

Newark Road  
Peterborough  
PE1 5UA  
Tel: 01733 566566

**SUPPLEMENTARY GROUND  
INVESTIGATION REPORT**

**SMALL DROVE  
WESTON  
NEAR SPALDING  
LINCOLNSHIRE**

**Report Reference No. C14022A**

**On behalf of:-**

**South Holland District Council  
Council Offices  
Priory Road  
Spalding  
Lincolnshire  
PE11 2XE**

**February 2018**

## **CONTENTS**

|                                                                                      | Page                                                           |
|--------------------------------------------------------------------------------------|----------------------------------------------------------------|
| INTRODUCTION                                                                         | 1                                                              |
| LOCATION, TOPOGRAPHY & GEOLOGY OF THE SITE                                           | 2                                                              |
| SITE WORK                                                                            | 4                                                              |
| LABORATORY WORK                                                                      | 6                                                              |
| GROUND CONDITIONS                                                                    | 7                                                              |
| Made Ground & Topsoil                                                                | 7                                                              |
| Tidal Flat Deposits                                                                  | 8                                                              |
| Marine Sand & Gravel                                                                 | 9                                                              |
| Till                                                                                 | 9                                                              |
| Groundwater                                                                          | 9                                                              |
| Live Roots                                                                           | 10                                                             |
| Evidence of Contamination                                                            | 10                                                             |
| COMMENTS ON THE GROUND CONDITIONS IN RELATION TO<br>FOUNDATION DESIGN & CONSTRUCTION | 11                                                             |
| Traditional Foundations                                                              | 12                                                             |
| Bearing Pressures                                                                    | 14                                                             |
| Excavations                                                                          | 15                                                             |
| Piled Foundations                                                                    | 16                                                             |
| Floor Slabs                                                                          | 18                                                             |
| Sulphate Conditions                                                                  | 19                                                             |
| Hardstanding & Pavement Design                                                       | 20                                                             |
| Drainage                                                                             | 21                                                             |
| BOREHOLE RECORDS                                                                     |                                                                |
| GEOTECHNICAL LABORATORY TEST RESULTS                                                 |                                                                |
| FIGURE 1 - SPT 'N'- value/Depth Plot                                                 |                                                                |
| FIGURE 2 - Moisture Content/Depth Plot                                               |                                                                |
| FIGURE 3 - Apparent Cohesion/Depth Plot                                              |                                                                |
| FIGURE 4 - Soil Profile                                                              |                                                                |
| BOREHOLE LOCATION PLAN                                                               |                                                                |
| APPENDIX 1                                                                           | Classification of Aggressive Chemical Environment for Concrete |

**SOUTH HOLLAND DISTRICT COUNCIL**

**WILLIAM SAUNDERS PARTNERSHIP LLP**

**SUPPLEMENTARY GROUND INVESTIGATION**

**AT**

**SMALL DROVE**

**WESTON**

**NEAR SPALDING**

**LINCOLNSHIRE**

**Report Reference No. C14022A**

**February 2018**

**INTRODUCTION**

South Holland District Council proposes to redevelop the site of ten detached bungalows, with a scheme of up to thirty-five houses along the east side of Small Drove, Weston. Details of the proposed residential development were not available at the time of this investigation although it was understood that the houses would have wall loads in the order of 30-40kN/m, and could apply uniform distributed loads of 25-27kN/m<sup>2</sup> on raft foundations.

A site investigation report (reference C14022) produced by Ground Engineering Limited on behalf of South Holland District Council in March 2017 discussed the underlying ground conditions in relation to the proposed development, and included a phase I desk study and a contamination risk assessment. The investigation found a thick succession of very soft and organic soils. A supplementary ground investigation was commissioned to provide information on deeper ground conditions and provide comments on these in relation to both shallow and piled foundation schemes. This report includes data from the latest phase of investigation together with updated comments on foundation design and construction.

## **LOCATION, TOPOGRAPHY AND GEOLOGY OF THE SITE**

The site is located on the eastern side of Small Drove, and immediately south of its junction with Delgate Avenue, in the village of Weston, approximately 4km east of Spalding. The site lies 250m south of St. Mary's Church and is opposite Weston St. Mary Primary School. The site is centred at National Grid Reference TF 2927 2482.

The rectangular site has a 150m long frontage along the east side of Small Drove and extends for 55m to the east along Delgate Avenue, which forms the north-eastern limit of the site. The site is bounded by open arable fields to the south and east. The far south-western end of the site is defined by a drainage ditch, with Kierdan Cottage beyond.

At the time of the investigation the site was occupied by ten brick bungalows, their associated gardens and open grassed or cultivated areas. The existing properties were separated from Small Drove by a strip of grassed land, and were accessed by three concrete and asphalt paths. The southern end of the site was occupied by a gravel surfaced car parking area and a corrugated metal roofed timber garage.

At the time of the investigation, the site was largely devoid of trees and vegetation, with the exception of a row of pollarded Cypress trees in the central eastern part of the site. The northern end of the site was bordered by a Privet hedge. A row of pollarded mature Lime trees stood within the verge of the neighbouring Delgate Avenue, about 2m north of the site. Similarly mature Ash trees stood on the opposite verge of Small Drove, about 10m from the site towards the southern and northern ends of the site. Several unidentified immature trees, a Pine and Apple tree grew within the far north-eastern corner of the site.

The site is located on level ground in an area of reclaimed Fenland, standing at about 3.0mOD. The drainage ditches to the south and east of the site, drain 250m south-eastwards into the southward flowing Delgate Drain.

Foul sewers comprising 150mm diameter vitreous clay pipes, cross the central eastern and northern parts of the site, and are routed to the neighbouring pumping station to the east of the site. These sewers cross the site at invert depths between 1.3m alongside Small

Drove, deepening to an invert depth of around 2.7m at the junction of the two sewers close to the eastern site boundary, within the northern half of the site.

The geological map for the area, sheet 144 (1992) at 1:50,000 scale, shows the site and surrounding area to be covered by the extensive superficial deposits of the Terrington Beds (more recently renamed Tidal Flat Deposits). The site is shown 400m south of the limit of reclamation in 1000AD, indicating the land of the village of Weston was reclaimed by then. The Tidal Flat Deposits are indicated to rest on the solid geology of the West Walton Formation.

Previous work in the vicinity has found the soft, becoming very soft and organic, Tidal Flat Deposits to extend to about 10m depth where an interbedded succession of very loose fine sand, soft and firm organic clays was found to about 15m depth, below which was medium dense to dense Marine Sand and Gravel. The underlying solid geology was not found within 17m depth.

## **SITE WORK**

Three cable percussive boreholes (BH1 to BH3) were sunk on the site between 13<sup>th</sup> December 2017 and 8<sup>th</sup> January 2018. The borehole positions are shown on the exploratory hole location plan at the rear of the report.

Public utility service drawings were consulted prior to determining the exploratory hole positions. A scan was made at each position using a CAT (Cable Avoidance Tool) to check for the absence of detectable buried services that may otherwise have been damaged by the investigation. Prior to boring, an inspection pit was hand excavated to 1.20m at each borehole position in order to confirm the absence of any buried services.

The boreholes were sunk to depths of 20.00m and 22.00m by a standard cable percussive boring rig using weighted claycutter and shell boring tools working within 150mm diameter steel casing.

Representative small disturbed (D) and bulk (B) samples of soil were taken from the boring tools at regular intervals throughout the depth of the boreholes. Undisturbed (U) samples 100mm in diameter were taken in clay at regular intervals. The ends of the samples were sealed to maintain them in as representative condition as possible during transit to the laboratory. Samples of groundwater (W) were taken when sufficient water had entered the boreholes.

Standard penetration tests, with either split spoon (S) or solid cone (C) attachment, were undertaken in clay or coarse-grained strata in order to give an indication of the in-situ relative density of the material. The test was made by the 50mm diameter tool into the soil at the base of the borehole by means of an automatic trip hammer weighing 63.50kg falling freely through 760mm. The penetration resistance was determined as the number of blows required to drive the tool the final 300mm of a total penetration of 450mm into the soil ahead of the borehole. The SPT 'N' values presented on the borehole records, have been tabulated in Table 1 to the rear of the borehole records, and have been plotted against depth in Figure 1.

The borehole records give the descriptions and depths of the various strata encountered, details of all samples taken, in-situ testing, and the groundwater conditions observed during boring and on completion. The ground levels of each borehole have been related to Ordnance Datum (O.D.) by interpolation from a topographic survey drawing provided by the client.

## **LABORATORY WORK**

The samples were inspected in the laboratory and assessments of the soil characteristics have been taken into account during preparation of the borehole records. The soil descriptions have been made in accordance with BS5930:2015 and laboratory testing in accordance with BS1377:1990 & 2016.

The particle size distributions of selected samples of sand were obtained by wet sieve analysis. The clay and silt fraction for selected samples were determined by sedimentation using a pipette. Results of these tests are given as particle size distribution curves.

Selected samples of soil and groundwater were analysed to determine the concentration of soluble sulphates. The pH values were also determined.

Test specimens were prepared at full diameter from selected undisturbed samples. Immediate undrained triaxial compression tests were undertaken on the samples under a single cell pressure. The values of apparent cohesion have been plotted against depth, together with the hand shear vane test results and triaxial results from the previous investigation (C14022) in Figure 2.

An indication of the settlement characteristics of selected samples of clay was obtained from the consolidation apparatus or oedometer. The test was performed on specimens approximately 19mm thick, contained in steel rings. Each specimen was saturated and the swelling pressure balanced prior to applying a constant load with drainage allowed at both ends. When primary compression was complete, the load was increased and this repeated for three increments of load. The sample was then unloaded. The rate and total amount of consolidation were continually monitored using a computer controlled E.L.E. Datasystem 7 Unit. The results were plotted and analysed by the computer for each increment of load to obtain the coefficients of compressibility ( $m_v$ ), and of consolidation ( $c_v$ ), which govern the amount and rate of settlement respectively.

## **GROUND CONDITIONS**

The ground conditions encountered by both phases of investigation have been plotted as soil profiles in Figure 3 (shallow ground conditions) and Figure 4 (deep ground conditions). The deep boreholes confirmed the previously encountered ground conditions, with a surface layer of made ground or topsoil resting on the anticipated soft and very soft Tidal Flat Deposits. A very thick succession of very soft organic clays and very loose clayey, slightly organic fine sand extended to between 14.30m and 14.80m depth where a layer of Marine Sand and Gravel was encountered. At 16.80m to 17.30m the boreholes entered stiff and very stiff glacial Till, which was proved to extend to at least the base of each borehole and to at least 22.00m below ground level.

### **Made Ground & Topsoil**

A surface layer of made ground was found at positions BH2, BH3, WS1, WS5, WS6, WS7, WS8 and WS10, to depths generally between 0.40m (WS1, WS7 and WS10) and 0.90m (BH3 and WS5) across most of the site, thickening locally to 1.55m (WS8) where a historical infilled drainage ditch was located beneath the northern part of the site.

The surface made ground layers were typically soft or firm, friable, dark brown and brown, slightly sandy, slightly gravelly, silt or clay fill and contained gravel of flint, limestone, asphalt, brick, pottery, textile, clinker, coal and ash fragments.

The thickest made ground was encountered in WS8, and was positioned on the line of a former drainage ditch beneath the northern part of the site. Below 0.90m depth, this made ground was a very soft, grey, brown, and orange brown mottled, slightly gravelly, silty, organic clay. This fill extended to 1.55m depth and contained fragments of wood, brick, ash and shell fragments.

A surface layer of topsoil was found at the remaining positions of BH1, WS2, WS3, WS4 and WS9. This was a soft, dark brown, slightly sandy, slightly gravelly, clayey silt or silty clay, and reached depths of 0.30m and 0.40m.

### **Tidal Flat Deposits**

The Tidal Flat Deposits were encountered beneath the surface layers of made ground or topsoil at depths between 0.30m and 1.55m. Across the southern part of the site these deposits were initially a very loose or loose, brown, orange brown and grey mottled, slightly clayey, sandy silt, representing 'roddons' or silt-filled creeks, and thickened south-westwards from 0.40m in WS7, to 2.30m in WS1. The sand within this deposit was predominantly fine grained.

Beneath the surface made ground and topsoil across the northern part of the site, and beneath the thin layer of sandy silt in BH1 and WS7, an initially firm or soft, brown, orange brown and grey mottled, slightly sandy, silty clay was present. This clay contained occasional seams and layers of fine sandy silt. The clay was typically initially firm where present at shallow depths, becoming soft below about 0.80m to 1.55m depth, and very soft below 1.80m depth. This soft clay was locally present beneath the near-surface sandy silt in BH1, WS2, WS3, WS4 and WS7.

At depths between 1.80m and 3.00m the boreholes entered a very soft, grey, dark grey, brown and black mottled, silty, organic clay. This very soft, organic clay extended to at least the base of the window sampled boreholes, and was found to between 10.20m and 10.50m in the deep boreholes, where a very loose, grey and brown, clayey, very silty, fine sand was met. This fine sand was slightly organic, contained occasional shells, and was found to be between 2.60m and 3.00m thick. The base of this fine sand in BH3 was marked by a large piece of wood, suspected to be a tree trunk, at 12.80m depth.

The base of the Tidal Flat Deposits was represented by a basal 1.10m to 1.60m thick layer of very soft or very loose, grey, dark grey and brown layer comprising slightly sandy, locally slightly gravelly clay or slightly gravelly, very clayey sand. These deposits contained angular to rounded flint and marine shells. The base of the Tidal Flat Deposits was found at depths between 14.30m and 14.80m beneath the site (-11.35mOD to -11.65mOD).

### **Marine Sand & Gravel**

Marine Sand and Gravel was encountered beneath the Tidal Flat Deposits at 14.30m, 14.60m and 14.80m depth (-11.35mOD to -11.65mOD). The medium dense and dense, grey and brown, slightly silty, very gravelly sand contained angular to rounded flint and shells. Rare flint cobbles were found within this stratum in BH1. The Marine Sand and Gravel was only found to be 1.80m to 2.00m thick.

### **Till**

Glacial Till (Boulder Clay) was met beneath the Marine Sand and Gravel at 16.20m and 16.80m depth (13.25mOD to 13.85mOD). The upper 1.10m of this Till in BH3 at the northern end of the site had a firm consistency, but merged into stiff and elsewhere very stiff, grey, gravelly clay. The gravel is angular to sub-rounded chalk, quartz, flint, ironstone and mudstone. The very stiff Till was proved to extend to at least the base of the 20.00m to 22.00m deep boreholes where they were terminated, reaching a minimum elevation of -19.05mOD.

