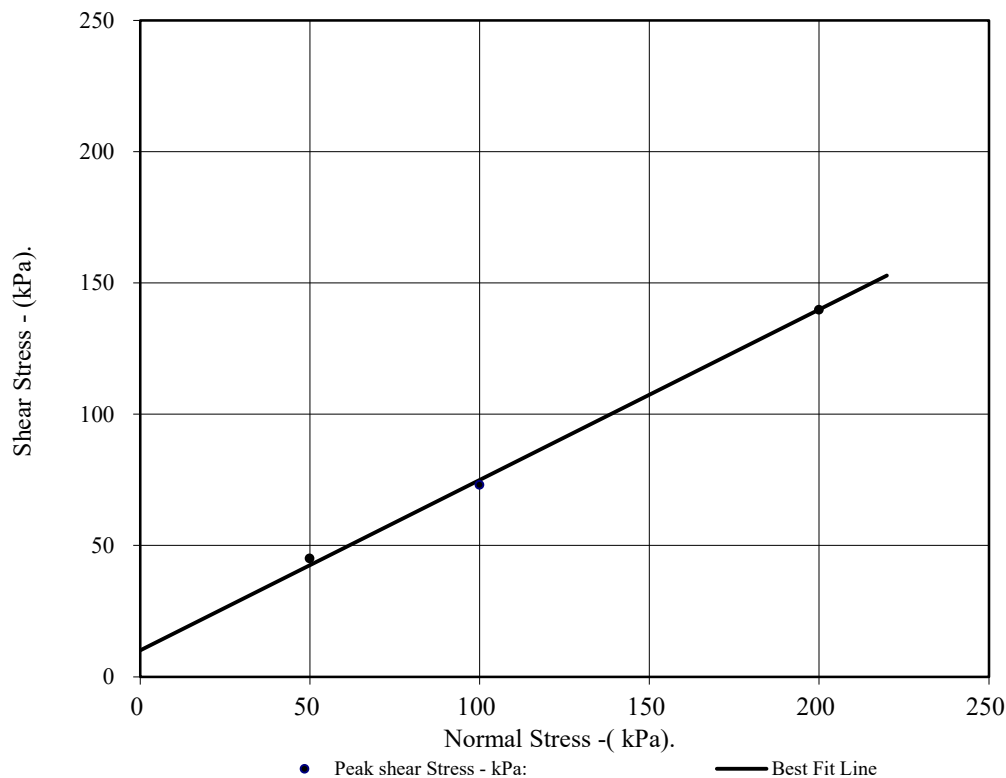
Bulwark Road, Chepstow

Contract No:  
**PSL20/7003**  
Client Ref:  
**799.02**

# CONSOLIDATED DRAINED SHEARBOX TEST

## BS1377:Part 7:1990 Clause 4

Hole Number:	WS1		Top Depth:	0.55	
Sample Number:			Base Depth:	0.95	
Sample Conditions:	Submerged		Sample Type	B	
Particle Density - Mg/m <sup>3</sup> :	2.65	Assumed	Remarks:		
Sample Preparation:	Material tested passing 2mm sieve Remoulded using 2.5kg effort.				
Sample Description:	See summary of soil descriptions.				
<b>STAGE</b>			<b>1</b>	<b>2</b>	<b>3</b>
<b>Initial Conditions</b>					
Height - mm:			20.05	20.05	20.05
Length - mm:			59.97	59.97	59.97
Moisture Content - %:			18	18	18
Bulk Density - Mg/m <sup>3</sup> :			2.13	2.13	2.13
Dry Density - Mg/m <sup>3</sup> :			1.79	1.79	1.79
Voids Ratio:			0.477	0.477	0.477
Normal Pressure- kPa			50	100	200
<b>Consolidation Stage</b>					
Consolidated Height - mm:			19.04	18.76	18.09
<b>Shearing Stage</b>					
Rate of Strain - mm/min			0.048	0.048	0.048
Displacement at peak shear stress - mm			3.01	10.20	3.01
Peak shear Stress - kPa:			45	73	140
<b>Final Consolidated Conditions</b>					
Moisture Content - %:			20	19	18
Bulk Density - Mg/m <sup>3</sup> :			2.24	2.27	2.36
Dry Density - Mg/m <sup>3</sup> :			1.87	1.91	2.00
<b>Peak</b>					
Angle of Shearing Resistance:( $\theta$ )			<b>33</b>		
Effective Cohesion - kPa:			<b>10</b>		



