

CONTRACT NO. E13043/2**GEO-ENVIRONMENTAL APPRAISAL FOR A
PROPOSED PETROL FILLING STATION AT
ASDA WORTHING FERRING**

**Prepared by
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Contents

Generic List of Acronyms and Abbreviations.....	iii
Executive Summary.....	1
1.0 INTRODUCTION	3
2.0 SITE DETAILS AND PROPOSED DEVELOPMENT	3
3.0 SUMMARY OF PRA INFORMATION.....	4
4.0 DETAILS OF SITE INVESTIGATION	5
4.1 Investigation Design and Methodology	5
4.2 Exploratory Hole Information	5
4.3 Gas and Groundwater Monitoring.....	6
4.4 Soil Sampling	6
4.5 Groundwater Sampling	6
4.6 Records of Fieldwork.....	7
5.0 LABORATORY TESTING.....	7
5.1 Soil Contamination Testing	7
5.2 Groundwater Contamination Testing	7
5.3 Geotechnical Testing.....	7
5.4 Results of Laboratory Tests	8
6.0 SEQUENCE OF STRATA	8
6.1 Site levels.....	8
6.2 Strata Encountered	8
6.3 Groundwater	9
7.0 GROUND CONTAMINATION APPRAISAL.....	10
7.1 Soil/Groundwater Contamination Assessment Methodology	10
7.2 Preliminary Risk Assessment.....	10
7.3 Quantitative Risk Assessment	10
7.4 Effect of Ground Contamination on Proposed Development.....	15
7.5 Risk Assessment of Proposed Future Site Use	15
7.6 Soil Gas	15
7.7 Off-site Disposal of Surplus Materials.....	16
8.0 ENGINEERING PROPERTIES OF STRATA	16
8.1 <i>In-situ</i> Penetration Tests	16
8.2 Water Content and Plasticity of Fine-Grained Soils	17
8.3 Undrained Shear Strength.....	17
8.4 California Bearing Ratio.....	18
9.0 GEOTECHNICAL ASSESSMENT	18
9.1 Proposed development.....	18
9.2 Fuel Pump Islands.....	18
9.3 PFS Canopy Foundations	18
9.4 Control room	19
9.5 Forecourt Paving	19
9.6 Fuel Storage Tanks	19

9.7 Buried Concrete	19
10.0 LIMITATIONS AND USE OF THE REPORT	20
References	22

Tables, Figures and Plates

Gas and Groundwater Monitoring Results	Table A
Site Location Plan	Figure 1
Street Map	Figure 2
Site Plan Indicating Exploratory Hole Locations	Figure 3
Proposed Development Plan	Figure 4
Cross Section Showing the Proposed UST Location	Figure 5
SPT N-Value vs Depth (m bgl)	Figure 6
Plot of Estimated Shear Strength versus Depth	Figure 7

Appendices

Borehole Records	Appendix 1	(7pages)
California Bearing Ratio Test Results	Appendix 2	(3 Pages)
Soil Contamination Laboratory Test Results	Appendix 3	(11 pages)
Groundwater Contamination Laboratory Test Results	Appendix 4	(8 pages)
Geotechnical Laboratory Test Results	Appendix 5	(13 pages)

Generic List of Acronyms and Abbreviations

µg/kg	micrograms per kilogram
µg/l	micrograms per litre
ACEC	aggressive chemical environment for concrete
ACM	asbestos containing material
AOD	above Ordnance datum
bgl	below ground level
BGS	British Geological Survey
BH	borehole
BTEX	benzene, toluene, ethylbenzene and xylene compounds
CBR	California bearing ratio
CH ₄	methane
CIRIA	Construction Industry Research and Information Association
CLR	Contaminated Land Report
CO	carbon monoxide
CO ₂	carbon dioxide
COMAH	control of major accident hazards
CPT	cone penetration test
CSM	conceptual site model
DEFRA	Department of Environment, Food and Rural Affairs
DoE	Department of Environment (now part of DEFRA)
DP	dynamic probe
DPSH	dynamic probe super heavy
DQRA	detailed quantitative risk assessment
DS	design sulphate class
DWS	drinking water standard
EA	Environment Agency
EHO	Environmental Health Officer
EQS	environmental quality standard
FRA	flood risk assessment
GAC	generic assessment criteria
GPR	ground penetrating radar
GPS	global positioning systems
GQRA	generic quantitative risk assessment
GW-TV	groundwater threshold value
ha	hectare
H ₂ S	hydrogen sulphide
HPA	Health Protection Agency (now PHE)
HSE	Health and Safety Executive
IPPC	Integrated Pollution Prevention and

	Control
LAPPC	Local Authority Pollution Prevention and Control
LNR	Local Nature Reserve
mb	millibar
MCERTS	Monitoring Certification Scheme
mg/kg	milligrams per kilogram
mg/l	milligrams per litre
NIEA	Northern Ireland Environment Agency
NGR	National Grid Reference
O ₂	oxygen
OS	Ordnance Survey
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
PFS	petrol filling station
PID	photo ionisation detector
PHE	Public Health England
PPE	personal protective equipment
PRA	preliminary risk assessment
SAC	Special Area of Conservation
S4UL	Suitable For Use Level
SEPA	Scottish Environment Protection Agency
SGV	soil guideline value
SOM	soil organic matter
SPA	Special Protection Area
SPT	standard penetration test
SPZ	Source Protection Zone
SSSI	Site of Special Scientific Interest
SVOCs	semi-volatile organic compounds
TOC	total organic carbon
TP	trial pit
TPH	total petroleum hydrocarbons
TPO	Tree Preservation Order
UKAS	United Kingdom Accreditation Service
UXO	unexploded ordnance
UST	underground storage tank
VOCs	volatile organic compounds
WAC	Waste Acceptance Criteria
WFD	Water Framework Directive
WHO	World Health Organisation
WS	window sampling borehole

GEO-ENVIRONMENTAL APPRAISAL FOR A PROPOSED PETROL FILLING STATION AT ASDA, WORTHING FERRING

Executive Summary

Objectives of Report	To carry out a ground investigation and quantitative ground contamination and geotechnical appraisal for the proposed development of a Petrol Filling Station (PFS). The investigation was designed following the completion of a PRA report (including CSM), by DTS Raeburn in September 2017 (Report ref E13043/1).
Site Description	The site covers about 0.35 hectares and is occupied by an area of overflow car park and limited soft landscaping with the adjacent ASDA retail store. The car park is predominantly surfaced by gravel, with a small area of tarmac surfacing present in the eastern section.
Proposed Development	It is understood that an automated PFS comprising an unmanned control room, a canopy, six fuel pumps, and two Underground Storage Tanks (USTs) are to be constructed.
Scope of Investigation	Two cable percussion boreholes, five window sampling boreholes, three DCP tests, geotechnical and laboratory testing, gas and groundwater monitoring and interpretive reporting.
Succession of Strata	The general sequence of strata encountered: • Made ground generally comprising very sandy mixed gravels to 0.3m-1.4m bgl (5.68-6.93mAOD). At one location only the made ground was very loose, extended to over 2m depth and exhibited a hydrocarbon odour from 1.6-2m bgl. • Superficial soft to firm becoming sandy gravelly clay (Aeolian deposits) to between 3.2m and 7.2m bgl (-0.08-4.03mAOD). The thickness of the Aeolian deposits is indicated to increase from approximately south to north across the site. • Lewes Nodular Chalk Formation comprising highly weathered matrix dominated chalk (Grade Dm). The evidence from the cable percussion boreholes is that the chalk becomes clast-dominant (Grade Dc) below about 9m bgl.
Groundwater	During drilling groundwater strikes were recorded within the chalk bedrock at 8.4m bgl (-0.92mAOD) in BH1 and 8.5m bgl (-1.38mAOD) in BH2. A shallower water strike was also recorded at 5m bgl (2.12mAOD) in BH2. During monitoring in December 2017, standing groundwater levels were measured at between 3.6 and 4.6mAOD across the site during the first and second visit respectively. This variation is most likely due to heavy rainfall and/or snowfall.
Ground Contamination	Localised slightly elevated PAHs were detected in groundwater around the proposed tank farm location. This is most likely associated with the made ground at that location. It is expected that these materials will be removed by the USTs excavation works.
Soil Gas	Gas monitoring carried out during November 2017 at a suitable range of atmospheric pressures indicates that methane and carbon dioxide exclusion measures are not required for the proposed unmanned control room. However, the site lies within an intermediate probability radon area, where basic radon protection measures are considered necessary for new buildings. Such protection can be afforded by the inclusion of a well-installed damp-proof membrane of minimum 1200-gauge, extended across the ground floor slab of the proposed unmanned control room.
Off-site Disposal of Surplus Soils	The test results indicate that most of the made ground could be accepted for off-site disposal as non-hazardous waste under the Landfill (England and Wales) (Amendment) Regulations 2004. However the localised area of hydrocarbon impacted made ground encountered would be classified as hazardous waste due to elevated concentrations of TPHs. The natural soils could be accepted for off-site disposal as inert waste. A watching brief is therefore recommended during excavation to ensure that the

	hazardous waste materials are suitably segregated from the surrounding and underlying inert waste soils, and to minimise the costs of off-site disposal. This advice is given for guidance purposes only and is subject to the Landfill Operator's certification.
Soil Engineering Properties	The near-surface ground conditions comprise mostly granular made ground overlying firm to stiff superficial clay underlain by structureless chalk. Laboratory testing has shown that the clay is of low to intermediate plasticity and low to medium shrinkage and swelling potential.
Geotechnical Assessment	The canopy stanchions could be supported on shallow pad foundations bearing onto the natural clay of at least <i>firm</i> consistency. Foundation level should be at least 1m below existing ground level. Foundations should bear onto natural soils of at least <i>firm</i> consistency. Founding on made ground should be avoided. Where the made ground is found to extend to greater depths, or if soft spots are encountered, these should be removed and replaced with suitably compacted granular fill. The unmanned control room is a lightly-loaded structure which may be built on reinforced concrete rafts that could also act as floor slabs. Formation level should be not less than 0.3m below forecourt level and a suitable thickness of compacted hardcore should be laid. Alternatively, the control room could be constructed on shallow strip foundations. Soil bearing resistances for square pad and strip foundations are given in Section 9.0. Groundwater inflow should be expected in the fuel tank excavations and lateral support by sheet piling will be required. Depending on the sheet pile length and design, additional measures may be required to exclude groundwater from the base of the excavation. Fuel pumps should be mounted on concrete plinths set on a reinforced concrete apron. Any hardstanding should be removed. New paving should be flexible and designed for a CBR of 3%, following thorough proof-rolling and removal of any soft, loose, organic or other unsuitable materials.
Buried Concrete	In accordance with BRE Special Digest 1 (3 rd edition), the appropriate classifications for buried concrete beneath the site are Design Sulphate (DS)-1 and Aggressive Chemical Environment for Concrete (ACEC) -1.
Limitations	The limitations of this report are highlighted in Section 10.0.

1.0 INTRODUCTION

DTS RAEBURN Limited (DTS) were commissioned by ASDA Stores Limited to undertake a ground contamination and geotechnical appraisal at the site of an operational ASDA Food Retail overflow car park at ASDA, Worthing Ferring. It is understood that the existing overflow car park is to be redeveloped into a PFS comprising a control room, canopy, six fuel pumps, and two petrol and diesel Underground Storage Tanks (USTs).

This appraisal has been designed in accordance with the risk assessment framework presented in CLR11 'Model Procedures for the Management of Land Contamination' (DEFRA and EA, 2004). CLR11 requires a phased approach to be undertaken to assess the risk of ground contamination. The phased approach involves the production of a 'preliminary risk assessment' (PRA), followed by an intrusive investigation and quantitative risk assessment, followed in turn by the design, implementation and verification of appropriate remediation works should any contaminants be found in unacceptable concentrations.

DTS Raeburn produced a PRA report (incorporating an initial CSM) for the site in September 2017 (Report E13043/1). This report identified that ground contamination could be present beneath the site as a result of off-site sources of contamination associated with the historical land uses of the surrounding area, and that this could potentially present an unacceptable risk to human receptors, the development end use and controlled waters. An intrusive investigation was therefore recommended in order to assess quantitatively the risk presented by ground contamination at the site.

Additional objectives of the investigation were as follows:

- To determine the requirement for soil gas protection to the proposed unmanned control room
- To provide an off-site disposal classification assessment of surplus soils arising from the proposed development
- To provide geotechnical recommendations for the design of foundations and temporary works for the proposed PFS

The scope of the investigation comprised cable percussion and window sampling boreholes to obtain samples of the underlying soils and rock for contamination and geotechnical laboratory testing. The investigation also included *in-situ* geotechnical tests, and the installation of gas and groundwater monitoring standpipes to identify the presence and proportions of methane, carbon dioxide, oxygen, hydrogen sulphide and carbon monoxide within the soil gas and the extent of groundwater beneath the site. Groundwater samples were also obtained from the borehole installations for contamination testing.

This report presents the findings of the ground contamination and geotechnical appraisal together with recommendations for the development proposals.

2.0 SITE DETAILS AND PROPOSED DEVELOPMENT

The site is located at Littlehampton Road (A259), Ferring, Worthing as shown in Figures 1 and 2. The site is centred on NGR 508740, 103330. Vehicular access to the site is gained from Littlehampton Road. A plan showing the site layout is included as Figure 3. Hereafter in this report 'the site' refers to the area within the boundary indicated in this Figure.

A detailed description of the site and surrounding area is included in Section 2.0 of the DTS PRA Report (E13043/1). At the time of the present investigation the site remained unchanged from that previously described and comprised by an area of overflow car park and limited soft landscaping associated with the adjacent ASDA retail store. The car park is predominantly surfaced by gravel, although a small area of tarmac surfacing present in the eastern section.

It is understood that the existing overflow car park is to be developed into an automated petrol station which will include an unmanned control room, six fuel pumps and two USTs. The proposed development is shown in Figure 4.

3.0 SUMMARY OF PRA INFORMATION

Relevant information from the PRA report is summarised in Table 3.1. Reference should be made to the full report for additional information.

Table 3.1 Summary of PRA information

Geology	BGS mapping indicates the site to be underlain by superficial <i>Quaternary</i> Aeolian Deposits (Brickearth), which are in turn underlain by <i>Cretaceous</i> chalk bedrock of the Lewes Nodular Chalk Formation. Ground investigations undertaken across the entire ASDA site in 2011/2012, prior to the construction of the store, were reviewed by DTS during preparation of the PRA REPORT. The ground conditions documented comprise about 0.5m of made ground overlying Aeolian Deposits consisting of soft silty gravelly clay. The underlying chalk bedrock was encountered at depths between 1.9m and 5.5m bgl, and continued to the termination depths of the boreholes at about 10m bgl. Groundwater was standing at approximately 2m bgl and an hydraulic down-gradient towards the south/south east was recorded by the previous investigations. The groundwater appears to be under sub-artesian pressure from the underlying chalk.
Hydrology	The closest surface water feature to the site is an unnamed river located at 160m to the south of the site. The river Ferring Rife is present at 350m to the east of the site, flowing towards the south.
Hydrogeology	The underlying superficial Aeolian deposits and chalk bedrock are classified as 'Secondary A' and 'Principal' aquifers respectively. The site does not lie within a Groundwater Source Protection Zone.
Ecological receptors	The South Downs National Park is located at 800m to the north of the site. No other major ecological receptors are located within a 1km radius.
Flood risk	The site lies within a 'Flood Zone 1'. This corresponds to the lowest risk classification with respect to fluvial or tidal flooding. A separate map produced on the basis of BGS data identifies that there is a potential for "groundwater flooding to occur at the surface" at the site.
Site history	The site has been occupied by buildings and car parks relating to commercial plant nurseries and a garden centre from the 1960s until the development of the ASDA store and car park in 2012. The land surrounding the site has historically been occupied by several garden centres/nurseries. Tanks and an electricity substation associated with a plant nursery were previously located adjacent the site to the south (previous investigations included targeted tests at this location and found no evidence of ground contamination). An engineering/joinery works was developed from Greenfield at about 100m to the north west of the site since the early 1970s and this unit is currently occupied by a self-storage facility.
Initial CSM	The initial CSM identifies the possibility of the accepted 'contaminant-pathway-receptor' linkage being completed for this site with respect to human health, the development end use, controlled waters and major ecological receptors as a result of off-site sources of contamination.

Since completion of the PRA Report a topographical survey has been prepared by Subscan Technology Limited, and provided to DTS. The survey indicates that the ground level at the site slopes gently downwards to the north, from about 7.40m to 7.0m Above Ordnance Datum (AOD). The grass landscaping in the southern section of the site lies at a slightly higher level, at approximately 7.5mAOD.

4.0 DETAILS OF SITE INVESTIGATION

4.1 Investigation Design and Methodology

The ground investigation was undertaken on the 27th and 28th December 2017 and consisted of two cable percussion boreholes (BH1-BH2), five window sampling boreholes (WS1-WS4 & WS3A) and three in-situ dynamic cone penetrometer (DCP1-DCP3). Figure 3 indicates the locations of the exploratory holes.

The PRA research did not identify any specific point sources of ground contamination within the proposed PFS site that required to be targeted by the investigation. The boreholes were positioned to enable non-targeted sampling, at a density appropriate to 'main investigation' as defined by BS10175:2011+A1:2013 *'Investigation of potentially contaminated sites – Code of practice'*. The siting of the exploratory holes also took account of the need to provide geotechnical data for the proposed PFS. Specifically, BH2, WS3A and WS4 were situated within the footprint of the proposed USTs, whilst also being located close to the proposed refuelling area, canopy and fuel pump islands.

Gas and groundwater monitoring standpipes were fitted into selected Boreholes upon completion (BH1-BH2, WS1-WS2 & WS3A). These boreholes were selected for monitoring to enable a comprehensive assessment of the soil gas emissions and groundwater levels across the site, including the areas of the proposed control room as well as the existing and proposed tanks.

The following subsections describe the investigation in additional detail. Figures 3 and 4 indicate the exploratory hole locations relative to the current site layout and the proposed development respectively.

4.2 Exploratory Hole Information

Cable Percussion Boreholes

Boreholes BH1 and BH2 were drilled to a depth of 10m bgl. Standard cable percussion boring equipment was used to produce boreholes of 150mm diameter. Clean drilling techniques were employed at the site and included casing through the made ground in each borehole to avoid the potential for any cross-contamination between strata. Due attention was maintained to determine whether groundwater was encountered within the strata penetrated.

SPTs, as described in BS EN ISO 22476-3:2005+A1:2011, were carried out during drilling to allow an assessment of the in-situ density or stiffness of the ground for foundation design. Disturbed samples were taken at close intervals during boring in order to give a comprehensive record of strata encountered.

Window Sampling Boreholes

Five window sampling boreholes were drilled to 5m bgl (WS3A & WS4) or to practical refusal at depths of 4m (WS1-WS2) and 2m (WS3) bgl using a tracked Archway Competitor 130 window sampling rig. Borehole WS3 terminated on an obstruction at 2m bgl and was therefore repositioned by approximately 1m and redrilled as WS3A. SPTs, as described in BS EN ISO 22476-3:2005, were

carried out at 1m intervals during the drilling of each borehole to allow an assessment of the in-situ density or stiffness of the encountered strata.

Dynamic Cone Penetrometer Tests

Dynamic cone penetrometer (DCP) tests were attempted at three locations (DCP1-DCP3) from ground level. However, the results were distorted due to granular material in the underlying soils. The purpose of these tests is to enable a California Bearing Ratio (CBR) to be calculated.

Gas and Groundwater Monitoring Installations

On completion, soil gas and groundwater monitoring installations were fitted into selected boreholes (BH1-BH2 & WS3A). The installations comprised 63mm HDPE tubes capped with gas control valves and perforated along differing lengths to suit the ground conditions encountered. These response zones were surrounded with clean pea gravel whilst the upper, non-perforated sections, were surrounded by a bentonite seal. Concrete secured protective covers were installed over each monitoring point.

Backfill and Reinstatement of Boreholes

The boreholes not fitted with monitoring standpipes and were backfilled with arisings and 10mm gravel, and reinstated as appropriate to the surrounding ground surface.

4.3 Gas and Groundwater Monitoring

The concentrations of methane, carbon dioxide, oxygen, hydrogen sulphide and carbon monoxide within the boreholes were recorded on 6th and 14th December 2017. The barometric pressure and gas flow rates were also noted, and one of the visits was undertaken during a period of low and falling atmospheric pressure in accordance with the recommendations of CIRIA Report C665 (2007) for a new commercial development.

The depth to groundwater in each borehole installation was also recorded during the monitoring visits and an interface meter was used to ascertain the presence of any free-phase product within the groundwater.

4.4 Soil Sampling

Geotechnical samples from the cable percussion boreholes were collected by the drilling crew in new clean bags or containers using appropriately cleaned tools. The samples were inspected and logged by a DTS Raeburn Engineer. Soil samples from the window sampling boreholes were collected in new clean 1m-length plastic liners, which were opened and sub-sampled by the Engineer.

The guidelines in BS10175:2011 'Investigation of Potentially Contaminated Sites - Code of Practice' were followed during the recovery of samples for chemical analysis. During sampling all reasonable effort was maintained to prevent potential cross-contamination or general failure of the sampling strategy. All samples were collected in new, clean bags or jars as appropriate using a stainless steel trowel, which was cleaned prior to the collection of each sample. The recovered samples were temporarily stored in cool boxes with freeze packs in order to maintain low temperatures during transfer to the laboratory.

4.5 Groundwater Sampling

Groundwater samples were recovered from the standpipes fitted to BH1-BH2 & WS3A on 6th December 2017. Dedicated disposable bailers were used to collect the samples following development of the installations by purging with at least three times the borehole volume of water.

The water samples were taken in glass bottles and vials and stored in cool boxes with freeze packs in order to maintain low temperatures during transfer to the laboratory.

4.6 Records of Fieldwork

Detailed records of the exploratory holes have been produced in accordance with BS EN ISO 14688-1:2002+A1:2013 in conjunction with BS 5930:2015 and are included as Appendix 1. Details of the samples, SPT results and borehole installations are given on the respective logs. Gas and groundwater monitoring results are provided in Table A, which is presented immediately after the report text.

The results of the DCP tests are included in Appendix 2.

5.0 LABORATORY TESTING

5.1 Soil Contamination Testing

Table 5.1 lists the contamination tests performed on soil samples during the present investigation, together with a brief summary of the purpose of each test.

Table 5.1 Soil contamination tests

Row	Test	No. of tests	Purpose
1	Speciated TPH ¹	4	Non-targeted and targeted tests undertaken on samples of made ground and natural soils taken from across the site, based upon the findings of the initial CSM and on-site observations (hydrocarbon odour in WS3).
2	Suite of contaminants including metals, phenols, cyanide, sulphate and sulphide ²	4	
3	PAH speciated according to the USEPA-16 'priority pollutants'	4	
4	asbestos screening	3	No asbestos fragments were identified during fieldwork, however samples of made ground were screened for asbestos.
5	water soluble sulphate and pH	7	Used to determine the required design classification for buried concrete.
6	TOC and Loss on ignition	3	Used in conjunction with the above analyses to classify surplus soils for off-site disposal.
7	Leachability testing for a series of parameters as required by the Waste Acceptance Criteria (WAC)	3	

¹ TPH were speciated into aliphatic and aromatic fractions in the carbon chain lengths C₅-C₆, C₆-C₈, C₈-C₁₀, C₁₀-C₁₂, C₁₂-C₁₆, C₁₆-C₂₁, C₂₁-C₃₅ and C₃₅-C₄₀. The tests also included BTEX compounds.