### **Groundwater**

Groundwater seepages and slow inflows were noted during withdrawal of the 1m long sampling barrels within the shallow window sampled boreholes at depths between 0.80m and 3.00m, with levels rising to stand at between 0.80m and 2.10m within all holes on completion, except WS7, which remained dry. However, water levels may have been still rising when they were backfilled.

Due to the relative speed of boring and the use of casing, water was only encountered in the deep boreholes on entering the Tidal Flat Deposit sand (BH3), or Marine Sand and Gravel (BH1 and BH2) at depths between 13.20m and 14.80m (-10.25mOD to -11.65mOD). Water levels rose quickly to between 10.80m and 8.00m depth, with 'blowing' conditions noted within the upper part of the very gravelly sand. These 'blowing' conditions were minimised by addition of water to provide a greater head to balance the sub-artesian inflow pressure. During drilling and on completion and following removal of the casing, water levels

rose to stand as shallow as 2.00m below ground level (0.95mOD), although it is likely that water levels were still rising slowly when the holes were backfilled.

Groundwater stood within the monitoring installations in WS1, WS6 and WS9 at depths between 0.63m and 1.34m during the monitoring period over December 2016 and January 2017. The standpipe water levels stood between 1.61mOD and 2.52mOD.

### **Live Roots**

Fibrous live roots were observed within the Tidal Flat Deposits in most of the holes across the site. Where present, these roots were observed to extend to depths between 0.90m (WS2), and a maximum depth of 1.70m in BH3. Borehole BH3 was positioned close to some trees in the north-eastern corner of the site.

### **Evidence of Contamination**

There was no olfactory or visual evidence of any hydrocarbon contamination within the soils or groundwater encountered on this site. The made ground commonly contained fragments of brick, coal and ash fragments. No asbestos containing materials (ACMs) were observed within the made ground soils.

## **COMMENTS ON THE GROUND CONDITIONS IN RELATION TO FOUNDATION DESIGN AND CONSTRUCTION**

The ground investigation found a surface layer of made ground or topsoil, resting on a very thick succession of Tidal Flat Deposits, which were initially locally firm and soft, but became very soft and organic typically below about 1.80m depth. The very soft, very loose and organic Tidal Flat Deposits extended to depths between 14.30m and 14.80m beneath the site (-11.35mOD to -11.65mOD), where an approximately 2.00m thick layer of water-bearing Marine Sand and Gravel was encountered, beneath which was stiff and very stiff Till.

The naturally deposited clays and silts of the Tidal Flat Deposits found across the site offer very limited bearing properties for traditional shallow strip or raft foundations, and the prospect of high total settlements, with potentially damaging differential movements. The clays and silts initially locally have either a firm or soft 'crust' at shallow depths, which may be capable of supporting lightly loaded structures, but these soils rapidly became very soft with increasing depth.

Localised deepening of traditional foundations will be required where proposed houses are located close to the existing trees, some of which will be removed. Foundations will need to penetrate the zones of root influence within the clay soils. The underlying soft and very soft clays found as shallow as 0.80m depth, are poorly consolidated, variable and unlikely to provide adequate support for deepened traditional strip foundations. Thus some of the deepened foundations will extend into the underlying very soft, grey, organic clay soils, which offer very limited support for traditional foundations.

Any proposed properties at the northern and north-eastern parts of the site, in areas close to existing trees, could adopt traditional foundations if all root affected clay soils above the groundwater table are removed and replaced with coarse-grained granular material, otherwise buildings in these areas close to trees, would require a piled foundation scheme in order to transfer loads to below at least 15m depth.

## **Traditional Foundations**

Large scale processes of natural sedimentation allow a certain degree of confidence to be placed in the absence of important variation of the engineering properties of natural soils across sites. By contrast, made ground whose history is not completely known, must, despite any amount of investigation, present the possibility of conditions existing which could not be accepted when considering the material as a bearing stratum. The thickness of the made ground, across the site was generally between 0.40m and 0.90m below existing ground level, and the risks associated with the use of this material as a bearing stratum are considered too great. Foundations should extend through the made ground soils. Similarly the 1.55m deep former ditch infill found in WS8 is likely to extend linearly across the site and should be avoided, removed and replaced, or bridged by any foundations in its proximity.

The near-surface naturally deposited clays and silts of the Tidal Flat Deposits have modified plasticity indices ranging from 6% to 27% and are rated as having a low and medium volume change potential. The underlying very soft, organic clay at 3.00m has a modified plasticity index of 65%, rating the clay as having a high volume change potential. Based on the National House Building Council (NHBC) Standards Chapter 4.2 'Building near trees' (2017), foundations in open ground, at least 17m from the nearest Lime tree; and at least 12m from the nearest Cypress tree; would require a minimum depth of 0.90m below either existing or finished ground level, whichever is greater, in order to penetrate the zone of seasonal influence.

The presence of isolated trees (Cypress) in the vicinity of some plots and the Lime trees beyond the northern site boundary mean that some of the proposed properties may be within their range of root influence. Fibrous live roots were found within the Tidal Flat Deposits to a maximum depth of 1.70m depth at the position of BH3, located in the north-eastern part of the site. Foundation depths will have to consider the presence of trees, with foundations extending through any root affected clay soils.

Trees and shrubs will extend the depth affected by seasonal moisture variation and advice on this is given in the National House Building Council (NHBC) Standards Chapter

4.2 “Building near trees” (2017). Based on this document, former high water demand Cypress trees at 5m distance, will require a minimum foundation depth of at least 1.25m in order to penetrate the zones of root influence. Similarly, a Lime tree located 10m from foundations along the northern edge of the site would require a minimum foundation depth of 1.35m below the original ground level.

Deepened foundations are required where they are to be cast within the influencing distance of trees, both in areas where trees remain or in areas where trees have been felled, in order to penetrate the zone of potential shrinkage and heave movements.

The potentially low to moderate swelling pressures could damage traditional foundations by exerting both lateral and upward heave movements over long periods following removal of trees. Such swelling pressures could be generated in areas where trees have been removed, and if the any desiccated near-surface clays are allowed to become saturated. The clay at 1.65m depth at the position of WS6, yielded a swelling pressure of only 1kPa, but greater pressures are likely closer to the trees and at shallower depths. Incorporation of some void forming or compressible material against the sides of the foundations or ground beams will be required within the zones of influence of former trees, in any root infested clay, in order to accommodate any vertical and horizontal movements caused by future heave movements of the clays.

The moisture contents plotted in Figure 3, suggest that the clays showed some evidence of slight desiccation within WS6 and WS9, extending to approximately 1.50m depth at the latter position, within the influence zone of the neighbouring Lime tree, below which moisture contents were at or in excess of their equilibrium moisture contents. This would be expected within such soils below the groundwater table.

In areas where buildings are proposed either where trees have been cleared or remain close by, it would be possible to adopt a raft foundation in accordance with NHBC Standards Chapter 4.2.9 (2017). This will require the underlying root affected clays to be removed and replaced with non-shrinkable compacted stone, with a thickness depending on the distance to trees. As an example, where an adjacent Lime tree is only 3m distant, the compacted

stone should extend to the minimum foundation depth of 0.90m, increasing to 1.10m depth where foundations are 1.0m from a former Cypress tree. This solution would also avoid requirement for anti-heave precautions, such as void forming or compressible materials, which will be needed alongside strip foundations within root affected clay soils.

### **Bearing Pressures**

Deepened traditional foundations would lose any benefit of utilising any upper firm 'crust' of the Tidal Flat Deposits as a bearing stratum, since they would extend into the highly compressible, very soft, organic clay/silt, which has very limited bearing properties.

The soft clays of the Tidal Flat Deposits at the minimum foundation depth of 0.90m, have a net maximum safe bearing capacity for a 0.60m wide strip footing of 45kN/m<sup>2</sup> with a factor of safety of 3.0 applied against general shear failure. If a reduced factor of safety of 2.5 could be accepted, the net maximum safe bearing capacity would increase to 55kN/m<sup>2</sup>. Where deepened foundations are required, on account of nearby trees, the bearing capacity reduces beneath a 0.60m wide strip at 1.80m depth, to 20kN/m<sup>2</sup> (F=3.0).

Based on the oedometer test results, the estimated consolidation settlement beneath such a 0.60m wide strip foundation at 0.90m depth applying 45kN/m<sup>2</sup> (F=3.0) is anticipated to be in the order of 60mm to 75mm, increasing to about 75mm to 95mm beneath a 0.90m wide strip foundation cast at the same depth and also applying 45kN/m<sup>2</sup>. Higher foundation pressures, if adopted with a lower factor of safety, would result in larger settlements.

Similarly the Tidal Flat Deposits beneath an 11m by 9m raft foundation would have a maximum safe bearing capacity of 30kN/m<sup>2</sup> with a factor of safety of 3.0 incorporated. Estimated consolidation settlement beneath such a raft only applying a uniformly distributed load of 15kN/m<sup>2</sup> would be in the order of 95mm to 120mm, with the potential for further long term secondary consolidation.

Structures founded within the Tidal Flat Deposits would have to tolerate potentially large total and differential settlements, which may be exaggerated where the foundations cross different soil types. Some differential settlement may occur across the building

plots, due to variations in thickness and compressibility of the underlying soils and difference in depth to the organic clay. Further differential movements will occur if and where foundation pressures locally increase along foundation runs or across a raft. Movements could be further exacerbated by effects of tree roots, which could also locally generate upward heave movements. New foundations should incorporate some nominal reinforcement in order to minimise any differential movements along, across or between them.

### **Excavations**

The soils should excavate easily by hand or with modern plant. Groundwater will be encountered locally within 1.00m depth, and should coincide with the water level in the adjacent drainage ditches to the east and south. Inflows within excavations are likely to occur as seepages or slow inflows within the clay, but faster inflows could be expected within the sandy silt at the southern end of the site. Inflows from the sandy silt may be accompanied by 'running sand' conditions with ensuing side instability.

Foundations could be cast below 0.90m depth, as soon as the groundwater is encountered, preferably by taking excavations to just above the water table and completing the foundation excavations immediately prior to pouring concrete. Whilst pumping from screened sumps may achieve sufficient draw-down of the groundwater across most of the northern half of the site, it is likely that it would be more effective to control the groundwater, particularly within deep excavations for sewers, within the loose and very loose, sandy silt beneath the southern part of the site, by a dewatering scheme using well-points. Care should be taken not to allow removal of the clay or silt fraction in order to avoid loosening of this stratum. A specialist dewatering contractor should be consulted, but such a well-pointing technique is likely to enable supported excavations to be completed dry. Consideration should be given to the possibility of settlement of any neighbouring existing foundations which may be induced by dewatering.

Any old foundations and buried structures associated with the existing bungalows should be grubbed out and replaced with compacted material in order to avoid the occurrence of

any 'hard spots' beneath new foundations. The building arrangement should consider the route of the existing sewers crossing the site.

The base of excavations should be inspected on completion to ensure that the condition of the soil complies with that assumed in design. It is possible that the ground conditions may vary across individual plots, particularly if buried silt, sand or peat-filled creeks or channels are present, which could result in variable inflows of groundwater. The stability of excavation sides within the soft and very soft clays and silt will deteriorate with increasing depth, with failure likely to occur within steeply cut faces.

Although excavation sides within dry excavations to around 0.80m depth, should remain stable, at least in the short term, the soils should not be relied upon to stand unsupported for any significant length of time. Excavation side instability is likely to occur both within the made ground, and the soft, becoming very soft naturally deposited Tidal Flat Deposits, particularly where excavations approach the groundwater table. Care should be taken by personnel who enter excavations, and adequate close and interlocking side support should be provided to protect such workers.

Should pockets of inferior peaty soil, or root infested clay be present within foundation excavations, they should be removed and replaced with well graded, well compacted hardcore or lean mix concrete. This should include inspection in the areas of the sewers and historically infilled south-east aligned ditch across the northern part of the site. The excavated surface should be protected from deterioration and a blinding layer of concrete used where foundations are not completed without delay. Surface water, perched water and groundwater should not be allowed to collect in the base of excavations, since the sandy silts and silty clays are prone to rapid softening with resulting loss of their already limited bearing properties.

### **Piled Foundations**

The option of a piled foundation scheme, provides the only realistic foundation solution for support of the proposed buildings on this site, as it will avoid potential problems associated with the proximity of trees and clay soils; the very soft and highly compressible

organic clays; as well as excessive settlements beneath raft or traditional foundations. The piles will have to extend through the Tidal Flat Deposits to bear within the Marine Sand and Gravel or very stiff Till, which would provide suitable pile bearing strata. The advice of a specialist piling contractor should be sought with regard to suitable methods of pile installation. Driven or Continuous Flight Augered (CFA) piles are likely to be best suited, although the latter may have problems with 'blowing' sand in the water-bearing Marine Sand and Gravel, with resulting loosening of this layer. Vibrations from driven piles could be potentially damaging to neighbouring properties if they are supported by shallow footings within the organic soils.

Preliminary working loads for single bored pile may be estimated for preliminary cost and design purposes using the pile bearing coefficients given overleaf, which are based on the following assumptions;

1. The ultimate load on a pile would be the sum of the adhesion and friction acting on the shaft of the pile together with the end bearing load.
2. The shaft adhesion within desiccated clay and very soft organic soils should be ignored. The effects of negative adhesion have also been ignored. If floor slabs are to be ground bearing, then negative shaft adhesion in the order of  $-15\text{kN/m}^2$  would need to be considered. The sides of pile caps, together with sides and underside of beams, should also be protected from future heave of desiccated soils using compressible or void forming material.
3. The shaft adhesion and end bearing within the Tidal Flat Deposits and Till are a function of the apparent cohesion of the clays (Figure 3).
4. The shaft friction and end bearing within the Marine Sand and Gravel would be a function of the average SPT 'N' values, taken from SPT 'N' Value versus depth plot in Figure 1 and the effective overburden pressure along the length of the pile shaft and at the level of the pile base.
5. A factor of safety of at least 2.0 would be used to assess the working load and if test loading of selected piles were not practical, the factor of safety would be increased to at least 2.5.

| Item                                                          | Ultimate Pile Bearing      |
|---------------------------------------------------------------|----------------------------|
|                                                               | Value (kN/m <sup>2</sup> ) |
| Shaft adhesion in root affected clay & Tidal Flat Deposits    | Ignored                    |
| Shaft friction/adhesion in Tidal Flat Deposits 10.5m to 14.5m | 15                         |
| Shaft adhesion in Marine Sand & Gravel to 17.0m               | 30                         |
| Shaft adhesion in Till, below 17.0m                           | 100                        |
| End bearing 14.0m to 17.0m                                    | 700                        |
| End bearing below 17.0m                                       | 1800                       |

Based on these coefficients it is estimated that a single 450mm diameter CFA pile installed to about 15m depth (-12mOD), would have a working load of 95kN (F=2.5), increasing to 250kN (F=2.5) for the same diameter pile installed within the very stiff Till at 18m depth (-15mOD).