**PSL**  
Professional Soils Laboratory

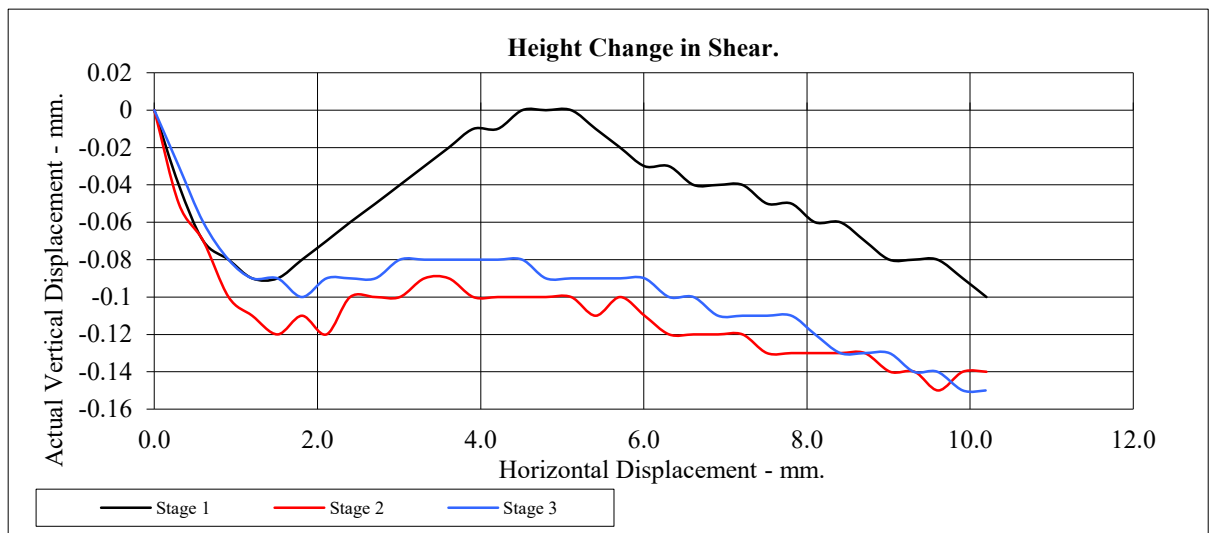