² The tested determinants comprised arsenic, cadmium, chromium, lead, copper, nickel, zinc, mercury, selenium, water soluble boron, free cyanide, total cyanide, total phenols and pH

5.2 Groundwater Contamination Testing

Groundwater samples from BH1-BH4 were subjected to analysis for the same determinants as outlined in Rows 1-3 and 5 of Table 5.1 above, based upon the findings of the initial CSM and observations made during sampling.

5.3 Geotechnical Testing

Selected soil samples recovered from the exploratory holes were tested in accordance with the recommendations of BS 1377:1990 'Methods of Test for Soils for Civil Engineering Purposes' to assist with the geotechnical appraisal of the site and the design of foundations for the proposed

development. Table 5.2 lists the number of each test performed together with a brief description of the purpose of each test:

Table 5.2 Geotechnical tests

Test	No. performed	Purpose
Natural water content and Atterberg Limits of cohesive soils	6	To classify the natural cohesive soils encountered and to assess their shrinkage and swelling potential in relation to changes in water content. Also used to provide an estimate of undrained shear strength.
Quick undrained triaxial (multi-stage)	2	Used to understand pore pressure set-up during shear failure and thus indicate the shear strength of a clay soil.

5.4 Results of Laboratory Tests

All of the above tests were undertaken by Terra Tek Limited at its UKAS-accredited laboratory in Birmingham. The soil contamination tests were also performed to MCERTS accreditation where applicable. The soil and groundwater contamination test results are presented in Appendices 3 and 4 respectively and the geotechnical results are presented in Appendix 5.

6.0 SEQUENCE OF STRATA

6.1 Site levels

The mean ground level measured at the borehole positions is 7.18mAOD (range 17.05mAOD to 17.48mAOD).

6.2 Strata Encountered

The general sequence of strata is made ground overlying superficial clay, which is underlain by chalk bedrock of the Lewes Nodular Chalk Formation. Table 6.1 gives a summary of the borehole records.

Table 6.1 Sequence of strata

stratum	top of stratum		base of stratum		thickness of stratum (m)
	mean depth to top (m) [range, m]	mean level of top (m AOD) [range, m AOD]	mean depth to base (m) [range, m]	mean level of base (m AOD) [range, m AOD]	
Made ground gravel surfacing overlying very sandy gravel of limestone, sandstone, concrete, brick fragment. Loose made ground with hydrocarbon odour encountered in WS3 to termination depth of 2m bgl.	0	7.18 [7.05-7.48]	0.83 ¹ [0.3-1.4]	6.47 ¹ [5.68-6.93]	0.83 ¹ [0.30-1.40]
Superficial clay (Aeolian deposits) soft to firm becoming stiff to very stiff silty sandy gravelly clay. Gravels are of chalk and flint, with cobbles. Becomes more gravelly and cobbly with depth. Base of strata not	0.83 ¹ [0.3-1.4]	6.47 ¹ [5.68-6.93]	4.48 ² [3.2-7.2]	2.79 ² [-0.08-4.03]	3.83 ² [2.90-6.20]

reached by WS3A & WS4. Base of the strata very silty and sandy in BH2.					
Lewes Nodular Chalk Formation Structureless chalk composed of light brown mottled cream white gravelly clay with cobbles. Gravels are of very weak chalk. (Grade Dm).	4.48 ² [3.2-7.2]	2.79 ² [-0.08-4.03]	9.00 ³ [9.00-9.00]	-1.70 ³ [-1.88- -1.52]	3.3 ³ [1.80-4.80]
Lewes Nodular Chalk Formation Structureless chalk composed of cream white very clayey gravel of weak chalk with cobbles of chalk (Grade Dc).	9.00 ³ [9.00-9.00]	-1.70 ³ [-1.88- -1.52]	Not reached by boreholes.		-

¹Does not include WS3 as based of stratum not reached.

²Calculated from WS1-WS2 & BH1-BH2.

³Calculated from BH1-BH2.

The chalk bedrock lies at between 3.2m (4.03mAOD) and 7.2m (-0.08mAOD) bgl where reached in the boreholes, showing a variation of up to 4m thickness and an increase in the depth to the top of the chalk from south to north.

The succession of strata encountered is generally consistent with the previous ground investigation information referenced in the DTS PRA Report, which also indicated a variation of depth to chalk across the wider ASDA site.

6.3 Groundwater

A groundwater strike was recorded at 8.4m (-0.92mAOD) in BH1, which rose to 7.3m (0.18mAOD) bgl after a period of 20 minutes. In BH2 groundwater strikes were encountered at 5m (2.12mAOD) and 8.5m (-1.38mAOD) bgl, which rose to 4.8m (2.32mAOD) and 7m (0.12mAOD) bgl after a period of 20 minutes, respectively. No groundwater strikes were recorded during the drilling of the window sampling boreholes, however, groundwater was observed to be standing at 3.2m bgl (4.03mAOD) on completion of WS1.

The groundwater levels and depths measured during monitoring of the installations in WS1-WS3A & BH1-BH2 during December 2017 are presented in Table A, which immediately follows the report text. Table 6.2 gives a summary of the groundwater levels recorded on 6th & 14th December.

Table 6.2 Summary of Groundwater Depths and Levels

Borehole Number	6th December		14th December	
	Depth (m bgl)	Level (m AOD)	Depth (m bgl)	Level (m AOD)
BH1	3.86	3.62	2.98	4.50
BH2	3.42	3.70	2.47	4.65
WS1	3.52	3.71	2.52	4.71
WS2	3.60	3.63	2.54	4.69
WS3A	3.56	3.52	2.45	4.63

Table 6.2 indicates the groundwater levels in each borehole to be broadly consistent during each monitoring visit, but show a difference of approximately 1m between each visit. This is most likely

due to heavy rainfall and/or snowfall which occurred throughout the week, which would have resulted in an influx of water into the underlying soils prior to the visit on 14th December.

On the basis of the observations made during the drilling of the boreholes and subsequent monitoring it is thought the standing groundwater within the boreholes likely represents a laterally continuous Groundwater Table within the chalk bedrock, which at some locations is under sub-artesian pressure from the overlying superficial clay deposits.

7.0 GROUND CONTAMINATION APPRAISAL

7.1 Soil/Groundwater Contamination Assessment Methodology

The ground contamination appraisal has been undertaken based on a risk-based approach and incorporating the accepted 'pollutant linkage' outlined in Part IIa of the Environmental Protection Act 1990 and detailed in Section 7.0 of the PRA report.

The detailed appraisal of the soil and groundwater contamination at the site has followed the tiered procedure adopted in CLR11 and repeated below:

- Development of a CSM summarising the identified pollutant linkages at the site (Preliminary Risk Assessment)
- Selection of appropriate generic screening criteria and comparisons to the measured contaminant concentrations (Generic Quantitative Risk Assessment)
- Derivation of site-specific values where the determinants exceed the generic screening criteria (Detailed Quantitative Risk Assessment) as appropriate.

7.2 Preliminary Risk Assessment

An initial CSM for the site was introduced and discussed in some detail in Section 7.0 of the PRA report. The present investigation has shown that made ground at the site is generally less than 1m, with the exception of an area of very loose material beneath the vicinity of WS3 & WS3A, which is greater than 2m in thickness in WS3. The made ground is underlain by a variable thickness of superficial soft to firm silty gravelly clay (Aeolian deposits), which becomes more gravelly and stiff with depth. In the southern section of the site the superficial deposits are underlain by highly weathered chalk bedrock at a shallow depth at between 3.2-4.2m bgl (3.28m – 4.03mAOD). Beneath the northern section of the site the depth to the weathered chalk bedrock increases to 7.2m bgl (-0.08mAOD) in BH1 and over 5m bgl (2.05-2.08mAOD) (unproven) at WS3A and WS4.

Standing groundwater recorded within the boreholes during the monitoring visits likely represents a laterally continuous Groundwater Table confined within the chalk bedrock. The groundwater table was recorded at approximately 3.6mAOD and 4.6mAOD during the first and second monitoring visits respectively. The rise of the Groundwater Table during December 2017 is suspected to be a result of heavy rainfall and/or snowfall.

Generally no evidence of contamination was observed during the investigation, however a hydrocarbon odour was identified in the made ground at between 1.6 and 2m bgl in WS3.

7.3 Quantitative Risk Assessment

For the various receptors identified in the CSM, appropriate screening criteria relevant to the potential 'pollutant linkages' were selected. These are summarised below:

7.3.1 Receptor: Short-term Human Health (Construction Workers)

The soil and contamination test results (Appendix 3) have indicated there to be concentrations of aromatic hydrocarbons (C₁₆-C₃₅) of over 6500mg/kg localised in the made ground. Slightly elevated levels of PAHs were also detected in the groundwater test results (Appendix 4), however the use of normal site PPE consisting of overalls, gloves and suitable protective footwear and headgear is generally considered appropriate to mitigate the risk of exposure by construction workers to soil or groundwater contamination. Further advice on PPE is given in HSE Publication HS(G)66 (1991) 'Protection of Workers and the General Public During Development of Contaminated Land'.

A Health and Safety Hazard Assessment for the detailed undertakings should be carried out as stipulated under the Construction Design and Management (CDM) Regulations 2015, with due regard to the laboratory test results included in Appendices 3 and 4 and also identifying procedures for dealing with any unforeseen hazardous conditions. A Working Health and Safety Plan should be prepared, which mitigates the potential risks/hazards to site workers from the specific undertakings as identified in the Hazard Assessment.

7.3.2 Receptor: Long-term Human Health (Site End Users) and Proposed Development End Use

The risk to long-term human health (site end users) has been assessed using a combination of appropriate generic assessment criteria for a proposed commercial development end use, as described in Science Report SC050021/SR3 (EA, 2009). This is considered appropriate for the development proposal at the site.

The results of laboratory analysis of recovered soil samples from the current investigation have been compared directly to GAC selected from the sources below (listed in order of preference). The maximum concentration of each determinant is presented in Table 7.1 together with the adopted assessment criteria.

1. CLEA Model SGVs, published by the EA (March – June 2009)
2. Suitable four Use Levels (S4ULs) published by Land Quality Management Limited (LQM) and the Chartered Institute of Environmental Health (CIEH) (2015)
3. GAC derived by DTS Raeburn using the CLEA UK (v1.06) Model 2009. The derivation of these GAC has taken account of the relevant TOX data and published literature information regarding chemical properties. The standard parameters for a commercial development end use and a UK sandy loam soil have been assumed.

Where necessary a soil organic matter (SOM) concentration of 1% has been assumed.

Table 7.1 Soil contamination test results

Determinant	Number of Samples	mg/kg		Source of Criteria	Number and Source of exceedances
		Maximum Value	Assessment Criteria		
arsenic	4	11.8	640	1	-
cadmium	4	0.60	230	1	-
chromium (total)	4	18	8,600	2	-
copper	4	31	68,000	2	-
lead	4	123	5,800	3	-
selenium	4	0.9	13,000	1	-
mercury (inorganic)	4	0.2	3,600	1	-
nickel	4	24	1,800	1	-
zinc	4	88	730,000	2	-

Determinant	Number of Samples	mg/kg		Source of Criteria	Number and Source of exceedances
		Maximum Value	Assessment Criteria		
boron	4	1.9	240,000	2	-
total cyanide ¹	4	0.2	16,000	3	-
phenol ²	4	3.6	760	2	-
PAH					
acenaphthene ³	4	4.5	57	2	-
acenaphthylene ³	4	0.45	86	2	-
anthracene	4	10.95	520,000	2	-
benzo(a)anthracene	4	15.42	170	2	-
benzo(a)pyrene	4	16.35	35	2	-
benzo(b)fluoranthene	4	21.68	44	2	-
benzo(g,h,i)perylene	4	9.86	3,900	2	-
benzo(k)fluoranthene	4	8.66	1,200	2	-
chrysene	4	18.99	350	2	-
dibenzo(a,h)anthracene	4	2.15	3.5	2	-
fluoranthene	4	49.66	23,000	2	-
fluorene ³	4	6.95	31	2	-
indeno(1,2,3-cd)pyrene	4	9.08	500	2	-
napthalene ³	4	0.23	76	2	-
phenanthrene	4	29.02	22,000	2	-
pyrene	4	39.79	54,000	2	-
TPH & BTEX					
aliphatic C ₅ -C ₆ ³	4	<0.03	304	2	-
aliphatic C ₆ -C ₈ ³	4	<0.03	114	2	-
aliphatic C ₈ -C ₁₀ ³	4	2	78	2	-
aliphatic C ₁₀ -C ₁₂ ³	4	18	48	2	-
aliphatic C ₁₂ -C ₁₆ ⁴	4	87	59,000	2	-
aliphatic C ₁₆ -C ₃₅	4	296	1,600,000	2	-
aliphatic C ₃₅ -C ₄₀	4	22	1,600,000	2	-
aromatic C ₆ -C ₇ ³	4	<0.01	1,120	2	-
aromatic C ₇ -C ₈ ³	4	<0.01	869	2	-
aromatic C ₈ -C ₁₀ ³	4	<0.01	643	2	-
aromatic C ₁₀ -C ₁₂ ³	4	13	364	2	-
aromatic C ₁₂ -C ₁₆ ⁴	4	435	36,000	2	-
aromatic C ₁₆ -C ₂₁	4	1,836	28,000	2	-
aromatic C ₂₁ -C ₃₅	4	4,434	28,000	2	-
aromatic C ₃₅ -C ₄₀	4	449	28,000	2	-
benzene	4	<0.005	27	2	-
toluene ³	4	<0.005	869	2	-
ethylbenzene ³	4	<0.005	518	2	-
m&p-xylene	4	<0.01	1,201	2	-
o-xylene	4	<0.005	478	2	-

¹ Calculated using TOX data for inorganic cyanide (R&D Publication TOX5, DEFRA and EA, 2002)

² Based on a threshold protective of direct skin contact with phenol (most conservative)

³ SGV/GAC capped at the lower of the vapor or aqueous saturation limits in soil

⁴ GAC calculated manually using the procedures specified in Section 4.12 of the CLEA Software Handbook

Table 7.1 indicates that the concentrations of all of the tested determinants were below the adopted GAC.

Trace amounts of amosite fibres (asbestos) were identified in one sample of made ground (WS3 1.6-1.8m) from beneath the site. However, quantification by phase contrast optical microscopy revealed the quantity of asbestos present to be less than 0.001% relative to the surrounding soil mass. This indicates that the presence of asbestos in the made ground beneath the site is limited to highly localised trace fibres.

On the basis of the laboratory test results obtained it is considered that the levels of contamination in the test soils present a sufficiently low risk to long-term human health and the proposed development end use.

7.3.3 Receptor: Controlled Waters

The CSM presented in Section 7.0 of the PRA report has shown that a pathway to controlled waters from soil contamination at the site can be completed, given the 'Secondary A' and 'Principal' aquifer classifications of the underlying superficial deposits and chalk bedrock geology respectively, and the presence of surface watercourses at about 160m and 350m from the site. A quantitative assessment was therefore undertaken in this regard by means of laboratory analysis of groundwater samples recovered from Boreholes BH1-BH2 WS1-WS2 and WS3A.

The results of the groundwater analysis are summarised in Table 7.2. The Table also includes a comparison of the maximum detected concentrations against the relevant GAC selected from the sources listed below:

1. The Water Framework Directive (Standards and Classification Directions (England and Wales) 2015
2. EQS for individual substances in fresh water.
3. 'Drinking Water Standards' (DWS) contained within the Water Supply (Water Quality) Regulations, 2000 (as amended).

Table 7.2 Groundwater Contamination Test Results

Determinant	µg/l unless stated		Location of Exceedance(s) <i>Maximum exceedance</i>
	Maximum Value	GAC (source)	
arsenic	3.6	7.5 (1)	-
cadmium	0.13	3.75 (1)	-
chromium (total)	4.47	37.5 (1)	-
copper	10.36	1,500 (1)	-
lead	0.05	7.5 (1)	-
mercury (inorganic)	0.09	0.75 (3)	-
selenium	1.2	7.5 (2)	-
nickel	16.2	15 (1)	WS3A
zinc	3.6	50 (2)	-
boron	1.3	1,000 (2)	-
phenol	<0.5	7.7 (2)	-
sulphate	322mg/l	188mg/l (1)	WS3A
Total cyanide	0.01	1 (2)	-
PAH			
naphthalene	<0.01	2.4 (1)	-
anthracene	0.02	0.1 (1)	-
fluoranthene	0.839	0.1 (1)	WS3A

Determinant	µg/l unless stated		Location of Exceedance(s) <i>Maximum exceedance</i>
	Maximum Value	GAC (source)	
benzo(a)pyrene	<0.01	0.05 (3)	-
benzo(b)fluoranthene & benzo(k)fluoranthene	0.015	0.01 (3)	WS3A
benzo(g,h,i)perylene & indeno(1,2,3-cd)pyrene	<0.01	0.1 (3)	-
TPH			
aliphatic C ₅ -C ₆	<10	10 ¹	-
aliphatic C ₆ -C ₈	<10		-
aliphatic C ₈ -C ₁₀	<10		-
aliphatic C ₁₀ -C ₁₂	<10		-
aliphatic C ₁₂ -C ₁₆	<10		-
aliphatic C ₁₆ -C ₂₁	<10		-
aliphatic C ₂₁ -C ₃₅	120		WS3A
aliphatic C ₃₅ -C ₄₀	<10		-
aromatic EC ₅ -EC ₇	<10		-
aromatic EC ₇ -EC ₈	<10		-
aromatic EC ₈ -EC ₁₀	<10		-
aromatic EC ₁₀ -EC ₁₂	<10		-
aromatic EC ₁₂ -EC ₁₆	<10		-
aromatic EC ₁₆ -EC ₂₁	<10		-
aromatic EC ₂₁ -EC ₃₅	19		BH2 (19µg/l), WS3A (19µg/l)
aromatic EC ₃₅ -EC ₄₀	<10		-
benzene	<1	0.75 (1)	-
toluene	<1	50 (2)	-
ethylbenzene	<1	10 ¹	-
m&p-xylene	<2	30 (2)	-
o-xylene	<1	10 ¹	-

¹ in the absence of a published assessment criteria, a notional screening value of 10µg/l has been adopted.

The exceedances detected are discussed below.

TPH

Concentrations of TPH (aliphatic C₂₁-C₃₅ and aromatic EC₂₁-EC₃₅) in excess of the notional screening criteria of 10µg/l were detected in WS3A and BH2. However, these compounds are the least readily soluble in water and the exceedances detected are likely to be attributable to fine sediments within the groundwater samples.

Other Exceedances

Concentrations of the PAH compounds fluoranthene, benzo(b)fluoranthene & benzo(k)fluoranthene, nickel and sulphate exceeded their respective GAC in the groundwater sample recovered from WS3A, but with the exceptions of fluoranthene and sulphate the exceedances are marginal. Concentrations of all of the tested determinants were below the respective GAC in the groundwater samples recovered from BH1-BH2 and WS1-WS2.

The PAH result is considered most likely to be a result of influence from the made ground at WS3 (located about 1m from WS3A) within which a hydrocarbon odour was noted during sampling and in which aromatic hydrocarbons (C₁₆-C₃₅) of over 6500mg/kg were detected by the laboratory test results. However, WS3 and WS3A were located within the footprint of the proposed USTs, and the

excavation works will therefore have the effect of removing much if not all of the affected made ground.

No apparent source of sulphate contamination in groundwater has been identified either from the soil contamination test results obtained during the present investigation, or by the initial CSM presented in the PRA report. On this basis it is considered that any remedial action with respect to sulphate in groundwater at WS3 is not warranted. However, the concentration detected has been taken into account with respect to buried concrete and services, and this is discussed in Section 9.7.

7.4 Effect of Ground Contamination on Proposed Development

The levels of contamination detected in the test soils are not considered to present a significant risk to long-term human health. However, the investigation has indicated that the slightly elevated levels of hydrocarbon detected in an area of very loose made ground in the vicinity of Boreholes WS3 and WS3A could be capable of entering the underlying groundwater.

The affected boreholes are located within the area of the proposed tank farm excavation, and the excavation works will therefore have the effect of removing most if not all of the source of residual contamination from the site. However, it should be ensured that any made ground excavated from the proposed tank farm is removed from site and not re-used at other locations on-site during development.

7.5 Risk Assessment of Proposed Future Site Use

The proposed PFS has been designed specifically so the petrol and diesel USTs will be located within the superficial clay (Aeolian deposits) beneath the northern section of the site, which is up to 7.2m in thickness, therefore they will not extend into the 'Principal' bedrock aquifer of the Lewes Nodular Chalk Formation. This is illustrated in a simplified cross-section presented in Figure 5. Regional hydrogeological mapping data consulted during the preparation of the DTS PRA Report (E13043/1, September) indicates that the Aeolian deposits are classified as a 'Secondary A' aquifer, although no significant water seepage was recorded within the superficial deposits. It is also noted that the site is not indicated to lie within a Groundwater Source Protection Zone (SPZ), and no SPZs have been identified within 1km of the site.

On the basis of the foregoing, the construction of new USTs at the site should be possible without contravening the policies specified in the EA (2017) document *'The Environment Agency's approach to groundwater protection'* (Version 1.0) provided that a suitable risk assessment is prepared demonstrating that the risks to controlled waters can be suitably mitigated. Such an assessment should take account of the quantity of hazardous substances being stored at the site together with the site-specific ground conditions. It should also be ensured that the proposals comply with appropriate engineering standards and Best Available Techniques (BAT) and that they include effective management systems.

It would also be prudent to backfill the existing borehole installations with grout prior to construction in order to ensure that these do not enable the creation of preferential pathways for contaminant migration to the chalk bedrock aquifer.

7.6 Soil Gas

Table 7.3 summarises the soil gas monitoring results recorded on two occasions during December 2017. The full results are included in Table A which immediately follows the report text.

Table 7.3 Summary of soil gas monitoring data

Number of monitoring visits:	2	Dates of monitoring visits:	06/12/17 & 14/12/17
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	Pressure (mb)	CH ₄ (%)	CO ₂ (%)	CO (ppm)	H ₂ S (ppm)	O ₂ (%)	Flow (l/hr)
Maximum concentration	1028	0.0	3.9	2	1	20.3	+0.2
Minimum concentration	993	0.0	0.0	0	0	7.3	0.0

Multiplication of the maximum carbon dioxide (CO₂) concentration by the maximum detected gas flow rate, in accordance with the methodology specified in CIRIA Report C665 (2007) results in a 'gas screening value' of 0.0078 litres/hour. This value falls into 'Characteristic Situation' Classification CS-1. Both CIRIA Report C665 and BS8485:2015 state that gas exclusion measures are not required for new commercial buildings in a 'CS-1' classification.

However, reference to the PRA Report and that online radon maps indicate that the site lies within an intermediate probability radon area, basic radon protection measures are therefore considered necessary for new buildings. Such protection can be afforded by the inclusion of a well-installed damp-proof membrane of minimum 1200-gauge, extended across the ground floor slab of the proposed control room.

7.7 Off-site Disposal of Surplus Materials

Waste Acceptance Criteria (WAC) analysis was undertaken on samples of the made ground and natural superficial soils. The purpose of these tests was to facilitate an initial assessment of the classification of any surplus materials for off-site disposal for general guidance. The waste classification of all surplus soils will be subjected to the tip operator's certification on receipt of the laboratory test results included in Appendix 3.