Larger pile diameters would have higher working loads. For example, the same 15m and 18m length piles at 600mm diameter, would have working loads of 145kN (F=2.5) and 385kN (F=2.5) respectively.

Final pile design should be undertaken by a piling specialist. Different size or length piles would have different working loads.

A substantial piling mat will be required on this site, which is underlain at relatively shallow depth by very soft soils.

### **Floor Slabs**

Ground bearing floor slabs could be adopted for properties in areas away from any existing or former trees and beyond their zones of root influence. However, ground bearing floor slabs could suffer some minor differential movements across them, or between the floor slab and building foundations. The surface layers of made ground found to 0.90m depth, and locally to 1.55m at the position of the former ditch, as well as the sewer pipe excavation backfill, are likely to have lateral variations in composition, which could result in differential movements.

Incorporation of nominal reinforcement could ensure minimal movement across floor slabs applying minimal loads.

In areas of root affected clay soils locally in upper parts, ground bearing floor slabs should not be adopted for proposed buildings in the north-eastern and far northern parts of the site. Damaging differential heave movements could occur across such slabs, particularly where they cover any clay affected by recently removed trees.

Raft foundations should avoid problems associated with shallow root affected clays, since they will require a minimum depth of 0.90m and in areas of former trees will need to be placed on a compacted stone blanket less than 1.25m thick.

Where piled foundations are adopted, it is recommended that the floor slab is suspended on them. Suspended floor slabs would negate consideration of negative shaft adhesion on piles, and any consequent reduction in pile working loads. Furthermore, suspended floor slabs would avoid any differential settlement or heave movements, providing that the sub-floor gaps recommended in NHBC Standards Chapter 4.2, Table 7 are adopted in areas close to extant or former trees.

### **Sulphate Conditions**

Sulphate analysis of selected samples of soil and groundwater yielded soluble sulphate concentrations within Design Sulphate Classes DS-1 and DS-2 of the BRE Special Digest 1, Table C1 (2005), presented in Appendix 1. The pH results ranged between 7.3 and 8.7.

These results indicate an Aggressive Chemical Environment for Concrete (ACEC) Class of AC-2 for buried concrete. This ACEC Class should be considered when specifying a Design Chemical Class (DC Class) for buried concrete on this site, as detailed in the above cited BRE document.

### **Hardstanding and Pavement Design**

Laboratory CBR tests on near-surface recompacted samples from WS1, WS6 and WS9 yielded CBR values between 0.1% and 2.6%.

Based on the plasticity indices for the clay sub-grade, Interim Advice Note 73/06 Revision 1 (2009) recommends an estimated design CBR value of 3.0% for a thin pavement construction on these clay soils, reducing to 1.0% for a silt soil. The clayey, sandy silts locally present at sub-grade level beneath the southern part of the site are potentially frost susceptible soils and will require a minimum construction thickness of 450mm for roads or hardstanding.

For the central and northern parts of the site, it would be prudent to adopt a conservative design CBR value of 1.5% for hardstanding design of a thin road pavement on this site.

The sub-grade should be inspected and compacted using a vibratory roller, with any soft clay, organic pockets or root infested clays removed and replaced with more suitable well-graded coarse grained fill. A permeable geotextile should be incorporated in order to prevent both loss of any sub-base material into the sub-grade and migration of sub-grade soils into the overlying sub-base. If proposed access roads cross the routes of the former drainage ditch or sewers, careful examination of exposed surfaces may identify the excavations, which should be assessed, since they may provide linear 'soft', 'hard' or potentially compressible features, resulting in differential movement of surface hardstanding.

Differential movement may occur across hardstanding where it crosses different strata or rests on any clay previously affected by tree roots. Ideally, any root-affected clay should be removed and replaced to a suitable depth with well compacted non-shrinkable material prior to placement of hardstanding in order to avoid future heave movements within the clay soils.

Care should be taken not to leave the sub-grade exposed to weather conditions, since in particular, the sandy silt soils are prone to rapid deterioration in the presence of surface water.

## **Drainage**

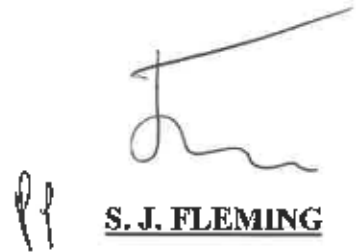
The shallow clay and silt soils beneath this site are not likely to offer a suitable drainage medium for disposal of surface water. The shallow groundwater table is likely to impede the functioning of drainage from soakaways as well as significantly limiting the available storage potential. The efficiency of such soakaway drainage systems would also deteriorate with time, since they will be prone to silting up.

Any soakaway drainage should be kept well away from buildings, otherwise there is a potential for the removal of fines and subsequent settlement of any structures, slabs or hardstanding based upon these soils, as well as heave of any root affected clay soils. Consequently soakaway drainage would not be considered appropriate for this site, and consideration should be made to utilising the existing pumped sewer network crossing the site.

### **GROUND ENGINEERING LIMITED**



**C. M. J. EBELING**  
M.Sc.(Eng.), M.A.E.G.,  
C.Geol., F.G.S.,  
**Director**



**S. J. FLEMING**  
M.Sc., M.C.S.M.,  
C.Geol., F.G.S.,  
**Director**

| GROUND ENGINEERING<br>LIMITED<br>Tel: 01793 566566<br>www.groundengineering.co.uk                                                                                                                                                                               |      |       | Site: SMALL DRIVE, WESTON                                                                                                                |                                                                                                                                                  |        | BOREHOLE<br>BH1                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------|------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|--------|--------------------------------------------------------------------------------------------------------|--------------|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|
| Date: 13/12/17<br>to 15/12/17                                                                                                                                                                                                                                   |      |       | Hole Size: 150mm dia to 22.00m                                                                                                           |                                                                                                                                                  |        | Ground Level: 3.25m G.D.                                                                               |              |  |                                                                                                                                                                                              |  |  |
| Samples and in-situ Tests                                                                                                                                                                                                                                       |      |       | (Date)                                                                                                                                   | Description of Strata                                                                                                                            | Legend | Depth m                                                                                                | O.D. Level m |  |                                                                                                                                                                                              |  |  |
| Depth m                                                                                                                                                                                                                                                         | Type | Blows | Casing                                                                                                                                   |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
| 0.10                                                                                                                                                                                                                                                            | D1   |       | 1.20                                                                                                                                     | TOPSOIL - Soft, dark brown, slightly sandy, slightly gravelly SILT. Gravel is fine and medium, sub-angular flint.                                |        | 0.35                                                                                                   | 2.90         |  |                                                                                                                                                                                              |  |  |
| 0.35                                                                                                                                                                                                                                                            | D2   |       |                                                                                                                                          | Firm, becoming soft at 0.70m, light brown/orange brown mottled, slightly clayey, slightly sandy SILT. Sand is fine grained. (TIDAL FLAT DEPOSIT) |        | 0.90                                                                                                   | 2.35         |  |                                                                                                                                                                                              |  |  |
| 0.40-0.90                                                                                                                                                                                                                                                       | B1   |       |                                                                                                                                          | Soft, becoming very soft below 1.50m, brown/grey/orange brown mottled silty CLAY.                                                                |        | 2.00                                                                                                   | 1.25         |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          | (TIDAL FLAT DEPOSIT)                                                                                                                             |        | 3.00                                                                                                   | 0.25         |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
| 1.10                                                                                                                                                                                                                                                            | D3   |       | 1.60                                                                                                                                     | Very soft, grey/dark grey/brown mottled, silty, slightly organic CLAY.                                                                           |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
| 1.20-1.70                                                                                                                                                                                                                                                       | B2   |       |                                                                                                                                          | (TIDAL FLAT DEPOSIT)                                                                                                                             |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
| 1.35-1.65                                                                                                                                                                                                                                                       | S    | N1    |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
| 1.65                                                                                                                                                                                                                                                            | D4   |       | 4.10                                                                                                                                     | Very soft, grey/dark grey/brown mottled, silty, organic CLAY.                                                                                    |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
| 2.00                                                                                                                                                                                                                                                            | D5   |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
| 2.10-2.60                                                                                                                                                                                                                                                       | B3   |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
| 2.25-2.55                                                                                                                                                                                                                                                       | S    | N2    |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
| 2.55                                                                                                                                                                                                                                                            | D6   |       | 3.00                                                                                                                                     |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
| 3.10-3.60                                                                                                                                                                                                                                                       | B4   |       | 4.60                                                                                                                                     | Very soft, grey/dark grey/brown mottled, silty, organic CLAY.                                                                                    |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
| 3.25-3.55                                                                                                                                                                                                                                                       | S    | N1    |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
| 3.65                                                                                                                                                                                                                                                            | D7   |       | 4.10                                                                                                                                     |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
| 4.10-4.60                                                                                                                                                                                                                                                       | B5   |       | 5.40                                                                                                                                     |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
| 4.25-4.55                                                                                                                                                                                                                                                       | S    | N2    |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
| 4.55                                                                                                                                                                                                                                                            | D8   |       | 5.40                                                                                                                                     |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
| 5.10-5.40                                                                                                                                                                                                                                                       | U1   | 3     | 6.10                                                                                                                                     |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
| 5.50                                                                                                                                                                                                                                                            | D9   |       | 6.10                                                                                                                                     |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
| 6.10                                                                                                                                                                                                                                                            | D10  |       | 6.10                                                                                                                                     |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
| 6.60-6.90                                                                                                                                                                                                                                                       | U2   | 5     | 6.10                                                                                                                                     |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
| 7.00                                                                                                                                                                                                                                                            | D11  |       | 6.10                                                                                                                                     |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
| 7.60                                                                                                                                                                                                                                                            | D12  |       | 6.10                                                                                                                                     |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
| 8.10-8.50                                                                                                                                                                                                                                                       | U3   | 6     | 8.10                                                                                                                                     |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
| 8.60                                                                                                                                                                                                                                                            | D13  |       | 8.10                                                                                                                                     | Occasional mussel and cockle shells below 8.50m depth.                                                                                           |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
| 9.60-10.00                                                                                                                                                                                                                                                      | U4   | 6     | 9.10                                                                                                                                     | (TIDAL FLAT DEPOSIT)                                                                                                                             |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        |                                                                                                        |              |  |                                                                                                                                                                                              |  |  |
| REMARKS 1. Excavating a pit from 0.00m to 1.20m for 1 hour<br>2. Fibrous live roots observed to 1.65m depth<br>3. 'Blowing' sand conditions associated with water strike at 14.80m<br>4. Water added from 15.00m to 16.80m<br>5. Borehole cased to 17.50m depth |      |       |                                                                                                                                          |                                                                                                                                                  |        | Project No<br>14022A                                                                                   |              |  |                                                                                                                                                                                              |  |  |
|                                                                                                                                                                                                                                                                 |      |       |                                                                                                                                          |                                                                                                                                                  |        | Scale<br>1:50                                                                                          | Page<br>1/3  |  |                                                                                                                                                                                              |  |  |
| KEY N/A - SPT Blows for 0.3m or given penetration<br>D - Disturbed Sample<br>B - Bulk Sample<br>U - Undisturbed Sample<br>W - Water Sample<br>S/C - SPT Spoon/Cone<br>Water Strike<br>Water Rise                                                                |      |       | ES - Environmental Sample<br>V - Vane Shear Test<br>Cohesion ( ) kPa<br>Level on completion<br>Level casing withdrawn<br>Standpipe Level |                                                                                                                                                  |        | Groundwater Strikes<br>Depth m<br>No Struck Rose to Rate Cased Sealed<br>1 14.80 8.00 fast 13.50 16.90 |              |  | Groundwater Observations<br>Date Hole Casing Water<br>13/12/17 7.00 7.00 dry<br>14/12/17 7.00 7.00 dry<br>14/12/17 16.90 16.90 6.60<br>15/12/17 16.90 16.90 6.60<br>15/12/17 22.00 17.50 dry |  |  |