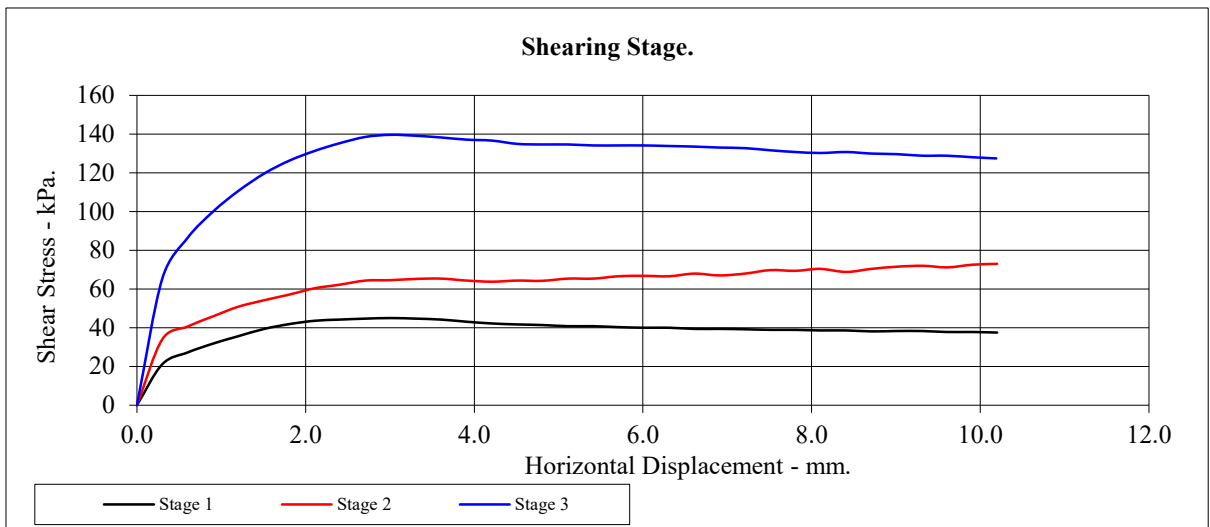
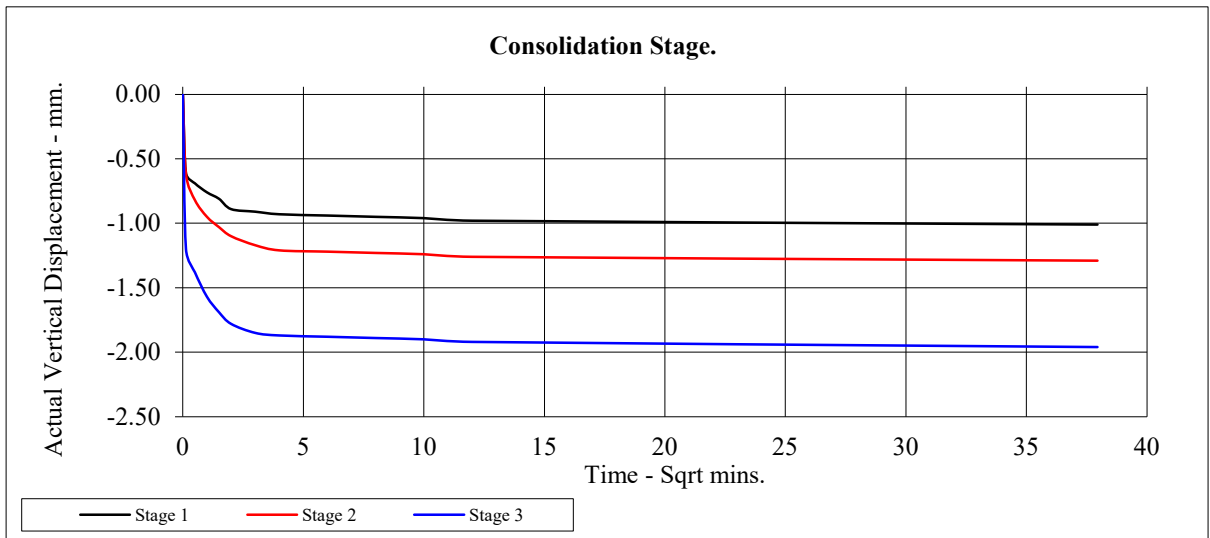
Bulwark Road, Chepstow