Loose made ground at WS3 to uppermost 1m of WS3A would be classified as hazardous waste due to TPH(C₁₀-C₄₀) in excess of 100mg/kg. This differs visually from the surrounding made ground and natural soils, which could be classified as non-hazardous waste (due to total organic carbon of 3.34%) and inert waste respectively, on the basis of the available results. A watching brief is recommended during the tank farm excavation to ensure that the hazardous waste soils are suitably segregated and the volumes of soil leaving site as hazardous waste (at premium transport and tipping charges) is kept to a minimum.

Allowance should also be made for potentially encountering relatively small quantities of hazardous waste soils at other locations that could not be explored by the present investigation.

8.0 ENGINEERING PROPERTIES OF STRATA

8.1 *In-situ* Penetration Tests

Standard Penetration Tests (SPTs) were performed during the drilling of Boreholes BH1 – BH2, WS1 – WS4 and WS3A. Each test result is expressed by an N-value, which is the blow-count from a calibrated free-fall trip hammer needed to advance a standard penetrometer by 300mm. The SPT N-values are given in the borehole logs. Figure 6 presents the SPT N-values plotted against depth.

There is a consistent increase of SPT N-values with depth which can be represented by the following equation:

$$N = -4.706z + 30.883 \quad [1]$$

where z is the depth (mAOD), and $-3.0\text{m} \leq z \leq 5.5\text{m}$ AOD (equivalent to about $1.8\text{m} \leq z \leq 11\text{m}$ below existing ground level).

8.2 Water Content and Plasticity of Fine-Grained Soils

Table 8.1 gives the natural moisture content w , liquid limit w_L and plastic limit w_P for six specimens of the natural clay soil taken from the boreholes. The Table also includes the derived plasticity index¹ I_P , liquidity index² I_L and estimated undrained shear strength³ c_u .

Table 8.1 Water content and plasticity of clay

BH	depth (m)	water content w (%)	liquid limit w_L (%)	plastic limit w_P (%)	plasticity index I_P	liquidity index I_L	estimated undrained shear strength c_u (kPa)
BH1	1.45	21	42	17	25	0.160	48
BH2	2.45	20	45	20	25	0	100
WS1	1.4-1.6	21	31	16	15	0.333	22
WS2	1.5-1.7	20	41	16	25	0.160	48
WS4	1.2-1.4	22	39	17	22	0.227	35
WS4	2.0-2.2	22	45	18	27	0.148	51

The tested clay samples are indicated to have low to intermediate plasticity and low to medium shrinkage and swelling potential. The shrink/swell potential of clay refers to its behaviour in response to a change in moisture content. Clays shrink when natural moisture content is reduced and swell when the moisture content is increased.

8.3 Undrained Shear Strength

Table 8.2 summarises the leading results of undrained triaxial compression tests performed on two specimens prepared from core samples from Boreholes BH1 – BH2.

Table 8.2 Undrained shear strength

BH	depth (m)	water content (%)	undrained shear strength (kPa)	soil type
BH1	1.45	21	85	slightly sandy gravelly clay
BH2	2.45	20	70	silty slightly sandy clay

The shear strength has also been estimated from the SPT N-values using:

$$c_u \text{ (kPa)} \cong 5 * N \quad [2]$$

Figure 7 shows the measured and estimated undrained shear strength plotted against depth below ground level. The best-fit linear relationship is:

$$c_u \cong -24.658z + 163.014 \quad [3]$$

¹ $I_P = w_L - w_P$.

² $I_L = (w - w_P) / I_P$

³ $c_u \text{ (kPa)} \cong 100^{(1-I_L)}$

where c_u represents the shear strength, z is the depth (mAOD) and $-1.5\text{m} \leq z \leq 5.8\text{m AOD}$ (equivalent to about $1.5\text{m} \leq z \leq 8.5\text{m}$ below existing ground level).

8.4 California Bearing Ratio

Table 8.3 gives the results of *in-situ* dynamic cone penetrometer (DCP) tests carried out to estimate the California Bearing Ratio (CBR) for successive depth intervals.

Table 8.3 California Bearing Ratio

Test	depth range (m)	mean depth (m)	penetration rate (mm/blow)	calculated CBR for depth interval (%)	soil stratum
DCP 1	0-0.357	0.18	23.80	11	made ground
	0.357-1.658	1.01	11.83	22	superficial clay
DCP 2	0-0.245	0.12	4.45	62	made ground
	0.245-1.553	0.90	26.16	10	superficial clay
DCP 3	0-0.277	0.14	2.64	108	made ground
	0.277-1.553	0.92	13.43	19	superficial clay

The results indicated appear to have been distorted, most likely due to the presence of shallow gravel and cobble-sized particles. CBR-values have therefore been estimated from the SPT N-values obtained from the boreholes and by field measurements of the consistency of the natural clay soils, as recommended by BS5930:2015. On this basis a CBR-value of 3% is recommended for pavement design.

9.0 GEOTECHNICAL ASSESSMENT

9.1 Proposed development

The proposed development comprises the construction of a new PFS which will include six fuel pump islands covered by a canopy supported on stanchions, and an unmanned control room. Fuel is to be stored in underground petrol and diesel storage tanks.

9.2 Fuel Pump Islands

The new fuel pumps should be mounted on concrete islands built on a reinforced concrete apron. The proposed formation level should be prepared by proof-rolling.

9.3 PFS Canopy Foundations

Ground conditions consist of granular made ground ranging in thickness from 0.3m to about 2.0m. The made ground was found to include cohesive material in one of the boreholes (WS3A). It is underlain by naturally occurring firm becoming stiff with depth sandy gravelly clay extending to depths of between 3.2m to 7.2m bgl (between 4.03m to -0.08m AOD). This overlies structureless chalk composed of gravelly clay.

The proposed PFS canopy stanchions could be supported on shallow pad foundations bearing onto the natural clay of at least *firm* consistency. Each canopy stanchion is expected to carry a load of approximately 60kN. Foundation level should be at least 1m below existing ground level. Foundations should bear onto natural soils of at least *firm* strength. Founding on made ground should be avoided due to its variable composition and unpredictable settlement behaviour. Where the made ground is found to extend to greater depths, or if soft spots are encountered, for foundation purposes these should be removed and replaced with suitably compacted granular fill.

Bearing resistance of the natural soils of at least *firm* consistency for square pad foundations of breadth B x B (m), for a calculated settlement in the order of 25mm are presented in Table 9.1.

Table 9.1 Net design bearing resistance for pad foundations

foundation breadth B (m)	1.0	1.5	2.0
net design bearing resistance (kPa)	105	70	50

9.4 Control room

This lightly-loaded structure may be built on reinforced concrete rafts that could also act as floor slabs. Formation level should be not less than 0.3m below forecourt level and a suitable thickness of compacted hardcore should be laid. Alternatively, the control room could be constructed on shallow strip foundations at a minimum depth of 1m below existing ground level and bearing onto natural firm clay. Bearing resistances of natural soils of at least *firm* or *medium dense* consistency for a range of foundation breadths B (m), and a calculated settlement in the order of 25mm are presented in Table 9.2 below.

Table 9.2 Net design bearing resistance for strip foundations

foundation breadth B (m)	0.75	1.00	1.25	1.5
net design bearing resistance (kPa)	60	45	35	30

9.5 Forecourt Paving

Any hardstanding should be removed. Existing gravel surfacing and the underlying sub-base material should be proof-rolled. Any inferior materials should be removed. Soft areas should be excavated and the void replaced by compacted hardcore. New paving should be flexible and designed for a CBR of 3%.

9.6 Fuel Storage Tanks

An excavation about 4m-deep will be needed for the fuel storage tanks (invert level about 3.2m AOD). The excavation will be through mostly granular made ground (which was in one location about 2m thick) and firm and stiff clay. Groundwater inflow should be expected in the fuel tank excavations and lateral support by sheet piling will be required. Depending on the sheet pile length and design, additional measures may be required to exclude groundwater from the base of the excavation.

9.7 Buried Concrete

Measurements of the soluble sulphate content of seven soil samples revealed concentrations of between 30mg/l and 370mg/l. These values fall into Design Sulphate Class DS-1. The soil pH values and the presence of a laterally continuous groundwater table at shallow depth beneath the site indicate an Aggressive Chemical Environment for Concrete (ACEC) Class of AC-1.

Measurements of the total (acid soluble) sulphate and total sulphur contents of the test soils indicate that no additional measures are necessary to protect buried concrete against the oxidation of pyrite.

10.0 LIMITATIONS AND USE OF THE REPORT

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

- a) This report has been prepared at the request of ASDA Stores Limited ('the Client') pursuant to their appointment of DTS Raeburn Limited in connection with the intrusive investigation;
- b) Except for ASDA Stores Limited, no duty is undertaken or warranty or representation made to any party in respect of the opinions, advice, recommendations or conclusions contained in this report;
- c) All work carried out in preparing this report has used, and is based upon DTS Raeburn's professional knowledge and understanding of the current (November 2017) relevant English, Scottish and European Community standards and codes, technology and legislation. Changes in the above may cause the opinion, advice, recommendations or conclusions set out in this report to become inappropriate or incorrect. However, in giving its opinions, advice, conclusions and recommendations, DTS Raeburn have considered pending changes to environmental legislation and regulations of which they are currently aware. Following delivery of this report, DTS Raeburn will have no obligation to advise the Clients of any such changes or of their repercussions,
- d) Some of the information referenced and included in the report has been provided by third parties and whilst DTS Raeburn has no reason to doubt the accuracy, these items have not been verified. DTS Raeburn accepts no responsibility for errors within third party materials referenced and presented in this report;
- e) DTS Raeburn acknowledge that they are being retained, in part, because of their knowledge and experience with respect to geotechnical and environmental matters. DTS Raeburn will consider and analyse all information provided in the context of their knowledge and experience and all other relevant information known to DTS Raeburn. To the extent that the information provided to DTS Raeburn is not inconsistent and/or incompatible therewith, DTS Raeburn shall be entitled to rely upon and assume, without independent verification, the accuracy and completeness of all such information and shall have no obligation to verify the accuracy and completeness of such information,
- f) The opinions expressed in this report are based on the ground conditions revealed by investigation, together with an assessment of the site and of laboratory test results. Whilst opinions may be expressed relating to sub-soil conditions in parts of the site not investigated, for example between borehole positions, these are only for guidance and no liability can be accepted for their accuracy;
- g) The groundwater and ground gas conditions entered on the various records are those observed during subsequent monitoring. Groundwater is subject to seasonal variation or changes in local drainage conditions. Ground gas levels may vary depending on variations in weather conditions particularly barometric pressure. Rates of decomposition / degradation of organic matter in the underlying soils can also affect the generation of ground gases.
- h) The content of this report represents the professional opinion of experienced geotechnical and environmental specialists/consultants. DTS Raeburn does not provide associated legal advice and appropriate legal advice should be sought if required.
- i) The lack of evidence of the presence of hazardous materials, voids or obstructive features at the subject property does not guarantee the absence of such materials, rather it indicates only that none were found as a result of the services provided.

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E13043/2 – December 2017

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TABLE A – BOREHOLE GAS AND GROUNDWATER MONITORING RESULTS

E13043/2: ASDA Worthing Ferring

Date: 06/12/17

Atmospheric Pressure: 1028 mb steady

Weather: Raining, cloudy

Borehole	Groundwater Level (m bgl)	Groundwater Level (m AOD)	Flow Rate (l/hr)		Gas Concentration (by volume)									
					CH ₄ (%)		CO ₂ (%)		O ₂ (%)		H ₂ S (ppm)		CO (ppm)	
			Peak	Steady	Peak	Steady	Peak	Steady	Min.	Steady	Peak	Steady	Peak	Steady
Calibration	-	-	-	-	0.0	0.0	0.0	0.0	21.2	21.2	0	0	0	0
BH1	3.86	3.62	0.0	0.0	0.0	0.0	0.9	0.9	18.6	18.6	0	0	1	0
BH2	3.42	3.70	0.0	0.0	0.0	0.0	0.3	0.3	14.8	14.8	0	0	2	2
WS1	3.52	3.71	0.0	0.0	0.0	0.0	3.0	3.0	17.9	17.9	0	0	0	0
WS2	3.60	3.63	0.0	0.0	0.0	0.0	1.3	1.3	10.5	10.5	0	0	0	0
WS3A	3.56	3.52	0.0	0.0	0.0	0.0	3.3	3.3	7.3	7.3	0	0	1	0

Date: 14/12/2017

Atmospheric Pressure: 993mb steady

Weather: Raining, cloudy

Borehole	Groundwater Level (m bgl)	Groundwater Level (m AOD)	Flow Rate (l/hr)		Gas Concentration (by volume)									
					CH ₄ (%)		CO ₂ (%)		O ₂ (%)		H ₂ S (ppm)		CO (ppm)	
			Peak	Steady	Peak	Steady	Peak	Steady	Min.	Steady	Peak	Steady	Peak	Steady
Calibration	-	-	-	-	0.0	0.0	0.0	0.0	20.3	20.3	0	0	0	0
BH1	2.98	4.50	0.0	0.0	0.0	0.0	0.5	0.5	20.3	20.3	0	0	0	0
BH2	2.47	4.65	0.0	0.0	0.0	0.0	0.0	0.0	9.3	9.3	1	0	0	0
WS1	2.52	4.71	0.2	0.2	0.0	0.0	3.9	3.9	16.9	16.9	0	0	0	0
WS2	2.54	4.69	0.0	0.0	0.0	0.0	1.7	1.7	9.7	9.7	1	1	0	0
WS3A	2.45	4.63	0.0	0.0	0.0	0.0	2.3	2.3	11.4	11.4	0	0	0	0



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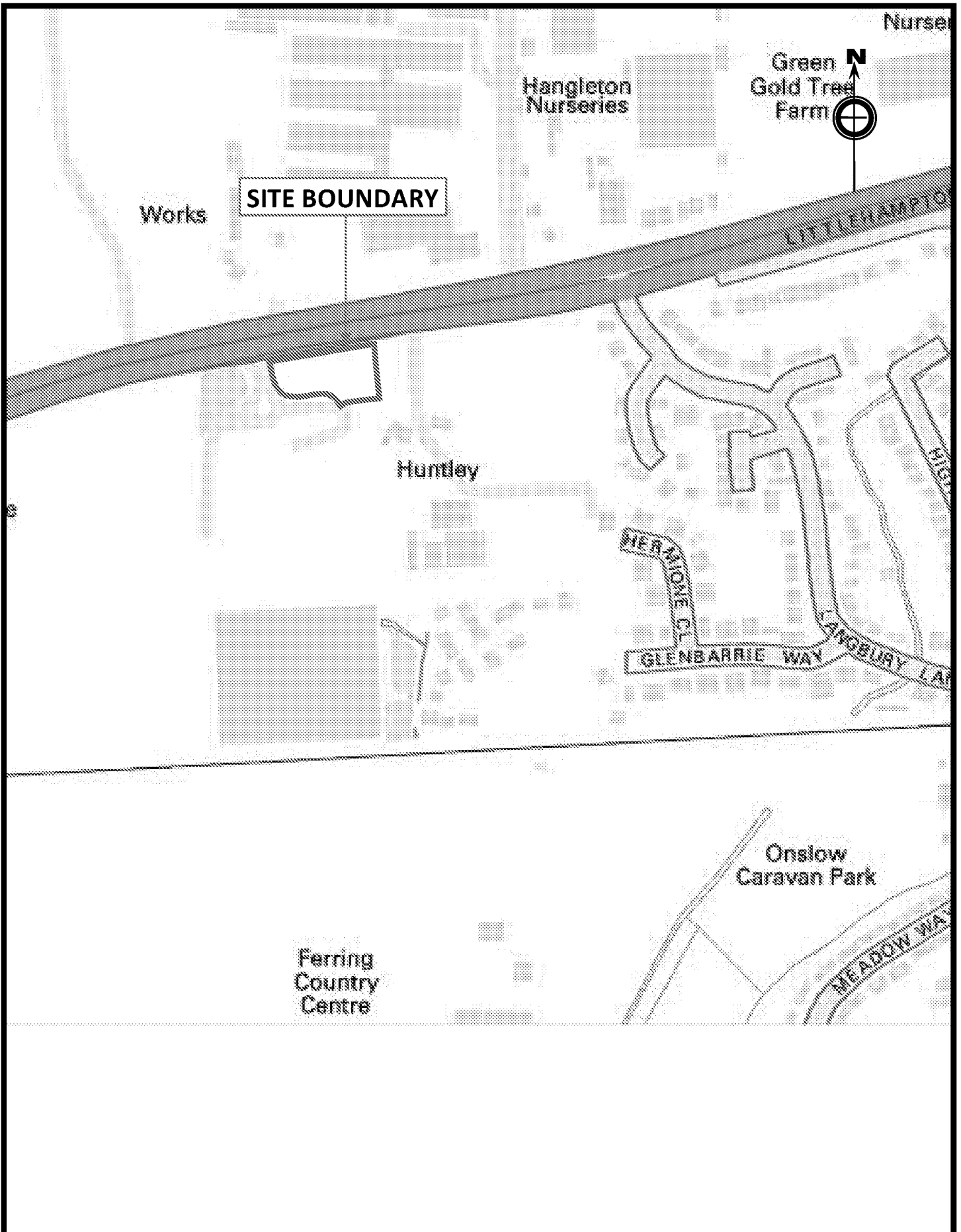
Moor Lane, Witton, Birmingham B6 7HG

Telephone: +44(0)121 344 5885 Facsimile: +44(0)121 344 5886

FIGURE 1

Site Location Plan
 Scale 1:200,000 @A4

E13043/2: ASDA Worthing Ferring
 Prepared for: ASDA Stores Limited



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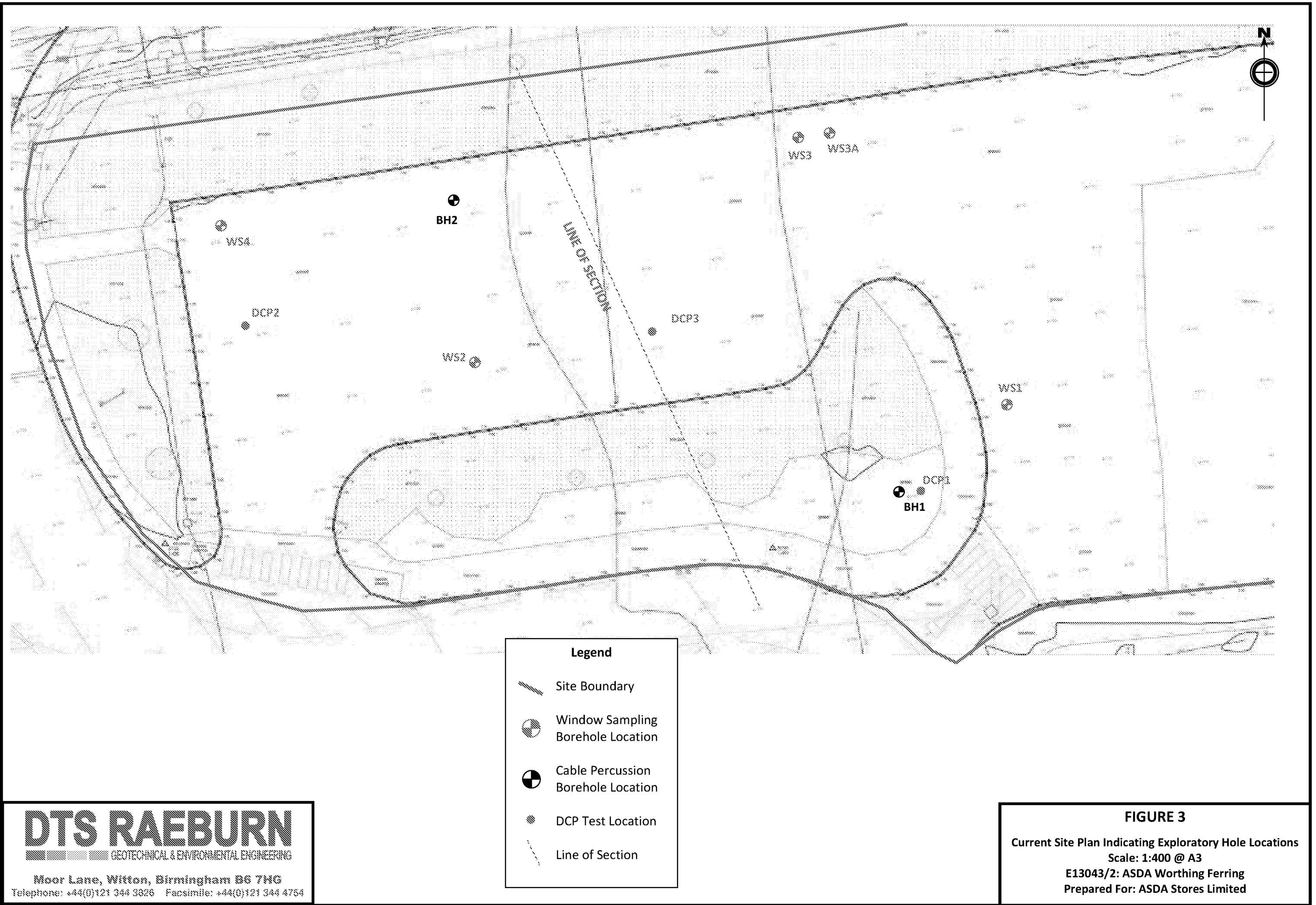
FIGURE 2

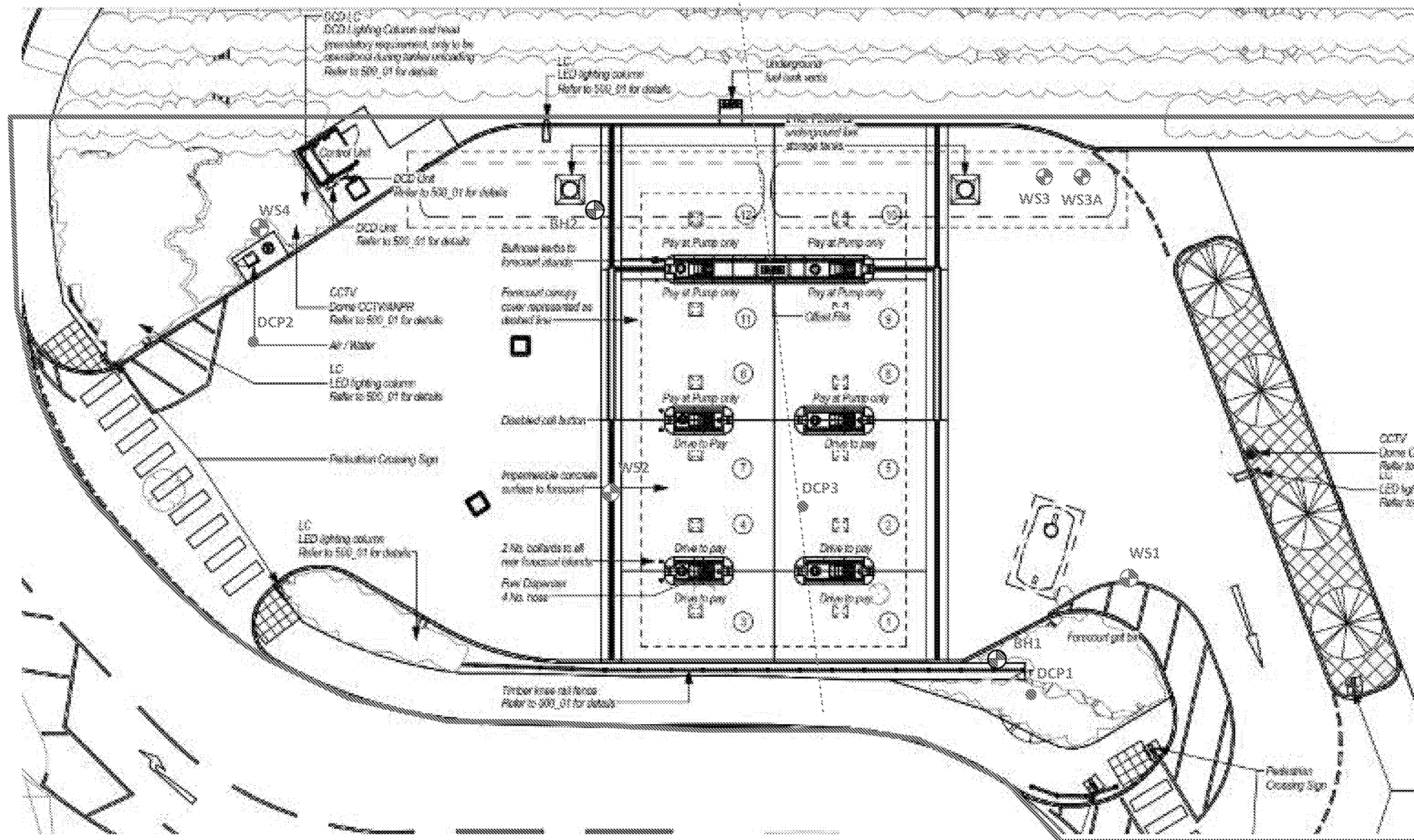
Street Map

Scale 1:2,500 @A4

E13043/2: ASDA Ferring

Prepared for: ASDA Stores Limited





Legend

-  Site Boundary
-  Window Sampling Borehole Location
-  Cable Percussion Borehole Location
-  DCP Test Location
-  Line of Section