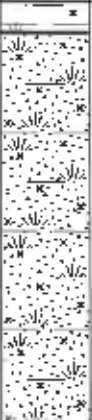
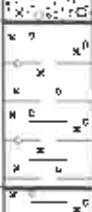
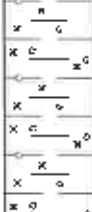
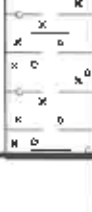
| GROUND ENGINEERING<br>LIMITED<br>Tel: 01733-666666<br>www.groundengineering.co.uk                                                                       |      |                      | Site: SMALL DROVE, WESTON                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                    | BOREHOLE<br>BH1                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|------|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|--------|-------|
|                                                                                                                                                         |      |                      | Date: 13/12/17<br>to 15/12/17                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Hole Size: 150mm dia to 22.00m                                                                     |                                                                                                                                                                                | Ground Level: 3.25m. O.D.                                                                                                                                                                                                                                                                                                                                                                                                                       |                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
| Samples and In-situ Tests                                                                                                                               |      |                      | (Date)                                                                                                                                                                                    | Description of Strata                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                    | Legend                                                                                                                                                                         | Depth<br>m                                                                                                                                                                                                                                                                                                                                                                                                                                      | O.D.<br>Level<br>m |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
| Depth m                                                                                                                                                 | Type | Blows                | Casing                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                    |                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
| 10.10                                                                                                                                                   | D14  |                      | 10.60                                                                                                                                                                                     | Very soft, grey/dark grey/brown mottled, silty, organic CLAY. (TIDAL FLAT DEPOSIT)                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                    |                                                                                             | 10.00                                                                                                                                                                                                                                                                                                                                                                                                                                           | -6.75              |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
| 10.50                                                                                                                                                   | D15  |                      |                                                                                                                                                                                           | Very loose, grey, clayey, very silty, slightly organic, fine SAND with occasional shells.                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                    |                                                                                             | 10.50                                                                                                                                                                                                                                                                                                                                                                                                                                           | -7.25              |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
| 11.00-11.50                                                                                                                                             | B6   |                      |                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 12.50                                                                                              |                                                                                                                                                                                | <br><br><br><br> | 13.20              | -9.95                                                                                                                                                                                                                                                                                                                                                                                                                                                     |       |        |       |
| 11.15-11.45                                                                                                                                             | S    |                      |                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                    |                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           | N1    |        |       |
| 11.45                                                                                                                                                   | D16  |                      |                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                    |                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
| 12.50-13.00                                                                                                                                             | B7   |                      | 13.50                                                                                                                                                                                     | Very soft, grey, slightly sandy, silty CLAY with rare shells.                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                    |                                                                                             | 14.80                                                                                                                                                                                                                                                                                                                                                                                                                                           | -11.55             |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
| 12.65-12.95                                                                                                                                             | S    |                      |                                                                                                                                                                                           | N1                                                                                                                                                                                                                                                                                                                                                                                                                                                        | (TIDAL FLAT DEPOSIT)                                                                               |                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                    | <br><br><br><br>      |       |        |       |
| 12.95                                                                                                                                                   | D17  |                      |                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                    |                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
| 13.20                                                                                                                                                   | D18  |                      |                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                    |                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
| 13.50-14.00                                                                                                                                             | B8   |                      |                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                    |                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
| 13.65-13.95                                                                                                                                             | S    | N2                   | 15.80                                                                                                                                                                                     | Dense (loosened to 15.50m), brown/grey, slightly silty, very gravelly SAND. Gravel is angular to sub-angular flint. Occasional shells and rare flint cobbles.                                                                                                                                                                                                                                                                                             |                                                                                                    |                                                                                           | 16.80                                                                                                                                                                                                                                                                                                                                                                                                                                           | -13.55             |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
| 13.95                                                                                                                                                   | D19  | (TIDAL FLAT DEPOSIT) |                                                                                                                                                                                           | <br><br><br><br> |                                                                                                    |                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
| 15.00-15.50                                                                                                                                             | B9   |                      |                                                                                                                                                                                           | 17.00                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Very stiff, grey, gravelly CLAY. Gravel is sub-angular to sub-rounded chalk, quartz and ironstone. |                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                    |                                                                                                                                                                                                                                                                                                                                                                      | 20.00 | -16.75 |       |
| 15.15-15.45                                                                                                                                             | C    |                      |                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                           | N6                                                                                                 | (MARINE SAND AND GRAVEL)                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                    | <br><br><br><br> |       |        |       |
| 15.80-16.30                                                                                                                                             | B10  |                      |                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                    |                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
| 15.95-16.25                                                                                                                                             | C    |                      | N35                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                    |                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
| 16.80                                                                                                                                                   | D20  |                      |                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                    |                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
| 17.00-17.25                                                                                                                                             | U5   | 80                   | 17.50                                                                                                                                                                                     | (TILL)                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                    | <br> |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
| 17.35                                                                                                                                                   | D21  |                      |                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                    |                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
| 18.00                                                                                                                                                   | D22  |                      |                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                    |                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
| 18.50-18.90                                                                                                                                             | U6   | 100                  |                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                    |                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
| 19.00                                                                                                                                                   | D23  |                      |                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                    |                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
| 19.50-19.90                                                                                                                                             | U7   | 100                  | 17.50                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                    |                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
| 20.00                                                                                                                                                   | D24  |                      |                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                    |                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
| REMARKS                                                                                                                                                 |      |                      |                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                    |                                                                                                                                                                                | Project No<br>14022A                                                                                                                                                                                                                                                                                                                                                                                                                            |                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
|                                                                                                                                                         |      |                      |                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                    |                                                                                                                                                                                | Scale<br>1:50                                                                                                                                                                                                                                                                                                                                                                                                                                   | Page<br>2/3        |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
| KEY                                                                                                                                                     |      |                      | Groundwater Strikes                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                    |                                                                                                                                                                                | Groundwater Observations                                                                                                                                                                                                                                                                                                                                                                                                                        |                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
| D - Disturbed Sample<br>B - Bulk Sample<br>U - Undisturbed Sample<br>W - Water Sample<br>S/C - SPT Spoon/Conc<br>W/S - Water Strike<br>W/R - Water Rise |      |                      | N/A - SPT Blows for 0.3m or given penetration<br>ES - Environmental Sample<br>V - Vane Shear Test<br>Cohesion ( ) kPa<br>Level on completion<br>Level casing withdrawn<br>Standpipe Level |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                    | Depth m                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Depth m            |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |        |       |
|                                                                                                                                                         |      |                      | No                                                                                                                                                                                        | Struck                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Rose to                                                                                            | Rate                                                                                                                                                                           | Cased                                                                                                                                                                                                                                                                                                                                                                                                                                           | Sealed             | Date                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Hole  | Casing | Water |
|                                                                                                                                                         |      |                      |                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                    |                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                    | 15/12/17                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 22.00 | 0.00   | 5.30  |

|                                                                                                                                                           |      |       |                                                                                                                                                                                           |                                                                                                    |  |                                                                                           |                                  |                      |                    |                                                                               |  |  |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|--|-------------------------------------------------------------------------------------------|----------------------------------|----------------------|--------------------|-------------------------------------------------------------------------------|--|--|--|
| <b>GROUND ENGINEERING</b><br>LIMITED<br>Tel: 01733-666666<br>www.groundengineering.co.uk                                                                  |      |       | Site: <b>SMALL DROVE, WESTON</b>                                                                                                                                                          |                                                                                                    |  |                                                                                           | <b>BOREHOLE BH1</b>              |                      |                    |                                                                               |  |  |  |
| Date: <b>13/12/17 to 15/12/17</b>                                                                                                                         |      |       | Hole Size: 150mm dia to 22.00m                                                                                                                                                            |                                                                                                    |  |                                                                                           | Ground Level: <b>3.25m. O.D.</b> |                      |                    |                                                                               |  |  |  |
| <b>Samples and In-situ Tests</b>                                                                                                                          |      |       | (Date)<br>Casing                                                                                                                                                                          | Description of Strata                                                                              |  |                                                                                           | Legend                           | Depth<br>m           | O.D.<br>Level<br>m |                                                                               |  |  |  |
| Depth m                                                                                                                                                   | Type | Blows |                                                                                                                                                                                           |                                                                                                    |  |                                                                                           |                                  |                      |                    |                                                                               |  |  |  |
| 20.50-20.75                                                                                                                                               | U8   | 100   | 17.50                                                                                                                                                                                     | Very stiff, grey, gravelly CLAY. Gravel is sub-angular to sub-rounded chalk, quartz and ironstone. |  |                                                                                           |                                  | 20.00                | -16.75             |                                                                               |  |  |  |
| 20.85                                                                                                                                                     | D25  |       |                                                                                                                                                                                           | (TILL)                                                                                             |  |                                                                                           |                                  |                      |                    |                                                                               |  |  |  |
| 21.50-21.90                                                                                                                                               | U9   | 100   | 17.50                                                                                                                                                                                     |                                                                                                    |  |                                                                                           |                                  |                      |                    |                                                                               |  |  |  |
| 22.00                                                                                                                                                     | D26  |       |                                                                                                                                                                                           |                                                                                                    |  |                                                                                           |                                  |                      |                    |                                                                               |  |  |  |
|                                                                                                                                                           |      |       |                                                                                                                                                                                           | Borehole completed at 22.00m depth                                                                 |  |                                                                                           |                                  | 22.00                | -18.75             |                                                                               |  |  |  |
| <b>REMARKS</b>                                                                                                                                            |      |       |                                                                                                                                                                                           |                                                                                                    |  |                                                                                           |                                  | Project No<br>14022A |                    |                                                                               |  |  |  |
|                                                                                                                                                           |      |       |                                                                                                                                                                                           |                                                                                                    |  |                                                                                           |                                  | Scale<br>1:50        | Page<br>3/3        |                                                                               |  |  |  |
| <b>KEY</b><br>D - Disturbed Sample<br>B - Bulk Sample<br>U - Undisturbed Sample<br>W - Water Sample<br>S/C - SPT Spoon/Cone<br>Water Strike<br>Water Rise |      |       | N/A - SPT Blows for 0.3m or given penetration<br>ES - Environmental Sample<br>V - Vane Shear Test<br>Cohesion ( ) kPa<br>Level on completion<br>Level casing withdrawn<br>Standpipe Level |                                                                                                    |  | <b>Groundwater Strikes</b><br>Depth m<br>No. Struck    Rose to    Rate    Cased    Sealed |                                  |                      |                    | <b>Groundwater Observations</b><br>Date    Hole    Casing    Water<br>Depth m |  |  |  |

| GROUND ENGINEERING<br>L I M I T E D<br>Tel: 01733 566566<br>www.groundengineering.co.uk                                                                                                                                                                 |          |       |        | Site: SMALL DROVE, WESTON                                                                                                                                                                 |        |         | BOREHOLE<br>BH2           |             |              |          |       |        |       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|---------|---------------------------|-------------|--------------|----------|-------|--------|-------|
| Date: 04/01/18<br>to 08/01/18                                                                                                                                                                                                                           |          |       |        | Hole Size: 150mm dia to 20.00m                                                                                                                                                            |        |         | Ground Level: 2.95m, O.D. |             |              |          |       |        |       |
| Samples and in-situ Tests                                                                                                                                                                                                                               |          |       | (Date) | Description of Strata                                                                                                                                                                     |        |         | Legend                    | Depth m     | O.D. Level m |          |       |        |       |
| Depth m                                                                                                                                                                                                                                                 | Type     | Blows | Casing |                                                                                                                                                                                           |        |         |                           |             |              |          |       |        |       |
| 0.10<br>0.20-0.60                                                                                                                                                                                                                                       | D1<br>B1 |       |        | MADE GROUND - Soft, brown, slightly gravelly, clayey SILT. Gravel is fine and medium angular flint and clinker fragments.                                                                 |        |         |                           | 0.60        | 2.35         |          |       |        |       |
| 0.60<br>0.70-1.20                                                                                                                                                                                                                                       | D2<br>B2 |       |        | Firm, becoming soft at 1.20m, brown/light brown/grey mottled, slightly sandy, silty CLAY.                                                                                                 |        |         |                           |             |              |          |       |        |       |
| 1.20-1.60                                                                                                                                                                                                                                               | U1       | 10    | 1.20   | (TIDAL FLAT DEPOSIT)                                                                                                                                                                      |        |         |                           | 2.00        | 0.95         |          |       |        |       |
| 1.70                                                                                                                                                                                                                                                    | D3       |       |        |                                                                                                                                                                                           |        |         |                           |             |              |          |       |        |       |
| 2.20-2.60                                                                                                                                                                                                                                               | U2       | 8     | 1.60   | Very soft, grey/brown/dark grey/black mottled, silty, organic CLAY with occasional peaty root traces.                                                                                     |        |         |                           | 2.00        | 0.95         |          |       |        |       |
| 2.70                                                                                                                                                                                                                                                    | D4       |       |        |                                                                                                                                                                                           |        |         |                           |             |              |          |       |        |       |
| 3.20-3.60                                                                                                                                                                                                                                               | U3       | 6     | 3.00   |                                                                                                                                                                                           |        |         |                           | 2.00        | 0.95         |          |       |        |       |
| 3.70                                                                                                                                                                                                                                                    | D5       |       |        |                                                                                                                                                                                           |        |         |                           |             |              |          |       |        |       |
| 4.20-4.60                                                                                                                                                                                                                                               | U4       | 5     | 4.20   |                                                                                                                                                                                           |        |         |                           | 2.00        | 0.95         |          |       |        |       |
| 4.70                                                                                                                                                                                                                                                    | D6       |       |        |                                                                                                                                                                                           |        |         |                           |             |              |          |       |        |       |
| 5.20-5.60                                                                                                                                                                                                                                               | U5       | 5     | 4.50   |                                                                                                                                                                                           |        |         |                           | 2.00        | 0.95         |          |       |        |       |
| 5.70                                                                                                                                                                                                                                                    | D7       |       |        |                                                                                                                                                                                           |        |         |                           |             |              |          |       |        |       |
| 6.20                                                                                                                                                                                                                                                    | D8       |       |        |                                                                                                                                                                                           |        |         |                           | 2.00        | 0.95         |          |       |        |       |
| 6.70-7.20<br>6.85-7.15                                                                                                                                                                                                                                  | B3<br>S  | N1    | 6.10   | (TIDAL FLAT DEPOSIT)                                                                                                                                                                      |        |         |                           |             |              |          |       |        |       |
| 7.15                                                                                                                                                                                                                                                    | D9       |       |        |                                                                                                                                                                                           |        |         |                           | 2.00        | 0.95         |          |       |        |       |
| 7.70                                                                                                                                                                                                                                                    | D10      |       |        |                                                                                                                                                                                           |        |         |                           |             |              |          |       |        |       |
| 8.20-8.70<br>8.35-8.65                                                                                                                                                                                                                                  | B4<br>S  | N1    | 7.60   |                                                                                                                                                                                           |        |         |                           | 2.00        | 0.95         |          |       |        |       |
| 8.65                                                                                                                                                                                                                                                    | D11      |       |        |                                                                                                                                                                                           |        |         |                           |             |              |          |       |        |       |
| 9.20                                                                                                                                                                                                                                                    | D12      |       |        |                                                                                                                                                                                           |        |         |                           | 2.00        | 0.95         |          |       |        |       |
| 9.70-10.20<br>9.70-8.15                                                                                                                                                                                                                                 | B5<br>S  | N1    | 9.10   |                                                                                                                                                                                           |        |         |                           |             |              |          |       |        |       |
| REMARKS 1. Excavating a pit from 0.00m to 1.20m for 1 hour<br>2. Live roots observed to 1.20m depth<br>3. 'Blowing' sand conditions associated with water strike at 14.60m<br>4. Water added from 14.50m to 16.80m<br>5. Borehole cased to 17.50m depth |          |       |        |                                                                                                                                                                                           |        |         | Project No<br>14022A      |             |              |          |       |        |       |
|                                                                                                                                                                                                                                                         |          |       |        |                                                                                                                                                                                           |        |         | Scale<br>1:50             | Page<br>1/2 |              |          |       |        |       |
| KEY                                                                                                                                                                                                                                                     |          |       |        | Groundwater Strikes                                                                                                                                                                       |        |         | Groundwater Observations  |             |              |          |       |        |       |
| D - Disturbed Sample<br>B - Bulk Sample<br>U - Undisturbed Sample<br>W - Water Sample<br>S/C - SPT Spoon/Cone<br>WS - Water Strike<br>WR - Water Rise                                                                                                   |          |       |        | N/A - SPT Blows for 0.3m or given penetration<br>ES - Environmental Sample<br>V - Vane Shear Test<br>Cohesion ( ) kPa<br>Level on completion<br>Level casing withdrawn<br>Standpipe Level |        |         | Depth m                   |             |              |          |       |        |       |
|                                                                                                                                                                                                                                                         |          |       |        | No                                                                                                                                                                                        | Struck | Rose to | Rate                      | Cased       | Sealed       | Date     | Hole  | Casing | Water |
|                                                                                                                                                                                                                                                         |          |       |        | 1                                                                                                                                                                                         | 14.60  | 10.80   | fast                      | 14.60       | 17.50        | 04/01/18 | 5.70  | 4.50   | dry   |
|                                                                                                                                                                                                                                                         |          |       |        |                                                                                                                                                                                           |        |         |                           |             |              | 05/01/18 | 5.70  | 4.50   | dry   |
|                                                                                                                                                                                                                                                         |          |       |        |                                                                                                                                                                                           |        |         |                           |             |              | 05/01/18 | 15.10 | 15.10  | 2.00  |
|                                                                                                                                                                                                                                                         |          |       |        |                                                                                                                                                                                           |        |         |                           |             |              | 08/01/18 | 15.10 | 15.10  | 3.10  |
|                                                                                                                                                                                                                                                         |          |       |        |                                                                                                                                                                                           |        |         |                           |             |              | 08/01/18 | 20.00 | 17.50  | dry   |