**Contract No:**  
PSL20/7003  
**Client Ref:**  
799.02

# CONSOLIDATED DRAINED SHEARBOX TEST

BS1377:Part 7:1990 Clause 4

Hole Number:	WS1	Top Depth:	0.55
Sample Number:		Base Depth:	0.95



**PSL**  
Professional Soils Laboratory

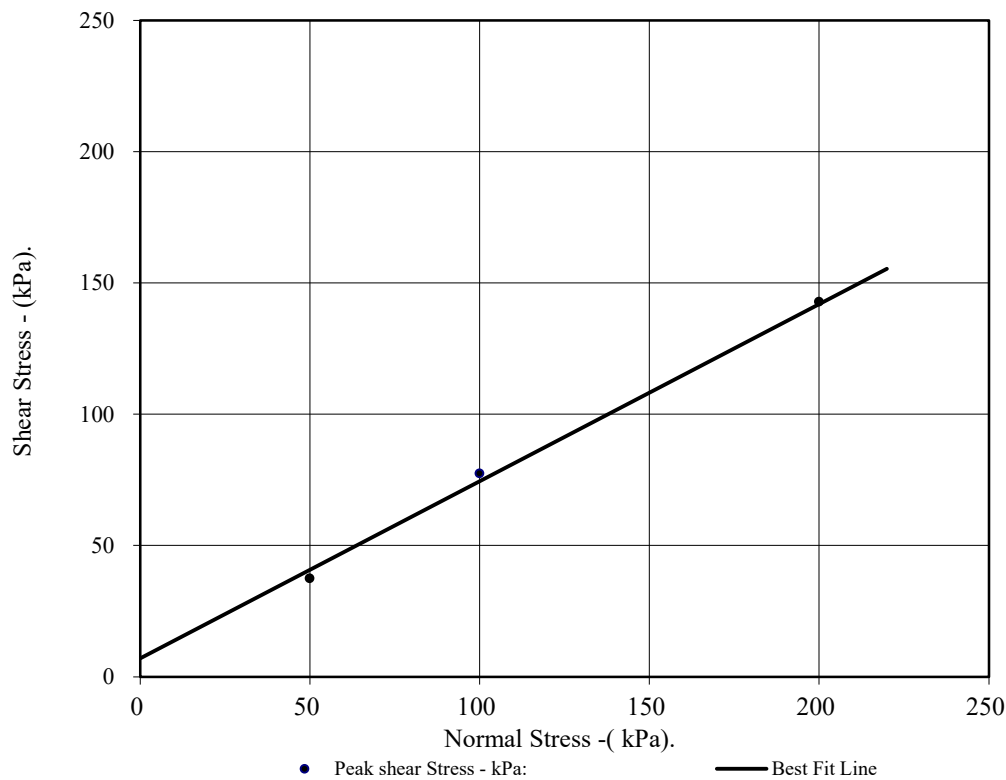
Bulwark Road, Chepstow

<b>Contract No:</b>	PSL20/7003
<b>Client Ref:</b>	799.02

# CONSOLIDATED DRAINED SHEARBOX TEST

## BS1377:Part 7:1990 Clause 4

Hole Number:	WS2		Top Depth:	0.85	
Sample Number:			Base Depth:	1.10	
Sample Conditions:	Submerged		Sample Type	B	
Particle Density - Mg/m <sup>3</sup> :	2.65	Assumed	Remarks:		
Sample Preparation:	Material tested passing 2mm sieve Remoulded using 2.5kg effort.				
Sample Description:	See summary of soil descriptions.				
<b>STAGE</b>			<b>1</b>	<b>2</b>	<b>3</b>
<b>Initial Conditions</b>					
Height - mm:			20.05	20.05	20.05
Length - mm:			59.97	59.97	59.97