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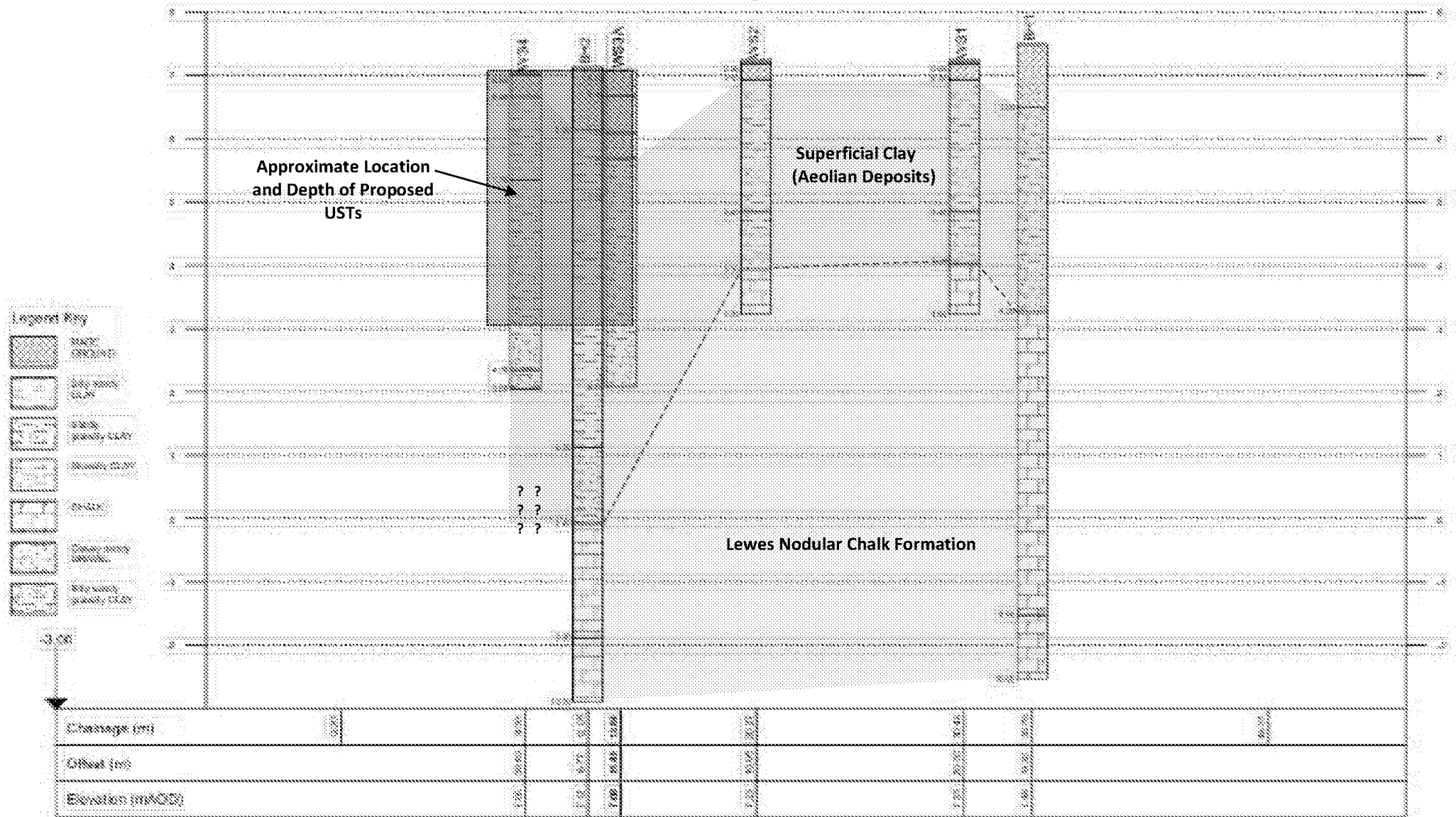
Telephone: +44(0)121 344 3826 Facsimile: +44(0)121 344 4754

FIGURE 4

Proposed Site Plan

1:200 @ A3

E13043/2: ASDA Worthing Ferring
Prepared for: ASDA Stores Limited



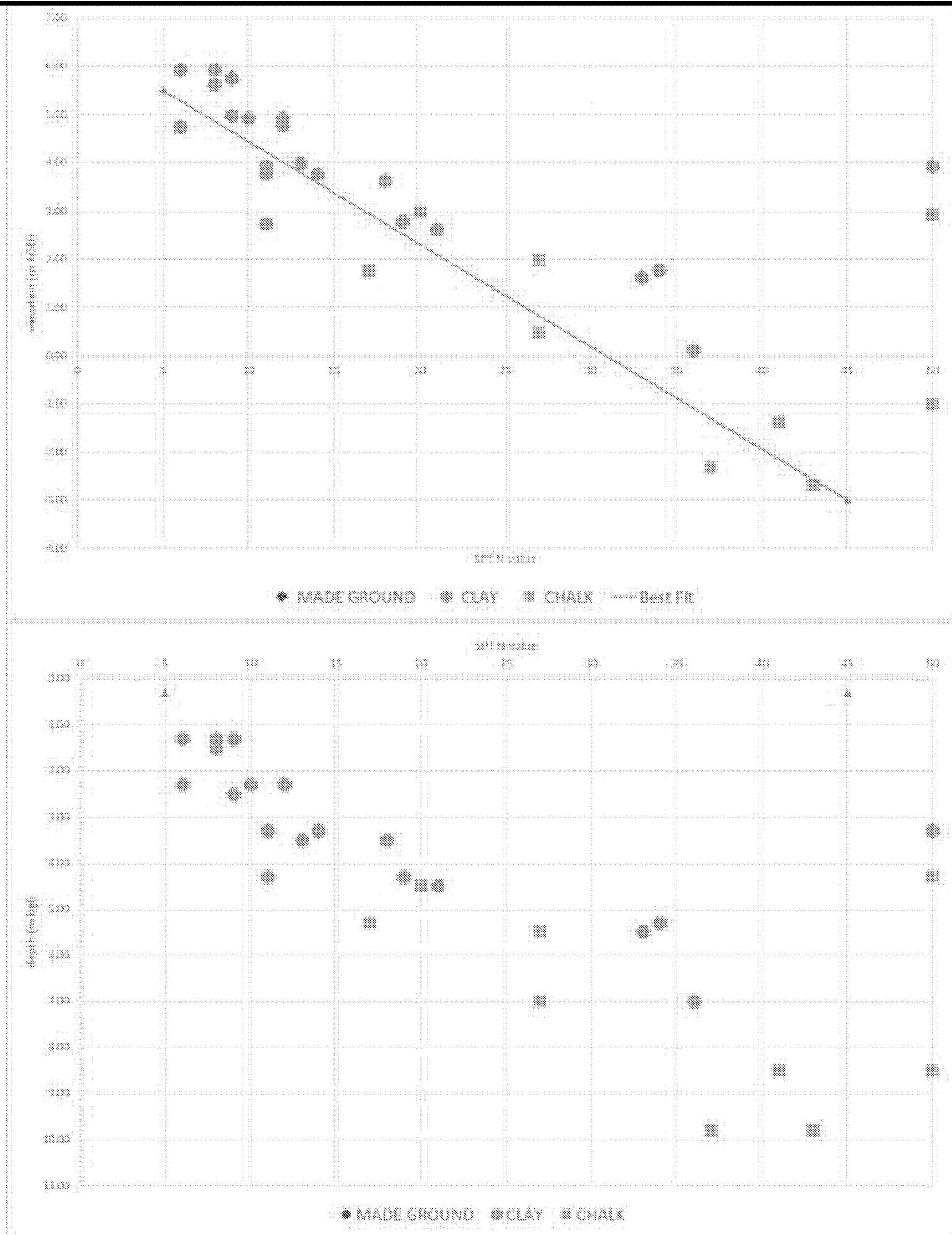
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FIGURE 5

Cross Section Showing the Proposed USTs Location
 Vertical Scale: 1:85 Horizontal Scale: 1:263
 E13043/2: ASDA Worthing Ferring
 Prepared For: ASDA Stores Limited



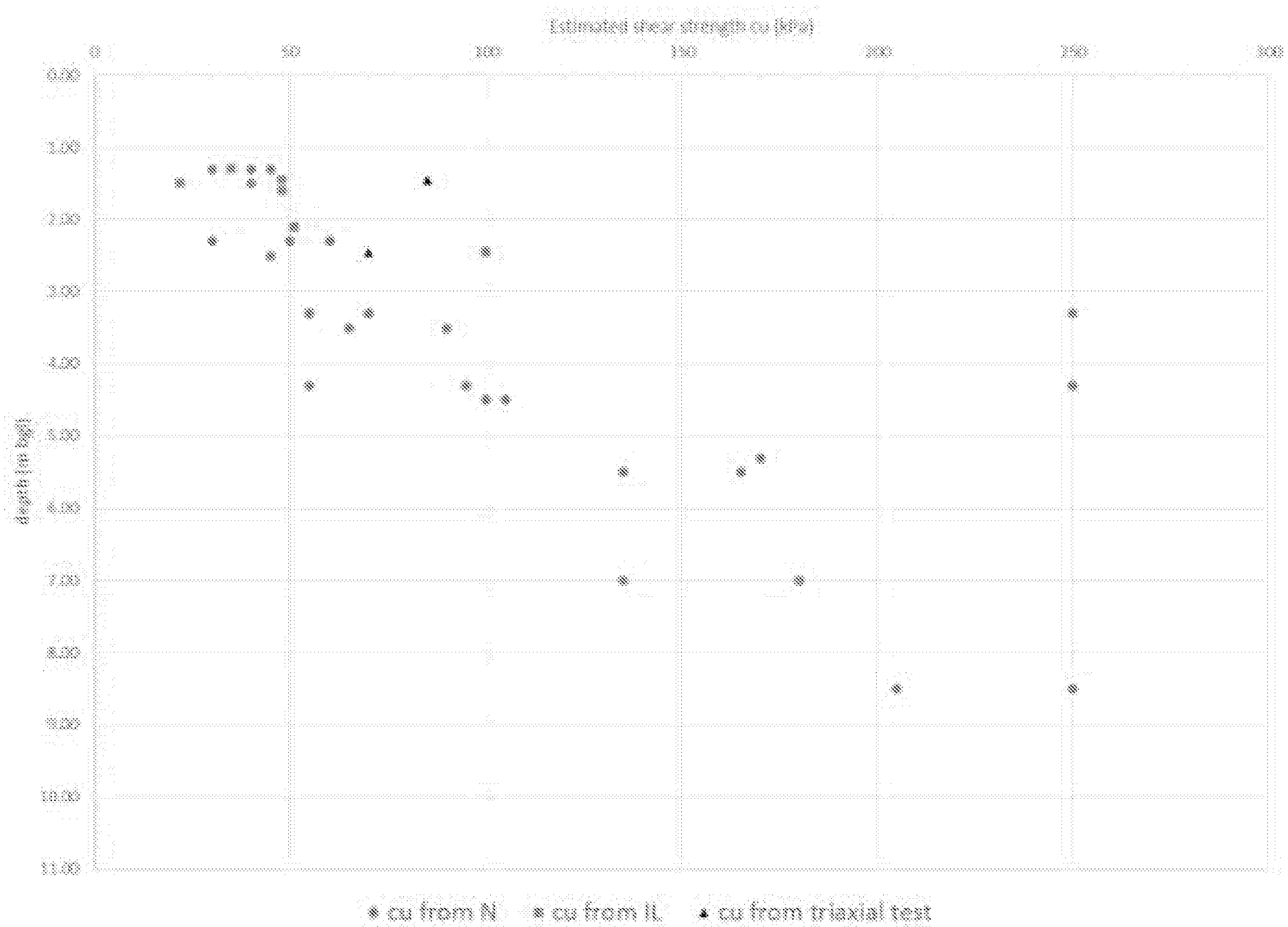
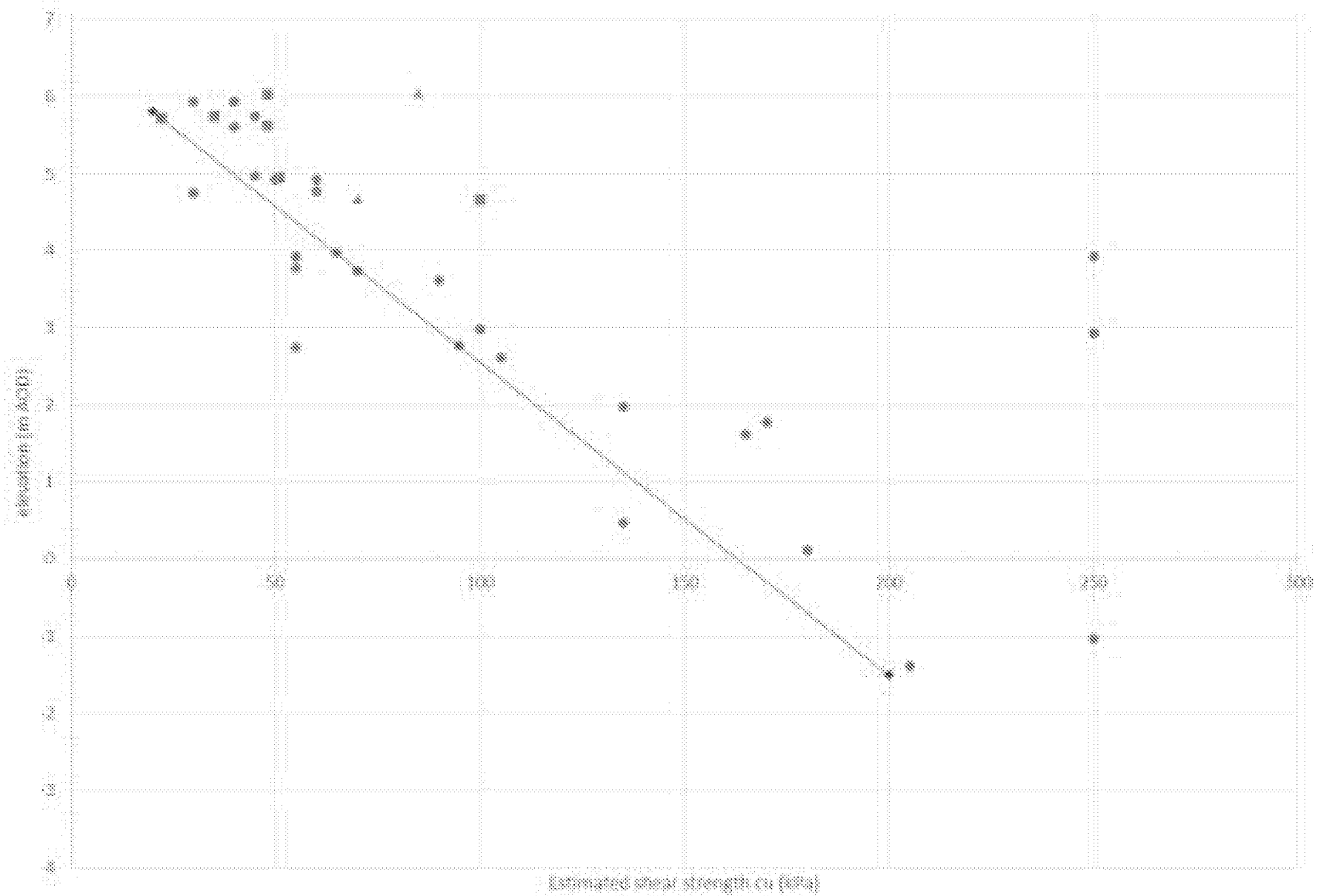
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FIGURE 6

Plot of SPT N-Value versus Depth

E13043/2: ASDA Worthing Ferring
Prepared for: ASDA Stores Limited



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FIGURE 7

Plot of Estimated Shear Strength versus Depth

E13043/2: ASDA Worthing Ferring
Prepared for: ASDA Stores Limited

Appendix 1

Borehole Records

(7 pages)

DTS RAE BURN GEOTECHNICAL & ENVIRONMENTAL ENGINEERING					Moor Lane, Witton, Birmingham, B6 7HG		Borehole No. BH1								
							Sheet 1 of 1								
Project Name:		ASDA Worthing Ferring		Project No. E13043/2		Co-ords:		508751E - 103318N		Hole Type: CP					
Location:		Littlehampton Road, Worthing				Level:		7.48m AOD		Scale: 1:50					
Client:		ASDA Stores Limited				Dates:		28/11/2017		Logged by: DP					
Well	Water Strikes	Samples and In Situ Testing			Depth (m bgl)	Level (m AOD)	Legend	Stratum Description							
		Depth (m bgl)	Type	Results											
		0.50 - 1.00	B	Ublow=17	1.00	6.48		MADE GROUND: Dark brown clayey very sandy angular fine to coarse gravel of brick fragments, concrete, flint with rare ceramic and plastic.		1					
		1.20 - 1.70	UT					Firm brown slightly sandy gravelly CLAY. Gravels are sub-angular to sub-rounded fine to coarse of chalk and flint with occasional cobbles of chalk and flint. [SUPERFICIAL AEOLIAN DEPOSITS]							
		1.70 - 2.20	B												
		2.20 - 2.70	SPT D	N=9 (1,2/2,2,2,3)	4.20	3.28		Structureless CHALK composed of stiff becoming very stiff light brown mottled cream white very gravelly clay. Gravels are angular fine to coarse of very weak chalk with occasional cobbles. (Grade Dm) [LEWES NODULAR CHALK FORMATION]		2					
		2.70 - 3.20	B												
		3.20 - 3.70	SPT D	N=13 (2,2/3,3,3,4)											
		3.70 - 4.20	B												
		4.20 - 4.70	SPT D	N=20 (3,3/4,4,5,7)											
		4.70 - 5.20	B												
		5.20 - 5.70	SPT D	N=27 (3,3/6,6,7,8)	9.00	-1.52		Structureless CHALK composed of dense cream white very clayey angular fine to coarse gravels of very weak chalk with frequent cobbles of chalk. (Grade Dc) [LEWES NODULAR CHALK FORMATION]		5					
		6.00 - 6.50	B												
		6.70 - 7.20	SPT D	N=27 (4,4/6,6,7,8)											
		7.20 - 7.70	B												
		8.20 - 8.70	SPT B	N=51 (3,3/4,12,16,19)							10.00	-2.52			9
		8.20 - 8.70	D												
		9.00 - 9.50	B	N=37 (6,6/7,9,10,11)	10.00	-2.52			10						
		9.50 - 10.00	SPT D												
						10.00	-2.52	End of borehole at 10.00m bgl		10					
Remarks	Groundwater was encountered 8.4m bgl.									Final					

DTS RAE BURN GEO TECHNICAL & ENVIRONMENTAL ENGINEERING					Moor Lane, Witton, Birmingham, B6 7HG		Borehole No. BH2 Sheet 1 of 1		
Project Name:		ASDA Worthing Ferring		Project No. E13043/2		Co-ords:		508730E - 103335N	Hole Type: CP
Location:		Littlehampton Road, Worthing				Level:		7.12m AOD	Scale: 1:50
Client:		ASDA Stores Limited				Dates:		27/11/2017	Logged by: DP
Well	Water Strikes	Samples and In Situ Testing			Depth (m bgl)	Level (m AOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
		0.50 - 1.00	B		1.00	6.12		MADE GROUND: Dark brown clayey sand and angular fine to coarse gravel of brick fragments, concrete, flint with rare ceramic and plastic.	1
		1.20 1.20 - 1.70	SPT D	N=8 (1,1/2,2,2,2)				Firm becoming very stiff brown silty slightly sandy CLAY. [SUPERFICIAL AEOLIAN DEPOSITS]	
		1.70 - 2.20	B					2.70-3.70 - Fine to medium gravels of chalk and flint present with occasional cobbles.	2
		2.20 - 2.70	UT	Ublow=12					
		2.70 - 3.20	B						
		3.20 3.20 - 3.70	SPT D	N=18 (3,3/4,4,5,5)					
		3.70 - 4.20	B					3.70-6.00 - Becomes very gravelly with frequent cobbles.	3
		4.20 4.20 - 4.70	SPT D	N=21 (2,3/3,4,7,7)					
		4.70 - 5.20	B					Very stiff brown very silty very sandy slightly gravelly CLAY. Gravels are sub-rounded to sub-angular fine to coarse of chalk and flint with occasional cobbles. [SUPERFICIAL AEOLIAN DEPOSITS]	4
		5.20 5.20 - 5.70	SPT D	N=33 (7,7/7,8,9,9)					
		6.00 - 6.50	B		6.00	1.12		Structureless CHALK composed of very stiff light brown mottled cream white very gravelly clay. Gravels are angular fine to coarse of very weak chalk with occasional cobbles. (Grade Dm) [LEWES NODULAR CHALK FORMATION]	5
		6.70 6.70 - 7.20	SPT D	N=36 (3,3/7,9,10,10)					
		7.20 - 7.70	B		7.20	-0.08		Structureless CHALK composed of dense cream white very clayey angular fine to coarse gravels of very weak chalk with frequent cobbles of chalk. (Grade Dc) [LEWES NODULAR CHALK FORMATION]	6
		8.20 8.20 - 8.70	SPT D	N=41 (3,3/8,9,11,13)					
		9.00 - 9.50	B		9.00	-1.88		Structureless CHALK composed of dense cream white very clayey angular fine to coarse gravels of very weak chalk with frequent cobbles of chalk. (Grade Dc) [LEWES NODULAR CHALK FORMATION]	7
	9.50 9.50 - 10.00	SPT D	N=43 (2,7/7,8,12,16)						
				10.00	-2.88	End of borehole at 10.00m bgl			8
Remarks	Groundwater was encountered at 5m and 8.5m bgl.								Final