| GROUND ENGINEERING LIMITED<br>Tel: 01733 666566<br>www.groundengineering.co.uk |      |       | Site: SMALL DROVE, WESTON          |                                                                                                                                                |         | BOREHOLE BH2              |                          |         |                   |          |        |       |
|--------------------------------------------------------------------------------|------|-------|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|---------|---------------------------|--------------------------|---------|-------------------|----------|--------|-------|
| Date: 04/01/18 to 08/01/18                                                     |      |       | Hole Size: 150mm dia to 20.00m     |                                                                                                                                                |         | Ground Level: 2.95m. O.D. |                          |         |                   |          |        |       |
| Samples and in-situ Tests                                                      |      |       | (Date)                             | Description of Strata                                                                                                                          |         |                           | Legend                   | Depth m | O.D. Level m      |          |        |       |
| Depth m                                                                        | Type | Blows | Casing                             |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
| 10.15                                                                          | D13  |       |                                    | Very soft, grey/brown/dark grey/black mottled, silty, organic CLAY with occasional peaty root traces.<br>(TIDAL FLAT DEPOSIT)                  |         |                           |                          | 10.00   | -7.05             |          |        |       |
| 10.40                                                                          | D14  |       |                                    |                                                                                                                                                |         |                           |                          | 10.40   | -7.45             |          |        |       |
| 10.50-11.00                                                                    | B6   |       |                                    |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
| 10.65-10.95                                                                    | S    | N1    | 10.50                              | Very loose, grey/brown, clayey, very silty, slightly organic, fine SAND with occasional shells.                                                |         |                           |                          |         |                   |          |        |       |
| 10.95                                                                          | D15  |       |                                    |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
| 12.00-12.50                                                                    | B7   |       |                                    | (TIDAL FLAT DEPOSIT)                                                                                                                           |         |                           |                          |         |                   |          |        |       |
| 12.15-12.45                                                                    | S    | N2    | 12.00                              |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
| 12.45                                                                          | D16  |       |                                    |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
| 13.50-14.00                                                                    | B8   |       |                                    |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
| 13.55-13.85                                                                    | C    | N2    | 13.40                              | Very soft, dark grey, slightly sandy, slightly gravelly CLAY. Gravel is fine and medium, sub-angular to rounded flint.<br>(TIDAL FLAT DEPOSIT) |         |                           |                          | 13.40   | -10.45            |          |        |       |
| 14.60-15.10                                                                    | B9   |       |                                    |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
| 14.60                                                                          | M1   |       |                                    |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
| 14.75-15.05                                                                    | C    | N8    | 14.60                              | Dense, (loosened to 15.00m), brown/grey, silty, very gravelly SAND. Gravel is fine and medium, angular to rounded flint and shells.            |         |                           |                          | 14.60   | -11.65            |          |        |       |
| 16.10-16.60                                                                    | B10  |       |                                    | (MARINE SAND AND GRAVEL)                                                                                                                       |         |                           |                          |         |                   |          |        |       |
| 16.25-16.55                                                                    | C    | N32   | 16.10                              |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
| 16.80                                                                          | D17  |       |                                    |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
| 16.90-17.25                                                                    | U6   | 70    | 16.90                              | Stiff, becoming very stiff below 17.90m, grey, gravelly CLAY. Gravel is sub-angular to sub-rounded chalk, mudstone and flint.                  |         |                           |                          | 16.80   | -13.85            |          |        |       |
| 17.35                                                                          | D18  |       |                                    |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
| 17.90                                                                          | D19  |       |                                    | (TILL)                                                                                                                                         |         |                           |                          |         |                   |          |        |       |
| 18.40-18.80                                                                    | U7   | 90    | 17.50                              |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
| 18.90                                                                          | D20  |       |                                    |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
| 19.40                                                                          | D21  |       |                                    |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
| 19.50-19.85                                                                    | U8   | 100   | 17.50                              |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
| 19.95                                                                          | D22  |       |                                    |                                                                                                                                                |         |                           |                          | 20.00   | -17.05            |          |        |       |
| REMARKS                                                                        |      |       | Borehole completed at 20.00m depth |                                                                                                                                                |         |                           |                          |         | Project No 14022A |          |        |       |
|                                                                                |      |       |                                    |                                                                                                                                                |         |                           |                          |         | Scale 1:50        | Page 2/2 |        |       |
| KEY                                                                            |      |       | Groundwater Strikes                |                                                                                                                                                |         |                           | Groundwater Observations |         |                   |          |        |       |
| N/A - SPT Blows for 0.3m or given penetration                                  |      |       | Depth m                            |                                                                                                                                                |         |                           | Depth m                  |         |                   |          |        |       |
| D - Disturbed Sample                                                           |      |       | No                                 | Struck                                                                                                                                         | Rose to | Rate                      | Cased                    | Sealed  | Date              | Hole     | Casing | Water |
| B - Bulk Sample                                                                |      |       |                                    |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
| U - Undisturbed Sample                                                         |      |       |                                    |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
| W - Water Sample                                                               |      |       |                                    |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
| S/C - SPT Spoon/Conc                                                           |      |       |                                    |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
| Water Strike                                                                   |      |       |                                    |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
| Water Rise                                                                     |      |       |                                    |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
| ES - Environmental Sample                                                      |      |       |                                    |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
| V - Vane Shear Test                                                            |      |       |                                    |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
| Cohesion ( ) kPa                                                               |      |       |                                    |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
| Level on completion                                                            |      |       |                                    |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
| Level casing withdrawn                                                         |      |       |                                    |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
| Standpipe Level                                                                |      |       |                                    |                                                                                                                                                |         |                           |                          |         |                   |          |        |       |
|                                                                                |      |       |                                    |                                                                                                                                                |         |                           |                          |         | 08/01/18          | 20.00    | 0.00   | 4.00  |

| GROUND ENGINEERING<br>L I M I T E D<br>Tel: 01733-565566<br>www.groundengineering.co.uk                                                                                                                                                                 |          |       | Site: <b>SMALL DROVE, WESTON</b>                                                                                                                                                          |                                                                                                                                        |  |  | BOREHOLE<br><b>BH3</b>                                                               |                      |              |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|--|--|--------------------------------------------------------------------------------------|----------------------|--------------|--|
| Date: 15/12/17 to 19/12/17                                                                                                                                                                                                                              |          |       | Hole Size: 150mm dia to 22.00m                                                                                                                                                            |                                                                                                                                        |  |  | Ground Level: 2.95m. O.D.                                                            |                      |              |  |
| Samples and in-situ Tests                                                                                                                                                                                                                               |          |       | (Date)                                                                                                                                                                                    | Description of Strata                                                                                                                  |  |  | Legend                                                                               | Depth m              | O.D. Level m |  |
| Depth m                                                                                                                                                                                                                                                 | Type     | Blows | Casing                                                                                                                                                                                    |                                                                                                                                        |  |  |                                                                                      |                      |              |  |
| 0.10<br>0.20                                                                                                                                                                                                                                            | D1<br>D2 |       |                                                                                                                                                                                           | MADE GROUND - Soft, friable, dark brown/brown mottled, slightly sandy, silty CLAY with occasional ash, fine brick and shell fragments. |  |  |                                                                                      |                      |              |  |
| 1.00<br>1.20-1.60                                                                                                                                                                                                                                       | D3<br>U1 | 10    | 1.20                                                                                                                                                                                      | Soft, brown/grey mottled, silty CLAY with occasional silt partings.<br>(TIDAL FLAT DEPOSIT)                                            |  |  |                                                                                      | 0.90                 | 2.05         |  |
| 1.70                                                                                                                                                                                                                                                    | D4       |       |                                                                                                                                                                                           |                                                                                                                                        |  |  |                                                                                      |                      |              |  |
| 2.20-2.70<br>2.35-2.65                                                                                                                                                                                                                                  | B1<br>S  | N2    | 2.20                                                                                                                                                                                      | Very soft, grey/brown/black/dark grey mottled, silty, slightly organic CLAY.                                                           |  |  |                                                                                      | 2.20                 | 0.75         |  |
| 2.65                                                                                                                                                                                                                                                    | D5       |       |                                                                                                                                                                                           |                                                                                                                                        |  |  |                                                                                      |                      |              |  |
| 3.20-3.70<br>3.35-3.65                                                                                                                                                                                                                                  | B2<br>S  | N1    | 3.10                                                                                                                                                                                      |                                                                                                                                        |  |  |                                                                                      |                      |              |  |
| 3.65                                                                                                                                                                                                                                                    | D6       |       |                                                                                                                                                                                           |                                                                                                                                        |  |  |                                                                                      |                      |              |  |
| 4.20-4.50                                                                                                                                                                                                                                               | U2       | 5     | 4.20                                                                                                                                                                                      |                                                                                                                                        |  |  |                                                                                      |                      |              |  |
| 4.60                                                                                                                                                                                                                                                    | D7       |       |                                                                                                                                                                                           |                                                                                                                                        |  |  |                                                                                      |                      |              |  |
| 5.20-5.60                                                                                                                                                                                                                                               | U3       | 6     | 4.50                                                                                                                                                                                      | (TIDAL FLAT DEPOSIT)                                                                                                                   |  |  |                                                                                      |                      |              |  |
| 5.70                                                                                                                                                                                                                                                    | D8       |       |                                                                                                                                                                                           |                                                                                                                                        |  |  |                                                                                      |                      |              |  |
| 6.20                                                                                                                                                                                                                                                    | D9       |       |                                                                                                                                                                                           |                                                                                                                                        |  |  |                                                                                      |                      |              |  |
| 6.70-7.10                                                                                                                                                                                                                                               | U4       | 8     | 6.00                                                                                                                                                                                      |                                                                                                                                        |  |  |                                                                                      |                      |              |  |
| 7.20                                                                                                                                                                                                                                                    | D10      |       |                                                                                                                                                                                           |                                                                                                                                        |  |  |                                                                                      |                      |              |  |
| 7.70                                                                                                                                                                                                                                                    | D11      |       |                                                                                                                                                                                           |                                                                                                                                        |  |  |                                                                                      |                      |              |  |
| 8.20-8.60                                                                                                                                                                                                                                               | U5       | 8     | 7.50                                                                                                                                                                                      |                                                                                                                                        |  |  |                                                                                      |                      |              |  |
| 8.70                                                                                                                                                                                                                                                    | D12      |       |                                                                                                                                                                                           |                                                                                                                                        |  |  |                                                                                      |                      |              |  |
| 9.20                                                                                                                                                                                                                                                    | D13      |       |                                                                                                                                                                                           |                                                                                                                                        |  |  |                                                                                      |                      |              |  |
| 9.70-10.00                                                                                                                                                                                                                                              | U6       | 7     | 9.00                                                                                                                                                                                      |                                                                                                                                        |  |  |                                                                                      | 10.00                | -7.05        |  |
| REMARKS 1. Excavating a pit from 0.00m to 1.00m for 1 hour<br>2. Live roots observed to 1.70m depth<br>3. 'Blowing' sand conditions associated with water inflow at 14.30m<br>4. Water added from 13.40m to 16.20m<br>5. Borehole cased to 16.50m depth |          |       |                                                                                                                                                                                           |                                                                                                                                        |  |  |                                                                                      | Project No<br>14022A |              |  |
|                                                                                                                                                                                                                                                         |          |       |                                                                                                                                                                                           |                                                                                                                                        |  |  |                                                                                      | Scale<br>1:50        | Page<br>1/3  |  |
| KEY                                                                                                                                                                                                                                                     |          |       | Groundwater Strikes                                                                                                                                                                       |                                                                                                                                        |  |  | Groundwater Observations                                                             |                      |              |  |
| D - Disturbed Sample<br>B - Bulk Sample<br>U - Undisturbed Sample<br>W - Water Sample<br>SVC - SPT Spoon/Conc<br>WS - Water Strike<br>WR - Water Rise                                                                                                   |          |       | N/A - SPT Blows for 0.3m or given penetration<br>ES - Environmental Sample<br>V - Vane Shear Test<br>Cohesion ( ) kPa<br>Level on completion<br>Level casing withdrawn<br>Standpipe Level |                                                                                                                                        |  |  | Depth m<br>No Struck Rose to Rate Cased Sealed Date Hole Casing Water                |                      |              |  |
|                                                                                                                                                                                                                                                         |          |       | 1 13.20 10.60 fast 12.90 16.20                                                                                                                                                            |                                                                                                                                        |  |  | 15/12/17 1.00<br>18/12/17 1.00<br>18/12/17 16.30<br>19/12/17 16.30<br>19/12/17 22.00 |                      |              |  |
|                                                                                                                                                                                                                                                         |          |       |                                                                                                                                                                                           |                                                                                                                                        |  |  | 16.30 16.30 16.30                                                                    |                      |              |  |
|                                                                                                                                                                                                                                                         |          |       |                                                                                                                                                                                           |                                                                                                                                        |  |  | dry dry 6.00 6.00 dry                                                                |                      |              |  |