Moisture Content - %:			18	18	18
Bulk Density - Mg/m <sup>3</sup> :			2.00	2.00	2.00
Dry Density - Mg/m <sup>3</sup> :			1.70	1.70	1.70
Voids Ratio:			0.561	0.561	0.561
Normal Pressure- kPa			50	100	200
<b>Consolidation Stage</b>					
Consolidated Height - mm:			18.28	17.55	16.69
<b>Shearing Stage</b>					
Rate of Strain - mm/min			0.054	0.054	0.054
Displacement at peak shear stress - mm			7.51	10.20	10.20
Peak shear Stress - kPa:			38	77	143
<b>Final Consolidated Conditions</b>					
Moisture Content - %:			21	21	21
Bulk Density - Mg/m <sup>3</sup> :			2.20	2.29	2.41
Dry Density - Mg/m <sup>3</sup> :			1.81	1.89	1.99
<b>Peak</b>					
Angle of Shearing Resistance:( $\theta$ )			34		
Effective Cohesion - kPa:			7		



**PSL**  
Professional Soils Laboratory

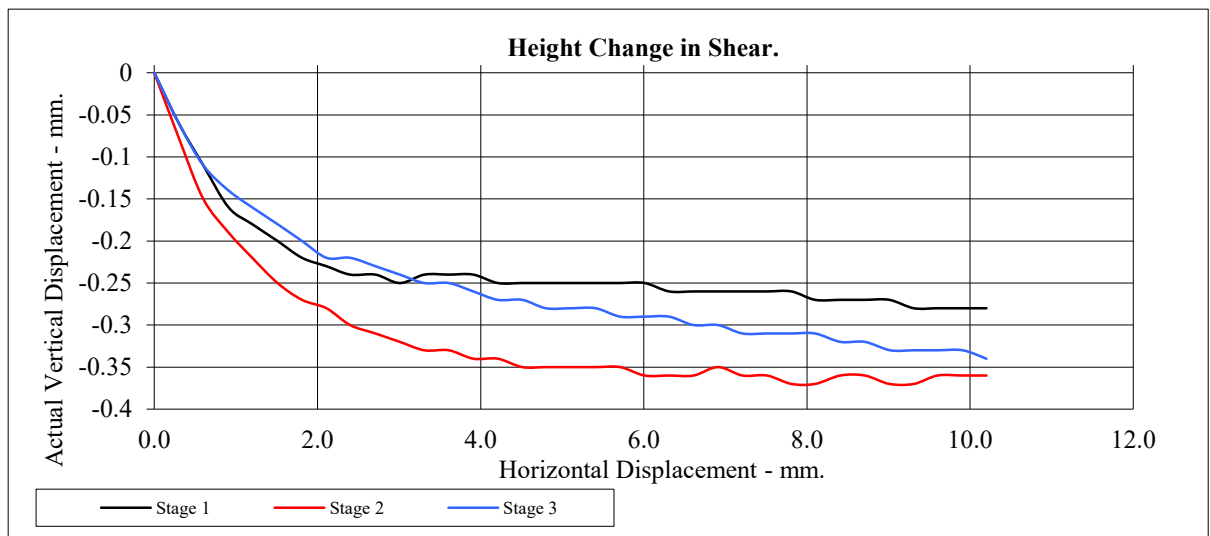
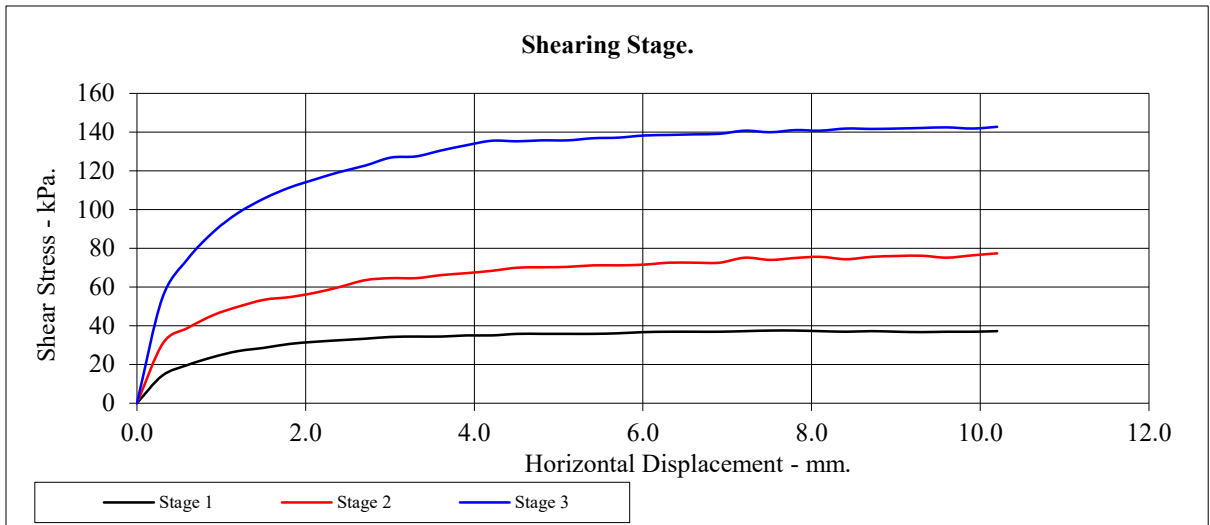
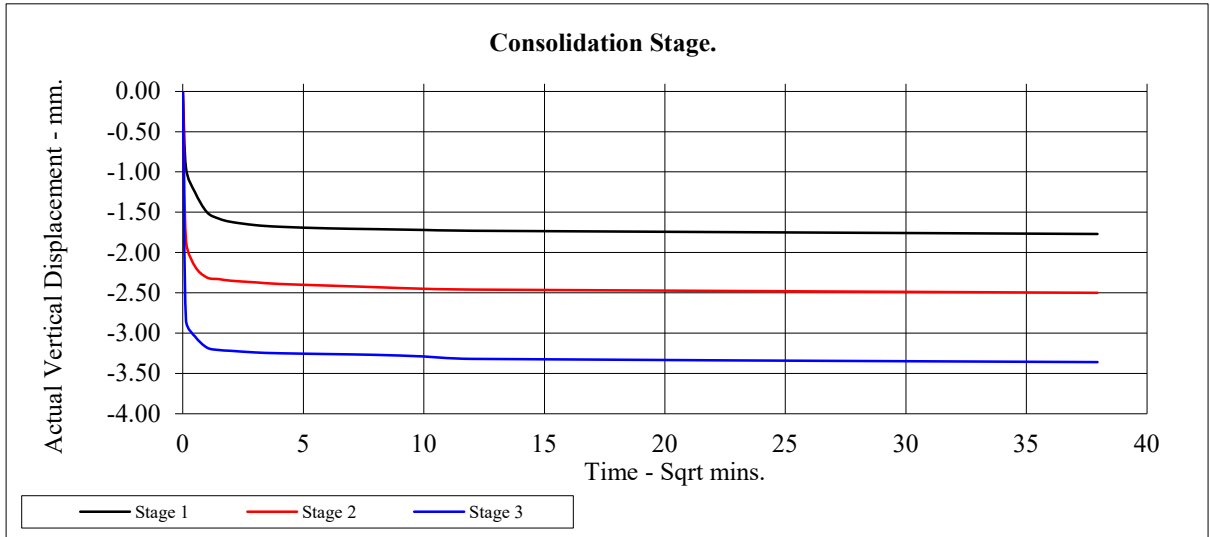
Bulwark Road, Chepstow