DTS RAE BURN GEO TECHNICAL & ENVIRONMENTAL ENGINEERING					Moor Lane, Witton, Birmingham, B6 7HG		Borehole No. [REDACTED] WS1				
Project Name:		ASDA Worthing Ferring		Project No. E13043/2		Co-ords:		508761E - 103324N		Hole Type: WS	
Location:		Littlehampton Road, Worthing				Level:		7.23m AOD		Scale: 1:50	
Client:		ASDA Stores Limited				Dates:		27/11/2017		Logged by: DP	
Well	Water Strikes	Samples and In Situ Testing			Depth (m bgl)	Level (m AOD)	Legend	Stratum Description			
		Depth (m bgl)	Type	Results							
		0.10 - 0.30	ES		0.05	7.18		MADE GROUND: Gravel surfacing.			
	0.40 - 0.60	ES			0.30	6.93				MADE GROUND: Greyish brown slightly clayey very sandy angular fine to coarse gravel of concrete, brick fragment, sandstone, limestone, flint and rare ceramic.	
	1.00	SPT	N=6 (1,2/1,1,2,2)				Firm orangish brown mottled greyish brown silty slightly sandy CLAY. [SUPERFICIAL AEOLIAN DEPOSITS] 0.40-0.60 - Slight organic odour.				
	1.40 - 1.60	ES									
	2.00	SPT	N=12 (1,1/2,3,3,4)								
	2.40 - 2.60	ES		2.40	4.83			Firm becoming very stiff light brown gravelly CLAY. Gravels are sub-angular fine to coarse of chalk and flint. [SUPERFICIAL AEOLIAN DEPOSITS]			
	3.00	SPT	N=51 (6,7/8,12,15,16)								
	3.40 - 3.60	ES		3.20	4.03			Highly weathered CHALK recovered as very stiff cream mottled light brown very gravelly clay. Gravels are sub-angular to sub-rounded fine to coarse of moderately strong chalk and flint with occasional cobbles of chalk. (Grade DM) [LEWES NODULAR CHALK FORMATION]			
	4.00	SPT	N=62 (5,10/12,14,16,20)	4.00	3.23			End of borehole at 4.00m bgl			
	Remarks	No groundwater was encountered during drilling, however standing groundwater was observed at 3.2m bgl during installation. Borehole terminated at 4m bgl due to refusal.								Final	

DTS RAE BURN GEO TECHNICAL & ENVIRONMENTAL ENGINEERING					Moor Lane, Witton, Birmingham, B6 7HG 		Borehole No. WS2 Sheet 1 of 1				
Project Name:		ASDA Worthing Ferring		Project No. E13043/2		Co-ords:		508728E - 103326N		Hole Type: WS	
Location:		Littlehampton Road, Worthing				Level:		7.23m AOD		Scale: 1:50	
Client:		ASDA Stores Limited				Dates:		27/11/2017		Logged by: DP	
Well	Water Strikes	Samples and In Situ Testing			Depth (m bgl)	Level (m AOD)	Legend	Stratum Description			
		Depth (m bgl)	Type	Results							
		0.10 - 0.30	ES	N=8 (2,2/2,2,2,2)	0.05	7.18		MADE GROUND: Gravel surfacing.			
		0.70 - 0.90	ES		0.30	6.93				MADE GROUND: Brownish black very sandy angular fine to coarse gravel of concrete, brick fragment, flint, sandstone and limestone.	
		1.00	SPT	N=10 (2,2/3,2,3,2)						Firm orangish brown silty slightly sandy CLAY. [SUPERFICIAL AEOLIAN DEPOSITS]	
		1.50 - 1.70	ES							0.30-0.80 - Slight organic odour.	
		2.00	SPT	N=11 (2,3/3,2,3,3)						1.80-2.40 - Occasional medium to coarse gravels of chalk.	
		2.50 - 2.70	ES			2.40		4.83			Firm light brown gravelly CLAY. Gravels are angular to sub-rounded fine to coarse of chalk and flint with occasional cobbles of chalk and flint. [SUPERFICIAL AEOLIAN DEPOSITS]
		3.00	SPT		3.30	3.93		Highly weathered CHALK recovered as very stiff cream mottled light brown gravelly clay. Gravels are sub-angular to sub-rounded fine to coarse of moderately strong chalk and flint with occasional cobbles of chalk. (Grade DM) [LEWES NODULAR CHALK FORMATION]			
		3.50 - 3.70	ES		4.00	3.23				End of borehole at 4.00m bgl	
Remarks	No groundwater was encountered. Borehole terminated at 4m bgl due to refusal.								Final		

DTS RAE BURN GEOTECHNICAL & ENVIRONMENTAL ENGINEERING						Moor Lane, Witton, Birmingham, B6 7HG		Borehole No. WS3	
						Sheet 1 of 1			
Project Name:		ASDA Worthing Ferring		Project No. E13043/2		Co-ords:		508748E - 103338N	
Location:		Littlehampton Road, Worthing				Level:		7.08m AOD	
Client:		ASDA Stores Limited				Dates:		27/11/2017	
Hole Type:		WS							
Scale:		1:50							
Logged by:		DP							
Well	Water Strikes	Samples and In Situ Testing			Depth (m bgl)	Level (m AOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
		0.20 - 0.40	ES	N=0 (0,0/0,0,0,0)	0.05	7.03		MADE GROUND: Gravel surfacing.	1
	0.60 - 0.80	ES			Very loose light brownish black very clayey very sandy very angular to angular fine to coarse gravel of sandstones, brick fragment, concrete, flint, wood and ceramic, occasional cobbles of concrete and brick fragment.				
	1.00	SPT			1.00-1.60 - Poor recovery.				
	1.60 - 1.80	ES			1.60-2.00 - Hydrocarbon odour.				
	2.00	SPT	50 (10,15/50 for 150mm)		2.00	5.08		End of borehole at 2.00m bgl	
									3
									4
									5
									6
									7
									8
									9
									10
									10
									10
Remarks	No groundwater was encountered. Hydrocarbon odour at 1.6m bgl. Borehole terminated at 2m bgl due to refusal.								Final

Project Name:	ASDA Worthing Ferring	Project No. E13043/2	Co-ords:	508752E - 103339N	Hole Type: WS
Location:	Littlehampton Road, Worthing		Level:	7.08m AOD	Scale: 1:50
Client:	ASDA Stores Limited		Dates:	27/11/2017	Logged by: DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m bgl)	Level (m AOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
		0.20 - 0.40	ES		0.40	6.68		MADE GROUND: Brownish black very sandy angular fine to coarse gravel of sandstone, concrete, limestone, brick fragment, ceramic and timber.	
		0.60 - 0.80	ES					MADE GROUND: Firm greyish black sandy very gravelly clay. Gravels are very angular to sub-angular fine to coarse of brick fragment, flint, ceramic and concrete with occasional cobbles of brick fragment.	
		1.00	SPT	N=9 (2,3/2,3,2,2)	1.00	6.08		MADE GROUND: Loose light brownish mottled greyish brown clayey very sandy gravel of chalk, sandstone, brick fragment and flint.	1
		1.50 - 1.70	ES		1.40	5.68		MADE GROUND: Firm becoming very stiff orangish brown mottled greyish brown slightly sandy slightly gravelly CLAY. Gravels are sub-angular to sub-rounded fine to coarse of chalk and flint. [SUPERFICIAL AEOLIAN DEPOSITS]	2
		2.00	SPT	N=12 (2,2/3,2,3,4)				MADE GROUND: Firm becoming very stiff orangish brown mottled greyish brown slightly sandy slightly gravelly CLAY. Gravels are sub-angular to sub-rounded fine to coarse of chalk and flint. [SUPERFICIAL AEOLIAN DEPOSITS]	
		2.50 - 2.70	ES					MADE GROUND: Firm becoming very stiff orangish brown mottled greyish brown slightly sandy slightly gravelly CLAY. Gravels are sub-angular to sub-rounded fine to coarse of chalk and flint. [SUPERFICIAL AEOLIAN DEPOSITS]	
		3.00	SPT	N=11 (2,3/3,2,3,3)				MADE GROUND: Firm becoming very stiff orangish brown mottled greyish brown slightly sandy slightly gravelly CLAY. Gravels are sub-angular to sub-rounded fine to coarse of chalk and flint. [SUPERFICIAL AEOLIAN DEPOSITS]	3
		3.50 - 3.70	ES					MADE GROUND: Firm becoming very stiff orangish brown mottled greyish brown slightly sandy slightly gravelly CLAY. Gravels are sub-angular to sub-rounded fine to coarse of chalk and flint. [SUPERFICIAL AEOLIAN DEPOSITS]	
		4.00	SPT	N=19 (2,3/4,5,4,6)				MADE GROUND: Firm becoming very stiff orangish brown mottled greyish brown slightly sandy slightly gravelly CLAY. Gravels are sub-angular to sub-rounded fine to coarse of chalk and flint. [SUPERFICIAL AEOLIAN DEPOSITS]	4
		4.50 - 4.70	ES					MADE GROUND: Firm becoming very stiff orangish brown mottled greyish brown slightly sandy slightly gravelly CLAY. Gravels are sub-angular to sub-rounded fine to coarse of chalk and flint. [SUPERFICIAL AEOLIAN DEPOSITS]	
		5.00	SPT	N=34 (5,6/8,7,8,11)	5.00	2.08		MADE GROUND: Firm becoming very stiff orangish brown mottled greyish brown slightly sandy slightly gravelly CLAY. Gravels are sub-angular to sub-rounded fine to coarse of chalk and flint. [SUPERFICIAL AEOLIAN DEPOSITS]	5
End of borehole at 5.00m bgl									
									6
									7
									8
									9
									10
Remarks	No groundwater was encountered.								Final

Project Name:	ASDA Worthing Ferring	Project No. E13043/2	Co-ords:	508710E - 103333N	Hole Type: WS
Location:	Littlehampton Road, Worthing		Level:	7.05m AOD	Scale: 1:50
Client:	ASDA Stores Limited		Dates:	27/11/2017	Logged by: DP

Well	Water Strikes	Samples and In Situ Testing			Depth (m bgl)	Level (m AOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
		0.10 - 0.30	ES		0.05	7.00		MADE GROUND: Gravel surfacing.	
		0.50 - 0.70	ES		0.40	6.65		Light brown mottled blackish grey clayey very sandy angular fine to coarse gravel of sandstone, limestone and brick fragment. [SUPERFICIAL AEOLIAN DEPOSITS]	
		1.00	SPT	N=9 (1,2/2,2,2,3)				Firm orangish brown silty slightly sandy CLAY. [SUPERFICIAL AEOLIAN DEPOSITS]	1
		1.20 - 1.40	ES					1.20-1.70 - Rare medium to coarse chalk and flint gravels.	
		2.00	SPT	N=6 (1,1/1,1,2,2)	1.70	5.35		Soft becoming firm orangish brown slightly sandy slightly gravelly CLAY. Gravels are sub-angular to sub-rounded fine to coarse of chalk and flint. [SUPERFICIAL AEOLIAN DEPOSITS]	2
		2.00 - 2.20	ES					2.00-4.70 - Becomes gravelly with occasional cobbles of flint and chalk.	
		3.00	SPT	N=14 (1,2/4,3,4,3)					3
		3.50 - 3.70	ES						
		4.00	SPT	N=11 (2,2/3,2,3,3)					4
		4.20 - 4.40	ES						
		4.70 - 4.90	ES		4.70	2.35		Medium dense light brown very clayey very sandy angular to sub-rounded fine to coarse gravel of chalk and flint with occasional cobbles of flint. [SUPERFICIAL AEOLIAN DEPOSITS]	5
		5.00	SPT	N=17 (4,5/4,4,5,4)	5.00	2.05		End of borehole at 5.00m bgl	
									6
									7
									8
									9
									10
Remarks	No groundwater was encountered.								Final

Appendix 2

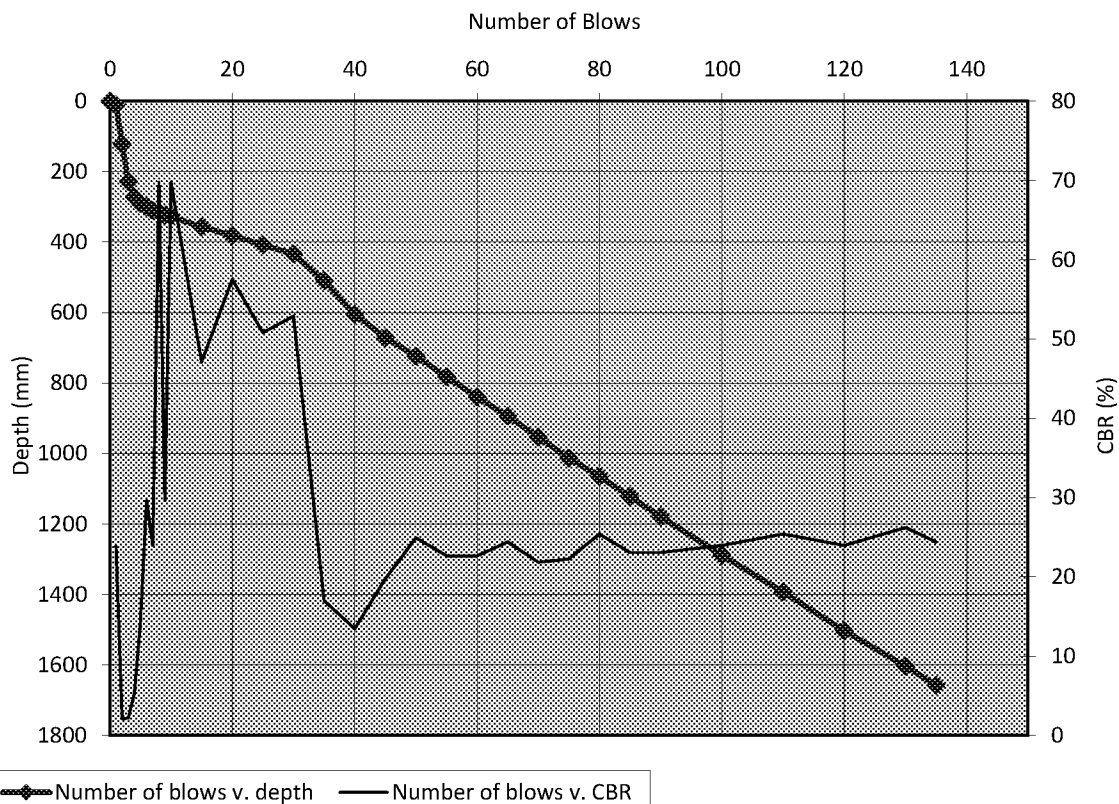
DCP Test Results

(3 pages)

Contract Number:	E13043/2
Site Name:	ASDA Worthing Ferring
Client:	ASDA Stores Limited

Test Location:	DCP1
Date Tested:	14/12/2017
Tested by:	D Pacheco

DYNAMIC CONE PENETROMETER GRAPH



Start Depth (mm)	Finish Depth (mm)	No. of Blows	Blows per Layer	Material	DCP mm/blow	Estimated average CBR over depth range (%)
0	357	15	15	Made ground	23.80	11
357	1658	135	110	Superficial Clay	11.83	22

(CBR value at 50th percentile between 50mm and 550mm penetration as per IAN 73/06 Rev 1 2009 Clause 893.2)

30 %

Remarks:

Cone Angle 60°

UKAS accredited test - No

Test stopped to add extension rods at a depth of 510mm

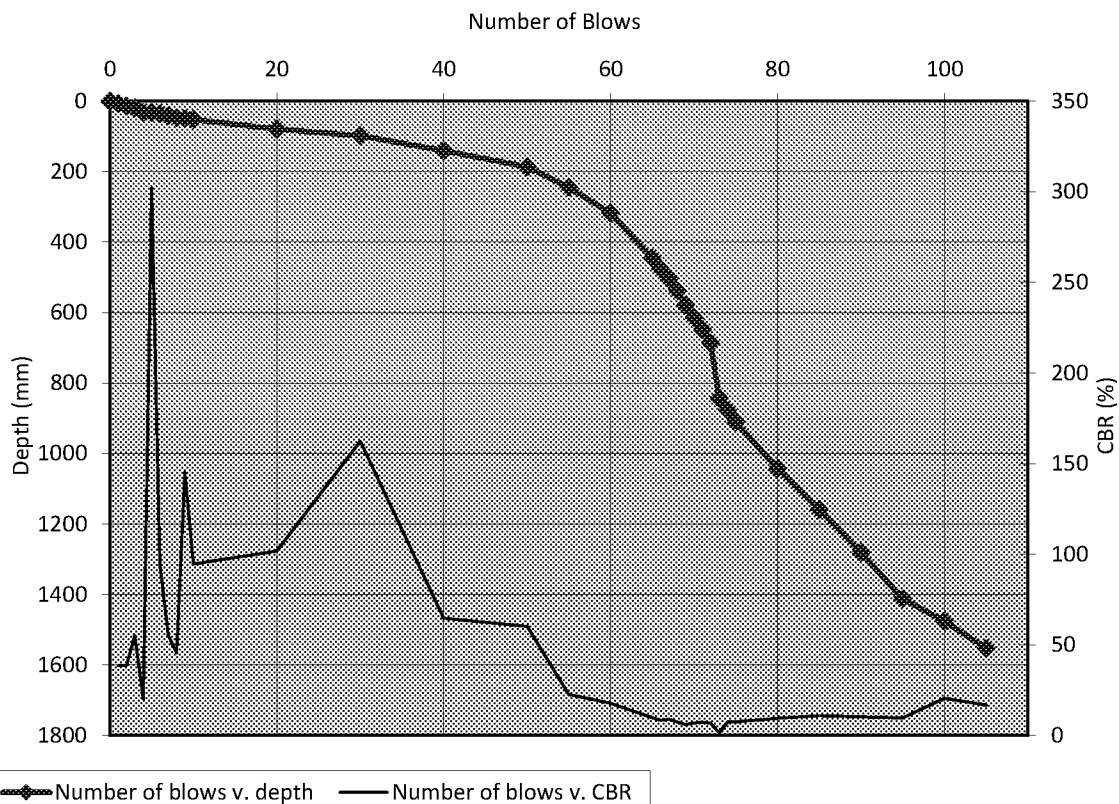
Terminated due to practical refusal

Originator	Checked & Approved	Determination of Penetration Value using Dynamic Cone Penetrometer	DCP 1
DP	JS	In-house procedure SP341 and Highways Agency IAN 73/06 Rev. 1 2009	

Contract Number:	E13043/2
Site Name:	ASDA Worthing Ferring
Client:	ASDA Stores Limited

Test Location:	DCP2
Date Tested:	14/12/2017
Tested by:	D Pacheco

DYNAMIC CONE PENETROMETER GRAPH



Start Depth (mm)	Finish Depth (mm)	No. of Blows	Blows per Layer	Material	DCP mm/blow	Estimated average CBR over depth range (%)
0	245	55	55	Made ground	4.45	62
245	1553	105	50	Superficial Clay	26.16	10

(CBR value at 50th percentile between 50mm and 550mm penetration as per IAN 73/06 Rev 1 2009 Clause 893.2)

20 %

Remarks:

Cone Angle 60°

UKAS accredited test - No

Test stopped to add extension rods at a depth of 820mm

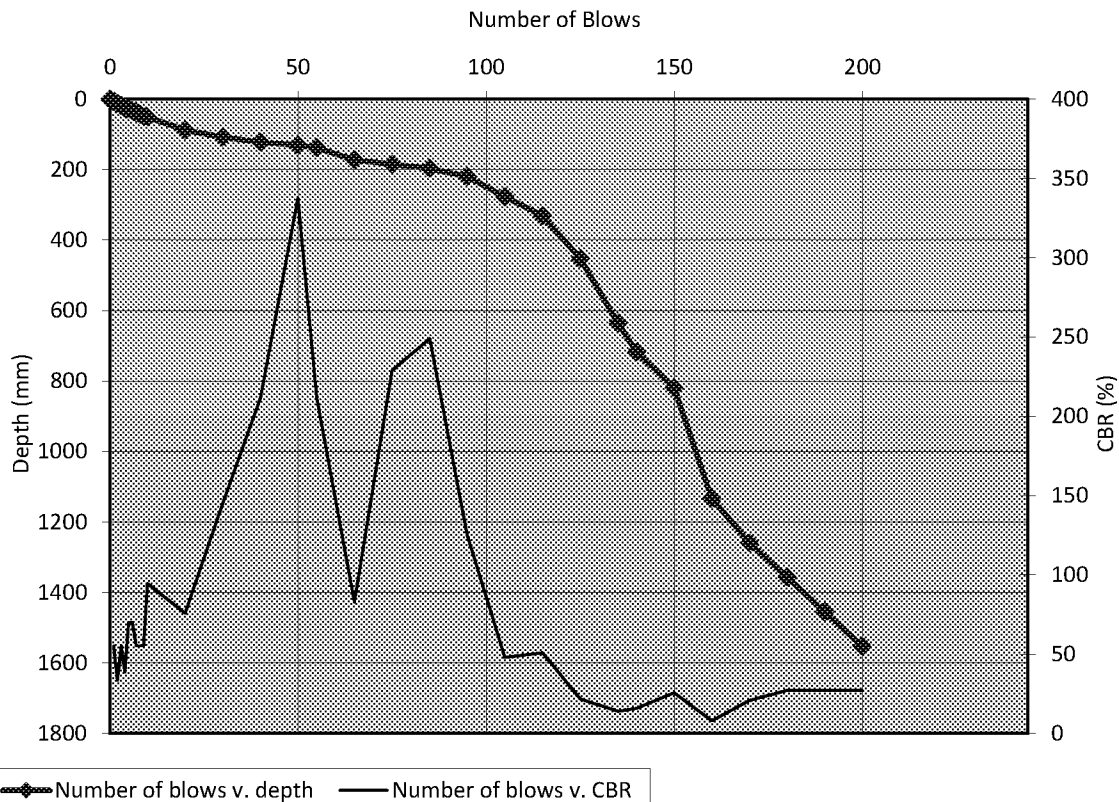
Terminated due to practical refusal

Originator	Checked & Approved	Determination of Penetration Value using Dynamic Cone Penetrometer	DCP 2
DP	JS	In-house procedure SP341 and Highways Agency IAN 73/06 Rev. 1 2009	Sheet 1 of 1

Contract Number:	E13043/2
Site Name:	ASDA Worthing Ferring
Client:	ASDA Stores Limited

Test Location:	DCP23
Date Tested:	14/12/2017
Tested by:	D Pacheco

DYNAMIC CONE PENETROMETER GRAPH



Start Depth (mm)	Finish Depth (mm)	No. of Blows	Blows per Layer	Material	DCP mm/blow	Estimated average CBR over depth range (%)
0	277	105	105	Made ground	2.64	108
277	1553	200	95	Superficial Clay	13.43	19

(CBR value at 50th percentile between 50mm and 550mm penetration as per IAN 73/06 Rev 1 2009 Clause 893.2)

19 %

Remarks:

Cone Angle 60°

UKAS accredited test - No

Test stopped to add extension rods at a depth of 844mm

Terminated due to practical refusal

Originator	Checked & Approved	Determination of Penetration Value using Dynamic Cone Penetrometer	DCP 3
DP	JS	In-house procedure SP341 and Highways Agency IAN 73/06 Rev. 1 2009	Sheet 1 of 1