| GROUND ENGINEERING<br>L I M I T E D<br>Tel: 01733-686686<br>www.groundengineering.co.uk |                                      |           | Site: SMALL DROVE, WESTON                     |                                                                                                                                                                                                              | BORE-HOLE<br>BH3                                                                      |                     |                    |                          |        |
|-----------------------------------------------------------------------------------------|--------------------------------------|-----------|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------|--------------------|--------------------------|--------|
| Date: 15/12/17<br>to 19/12/17                                                           |                                      |           | Hole Size: 150mm dia to 22.00m                |                                                                                                                                                                                                              | Ground Level: 2.95m. O.D.                                                             |                     |                    |                          |        |
| Samples and in-situ Tests                                                               |                                      |           | (Date)                                        | Description of Strata                                                                                                                                                                                        | Legend                                                                                | Depth<br>m          | O.D.<br>Level<br>m |                          |        |
| Depth m                                                                                 | Type                                 | Blows     | Casing                                        |                                                                                                                                                                                                              |                                                                                       |                     |                    |                          |        |
| 10.10<br>10.20<br>10.30-10.80<br>10.45-10.75<br>10.75                                   | D14<br>D15<br>B3<br>S<br>D16         | N2        | 10.30                                         | Very soft, grey/brown/black/dark grey mottled, silty, slightly organic CLAY. (TIDAL FLAT DEPOSIT)<br><br>Very loose, grey/brown clayey, very silty, slightly organic, fine SAND.<br><br>(TIDAL FLAT DEPOSIT) |    | 10.00<br>10.20      | -7.05<br>-7.25     |                          |        |
| 11.30                                                                                   | D17                                  |           |                                               |                                                                                                                                                                                                              |                                                                                       |                     |                    |                          |        |
| 11.80-12.30<br>11.95-12.25<br>12.25                                                     | B4<br>S<br>D18                       | N1        | 11.80                                         |                                                                                                                                                                                                              |    | 12.80               | -9.85              |                          |        |
| 12.80<br>12.90-13.20<br>13.05-13.35                                                     | D19<br>B5<br>S                       | N36       | 12.90                                         | WOOD (suspected tree trunk).                                                                                                                                                                                 |   | 13.20               | -10.25             |                          |        |
| 13.30<br>13.40-13.90<br>13.40<br>13.55-13.85                                            | D20<br>B6<br>W1<br>C                 | N5        | 13.40                                         | Loose, brown/grey, slightly gravelly, very clayey SAND with occasional seams of soft grey clay. Gravel is angular flint and shells.<br><br>(TIDAL FLAT DEPOSIT)                                              |  | 14.30               | -11.35             |                          |        |
| 14.50-15.00<br>14.65-14.95                                                              | B7<br>C                              | N21       | 14.50                                         | Medium dense to dense, grey/brown, silty, very gravelly SAND. Gravel is angular flint and shells.<br><br>(MARINE SAND AND GRAVEL)                                                                            |  | 16.20               | -13.25             |                          |        |
| 15.50-16.00<br>15.65-15.95                                                              | B8<br>C                              | N34       | 15.30                                         |                                                                                                                                                                                                              |                                                                                       |                     |                    |                          |        |
| 16.20<br>16.50-16.85<br>16.90                                                           | D21<br>U7<br>D22                     | 70        | 16.50                                         | Firm, grey, slightly gravelly CLAY. Gravel is sub-angular to sub-rounded chalk and flint.<br><br>(TILL)                                                                                                      |  | 17.30               | -14.35             |                          |        |
| 17.50<br>18.00-18.40<br>18.50<br>19.00<br>19.50-19.95<br>20.00                          | D23<br>U8<br>D24<br>D25<br>U9<br>D26 | 90<br>100 | 16.50                                         | Stiff, becoming very stiff below 19.00m, grey, gravelly CLAY. Gravel is angular to sub-rounded chalk, flint, quartz and mudstone.<br><br>(TILL)                                                              |  | 20.00               | -17.05             |                          |        |
| REMARKS                                                                                 |                                      |           |                                               |                                                                                                                                                                                                              | Project No<br>14022A                                                                  |                     |                    |                          |        |
|                                                                                         |                                      |           |                                               |                                                                                                                                                                                                              | Scale<br>1:50                                                                         | Page<br>2/3         |                    |                          |        |
| KEY                                                                                     |                                      |           | N/* - SPT Blows for 0.3m or given penetration |                                                                                                                                                                                                              |                                                                                       | Groundwater Strikes |                    | Groundwater Observations |        |
| D - Disturbed Sample                                                                    |                                      |           | ES - Environmental Sample                     |                                                                                                                                                                                                              |                                                                                       | Depth m             |                    | Depth m                  |        |
| B - Bulk Sample                                                                         |                                      |           | V - Vane Shear Test                           |                                                                                                                                                                                                              |                                                                                       | No Struck           | Rose to            | Date                     | Hole   |
| U - Undisturbed Sample                                                                  |                                      |           | Cohesion ( ) kPa                              |                                                                                                                                                                                                              |                                                                                       | Rate                | Cased              |                          | Casing |
| W - Water Sample                                                                        |                                      |           | Level on completion                           |                                                                                                                                                                                                              |                                                                                       | Sealed              |                    |                          | Water  |
| S/C - SPT Spoon/Cone                                                                    |                                      |           | Level casing withdrawn                        |                                                                                                                                                                                                              |                                                                                       |                     |                    | 19/12/17                 | 22.00  |
| W - Water Strike                                                                        |                                      |           | Standpipe Level                               |                                                                                                                                                                                                              |                                                                                       |                     |                    |                          | 0.00   |
| W - Water Rise                                                                          |                                      |           |                                               |                                                                                                                                                                                                              |                                                                                       |                     |                    |                          | 3.10   |

|                                                                                                                                                                   |      |       |                                                                                                                                                                                           |                                                                                                      |  |                                                                                          |                                  |        |                                                                               |                      |             |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|--|------------------------------------------------------------------------------------------|----------------------------------|--------|-------------------------------------------------------------------------------|----------------------|-------------|
| <b>GROUND ENGINEERING</b><br>LIMITED<br>Tel: 01793-688588<br>www.groundengineering.co.uk                                                                          |      |       | Site: <b>SMALL DROVE, WESTON</b>                                                                                                                                                          |                                                                                                      |  |                                                                                          | <b>BOREHOLE BH3</b>              |        |                                                                               |                      |             |
| Date: <b>15/12/17</b><br>to <b>19/12/17</b>                                                                                                                       |      |       | Hole Size: <b>150mm dia to 22.00m</b>                                                                                                                                                     |                                                                                                      |  |                                                                                          | Ground Level: <b>2.95m. O.D.</b> |        |                                                                               |                      |             |
| <b>Samples and In-situ Tests</b>                                                                                                                                  |      |       | (Date)                                                                                                                                                                                    | Description of Strata                                                                                |  |                                                                                          |                                  | Legend | Depth m                                                                       | O.D. Level m         |             |
| Depth m                                                                                                                                                           | Type | Blows | Casing                                                                                                                                                                                    |                                                                                                      |  |                                                                                          |                                  |        |                                                                               |                      |             |
| 20.50-20.90                                                                                                                                                       | U10  | 100   | 16.50                                                                                                                                                                                     | Very stiff, grey, gravelly CLAY. Gravel is angular to sub-rounded chalk, flint, quartz and mudstone. |  |                                                                                          |                                  |        | 20.00                                                                         | -17.05               |             |
| 21.00                                                                                                                                                             | D27  |       |                                                                                                                                                                                           | (TILL)                                                                                               |  |                                                                                          |                                  |        |                                                                               |                      |             |
| 21.50-21.90                                                                                                                                                       | U11  | 100   | 16.50                                                                                                                                                                                     |                                                                                                      |  |                                                                                          |                                  |        |                                                                               |                      |             |
| 22.00                                                                                                                                                             | D28  |       |                                                                                                                                                                                           | Borehole completed at 22.00m depth                                                                   |  |                                                                                          |                                  |        | 22.00                                                                         | -19.05               |             |
| <b>REMARKS</b>                                                                                                                                                    |      |       |                                                                                                                                                                                           |                                                                                                      |  |                                                                                          |                                  |        |                                                                               | Project No<br>14022A |             |
|                                                                                                                                                                   |      |       |                                                                                                                                                                                           |                                                                                                      |  |                                                                                          |                                  |        |                                                                               | Scale<br>1:50        | Page<br>3/3 |
| <b>KEY</b><br>D - Disturbed Sample<br>B - Bulk Sample<br>U - Undisturbed Sample<br>W - Water Sample<br>S/C - SPT Spoon/Cone<br>W - Water Strike<br>W - Water Rise |      |       | N/A - SPT Blows for 0.3m or given penetration<br>ES - Environmental Sample<br>V - Vane Shear Test<br>Cohesion ( ) kPa<br>Level on completion<br>Level casing withdrawn<br>Standpipe Level |                                                                                                      |  | <b>Groundwater Strikes</b><br>Depth m<br>No Struck    Rose to    Rate    Cased    Sealed |                                  |        | <b>Groundwater Observations</b><br>Depth m<br>Date    Hole    Casing    Water |                      |             |



LABORATORY TEST RESULTS

CONTRACT SMALL DRIVE, WESTON

| Bore-hole | Sample | Depth<br>m       | Classification       |                       |                          |                          | Density                   |                          | Triaxial Compression |                                          |                         |                          |                                            | Su values (SO <sub>4</sub> )       |                            |               |     | Remarks |
|-----------|--------|------------------|----------------------|-----------------------|--------------------------|--------------------------|---------------------------|--------------------------|----------------------|------------------------------------------|-------------------------|--------------------------|--------------------------------------------|------------------------------------|----------------------------|---------------|-----|---------|
|           |        |                  | Liquid<br>Limit<br>% | Plastic<br>Limit<br>% | Plasticity<br>Index<br>% | Moisture<br>Content<br>% | Bulk<br>Mg/m <sup>3</sup> | Dry<br>Mg/m <sup>3</sup> | Type                 | Principal<br>Stress<br>Difference<br>kPa | Cell<br>Pressure<br>kPa | Shear<br>Strength<br>kPa | Angle of<br>Shear<br>Resistance<br>degrees | Total<br>N <sub>2</sub><br>Dry Wt. | Aqueous<br>Extract<br>mg/l | Water<br>mg/l | pH  |         |
|           |        |                  |                      |                       |                          |                          |                           |                          |                      |                                          |                         |                          |                                            |                                    |                            |               |     |         |
| BH1       | U1     | 5.10 -<br>5.40   |                      |                       |                          | 54                       | 1.73                      | 1.12                     | Q                    | 12                                       | 100                     | 6                        | 0                                          |                                    |                            |               |     |         |
|           | U5     | 17.00 -<br>17.25 |                      |                       |                          | 17                       | 2.17                      | 1.86                     | Q                    | 515                                      | 340                     | 257                      | 0                                          |                                    |                            |               |     |         |
|           | U6     | 18.50 -<br>18.90 |                      |                       |                          | 16                       | 2.18                      | 1.88                     | Q                    | 712                                      | 370                     | 356                      | 0                                          |                                    |                            |               |     |         |
|           | U7     | 19.50 -<br>19.90 |                      |                       |                          | 16                       | 2.23                      | 1.92                     | Q                    | 550                                      | 390                     | 275                      | 0                                          | 448                                |                            |               | 8.6 |         |
|           | U8     | 20.50 -<br>20.75 |                      |                       |                          | 15                       | 2.16                      | 1.87                     | Q                    | 723                                      | 400                     | 361                      | 0                                          |                                    |                            |               |     |         |
|           | U9     | 21.50 -<br>21.90 |                      |                       |                          | 15                       | 2.21                      | 1.92                     | Q                    | 863                                      | 420                     | 432                      | 0                                          |                                    |                            |               |     |         |
|           | U1     | 1.20 -<br>1.60   |                      |                       |                          | 28                       | 1.93                      | 1.51                     | Q                    | 37                                       | 40                      | 18                       | 0                                          |                                    |                            |               |     |         |
| BH2       | U3     | 3.20 -<br>3.60   |                      |                       |                          | 63                       | 1.58                      | 0.96                     | Q                    | 10                                       | 60                      | 5                        | 0                                          |                                    |                            |               |     |         |
|           | B4     | 8.20 -<br>8.70   |                      |                       |                          |                          |                           |                          |                      |                                          |                         |                          |                                            | 527                                |                            |               | 8.3 |         |
|           | B8     | 13.50 -<br>14.00 |                      |                       |                          |                          |                           |                          |                      |                                          |                         |                          |                                            | 716                                |                            |               | 7.8 |         |
|           | W1     | 14.60            |                      |                       |                          |                          |                           |                          |                      |                                          |                         |                          |                                            | 313                                |                            |               | 7.8 |         |

Aqueous Extract 2:1 Water:Soil

U - UNDISTURBED SAMPLE  
D - DISTURBED SAMPLE  
B - BULK SAMPLE  
W - WATER SAMPLE  
C.U. - CONSOLIDATED UNDRAINED  
C.D. - CONSOLIDATED DRAINED  
Q. - IMMEDIATE UNDRAINED  
Q.M. - IMMEDIATE UNDRAINED MULTISTAGE