<b>Contract No:</b>
<b>PSL20/7003</b>
<b>Client Ref:</b>
<b>799.02</b>

# CONSOLIDATED DRAINED SHEARBOX TEST

BS1377:Part 7:1990 Clause 4

Hole Number:	WS2	Top Depth:	0.85
Sample Number:		Base Depth:	1.10



**PSL**  
Professional Soils Laboratory

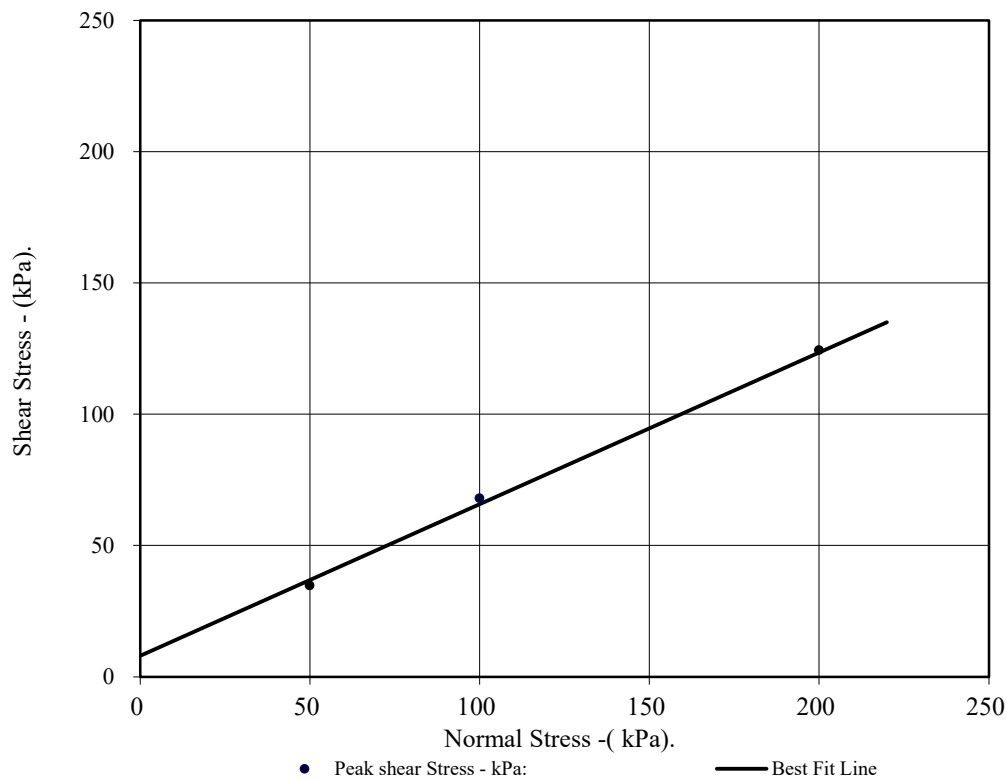
Bulwark Road, Chepstow

**Contract No:**  
PSL20/7003  
**Client Ref:**  
799.02

# CONSOLIDATED DRAINED SHEARBOX TEST

## BS1377:Part 7:1990 Clause 4

Hole Number:	WS3		Top Depth:	0.60	
Sample Number:			Base Depth:	1.20	
Sample Conditions:	Submerged		Sample Type	B	
Particle Density - Mg/m <sup>3</sup> :	2.65	Assumed	Remarks:		
Sample Preparation:	Material tested passing 2mm sieve Remoulded using 2.5kg effort.				
Sample Description:	See summary of soil descriptions.				
<b>STAGE</b>			<b>1</b>	<b>2</b>	<b>3</b>
<b>Initial Conditions</b>					
Height - mm:			20.05	20.05	20.05
Length - mm:			59.97	59.97	59.97
Moisture Content - %:			24	24	24
Bulk Density - Mg/m <sup>3</sup> :			2.13	2.13	2.13
Dry Density - Mg/m <sup>3</sup> :			1.71	1.71	1.71
Voids Ratio:			0.547	0.547	0.546
Normal Pressure- kPa			50	100	200
<b>Consolidation Stage</b>					
Consolidated Height - mm:			18.75	18.33	17.84
<b>Shearing Stage</b>					
Rate of Strain - mm/min			0.052	0.052	0.052
Displacement at peak shear stress - mm			2.11	3.61	4.21
Peak shear Stress - kPa:			35	68	124
<b>Final Consolidated Conditions</b>					
Moisture Content - %:			19	18	17
Bulk Density - Mg/m <sup>3</sup> :			2.28	2.33	2.40
Dry Density - Mg/m <sup>3</sup> :			1.92	1.98	2.04
<b>Peak</b>					
Angle of Shearing Resistance:( $\theta$ )			<b>30</b>		
Effective Cohesion - kPa:			<b>8</b>		