Appendix 3

**Soil Contamination
Laboratory Test
Results**

(11 pages)

DTS Raeburn Limited

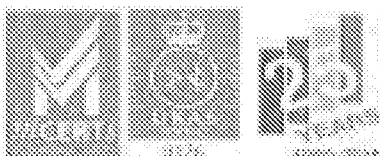
Moor Lane
Witton
Birmingham
B6 7HG

For the attention of David Pacheco

Report No: B21265
Issue No 02

LABORATORY TEST REPORT

Project Name		ASDA WORTHING FERRING	
Project Number	B21265	Date samples received	01/12/2017
Your Ref	E13043/2	Date written instructions received	01/12/2017
Purchase Order	29186/E13043/2	Date testing commenced	01/12/2017
Please find enclosed the results as summarised below			
Figure / Table	Test Quantity	Description	ISO 17025 Accredited
1	7	Client Specified Suite - Soil	See Report
2	4	PAHs (speciated) - Soil	Yes
3	4	TPHCWG - Soil	Yes
4	4	VPHCWG - Soil	Yes
5	3	Asbestos Screen / Quantification - Soil	S/C
6	3	WAC Two-Stage Leachate Suite - Soil	No
App S1	~	Sample Descriptions - Soil	N/A
App S2	~	Deviating Samples - Soil	N/A
App S3	~	Summary of In-House Analytical Test Methods - Soil	N/A
Remarks :			
Issued by : Stephen Langman		Date of Issue : 15/12/2017	Key to symbols used in this report S/C : Testing was sub-contracted
Approved Signatories :			
G Wilson (JMD/Laboratories Director), S Langman (Laboratory Coordinator)			
Unless we are notified to the contrary, samples will be disposed after a period of one month from this date. The results reported relate to samples received in the laboratory only. All results contained in this report are provisional unless signed by an approved signatory This report should not be reproduced except in full without the written approval of the laboratory. Under multisite accreditation the testing contained in this report may have been performed at another Terra Tek laboratory. The enclosed results remain the property of Terra Tek Limited and we reserve the right to withdraw our report if we have not received cleared funds in accordance with our standard terms and conditions Only those results indicated in this report are UKAS accredited and any opinions or interpretations expressed are outside the scope of UKAS accreditation. Feedback on the this report may be left via our website www.terratek.co.uk/contact-us			



TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES				Site ASDA WORTHING FERRING																			Contract No E13043/2												
				Client ASDA Stores Ltd																															
				Engineer																															
Sample Identification				Lab Sample ID	Arsenic	Cadmium	Chromium	Lead	Mercury	Selenium	Copper	Nickel	Zinc	Boron (water soluble)	Phenol	Total Cyanide	Free Cyanide	Sulphate (acid soluble as SO4)	Sulphate (water soluble in 2:1 extract) as SO4	Sulphide	Total Sulphur	Loss on ignition	Total organic carbon	pH											
Hole	Depth m	Sample Ref	Sample Type																																
WS01	0.10-0.30		ET	429937	7.9	0.43	16	123	<0.10	0.7	22	12	79	<1.0	<0.7	<0.01	<1.0	0.15	0.13	<4	0.01	2.5	3.34	11.0											
WS02	0.70-0.90		ET	429943	11.8	0.56	31	17	<0.10	0.8	12	24	58	<1.0	0.7	<0.01	<1.0	0.03	0.40	<4	0.07	3.6	0.40	7.8											
WS03	1.60-1.80		ET	429949	7.7	0.38	11	15	0.20	0.7	10	11	42	1.4	3.6	<0.01	<1.0	0.46	0.37	125	0.18	2.9	1.19	11.0											
WS03A	0.60-0.80		ET	429952	8.7	0.60	28	53	<0.10	0.9	24	23	88	1.9	1.8	0.2	<1.0	0.11	0.15	14	0.04	~	~	9.1											
BH01	4.70-5.20		B	429966	~	~	~	~	~	~	~	~	~	~	~	~	~	0.06	0.04	~	0.02	~	~	8.6											
BH02	6.00-6.50		B	429967	~	~	~	~	~	~	~	~	~	~	~	~	~	0.05	0.05	~	0.03	~	~	8.6											
WS04	3.50-3.70		ET	429963	~	~	~	~	~	~	~	~	~	~	~	~	~	0.04	0.03	~	0.01	~	~	8.4											
Limits of Detection Terra Tek Analysis Method					0.5 TP137 M	0.10 TP137 M	1 TP137 M	1 TP137 M	0.10 TP137 M	0.5 TP137 M	1 TP137 M	1 TP137 M	0.5 TP137 M	1.0 TP032 U	0.7 TP046 M	0.1 TP048 M	1.0 TP047 U	0.02 TP029 M	0.01 TP043 M	4 TP051 M	0.01 TP129 N	0.1 TP042 M	0.10 TP174 N	~ TP019 M											
Accreditation M=Mcerts U=UKAS N=No accreditation																																			
Originator	Checked & Approved		RESULTS OF CHEMICAL CONTAMINATION TESTS - SOIL											KEY							Tk Figure 1														
TGH																									* - deviating result (refer to Appendix S2 for details) ^ - result expressed on as-received basis										
Sheet 1 of 1																																			

TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES				Site ASDA WORTHING FERRING																	Contract No E13043/2				
				Client ASDA Stores Ltd																					
				Engineer																					
Sample Identification				Lab Sample ID	Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benzo (a) anthracene	Chrysene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Indeno (1,2,3 - cd) pyrene	Dibenzo (ah) anthracene	Benzo (ghi) perylene	Total PAHs (USEPA 16)				
Hole	Depth m	Sample Ref	Sample Type																						mg/kg
WS01	0.10-0.30		ET	429937	<0.05	<0.05	0.20	0.27	2.15	0.76	4.90	4.12	1.71	2.36	2.62	1.61	1.84	1.41	0.18	1.77	25.9				
WS02	0.70-0.90		ET	429943	<0.05	<0.05	<0.10	<0.05	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.05	<0.05	<0.05	<0.10	<0.10	<0.10	<1.3				
WS03	1.60-1.80		ET	429949	0.23	0.45	4.50	6.95	29.02	10.95	49.66	39.79	15.42	18.99	21.68	8.66	16.35	9.08	2.15	9.86	243.7				
WS03A	0.60-0.80		ET	429952	0.21	0.14	0.23	0.21	2.31	0.92	8.11	7.54	4.11	3.84	5.79	3.07	4.44	3.03	0.43	3.34	47.7				
Limits of Detection Terra Tek Analysis Method Accreditation M=Meerts U=UKAS N=No accreditation					0.05 TP045 M	0.05 TP045 M	0.10 TP045 M	0.05 TP045 M	0.10 TP045 M	0.10 TP045 M	0.10 TP045 M	0.10 TP045 M	0.10 TP045 M	0.10 TP045 M	0.05 TP045 M	0.05 TP045 M	0.05 TP045 M	0.10 TP045 M	0.10 TP045 M	0.10 TP045 M	1.3 TP045 M				
Originator	Checked & Approved		POLYAROMATIC HYDROCARBONS (USEPA 16) - SOIL										KEY										Tk Figure 2 Sheet 1 of 1		
DAB													* - deviating result (refer to Appendix S2 for details) ^ - result expressed on as-received basis												

TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES				Site ASDA WORTHING FERRING																Contract No E13043/2				
				Client ASDA Stores Ltd																				
				Engineer																				
Sample Identification				Lab Sample ID	TPH (Aliphatics C8-C10)	TPH (Aliphatics >C10-C12)	TPH (Aliphatics >C12-C16)	TPH (Aliphatics >C16-C21)	TPH (Aliphatics >C21-C35)	TPH (Aliphatics >C35-C40)	TPH (Aromatics >C10-C12)	TPH (Aromatics >C12-C16)	TPH (Aromatics >C16-C21)	TPH (Aromatics >C21-C35)	TPH (Aromatics >C35-C40)									Sample received in appropriate container
Hole	Depth m	Sample Ref	Sample Type		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg								
WS01	0.10-0.30		V	429938	<1	<1	<1	3	44	24	<1	8	4	52	57									Yes
WS02	0.70-0.90		V	429944	<1	<1	<1	<1	<1	11	<1	<1	2	<1	8									Yes
WS03	1.60-1.80		V	429950	2	18	87	69	227	22	13	435	1,836	4,434	449									Yes
WS03A	0.60-0.80		V	429953	<1	<1	<1	1	5	9	<1	5	8	14	15									Yes
Limits of Detection Terra Tek Analysis Method Accreditation U=UKAS N=No accreditation					1 TP126 U	1 TP126 U	1 TP126 U	1 TP126 U	1 TP126 U	1 TP126 U	1 TP126 U	1 TP126 U	1 TP126 U	1 TP126 U	1 TP126 U									
Originator	Checked & Approved	TPHCWG - SOIL										KEY * - deviating result (refer to Appendix S2 for details) ^ - result expressed on as-received basis					Tk Figure 3 Sheet 1 of 1							
DAB																								

TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES				Site ASDA WORTHING FERRING																Contract No E13043/2			
				Client ASDA Stores Ltd																			
				Engineer																			
Sample Identification				Lab Sample ID	TPH (Aliphatics C5-C6)	TPH (Aliphatics C6-C8)	TPH (Aromatics C6-C7)	TPH (Aromatics C7-C8)	TPH (Aromatics C8-C10)	Benzene	Ethylbenzene	m & p - Xylene	o - Xylene	Toluene	MTBE								Sample received in appropriate container
Hole	Depth m	Sample Ref	Sample Type		µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg							
WS01	0.10-0.30		V	429938	<10	<10	<10	<10	<10	<5	<5	<10	<5	<5	<5								Yes
WS02	0.70-0.90		V	429944	<10	<10	<10	<10	<10	<5	<5	<10	<5	<5	<5								Yes
WS03	1.60-1.80		V	429950	<30	<30	<10	<10	<10	<5	<5	<10	<5	<5	<15								Yes
WS03A	0.60-0.80		V	429953	<10	<10	<10	<10	<10	<5	<5	<10	<5	<5	<5								Yes
Limits of Detection Terra Tek Analysis Method Accreditation U=UKAS N=No accreditation					10 TP154 M	10 TP154 M	10 TP154 M	10 TP154 M	10 TP154 M	5 TP154 M	5 TP154 M	10 TP154 M	5 TP154 M	5 TP154 M	5 TP154 M								
Originator	Checked & Approved	VPHCWG - SOIL										KEY										Tk Figure 4	
DAB												* - deviating result (refer to Appendix S2 for details) ^ - result expressed on as-received basis											
																						Sheet 1 of 1	

TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES				Site ASDA WORTHING FERRING			Contract No E13043/2	
				Client ASDA Stores Ltd				
				Engineer				
Sample Identification				Lab Sample ID	Asbestos Screen	Comments	Quantification by Phase Contrast Optical Microscopy %	
Hole	Depth m	Sample Ref	Sample Type					
WS01	0.10-0.30		ET	429937	ND	None	~	
WS03	1.60-1.80		ET	429949	D	Amosite Loose Fibres Detected	<0.001	
WS03A	0.60-0.80		ET	429952	ND	None	~	
Limits of Detection Terra Tek Analysis Method Accreditation M=Moerts U=UKAS N=No accreditation				~	S/C	U	0.001 S/C U	
Originator	Checked & Approved	ASBESTOS SCREEN/IDENTIFICATION				KEY * - deviating result (refer to Appendix S2 for details) ND - no asbestos detected D - asbestos detected		 Figure 5 Sheet 1 of 1
TGH								

TERRA TEK Soil Investigation & Laboratory Services				Site ASDA WORTHING FERRING																		Contract No E13043/2			
				Client ASDA Stores Ltd																		All results expressed at L/S ratio 10:1			
				Engineer																					
Sample Identification				Lab Sample ID	Arsenic	Barium	Cadmium	Chromium	Copper	Mercury	Molybdenum	Nickel	Lead	Antimony	Selenium	Zinc	Chloride	Fluoride	Sulphate	Dissolved Solids	Phenol	Dissolved Organic Carbon			
Exploratory Hole	Depth m	Sample Ref	Sample Type		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg		
WS01	0.10-0.30		ET	429937	<0.05	0.11	<0.04	<0.1	<0.1	<0.005	0.02	<0.1	<0.2	<0.05	<0.05	<0.2	46	<1	<100	2015	<0.1	26			
WS02	0.70-0.90		ET	429943	<0.05	0.06	<0.04	<0.1	<0.1	<0.005	<0.01	<0.1	<0.2	<0.05	<0.05	<0.2	<40	<1	<100	604	<0.1	23			
WS03	1.60-1.80		ET	429949	<0.05	0.34	<0.04	<0.1	<0.1	<0.005	0.03	<0.1	<0.2	<0.05	<0.05	<0.2	150	2	821	2214	0.4	29			
Limits of Detection Terra Tek Analysis Method Accreditation M=Mcerts U=UKAS N=No accreditation					0.05 TP156 N	0.01 TP156 N	0.04 TP156 N	0.1 TP156 N	0.1 TP156 N	0.005 TP156 N	0.01 TP156 N	0.1 TP156 N	0.2 TP156 N	0.05 TP156 N	0.05 TP156 N	0.2 TP156 N	40 TP068 N	1 TP080 N	100 TP170 N	50 TP035 N	0.1 TP060 N	10 TP162 N			
Originator	Checked & Approved	RESULTS OF LEACHATE TESTING (BS EN 12457-3:2002)																		Tk Figure 6					
TGH																									
																				Sheet 1 of 1					

TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES				Site ASDA WORTHING FERRING					Contract No E13009/1		
				Client ASDA Stores Ltd							
				Engineer							
Sample Identification						Temperature on receipt °C	PRIMARY MATRIX	Secondary Matrix	Additional matrix	% Loss at 30C	% Retained 2mm
Exploratory Hole	Depth m	Sample Ref	Sample Type								
WS01	0.10-0.30		ET	429937	27/11/17	3.9	SAND	Fine to medium gravel		7.3	57.7
WS02	0.70-0.90		ET	429943	27/11/17	3.9	CLAY			16.9	17.3
WS03	1.60-1.80		ET	429949	27/11/17	3.9	Slurry of SAND	Fine to medium gravel		10.3	~
WS03A	0.60-0.80		ET	429952	27/11/17	3.9	Clayey SAND	Fine to medium gravel		12.1	46.7
WS04	3.50-3.70		ET	429963	27/11/17	3.9	CLAY	Fine to medium gravel		14.7	18.3
BH01	4.70-5.20		B	429966	27/11/17	3.9	Clayey CHALK	Fine to medium gravel		13.3	26.2
BH02	6.00-6.50		B	429967	27/11/17	3.9	Slurry of CLAY	Fine to medium gravel		19.6	19.7
Notes											
Terra Tek are accredited for clay, sand and loam matrix types only, where they constitute the major component of the sample. Other coarse granular materials such as gravel, are not accredited where they comprise the major component of the sample. Results are expressed on a dry-weight basis (samples dried at 30°C ± 5°C) except where stated. The laboratory removes any material > 2mm prior to analysis. The quantity and nature of the material is shown as the secondary and additional matrix types in the above table. Where a parameter cannot be determined in house it is our policy to use a UKAS/MCERTS accredited laboratory wherever possible. Terra Tek will assume responsibility for the quality of subcontracted tests and the performance of the subcontractor chosen. Where there is no known UKAS/MCERTS laboratory for a particular parameter, a laboratory listed within the Terra Tek Approved Subcontractors List, which is subject to performance assessment, will be selected.											
Originator	Checked & Approved	SAMPLE DESCRIPTIONS							Appendix S1		
TGH									Sheet 1 of 1		

TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES				Site ASDA WORTHING FERRING		Contract No E13043/2						
				Client ASDA Stores Ltd								
				Engineer								
Sample Identification				Lab Sample ID	Date Sampled	Deviating conditions						Preservatives used
Exploratory Hole	Depth m	Sample Ref	Sample Type			Sampling date has not been provided	Exceeded maximum holding time for selected test(s)	Presence of headspace in sample vial	Poorly fitting cap or lid	Damaged container		
WS01	0.10-0.30		ET	429937	27/11/17							
WS01	0.10-0.30		V	429938	27/11/17							
WS02	0.70-0.90		ET	429943	27/11/17							
WS02	0.70-0.90		V	429944	27/11/17							
WS03	1.60-1.80		ET	429949	27/11/17							
WS03	1.60-1.80		V	429950	27/11/17							
WS03A	0.60-0.80		ET	429952	27/11/17							
WS03A	0.60-0.80		V	429953	27/11/17							
BH01	4.70-5.20		B	429966	27/11/17							
BH02	6.00-6.50		B	429967	27/11/17							
WS04	3.50-3.70		ET	429963	27/11/17							
NOTES 1 Results reported for samples classified as deviating may be compromised. Deviation types are shown as "X" or "Yes" in the table above. 2 The absence of "X" or "Yes" in the table above indicates no reported deviations. 3 Deviations due to use of incorrect sample container are shown on result tables. 4 Deviating results are indicated within result tables.												
Originator		Checked & Approved		DEVIATING SAMPLES - SOIL					 Appendix S2 Sheet 1 of 1			
TGH												

TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES		Site	ASDA WORTHING FERRING		Contract No E13043/2		
		Client	ASDA Stores Ltd				
		Engineer					
Method Code	Reference	Description of Method			ISO17025 Accredited	MCERTS Accredited	Wet/Dry Sample Tested
GP001	BS1377, Part 3, 1990: Soils for Civil Engineering Purposes.	Preparation of soil samples for chemical analysis			Yes	Yes	N/A
GP012	BS EN 12457-3: Characterisation of Waste - Compliance test for leaching of granular waste materials and sludges (two-stage batch test)	Preparation of soil samples for two-stage leachate test					Dry
TP019	BS1377, Part 3, 1990: Soils for Civil Engineering Purposes.	Determination of pH in 2.5:1 water/soil extract using pH meter.			Yes	Yes	Dry
TP029	BS1377, Part 3, 1990: Soils for Civil Engineering Purposes.	Determination of acid soluble sulfate by gravimetry.			Yes	Yes	Dry
TP032	MAFF Book 427: The Analysis of Agricultural Materials: Method 8	Determination of water soluble boron by colorimetry			Yes		Dry
TP033	APHA/AWWA, 19th edition: Method 5520E	Determination of Toluene Extractable Matter by soxhlet extraction.			Yes		Dry
TP040	APHA/AWWA, 19th edition: Method 3500Cr-D	Determination of hexavalent chromium by colorimetry.			Yes		Dry
TP041	BS1377, Part 3, 1990: Soils for Civil Engineering Purposes.	Determination of organic matter by titrimetry.			Yes		Dry
TP042	BS1377, Part 3, 1990: Soils for Civil Engineering Purposes.	Determination of loss on ignition at 50-440°C by gravimetry			Yes	Yes	Dry
TP043	BS1377, Part 3, 1990: Soils for Civil Engineering Purposes.	Determination of water soluble sulfate in 2:1 water/soil extract			Yes	Yes	Dry
TP045	GACHAMJA A.M. Chromatography and Analysis: 1992 9-11 (modified)	Determination of polyaromatic hydrocarbons extractable in dichloromethane, by GC/MS			Yes	Yes	Dry
TP046	MEWAM method: Phenols in water and Effluents: 4-aminoantipyrine method	Determination of monohydric phenols by steam distillation/colorimetry			Yes	Yes	Dry
TP047	MEWAM method: Cyanide in Waters etc	Determination of Free Cyanide by steam distillation/colorimetry			Yes		Dry
TP048	MEWAM method: Cyanide in Waters etc	Determination of total cyanide by steam distillation/colorimetry.			Yes	Yes	Wet
TP049	MEWAM method: Cyanide in Waters etc	Determination of complex cyanide by calculation			Yes		Dry
TP050	MEWAM method: Determination of Thiocyanate ,1985	Determination of thiocyanate by colorimetry			Yes	Yes	Dry
TP051	USEPA Method 9030B	Determination of acid soluble sulfides by steam distillation/colorimetry.			Yes	Yes	Dry
TP052	BS1881: Part 324, 1988: Testing Concrete	Determination of elemental sulfur by soxhlet extraction and titrimetry.			Yes		Dry
TP067	TNRCC Method 1005: 2001 (modified)	Determination of pentane/acetone extractable petroleum hydrocarbons (C8 - C40) by GC/FID			Yes	Yes	Wet
TP072	In-house documented method	Determination of ammoniacal nitrogen by colorimetry.					Dry
Notes 1. Terra Tek (Birmingham) are MCERTS accredited for clay, sand & loam matrix types only, where they constitute the major component of the sample. Other coarse granular materials, ie gravel, are not accredited where they comprise the major component of the sample. 2. Results are expressed on a dry-weight basis (samples dried at 30°C ± 5°C) except where stated. 3. The laboratory removes any material >2mm prior to analysis. The quantity and nature of any material removed from samples is recorded and the information is available on request. 4. The laboratory records the date of analysis of each parameter. This information is available on request. 5. Where a parameter cannot be determined in house it is our policy to use a UKAS/MCERTS accredited laboratory wherever possible. Terra Tek will assume responsibility for the quality of subcontracted tests and the performance of the subcontractor chosen. Where there is no known UKAS/MCERTS laboratory for a particular parameter, a laboratory listed within the Terra Tek Approved Subcontractors list, which is subject to performance assessment, will be selected.							
Originator	Checked & Approved	SUMMARY OF IN-HOUSE ANALYTICAL TEST METHODS (SOIL)				Tk Appendix S3	
N/A	N/A						
Sheet 1 of 2							

TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES		Site ASDA WORTHING FERRING		Contract No E13043/2	
		Client ASDA Stores Ltd			
		Engineer			
Method Code	Reference	Description of Method	ISO17025 Accredited	MCERTS Accredited	Wet/Dry Sample Tested
TP073	In-house documented method	Determination of anionic detergent (MBAS) by colorimetry			Dry
TP074	In-house documented method	Determination of water soluble fluoride by ion selective electrode			Dry
TP098	BS1377, Part 3, 1990: Soils for Civil Engineering Purposes.	Determination of acid soluble chloride by titrimetry			Dry
TP099	BS1377, Part 3, 1990: Soils for Civil Engineering Purposes.	Determination of water soluble chloride by titrimetry	Yes	Yes	Dry
TP100	Wisconsin DNR Modified GRO method, Method for Determining Gasoline Range Organics	Determination of Volatile Petroleum Hydrocarbons/GRO.	Yes	Yes	Wet
TP110	USEPA Methods 8082A & 3665A	Determination of Total & Speciated 7 PCB Congeners by GC/MS SIM	Yes	Yes	Wet
TP114	BS1377, Part 3, 1990: Soils for Civil Engineering Purposes.	Determination of carbonate in soil (rapid titration method)			Dry
TP126	TNRCC Method 1006 (modified)	Extracted petroleum hydrocarbons from TP067 split into aromatic and aliphatic fractions. Analysed by GC/FID.	Yes		Wet
TP134	In-house documented method	Determination of water soluble chloride by titrimetry	Yes	Yes	Dry
TP135	USEPA Methods 8100 & 8270D. In-house method TP045	Determination of polyaromatic hydrocarbons extractable in dichloromethane, by GC/MS (with concentration stage)			Dry
TP137	BS7755: Section 3.9: 1995/ISO 11466:1995	Determination of acid extractable metals in soil by ICP-OES	Selected	Selected	Dry
TP145	USEPA Methods 3550C & 8270D	Determination of Semi-Volatile Organic Compounds by GC/MS	Yes	Yes	Wet
TP147	USEPA Methods 8082A & 3665A	Determination of total & speciated WHO 12 PCB Congeners by GC/MS SIM.			Wet
TP150	USEPA Methods 8081B & 8141B	Determination of pesticides and herbicides in soil by GC/MS SIM			Wet
TP152	USEPA Method 556	Determination of carbonyls by GC/MS.			Wet
TP154	USEPA Method 5021. Wisconsin DNR modified GRO method	Determination of volatiles in by GC/MS headspace	Yes	Selected	Wet
TP158	USEPA Method 1671	Determination of glycols by GC/FID DI			Wet
Notes 1. Terra Tek (Birmingham) are MCERTS accredited for clay, sand & loam matrix types only, where they constitute the major component of the sample. Other coarse granular materials, ie gravel, are not accredited where they comprise the major component of the sample. 2. Results are expressed on a dry-weight basis (samples dried at 30°C ± 5°C) except where stated. 3. The laboratory removes any material >2mm prior to analysis. The quantity and nature of any material removed from samples is recorded and the information is available on request. 4. The laboratory records the date of analysis of each parameter. This information is available on request. 5. Where a parameter cannot be determined in house it is our policy to use a UKAS/MCERTS accredited laboratory wherever possible. Terra Tek will assume responsibility for the quality of subcontracted tests and the performance of the subcontractor chosen. Where there is no known UKAS/MCERTS laboratory for a particular parameter, a laboratory listed within the Terra Tek Approved Subcontractors list, which is subject to performance assessment, will be selected.					
Originator	Checked & Approved	SUMMARY OF IN-HOUSE ANALYTICAL TEST METHODS (SOIL)		Tk	Appendix S3
N/A	N/A				
Sheet 2 of 2					