**PSL**  
Professional Soils Laboratory

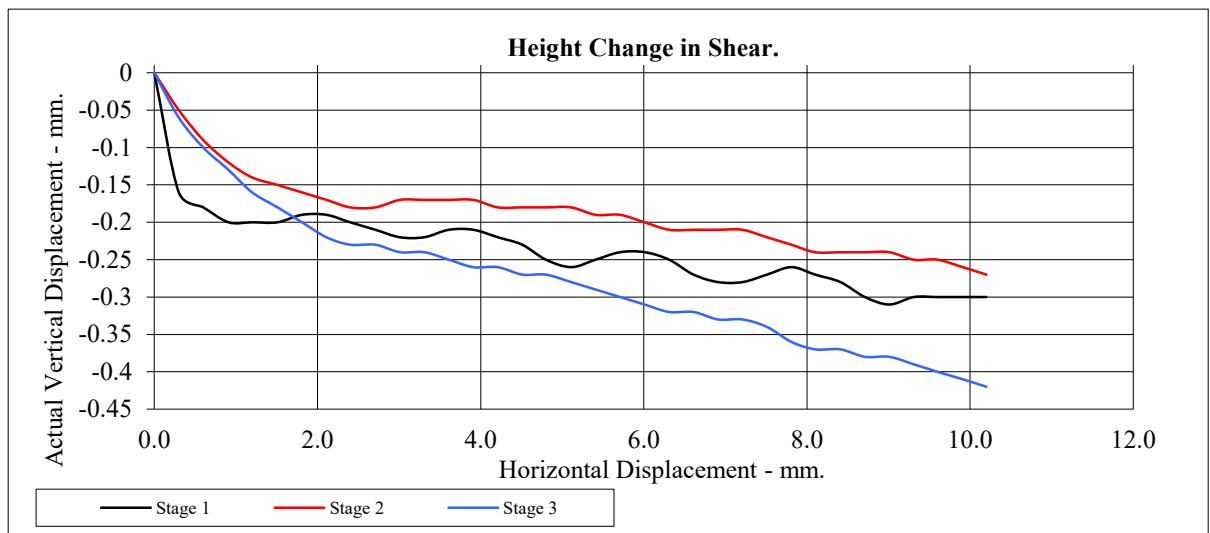
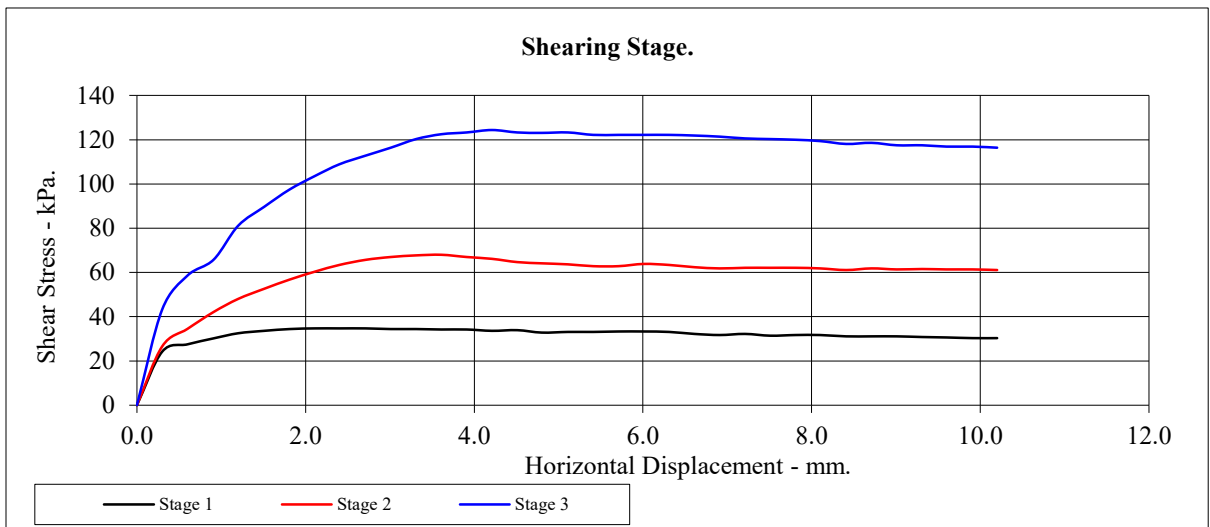
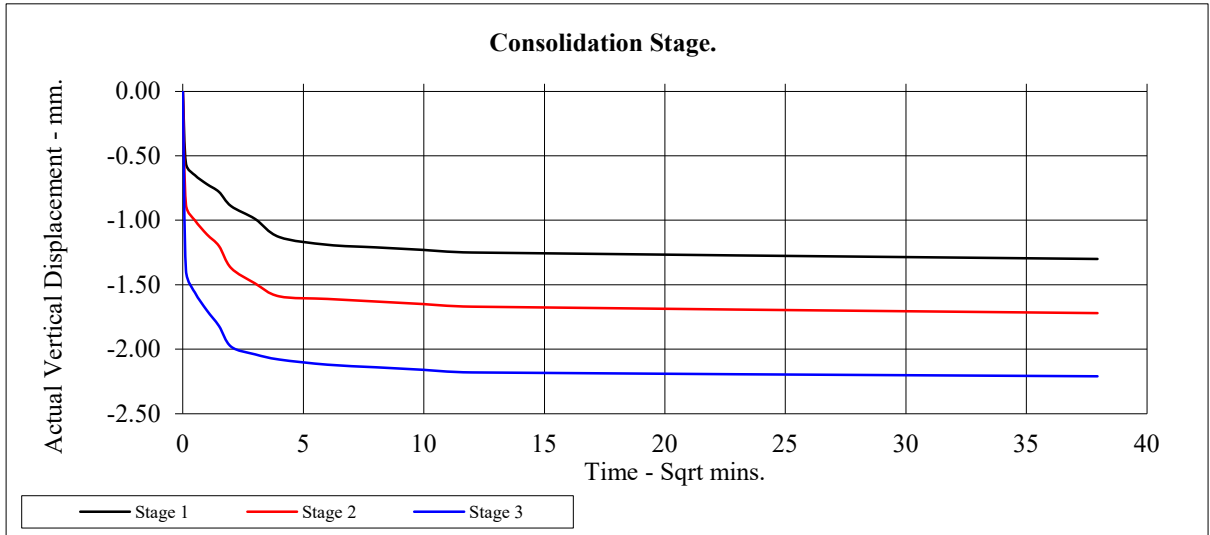
Bulwark Road, Chepstow