Appendix 4

**Groundwater
Contamination
Laboratory Test
Results**

(8 pages)

DTS Raeburn Limited

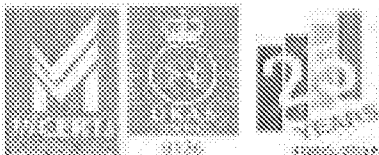
Moor Lane
Witton
Birmingham
B6 7HG

For the attention of David Pacheco

Report No: B21265-2
Issue No 01

LABORATORY TEST REPORT

Project Name		ASDA WORTHING FERRING	
Project Number	B21265-2	Date samples received	07/12/2017
Your Ref	E13043/2	Date written instructions received	08/12/2017
Purchase Order	29201/E13043/2	Date testing commenced	08/12/2017
Please find enclosed the results as summarised below			
Figure / Table	Test Quantity	Description	ISO 17025 Accredited
1	3	Client Specified Suite - Water	See Report
2	3	PAHs (speciated) - Water	No
3	3	TPHCWG - Water	No
4	3	VPHCWG - Water	Yes
App W1	~	Deviating Samples - Water	N/A
App W2	~	Summary of In-House Analytical Test Methods - Water	N/A
Remarks :			
Issued by : Stephen Langman		Date of Issue : 14/12/2017	Key to symbols used in this report S/C : Testing was sub-contracted
Approved Signatories : G Wilson (JMD/Laboratories Director), S Langman (Laboratory Coordinator)			
Unless we are notified to the contrary, samples will be disposed after a period of one month from this date. The results reported relate to samples received in the laboratory only. All results contained in this report are provisional unless signed by an approved signatory This report should not be reproduced except in full without the written approval of the laboratory. Under multisite accreditation the testing contained in this report may have been performed at another Terra Tek laboratory. The enclosed results remain the property of Terra Tek Limited and we reserve the right to withdraw our report if we have not received cleared funds in accordance with our standard terms and conditions Only those results indicated in this report are UKAS accredited and any opinions or interpretations expressed are outside the scope of UKAS accreditation. Feedback on the this report may be left via our website www.terratek.co.uk/contact-us			



TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES				Site ASDA WORTHING FERRING																	Contract No E13043/2				
				Client DTS Raeburn Limited																					
				Engineer																					
Sample Identification				Lab Sample ID	Arsenic µg/l	Cadmium µg/l	Chromium µg/l	Lead µg/l	Mercury µg/l	Selenium µg/l	Copper µg/l	Nickel µg/l	Zinc µg/l	Boron mg/l	Phenol µg/l	Total Cyanide mg/l	Free Cyanide mg/l	Sulphate (as SO4) mg/l	Sulphide mg/l	Sulphur mg/l	pH				
Hole	Depth m	Sample Ref	Sample Type																						
BH1			W1	430125	0.8	0.13	3.46	0.05	0.09	0.6	6.20	8.1	3.6	0.5	~	<0.01	<0.05	122	<0.01	41	8.5				
BH2			W1	430128	3.6	<0.04	4.47	0.05	<0.08	1.2	10.36	16.2	3.5	1.3	~	<0.01	<0.05	322	<0.01	108	8.3				
WS3			W1	430131	1.8	<0.04	3.25	0.04	<0.08	<0.5	4.30	8.5	1.5	<0.3	~	0.01	<0.05	84	<0.01	28	8.4				
BH1			W2	430126	~	~	~	~	~	~	~	~	~	~	~	<0.50	~	~	~	~	~	~			
BH2			W2	430129	~	~	~	~	~	~	~	~	~	~	~	<0.50	~	~	~	~	~	~			
WS3			W2	430132	~	~	~	~	~	~	~	~	~	~	~	<0.50	~	~	~	~	~	~			
Limits of Detection Terra Tek Analysis Method Accreditation U=UKAS N=No accreditation					0.2 TP156 N	0.04 TP156 N	0.04 TP156 N	0.01 TP156 N	0.08 TP156 N	0.5 TP156 N	0.03 TP156 N	0.3 TP156 N	0.3 TP054 U	0.50 TP113 N	0.01 TP062 U	0.05 TP061 U	4 TP170 N	0.01 TP066 U	50 TP170 N	~ TP020 U					
Originator	Checked & Approved		RESULTS OF CHEMICAL CONTAMINATION TESTS - WATER										KEY								Tk Figure 1 Sheet 1 of 1				
SPL	TGH																								* - deviating result (refer to Appendix W1 for details)

TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES				Site ASDA WORTHING FERRING																			Contract No E13043/2		
				Client DTS Raeburn Limited																					
				Engineer																					
Sample Identification				Lab Sample ID	Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benzo (a) anthracene	Chrysene	Benzo (b) fluoranthene	Benzo (k) fluoranthene	Benzo (a) pyrene	Indeno (1,2,3 - cd) pyrene	Dibenzo (ah) anthracene	Benzo (ghi) perylene	Polynuclear Aromatic Hydrocarbons (total)			Sample received in appropriate container	
Hole	Depth m	Sample Ref	Sample Type		ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l				
BH1			W2	430126	<10	<10	32	<10	<10	<10	<10	21	<10	<10	<10	<10	<10	<10	<10	<10	<160			Yes	
BH2			W2	430129	<10	<10	77	75	90	20	<10	28	<10	<10	<10	<10	<10	<10	<10	<10	290			Yes	
WS3			W2	430132	<10	17	579	29	<10	20	839	604	46	19	15	<10	<10	<10	<10	<10	2,168			Yes	
Limits of Detection Terra Tek Analysis Method Accreditation U=UKAS N=No accreditation					10 TP112 N	10 TP112 N	10 TP112 N	10 TP112 N	10 TP112 N	10 TP112 N	10 TP112 N	10 TP112 N	10 TP112 N	10 TP112 N	10 TP112 N	10 TP112 N	10 TP112 N	10 TP112 N	10 TP112 N	10 TP112 N	160 TP112 N				
Originator	Checked & Approved	POLYAROMATIC HYDROCARBONS (USEPA 16) - WATER											KEY * - deviating result (refer to Appendix W1 for details)								Tk Figure 2 Sheet 1 of 1				
DAB	TGH																								

TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES				Site ASDA WORTHING FERRING																Contract No E13043/2				
				Client DTS Raeburn Limited																				
				Engineer																				
Sample Identification				Lab Sample ID	TPH (Aliphatics C8-C10)	TPH (Aliphatics >C10-C12)	TPH (Aliphatics >C12-C16)	TPH (Aliphatics >C16-C21)	TPH (Aliphatics >C21-C35)	TPH (Aliphatics >C35-C40)	TPH (Aromatics >C10-C12)	TPH (Aromatics >C12-C16)	TPH (Aromatics >C16-C21)	TPH (Aromatics >C21-C35)	TPH (Aromatics >C35-C40)									Sample received in appropriate container
Hole	Depth m	Sample Ref	Sample Type		µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l								
BH1			W2	430126	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10									Yes
BH2			W2	430129	<10	<10	<10	<10	<10	<10	<10	<10	<10	19	<10									Yes
WS3			W2	430132	<10	<10	<10	<10	120	<10	<10	<10	<10	19	<10									Yes
Limits of Detection Terra Tek Analysis Method Accreditation U=UKAS N=No accreditation					10 TP130 N	10 TP130 N	10 TP130 N	10 TP130 N	10 TP130 N	10 TP130 N	10 TP130 N	10 TP130 N	10 TP130 N	10 TP130 N	10 TP130 N									
Originator	Checked & Approved		TPHCWG - WATER										KEY * - deviating result (refer to Appendix W1 for details)										Tk Figure 3 Sheet 1 of 1	
DAB	TGH																							



Site ASDA WORTHING FERRING															Contract No E13043/2							
Client DTS Raeburn Limited																						
Engineer																						
Sample	Sample Type	Lab Sample ID	TPH (Aliphatics C5-C6)	TPH (Aliphatics C6-C8)	TPH (Aromatics C6-C7)	TPH (Aromatics C7-C8)	TPH (Aromatics C8-C10)	Benzene	Ethylbenzene	m & p - Xylene	o - Xylene	Toluene	MTBE									Sample received in appropriate container
			µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l								
	V	430127	<10	<10	<10	<10	<10	<1	<1	<2	<1	<1	<1									Yes
	V	430130	<10	<10	<10	<10	<10	<1	<1	<2	<1	<1	<1									Yes
	V	430133	<10	<10	<10	<10	<10	<1	<1	<2	<1	<1	<1									Yes
Limits of Detection Terra Tek Analysis Method UKAS N=No accreditation			10 TP155 U	10 TP155 U	10 TP155 U	10 TP155 U	10 TP155 U	1 TP155 U	1 TP155 U	2 TP155 U	1 TP155 U	1 TP155 U	1 TP155 U									
VPHCWG - WATER												KEY * - deviating result (refer to Appendix W1 for details)								 Figure 4 Sheet 1 of 1		

TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES				Site ASDA WORTHING FERRING				Contract No E13043/2				
				Client DTS Raeburn Limited								
				Engineer								
Sample Identification				Lab Sample ID	Date Sampled	Deviating conditions						Preservatives used
Exploratory Hole	Depth m	Sample Ref	Sample Type			Sampling date has not been provided	Exceeded maximum holding time for selected test(s)	Presence of headspace in sample vial	Poorly fitting cap or lid	Damaged container		
BH1			W1	430125	06/12/17							
BH1			W2	430126	06/12/17							
BH1			V	430127	06/12/17							
BH2			W1	430128	06/12/17							
BH2			W2	430129	06/12/17							
BH2			V	430130	06/12/17							
WS3			W1	430131	06/12/17							
WS3			W2	430132	06/12/17							
WS3			V	430133	06/12/17							
NOTES 1 Results reported for samples classified as deviating may be compromised. Deviation types are shown as "X" or "Yes" in the table above. 2 The absence of "X" or "Yes" in the table above indicates no reported deviations. 3 Deviations due to use of incorrect sample container are shown on result tables. 4 Deviating results are indicated within result tables.												
Originator		Checked & Approved		DEVIATING SAMPLES - WATER					 Appendix W1 Sheet 1 of 1			
SPL		TGH										

TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES		Site ASDA WORTHING FERRING		Contract No E13043/2
		Client DTS Raeburn Limited		
		Engineer		
Method Code	Reference	Description of Method	ISO17025 Accredited	
TP020	APHA/AWWA, 19th edition	Determination of pH using pH meter	Yes	
TP035	BS1377, Part 3, 1990: Soils for Civil Engineering Purposes.	Determination of dissolved solids by gravimetry	Yes	
TP054	MAFF Book 427: The Analysis of Agricultural Materials: Method 8	Determination of boron by colorimetry	Yes	
TP057	APHA/AWWA, 19th edition: Method 3500Cr-D	Determination of hexavalent chromium by colorimetry	Yes	
TP060	MEWAM method: Phenols in water and Effluents: 4-aminoantipyrine method	Determination of monohydric phenols by steam distillation/colorimetry	Yes	
TP061	MEWAM method: Cyanide in Waters etc	Determination of free cyanide by colorimetry	Yes	
TP062	MEWAM method: Cyanide in Waters etc	Determination of total cyanide by steam distillation/colorimetry	Yes	
TP063	MEWAM method: Cyanide in Waters etc	Determination of complex cyanide by calculation	Yes	
TP064	MEWAM method: Determination of Thiocyanate ,1985	Determination of thiocyanate by colorimetry	Yes	
TP065	BS1377, Part 3, 1990: Soils for Civil Engineering Purposes.	Determination of sulfate by gravimetry	Yes	
TP066	MEWAM method: Sulphide in Waters and Effluents, Tentative Methods: 1983	Determination of sulfides by colorimetry	Yes	
TP068	APHA/AWWA, 19th edition: Method 4500-Cl-D	Determination of chlorides by titrimetry	Yes	
TP078	APHA/AWWA, 18th edition: Method 4500C	Determination of ammoniacal nitrogen by colorimetry	No	
TP079	In-house documented method	Determination of anionic detergent (MBAS) by colorimetry	No	
TP080	APHA/AWWA, 19th edition: Method 4500-F-C	Determination of fluoride by ion selective electrode	Yes	
TP081	APHA/AWWA, 19th edition: Method 2540D	Determination of suspended solids by gravimetry	Yes	
TP102	APHA/AWWA, 19th edition: Method 6640B USEPA Method 610	Determination of polyaromatic hydrocarbons extractable in dichloromethane, by GC/MS	Yes	
TP103	Texas Natural Resource Conservation Commission Method 1005 & USEPA Method 3510C	Determination of Extractable Petroleum Hydrocarbons (>C8 - C40) by GC/FID	No	
TP108	APHA/AWWA, 19th edition: Method 2510B	Determination of electrical conductivity by electrode	Yes	
TP112	USEPA Method 8100	Determination of polyaromatic hydrocarbons extractable in dichloromethane/hexane, by GC/MS	No	
Notes 1. The laboratory records the date of analysis of each parameter. This information is available on request. 2. Where a parameter cannot be determined in house it is our policy to use a UKAS accredited laboratory wherever possible. Terra Tek will assume responsibility for the quality of subcontracted tests and the performance of the subcontractor chosen. Where there is no known UKAS laboratory for a particular parameter, a laboratory listed within the Terra Tek Approved Subcontractors list, which is subject to performance assessment, will be selected.				
Originator	Checked & Approved	SUMMARY OF IN-HOUSE ANALYTICAL TEST METHODS (WATER)		Tk Appendix W2 Sheet 1 of 2
N/A	N/A			

TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES		Site ASDA WORTHING FERRING		Contract No E13043/2	
		Client DTS Raeburn Limited			
		Engineer			
Method Code	Reference	Description of Method	ISO17025 Accredited		
TP113	APHA/AWWA, 19th edition: Method 6410 USEPA Method 2870D	Determination of phenol by GC/MS	No		
TP117	APHA/AWWA, 19th edition: Method 2340B	Determination of hardness of water (calculation)	Yes		
TP118	APHA/AWWA, 19th edition: Method 2320B	Determination of total alkalinity by titration	Yes		
TP128	APHA/AWWA, 19th edition: Method 6410 USEPA Method 2870D	Determination of Semi-Volatile Organic Compounds by GC/MS	Yes		
TP130	Texas Natural Resource Conservation Commission Method 1005 & 1006	Determination of Extractable Petroleum Hydrocarbons (EPH-CWG C8-C40) by GC/FID	No		
TP132	APHA/AWWA, 19th edition: Method 4500-NO2-B	Determination of nitrite by colorimetry	Yes		
TP146	USEPA Methods 8082A & 3665A	Determination of Total & Speciated 7 PCB Congeners by GC/MS SIM	No		
TP149	USEPA Methods 8082A & 3665A	Determination of Total & Speciated WHO 12 PCB Congeners by GC/MS SIM	No		
TP155	USEPA method 5021. Wisconsin DNR modified GRO method	Determination of volatiles in water by GC/MS headspace	Yes		
TP156	APHA/AWWA, 19th edition: Method 3030B (filtration)	Determination of dissolved metals by ICP-MS	No		
TP159	USEPA Method 1671	Determination of glycols in water by GC/FID DI	No		
TP160	USEPA Method 556	Determination of formaldeyde in water by GC/MS	No		
TP162	USEPA Method 9060A	Determination of TOC/DOC in water by HT Combustion/NDIR	No		
Notes 1. The laboratory records the date of analysis of each parameter. This information is available on request. 2. Where a parameter cannot be determined in house it is our policy to use a UKAS accredited laboratory wherever possible. Terra Tek will assume responsibility for the quality of subcontracted tests and the performance of the subcontractor chosen. Where there is no known UKAS laboratory for a particular parameter, a laboratory listed within the Terra Tek Approved Subcontractors list, which is subject to performance assessment, will be selected.					
Originator	Checked & Approved	SUMMARY OF IN-HOUSE ANALYTICAL TEST METHODS (WATER)		Tk Appendix W2	
N/A	N/A				
Sheet 2 of 2					

Appendix 5
Geotechnical
Laboratory Test
Results

(13 pages)

DTS Raeburn Limited

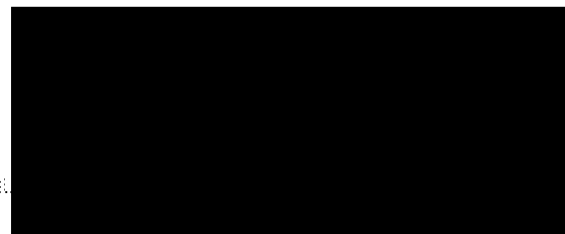
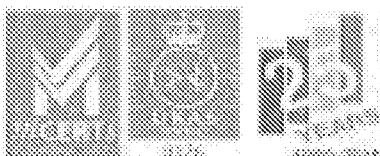
Moor Lane
Witton
Birmingham
B6 7HG

For the attention of David Pacheco

Report No: B21265
Issue No 01

LABORATORY TEST REPORT

Project Name		ASDA WORTHING FERRING	
Project Number	B21265	Date samples received	01/12/2017
Your Ref	E13043/2	Date written instructions received	01/12/2017
Purchase Order	29186/E13043/2	Date testing commenced	01/12/2017
Please find enclosed the results as summarised below			
Figure / Table	Test Quantity	Description	ISO 17025 Accredited
1	~	Summary of Geotechnical Tests	See Report
2 - 7	6	Atterberg Limit	Yes
8 - 9	2	Unconsolidated Undrained Triaxial Compression	Yes
Remarks :			
Issued by : Stephen Langman		Date of Issue : 12/12/2017	Key to symbols used in this report S/C : Testing was sub-contracted
Approved Signatories : 			
G Wilson (JMD/Laboratories Director), S Langman (Laboratory Coordinator)			
Unless we are notified to the contrary, samples will be disposed after a period of one month from this date. The results reported relate to samples received in the laboratory only. All results contained in this report are provisional unless signed by an approved signatory This report should not be reproduced except in full without the written approval of the laboratory. Under multisite accreditation the testing contained in this report may have been performed at another Terra Tek laboratory. The enclosed results remain the property of Terra Tek Limited and we reserve the right to withdraw our report if we have not received cleared funds in accordance with our standard terms and conditions Only those results indicated in this report are UKAS accredited and any opinions or interpretations expressed are outside the scope of UKAS accreditation. Feedback on the this report may be left via our website www.terratek.co.uk/contact-us			



TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES				Site ASDA WORTHING FERRING												Contract No E13043/2			
				Client ASDA Stores Ltd															
				Engineer															
Sample Identification					Non Engineering Sample Description	Moisture Content	Atterberg limits					Particle Density	Density		Total Stress			Other Tests	
Exploratory Hole	Depth m	Sample Ref	Sample Type				Liquid Limit	Plastic Limit	Plasticity Index	Percentage retained 425µm	Atterberg Classification		Bulk	Dry	Shear Strength	Apparent Cohesion C	Angle of Shearing Resistance Phi		
BH01	1.20-1.70		U	429961	Brown silty CLAY.	21	42	17	25	0	CI	Mg/m³	Mg/m³	Mg/m³	kPa	kPa	1.6		
BH02	2.20-2.70		U	429962	Brown sandy CLAY with much gravel. Gravel is fine to coarse.	20	45	20	25	39	CI		1.97	1.64	82 89 93	75	1.7		
WS01	1.40-1.60		ET	429940	Brown CLAY.	21	31	16	15	0	CL								
WS02	1.50-1.70		ET	429946	Brown silty CLAY with occasional gravel. Gravel is fine to medium.	20	41	16	25	4	CI								
WS04	1.20-1.40		ET	429955	Brown CLAY with occasional gravel. Gravel is fine to medium.	22	39	17	22	3	CI								
Notes				Opinions and interpretations are outside the scope of UKAS accreditation		UKAS Accredited Test Y/N		Test details are given on the 'Notes on Laboratory Procedures' sheet										See individual report sheets	
						Y		Y	Y	Y	Y	-	Y	Y	Y	Y	Y	Y	
Originator		Approved		SUMMARY OF GEOTECHNICAL TESTS														Tk Figure 1	
ME																			
																		Sheet 1 of 2	

TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES				Site ASDA WORTHING FERRING												Contract No E13043/2						
Client ASDA Stores Ltd																						
Engineer																						
Sample Identification				Lab Sample ID	Non Engineering Sample Description	Moisture Content	Atterberg limits					Particle Density	Density		Total Stress			Other Tests				
Exploratory Hole	Depth m	Sample Ref	Sample Type				Liquid Limit	Plastic Limit	Plasticity Index	Percentage retained 425µm	Atterberg Classification		Bulk	Dry	Shear Strength	Apparent Cohesion C	Angle of Shearing Resistance Phi					
WS04	2.00-2.20		ET	429958	Brown CLAY with much gravel. Gravel is fine to medium.	%	%	%		%	CI	Mg/m³	Mg/m³	Mg/m³	kPa	kPa						
Notes					Opinions and interpretations are outside the scope of UKAS accreditation					UKAS Accredited Test Y/N					Test details are given on the 'Notes on Laboratory Procedures' sheet					See individual report sheets		
Originator		Approved		SUMMARY OF GEOTECHNICAL TESTS														Tk Figure 1 Sheet 2 of 2				
ME																						



Site ASDA WORTHING FERRING

Contract No. E13043/2

Client ASDA Stores Ltd

Hole ID BH01

Sample Ref

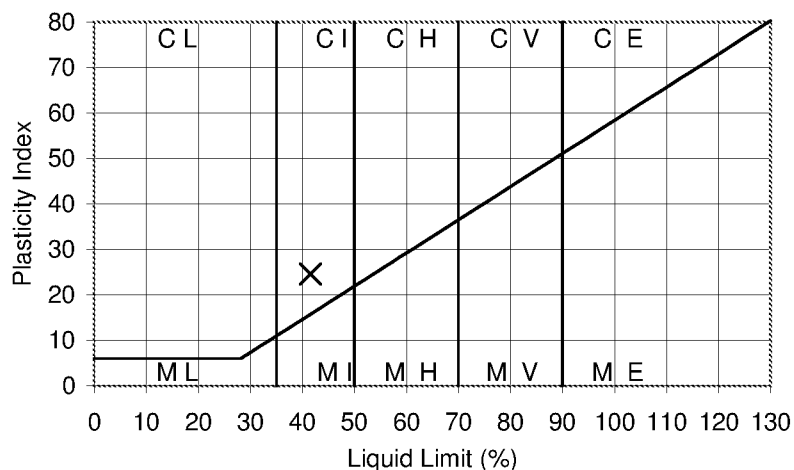
Depth (m) 1.20-1.70

Engineer

Sample Type U

Non Engineering Description : Brown silty CLAY.