**Contract No:**  
PSL20/7003  
**Client Ref:**  
799.02

# CONSOLIDATED DRAINED SHEARBOX TEST

BS1377:Part 7:1990 Clause 4

Hole Number:	WS3	Top Depth:	0.60
Sample Number:		Base Depth:	1.20



**PSL**  
Professional Soils Laboratory

Bulwark Road, Chepstow

**Contract No:**  
PSL20/7003  
**Client Ref:**  
799.02



# APPENDIX D

## SPT Hammer Calibration





**Dando Drilling International**  
**Unit G**  
**Ford Airfield industrial estate**  
**Ford**  
**West Sussex**  
**BN18 0HY**

SPT Hammer Ref: ADP 06  
Test Date: 17/12/2020  
Report Date: 17/12/2020  
File Name: ADP 06.spt  
Test Operator: MS



### Instrumented Rod Data

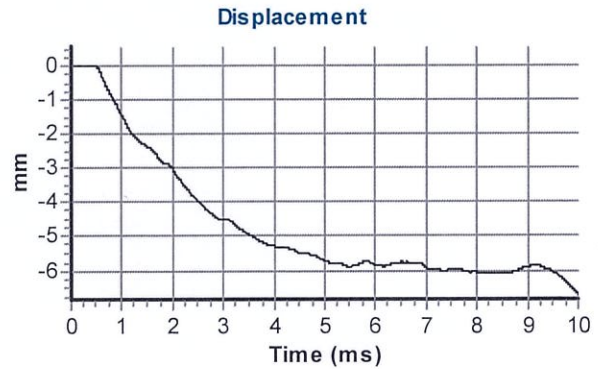
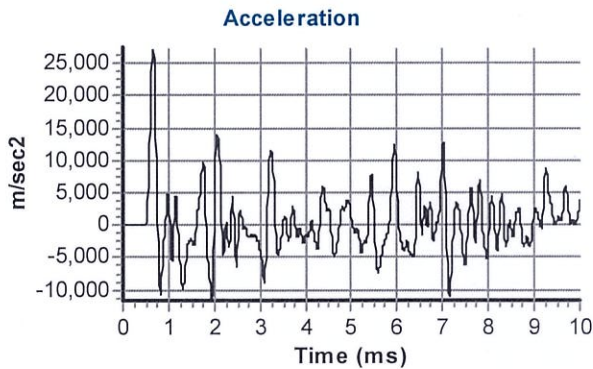
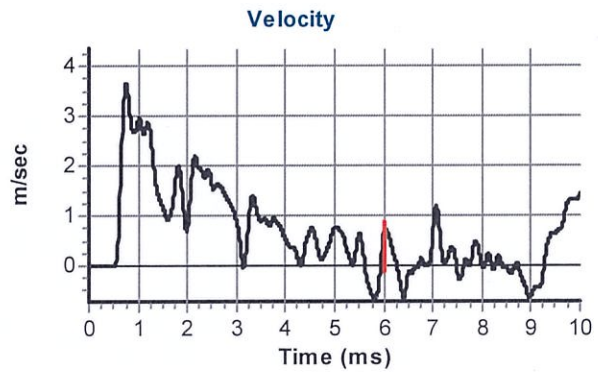
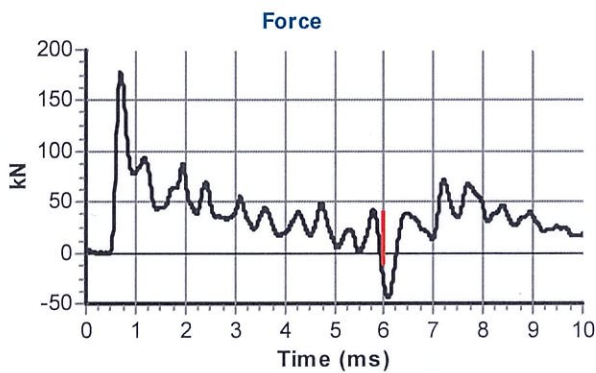
Diameter  $d_r$  (mm): 54  
Wall Thickness  $t_r$  (mm): 6.5  
Rod Length  $l_r$  (m): 1.0  
Assumed Modulus  $E_a$  (GPa): 208  
Accelerometer No.1: 11855  
Accelerometer No.2: 11406

### SPT Hammer Information

Hammer Mass  $m$  (kg): 63.5  
Falling Height  $h$  (mm): 760  
SPT String Length  $L$  (m): 15.0

### Comments / Location

ADP



### Calculations

Area of Rod A (mm<sup>2</sup>): 970  
Theoretical Energy  $E_{theor}$  (J): 473  
Measured Energy  $E_{meas}$  (J): 361

**Energy Ratio  $E_r$  (%):** 76

Signed: Matthew Simpson  
Title: Workshop Foreman