Preparation : Sample as received



Results :

As Received Moisture Content : (BS1377:Part 2:Clause 3:1990)	21 %
Percentage retained on 425µm sieve :	0 %
Liquid Limit :	42 %
Plastic Limit :	17 %
Plasticity Index :	25
Equivalent moisture content of material passing 425µm sieve :	21 %
Liquidity Index :	0.16

Originator

Checked & Approved

**Liquid Limit (One Point Cone Penetrometer Method)
Plastic Limit, Plasticity Index & Liquidity Index**

BS 1377:Part 2:Clause 4.4:1990

BS 1377:Part 2:Clause 5:1990



Figure 2

Sheet 1 of 1



Site ASDA WORTHING FERRING

Contract No. E13043/2

Client ASDA Stores Ltd

Hole ID BH02

Engineer

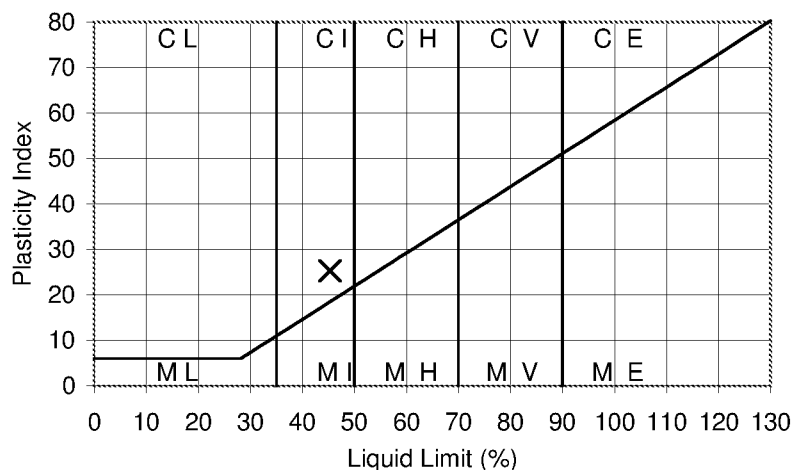
Sample Ref

Depth (m) 2.20-2.70

Sample Type U

Non Engineering Description : Brown sandy CLAY with much gravel. Gravel is fine to coarse.

Preparation : Sample washed and air dried



Results :

As Received Moisture Content : (BS1377:Part 2:Clause 3:1990) 20 %
 Percentage retained on 425µm sieve : 39 %
 Liquid Limit : 45 %
 Plastic Limit : 20 %
 Plasticity Index : 25

Equivalent moisture content of material passing 425µm sieve : 33 %
 Liquidity Index : 0.52

Originator

Checked & Approved

LG

**Liquid Limit (One Point Cone Penetrometer Method)
Plastic Limit, Plasticity Index & Liquidity Index**

BS 1377:Part 2:Clause 4.4:1990

BS 1377:Part 2:Clause 5:1990



Figure 3

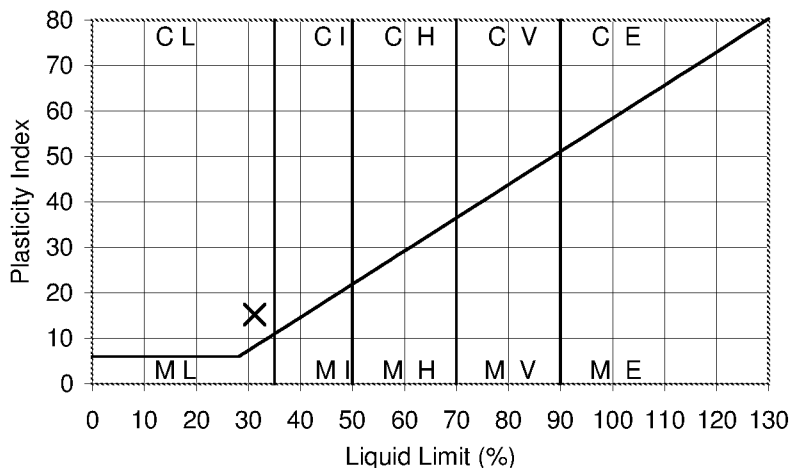
Sheet 1 of 1



Site	ASDA WORTHING FERRING	Contract No.	E13043/2
Client	ASDA Stores Ltd	Hole ID	WS01
Engineer		Sample Ref	
		Depth (m)	1.40-1.60
		Sample Type	ET

Non Engineering Description : Brown CLAY.

Preparation : Sample as received



Results :

As Received Moisture Content : (BS1377:Part 2:Clause 3:1990)	21 %
Percentage retained on 425µm sieve :	0 %
Liquid Limit :	31 %
Plastic Limit :	16 %
Plasticity Index :	15
Equivalent moisture content of material passing 425µm sieve :	21 %
Liquidity Index :	0.33

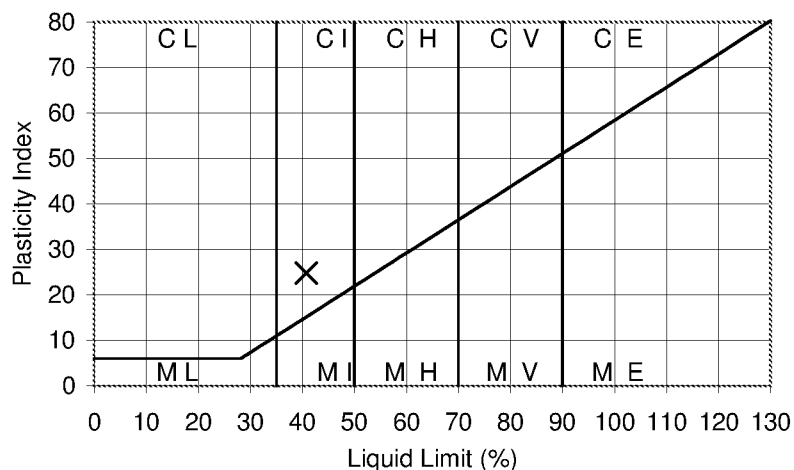
Originator	Checked & Approved	Liquid Limit (One Point Cone Penetrometer Method) Plastic Limit, Plasticity Index & Liquidity Index BS 1377:Part 2:Clause 4.4:1990 BS 1377:Part 2:Clause 5:1990	Figure 4 Sheet 1 of 1
LG			



Site	ASDA WORTHING FERRING	Contract No.	E13043/2
Client	ASDA Stores Ltd	Hole ID	WS02
Engineer		Sample Ref	
		Depth (m)	1.50-1.70
		Sample Type	ET

Non Engineering Description : Brown silty CLAY with occasional gravel. Gravel is fine to medium.

Preparation : Sample as received



Results :

As Received Moisture Content : (BS1377:Part 2:Clause 3:1990) 20 %
 Percentage retained on 425µm sieve : 4 %
 Liquid Limit : 41 %
 Plastic Limit : 16 %
 Plasticity Index : 25

Equivalent moisture content of material passing 425µm sieve : 21 %
 Liquidity Index : 0.20

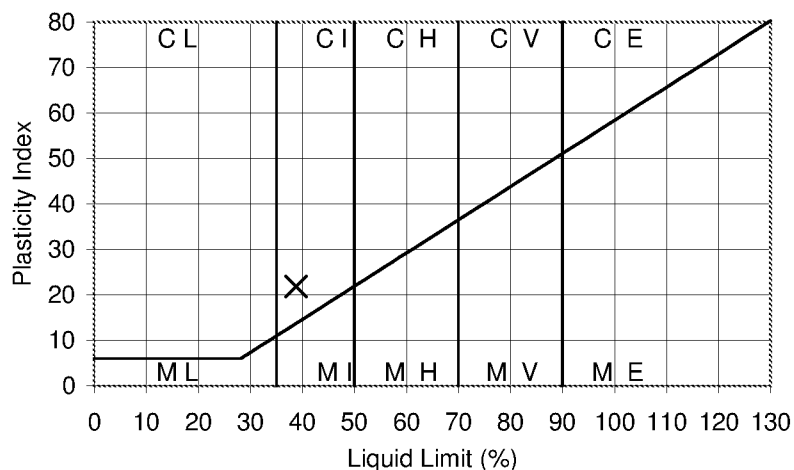
Originator	Checked & Approved	Liquid Limit (One Point Cone Penetrometer Method) Plastic Limit, Plasticity Index & Liquidity Index	Figure 5 Sheet 1 of 1
LG		BS 1377:Part 2:Clause 4.4:1990 BS 1377:Part 2:Clause 5:1990	



Site	ASDA WORTHING FERRING	Contract No.	E13043/2
Client	ASDA Stores Ltd	Hole ID	WS04
Engineer		Sample Ref	
		Depth (m)	1.20-1.40
		Sample Type	ET

Non Engineering Description : Brown CLAY with occasional gravel. Gravel is fine to medium.

Preparation : Sample as received



Results :

As Received Moisture Content : (BS1377:Part 2:Clause 3:1990) 22 %
 Percentage retained on 425µm sieve : 3 %
 Liquid Limit : 39 %
 Plastic Limit : 17 %
 Plasticity Index : 22

Equivalent moisture content of material passing 425µm sieve : 23 %
 Liquidity Index : 0.27

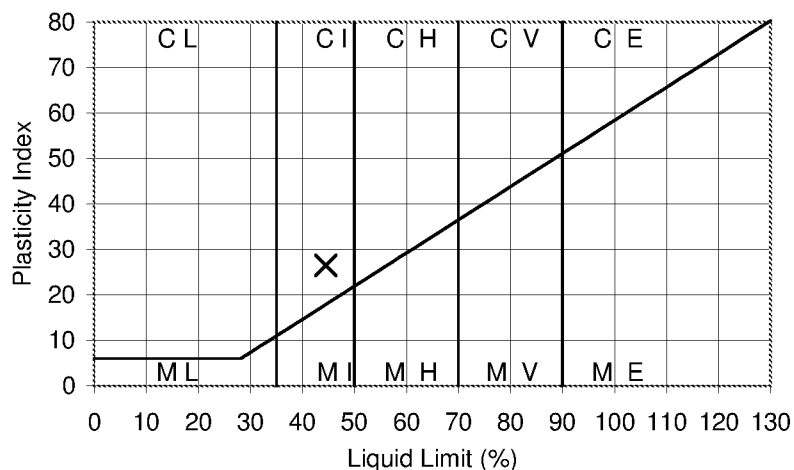
Originator	Checked & Approved	Liquid Limit (One Point Cone Penetrometer Method) Plastic Limit, Plasticity Index & Liquidity Index	Figure 6 Sheet 1 of 1
LG		BS 1377:Part 2:Clause 4.4:1990 BS 1377:Part 2:Clause 5:1990	



Site	ASDA WORTHING FERRING	Contract No.	E13043/2
Client	ASDA Stores Ltd	Hole ID	WS04
Engineer		Sample Ref	
		Depth (m)	2.00-2.20
		Sample Type	ET

Non Engineering Description : Brown CLAY with much gravel. Gravel is fine to medium.

Preparation : Sample washed and air dried



Results :

As Received Moisture Content : (BS1377:Part 2:Clause 3:1990)	22 %
Percentage retained on 425µm sieve :	35 %
Liquid Limit :	45 %
Plastic Limit :	18 %
Plasticity Index :	27
Equivalent moisture content of material passing 425µm sieve :	34 %
Liquidity Index :	0.59

Originator	Checked & Approved	Liquid Limit (One Point Cone Penetrometer Method) Plastic Limit, Plasticity Index & Liquidity Index BS 1377:Part 2:Clause 4.4:1990 BS 1377:Part 2:Clause 5:1990	Figure 7 Sheet 1 of 1
LG			

TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES	Site ASDA WORTHING FERRING		Contract No. E13043/2	
	Client ASDA Stores Ltd		Hole BH01	
	Engineer		Sample Ref Depth (m) 1.20-1.70 Sample Type U	

Sample Details		Undisturbed		
Sample Condition				
Height	mm	200.3		
Diameter	mm	99.9		
Moisture Content	%	21		
Bulk Density	Mg/m³	1.99		
Dry Density	Mg/m³	1.64		

Test Details		Stage	1	2	3
Membrane Thickness	mm		0.20	0.20	0.20
Membrane Correction	kPa		0.65	0.71	0.76
Rate of Axial Displacement	%/min		2.00	2.00	2.00
Cell Pressure	kPa		200	400	600
Strain at Failure	%		16.0	18.0	20.0
Maximum Deviator Stress	kPa		164	179	186
Shear Strength	kPa		82	89	93
Mode of Failure			Compound		

Non Engineering Description		Brown silty CLAY.	
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Comments		
Undisturbed specimen taken 100mm below top of tube		

Shear Strength Parameters		
C	75	kPa
Phi	1.6	°

Originator GM/SG	Checked & Approved 	UNCONSOLIDATED UNDRAINED MULTISTAGE TRIAXIAL COMPRESSION BS 1377 : Part 7 : 1990 Clause 9	TTk Figure 8 Sheet 1 of 2
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TERRA TEK

■■■■ SITE INVESTIGATION AND LABORATORY SERVICES

Site ASDA WORTHING FERRING

Client ASDA Stores Ltd

Engineer

Contract No **E13043/2**

Hole BH01

Sample Ref

Depth (m) 1.20-1.70

Sample Type U



Originator

Checked &
Approved

GM/SG

Please note that these photographs are intended to show the failure mode, and do not necessarily show accurately the colouration of the soil.

Tk

Figure 8

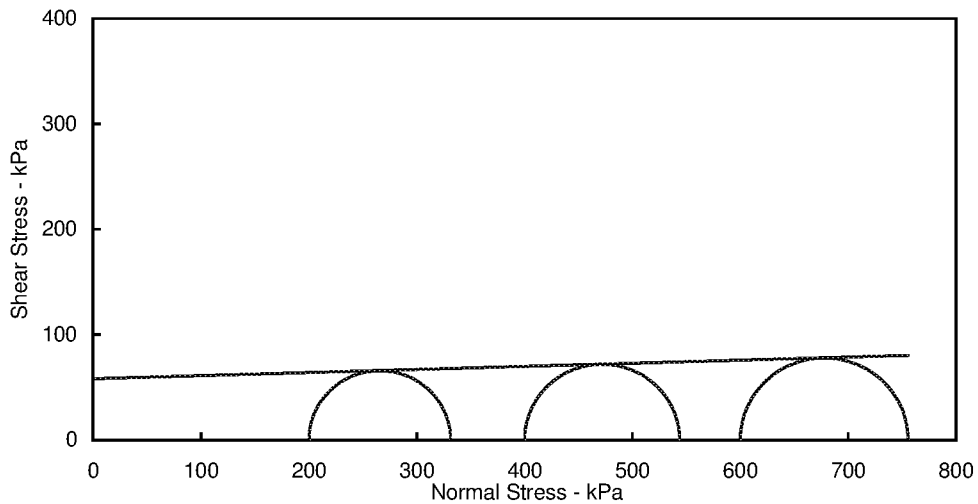
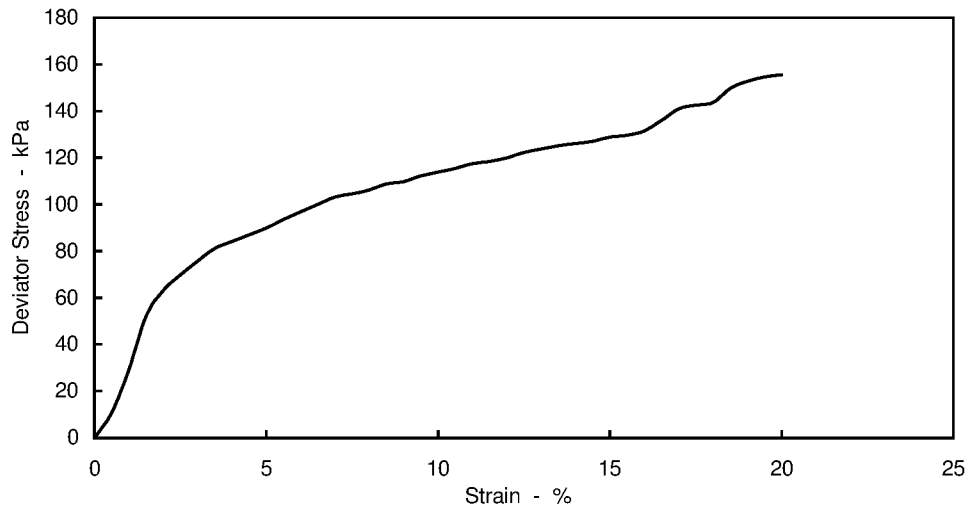
Sheet 2 of 2

TERRA TEK SITE INVESTIGATION AND LABORATORY SERVICES	Site	ASDA WORTHING FERRING	Contract No.	E13043/2
	Client	ASDA Stores Ltd	Hole	BH02
	Engineer		Sample Ref	
			Depth (m)	2.20-2.70
			Sample Type	U

Sample Details					
Sample Condition		Undisturbed			
Height	mm	200.0			
Diameter	mm	103.5			
Moisture Content	%	20			
Bulk Density	Mg/m³	1.97			
Dry Density	Mg/m³	1.64			
Test Details		Stage	1	2	3
Membrane Thickness	mm		0.20	0.20	0.20
Membrane Correction	kPa		0.62	0.68	0.73
Rate of Axial Displacement	%/min		2.00	2.00	2.00
Cell Pressure	kPa		200	400	600
Strain at Failure	%		16.0	18.0	20.0
Maximum Deviator Stress	kPa		131	144	156
Shear Strength	kPa		66	72	78
Mode of Failure			Plastic		
Non Engineering Description		Brown sandy CLAY with much gravel. Gravel is fine to coarse.			

Comments
 Undisturbed specimen taken 100mm below top of tube

Shear Strength Parameters		
C	58	kPa
Phi	1.7	°



Originator	Checked & Approved	UNCONSOLIDATED UNDRAINED MULTISTAGE TRIAXIAL COMPRESSION BS 1377 : Part 7 : 1990 Clause 9	Figure 9 Sheet 1 of 2
GM/SG			

TERRA TEK

SITE INVESTIGATION AND LABORATORY SERVICES

Site ASDA WORTHING FERRING

Client ASDA Stores Ltd

Engineer

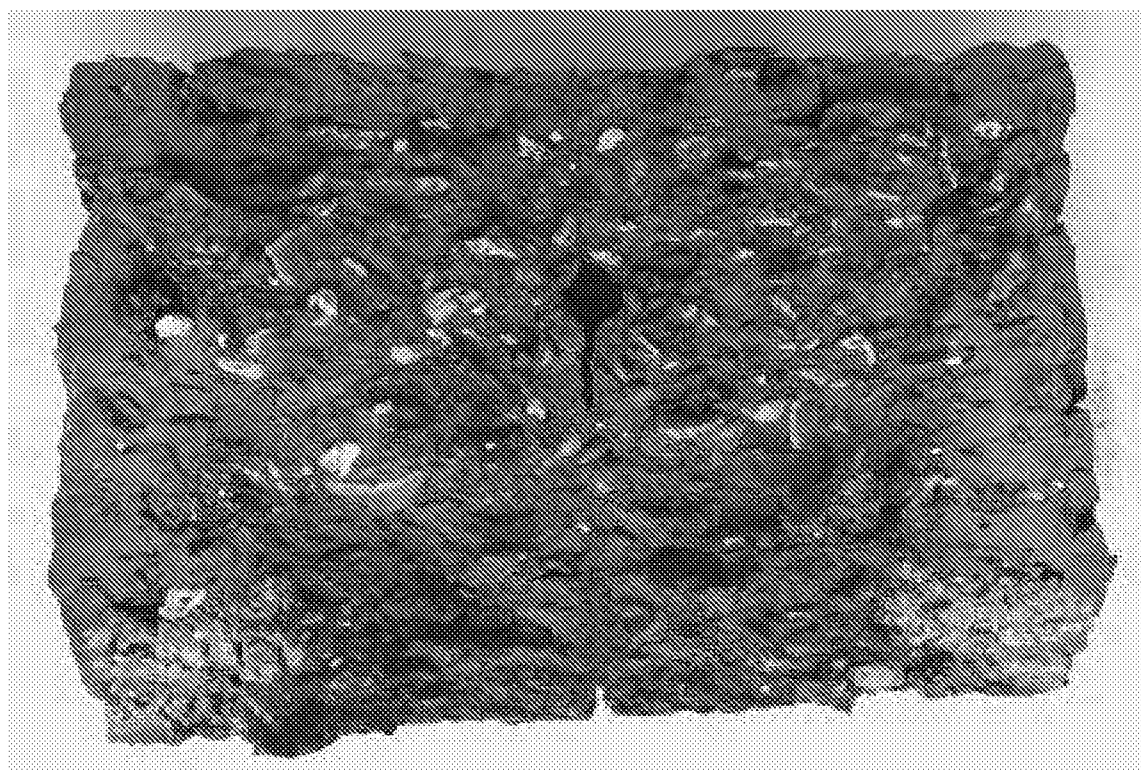
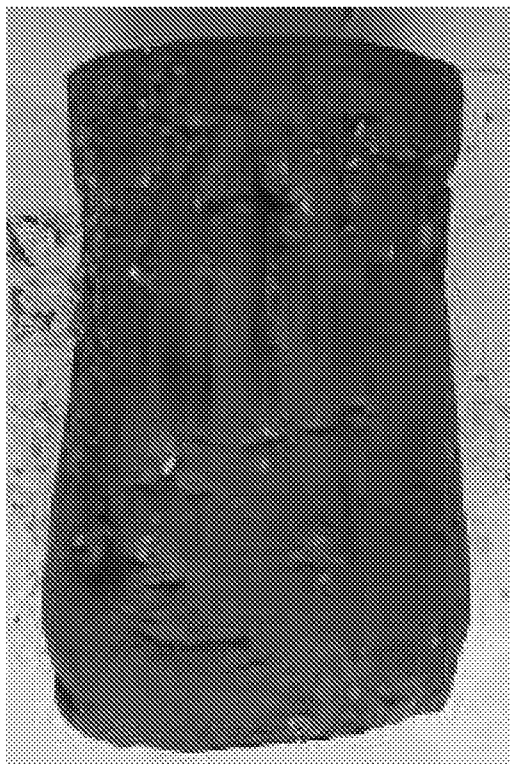
Contract No **E13043/2**

Hole BH02

Sample Ref

Depth (m) 2.20-2.70

Sample Type U



Originator

Checked &
Approved

GM/SG

12/12/2017

Please note that these photographs are intended to show the failure mode, and do not necessarily show accurately the colouration of the soil.

Tk**Figure 9**

Sheet 2 of 2