# LABORATORY TEST RESULTS

CONTRACT SMALL DROVE, WESTON

| Bore-hole | Sample | Depth<br>m       | Classification    |                    |                       |                       | Density                   |                          | Triaxial Compression           |                                    |                      |                       |                                      |                            | Sulphate (SO <sub>4</sub> ) |               |     | Remarks |
|-----------|--------|------------------|-------------------|--------------------|-----------------------|-----------------------|---------------------------|--------------------------|--------------------------------|------------------------------------|----------------------|-----------------------|--------------------------------------|----------------------------|-----------------------------|---------------|-----|---------|
|           |        |                  | Liquid Limit<br>% | Plastic Limit<br>% | Plasticity Index<br>% | Moisture Content<br>% | Bulk<br>Mg/m <sup>3</sup> | Dry<br>Mg/m <sup>3</sup> | Type                           | Principal Stress Difference<br>kPa | Cell Pressure<br>kPa | Shear Strength<br>kPa | Angle of Shear Resistance<br>degrees | Soil<br>Total<br>Dry Wt. % | Aqueous Extract<br>mg/l     | Water<br>mg/l | pH  |         |
| BH2       | U6     | 16.90 -<br>17.25 |                   |                    |                       | 18                    | 2.08                      | 1.76                     | Q                              | 192                                | 340                  | 96                    | 0                                    |                            |                             |               |     |         |
|           | U7     | 18.40 -<br>18.80 |                   |                    |                       | 17                    | 2.15                      | 1.84                     | Q                              | 515                                | 370                  | 257                   | 0                                    |                            |                             |               |     |         |
|           | U8     | 19.50 -<br>19.85 |                   |                    |                       | 17                    | 2.08                      | 1.79                     | Q                              | 454                                | 400                  | 227                   | 0                                    |                            |                             |               |     |         |
| BH3       | U1     | 1.20 -<br>1.60   |                   |                    |                       | 28                    | 2.01                      | 1.57                     | Q                              | 70                                 | 40                   | 35                    | 0                                    |                            |                             |               |     |         |
|           | U2     | 4.20 -<br>4.50   |                   |                    |                       | 45                    | 1.77                      | 1.22                     | Q                              | 14                                 | 80                   | 7                     | 0                                    |                            |                             |               |     |         |
|           | U4     | 6.70 -<br>7.10   |                   |                    |                       | 78                    | 1.57                      | 0.88                     | Q                              | 37                                 | 130                  | 19                    | 0                                    |                            |                             | 156           | 7.6 |         |
|           | W1     | 13.40            |                   |                    |                       |                       |                           |                          |                                |                                    |                      |                       |                                      |                            |                             |               |     |         |
|           | U7     | 16.50 -<br>16.85 |                   |                    |                       | 20                    | 2.13                      | 1.77                     | Q                              | 79                                 | 330                  | 40                    | 0                                    |                            |                             |               |     |         |
|           | U8     | 18.00 -<br>18.40 |                   |                    |                       | 16                    | 2.08                      | 1.79                     | Q                              | 168                                | 360                  | 84                    | 0                                    |                            | 486                         |               | 8.7 |         |
|           | U9     | 19.50 -<br>19.95 |                   |                    |                       | 16                    | 2.17                      | 1.87                     | Q                              | 528                                | 400                  | 264                   | 0                                    |                            |                             |               |     |         |
|           | U10    | 20.50 -<br>20.90 |                   |                    |                       | 18                    | 2.18                      | 1.85                     | Q                              | 673                                | 400                  | 337                   | 0                                    |                            |                             |               |     |         |
|           |        |                  |                   |                    |                       |                       |                           |                          | Aqueous Extract 2:1 Water:Soil |                                    |                      |                       |                                      |                            |                             |               |     |         |

U - UNDISTURBED SAMPLE  
D - DISTURBED SAMPLE  
B - BULK SAMPLE  
W - WATER SAMPLE

C.U. - CONSOLIDATED UNDRAINED  
C.D. - CONSOLIDATED DRAINED  
Q. - IMMEDIATE UNDRAINED  
Q.M. - IMMEDIATE UNDRAINED MULTI-STAGE

LABORATORY TEST RESULTS

CONTRACT SMALL DRIVE, WESTON

| Bore-hole                      | Sample | Depth<br>m       | Classification    |                    |                       |                       | Density                   |                          | Triaxial Compression |                                  |                      |                       |                                      | Sulphates (SO <sub>4</sub> ) |                       |       |      | Remarks |
|--------------------------------|--------|------------------|-------------------|--------------------|-----------------------|-----------------------|---------------------------|--------------------------|----------------------|----------------------------------|----------------------|-----------------------|--------------------------------------|------------------------------|-----------------------|-------|------|---------|
|                                |        |                  | Liquid Limit<br>% | Plastic Limit<br>% | Plasticity Index<br>% | Moisture Content<br>% | Bulk<br>Mg/m <sup>3</sup> | Dry<br>Mg/m <sup>3</sup> | Type                 | Pore Stress<br>Difference<br>kPa | Cell Pressure<br>kPa | Shear Strength<br>kPa | Angle of Shear Resistance<br>degrees | Soil                         |                       | Water |      |         |
|                                |        |                  |                   |                    |                       |                       |                           |                          |                      |                                  |                      |                       |                                      | Aqueous<br>Extract<br>mg/l   | Total<br>Dry Wt.<br>% | mg/l  | mg/l |         |
| BH3                            | U11    | 21.50 -<br>21.90 |                   |                    |                       | 16                    | 2.17                      | 1.87                     | Q                    | 716                              | 420                  | 358                   | 0                                    |                              |                       |       |      |         |
| Aqueous Extract 2:1 Water:Soil |        |                  |                   |                    |                       |                       |                           |                          |                      |                                  |                      |                       |                                      |                              |                       |       |      |         |

U - UNDISTURBED SAMPLE  
D - DISTURBED SAMPLE  
B - BULK SAMPLE  
W - WATER SAMPLE

C.U. - CONSOLIDATED UNDRAINED  
C.D. - CONSOLIDATED DRAINED  
Q. - IMMEDIATE UNDRAINED  
Q.M. - IMMEDIATE UNDRAINED MULTISTAGE

14022



8180

**TEST CERTIFICATE****GROUND ENGINEERING**

Newark Road Peterborough  
t: 01733 566566 f: 01733 315260  
e: admin@groundengineering.co.uk

**Determination of Particle Size Distribution**

Tested in Accordance with BS 1377-2: 1990: Clause 9.2 & 9.4  
Sieved Grading and Sedimentation by Pipette

Client: Ground Engineering Ltd  
Client Address: Newark Road  
Peterborough  
PE1 5UA

Certificate Number: PL6119-1/3/710-2

Client Reference: C14022

Lab Job Number: PL6119-1

Date Sampled: Unknown

Date Received: 11.01.2018

Date Tested: 24.01.2018

Contact: Chris Ebeling

Site Name: Small Drove

Site Address: Weston

Certificate of Sampling: N/A

Sampling Certificate No.: N/A

Sampled By: Client

**TEST RESULTS**

Laboratory Reference: PL6119-1/3

Client Reference: B6

Pre-treatment for  
organic material:

N/A

Sample Description: Grey-brown slightly gravelly clayey SAND. Gravel consists of bivalve shells

Material Specification: Not Required

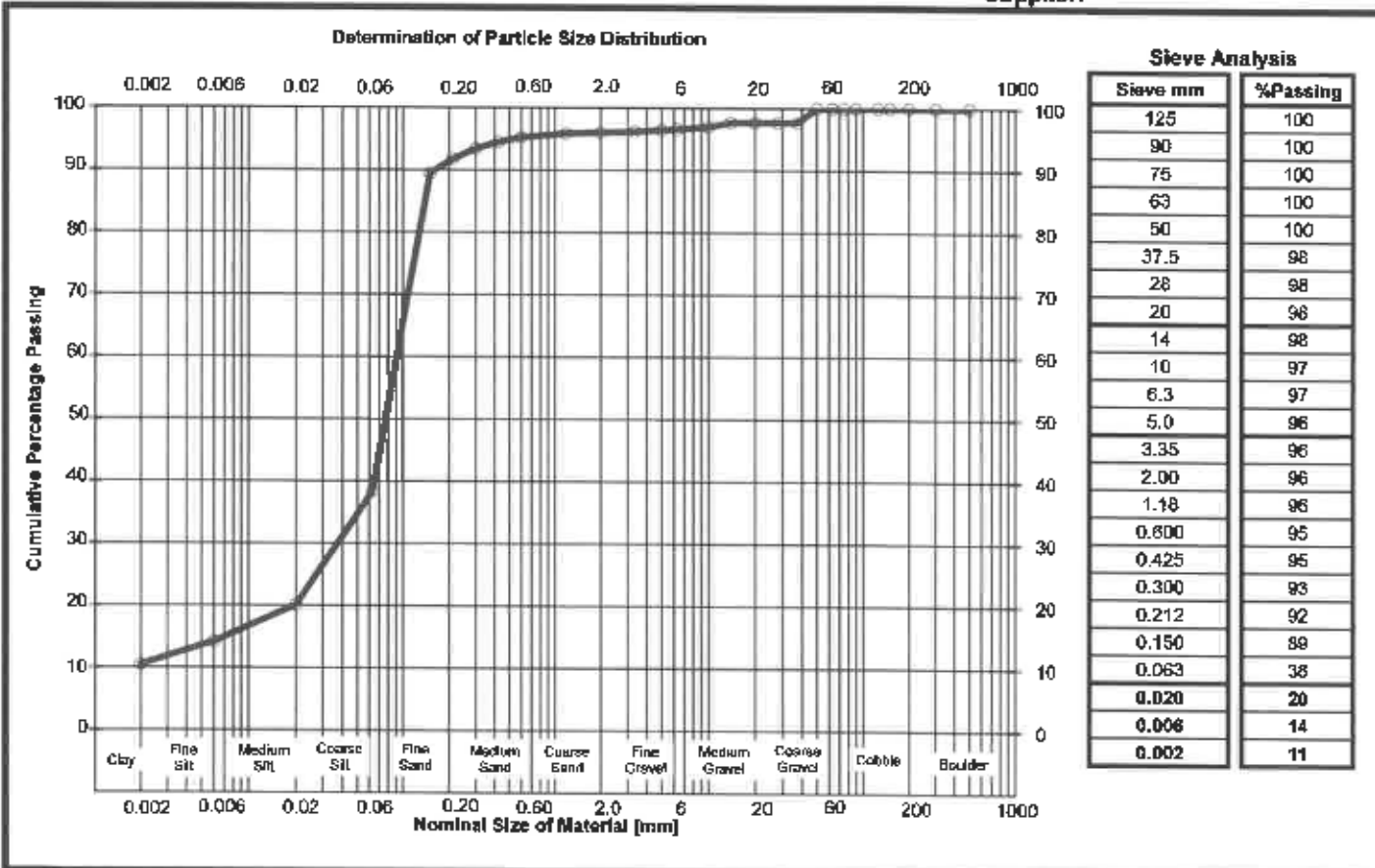
Location: BH1

Source:

Depth Top: 11.00m

Depth Base: 11.50m

Supplier:



Comments: Data relevant to material below 63 microns is outside the current scope of UKAS accreditation

Approved Signatory: M. Hartnup - Laboratory Manager

Signed:

Date Reported: 31.01.2018 Page 1 of 1

Form Number: GELab/C/709-2 Version 47

for and on behalf of Ground Engineering Ltd

Opinions and Interpretations expressed herein are outside of the scope of the UKAS Accreditation  
This report may not be reproduced other than in full without the prior written approval of the issuing laboratory

Registered in England & Wales  
Registration Number: 6829574  
Reg Office: Ground Engineering Ltd  
Newark Rd, Peterborough PE1 5UA



8180

**GROUND ENGINEERING****TEST CERTIFICATE**

Newark Road Peterborough  
t: 01733 566566 f: 01733 315280  
e: admin@groundengineering.co.uk

**Determination of Particle Size Distribution**

Tested in Accordance with BS 1377-2: 1990: Clause 9.2  
Sieved Grading

Client: Ground Engineering Ltd  
Client Address: Newark Road  
Peterborough  
PE1 5UA

Certificate Number: PL6119-1/4/710-2

Client Reference: C14022

Lab Job Number: PL6119-1

Date Sampled: Unknown

Date Received: 11.01.2018

Date Tested: 24.01.2018

Certificate of Sampling: N/A

Sampling Certificate No.: N/A

Sampled By: Client

Contact: Chris Ebeling

Site Name: Small Drove

Site Address: Weston

**TEST RESULTS**

Laboratory Reference: PL6119-1/4

Pre-treatment for  
organic material:

N/A

Client Reference: B9

Sample Description: Brown SAND and GRAVEL. Gravel consists of angular flint and bivalve shells

Material Specification: Not Required

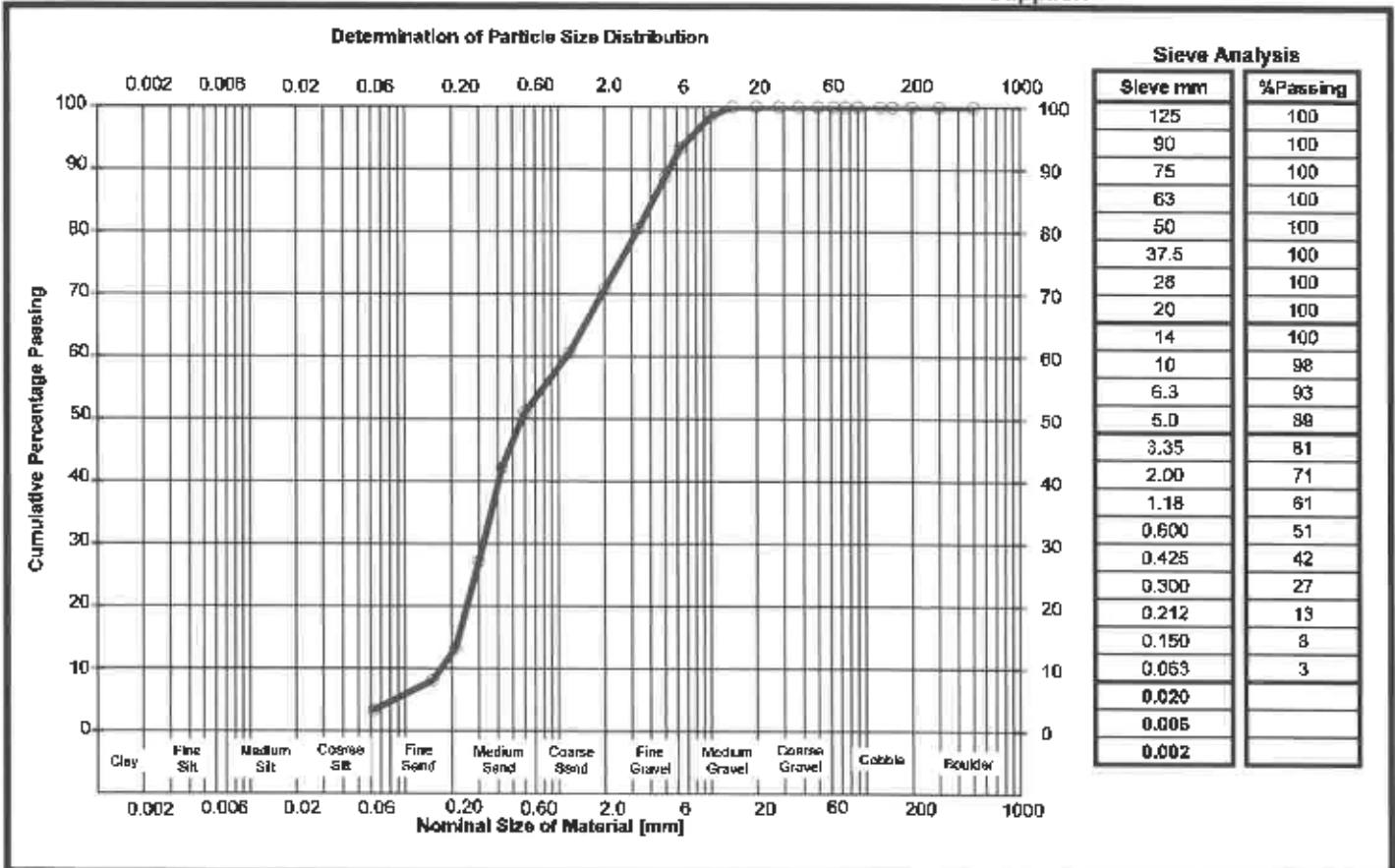
Location: BH1

Depth Top: 15.00m

Depth Base: 15.50m

Source:

Supplier:



Comments:

Approved Signatory: M. Hartnup - Laboratory Manager

Signed:

for and on behalf of Ground Engineering Ltd

Date Reported: 31.01.2018 Page 1 of 1

Form Number: GELab/C/709-2 Version 47

Opinions and interpretations expressed herein are outside of the scope of the UKAS Accreditation  
This report may not be reproduced other than in full without the prior written approval of the issuing laboratory

Registered in England & Wales  
Registration Number: 6929574  
Reg Office: Ground Engineering Ltd  
Newark Rd, Peterborough PE1 5UA



8180

**GROUND ENGINEERING****TEST CERTIFICATE**

Newark Road Peterborough  
t: 01733 568566 f: 01733 315280  
e: admin@groundengineering.co.uk

**Determination of Particle Size Distribution**

Tested in Accordance with BS 1377-2: 1990: Clause 9.2  
Sieved Grading

Client: Ground Engineering Ltd  
Client Address: Newark Road  
Peterborough  
PE1 5UA

Certificate Number: PL6119-1/5/710-2  
Client Reference: C14022  
Lab Job Number: PL6119-1  
Date Sampled: Unknown  
Date Received: 11.01.2018  
Date Tested: 24.01.2018  
Certificate of Sampling: N/A  
Sampling Certificate No.: N/A  
Sampled By: Client

Contact: Chris Ebeling

Site Name: Small Drove  
Site Address: Weston

**TEST RESULTS**

Laboratory Reference: PL6119-1/5

Pre-treatment for organic material: N/A

Client Reference: B10

Sample Description: Brown gravelly SAND. Gravel consists of angular flint and bivalve shells

Material Specification: Not Required

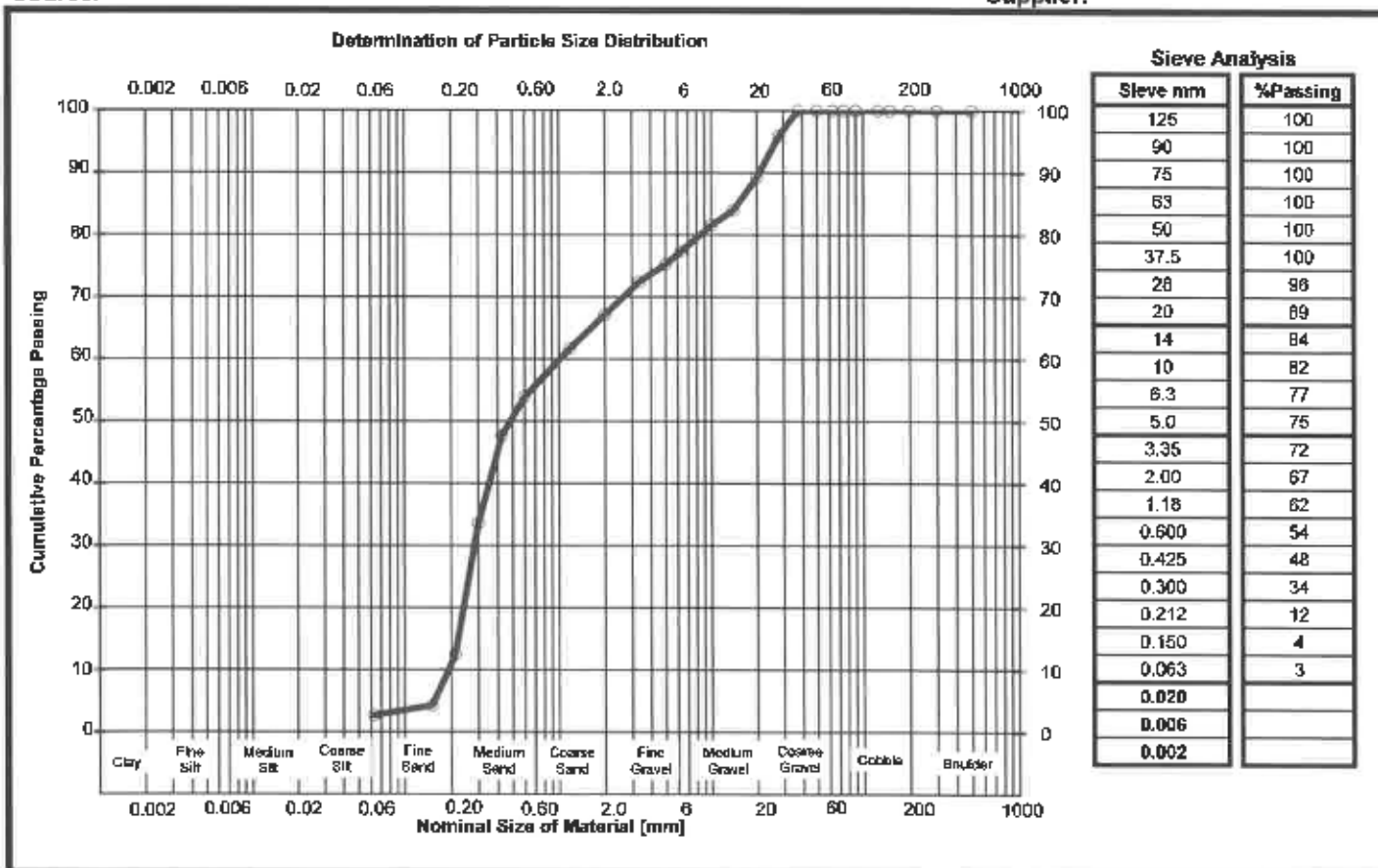
Depth Top: 15.80m

Location: BH1

Depth Base: 16.30m

Source:

Supplier:



Comments:

Approved Signatory: M. Hartnup - Laboratory Manager

Signed:

for and on behalf of Ground Engineering Ltd

Date Reported: 31.01.2018 Page 1 of 1  
Form Number: GELab/C/709-2 Version 47

Registered in England & Wales  
Registration Number: 6829574

Reg Office: Ground Engineering Ltd  
Newark Rd, Peterborough PE1 5UA

Opinions and Interpretations expressed herein are outside of the scope of the UKAS Accreditation  
This report may not be reproduced other than in full without the prior written approval of the issuing laboratory



8160

**GROUND ENGINEERING**

Newark Road Peterborough  
 E 01733 566566 f: 01733 315280  
 e: admin@groundengineering.co.uk

**TEST CERTIFICATE****Determination of Particle Size Distribution**

Tested in Accordance with BS 1377-2: 1990: Clause 9.2 & 9.4  
 Sieved Grading and Sedimentation by Pipette

Client: Ground Engineering Ltd  
 Client Address: Newark Road  
 Peterborough  
 PE1 5UA

Certificate Number: PL6119-1/14/710-2

Client Reference: C14022

Lab Job Number: PL6119-1

Date Sampled: Unknown

Date Received: 11.01.2018

Date Tested: 24.01.2018

Certificate of Sampling: N/A

Sampling Certificate No.: N/A

Sampled By: Client

Contact: Chris Ebeling

Site Name: Small Drove

Site Address: Weston

**TEST RESULTS**

Laboratory Reference: PL6119-1/14

Client Reference: B7

Pre-treatment for  
organic material:

N/A

Sample Description: Grey-brown slightly gravelly clayey SAND. Gravel consists of bivalve shells

Material Specification: Not Required

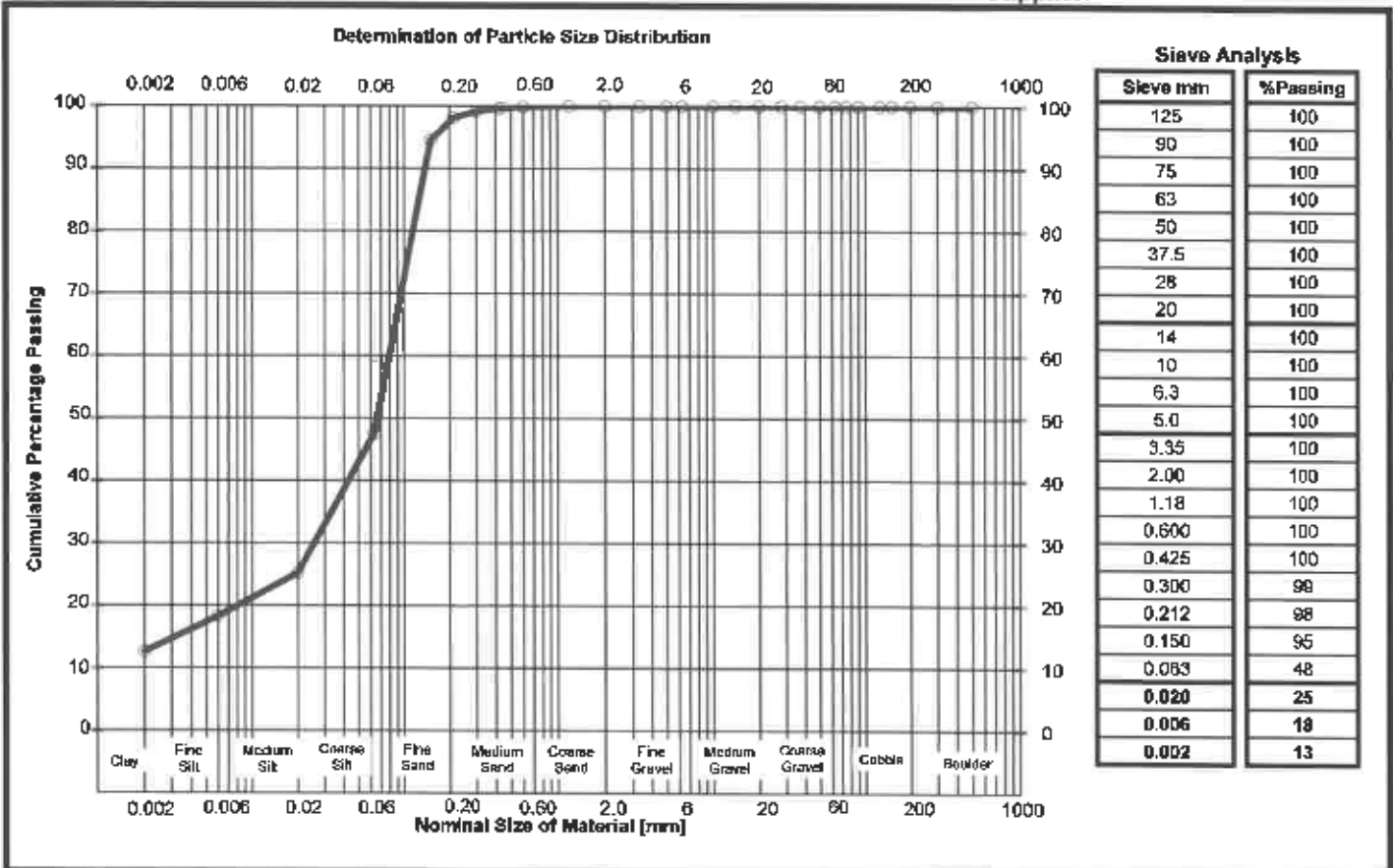
Location: BH2

Source:

Depth Top: 12.00m

Depth Base: 12.50m

Supplier:



Comments: Data relevant to material below 63 microns is outside the current scope of UKAS accreditation

Approved Signatory: M. Hartnup - Laboratory Manager

Signed:

for and on behalf of Ground Engineering Ltd

Date Reported: 31.01.2018 Page 1 of 1

Form Number: GELab/C/709-2 Version 47

Opinions and interpretations expressed herein are outside of the scope of the UKAS Accreditation  
 This report may not be reproduced other than in full without the prior written approval of the issuing laboratory

Registered in England & Wales  
 Registration Number: 6929574  
 Reg Office: Ground Engineering Ltd  
 Newark Rd, Peterborough PE1 5UA



8180

**TEST CERTIFICATE****GROUND ENGINEERING**

Newark Road Peterborough  
t: 01733 586566 f: 01733 315280  
e: admin@groundengineering.co.uk

**Determination of Particle Size Distribution**

Tested in Accordance with BS 1377-2: 1990: Clause 9.2  
Sieved Grading

Client: Ground Engineering Ltd  
Client Address: Newark Road  
Peterborough  
PE1 5UA

Certificate Number: PL6119-1/16/710-2

Client Reference: C14022

Lab Job Number: PL6119-1

Date Sampled: Unknown

Date Received: 11.01.2018

Date Tested: 24.01.2018

Certificate of Sampling: N/A

Sampling Certificate No.: N/A

Sampled By: Client

Contact: Chris Ebeling

Site Name: Small Drove

Site Address: Weston

**TEST RESULTS**

Laboratory Reference: PL6119-1/16

Client Reference: B9

Pre-treatment for  
organic material:

N/A

Sample Description: Brown gravelly SAND. Gravel consists of bivalve fragments

Material Specification: Not Required

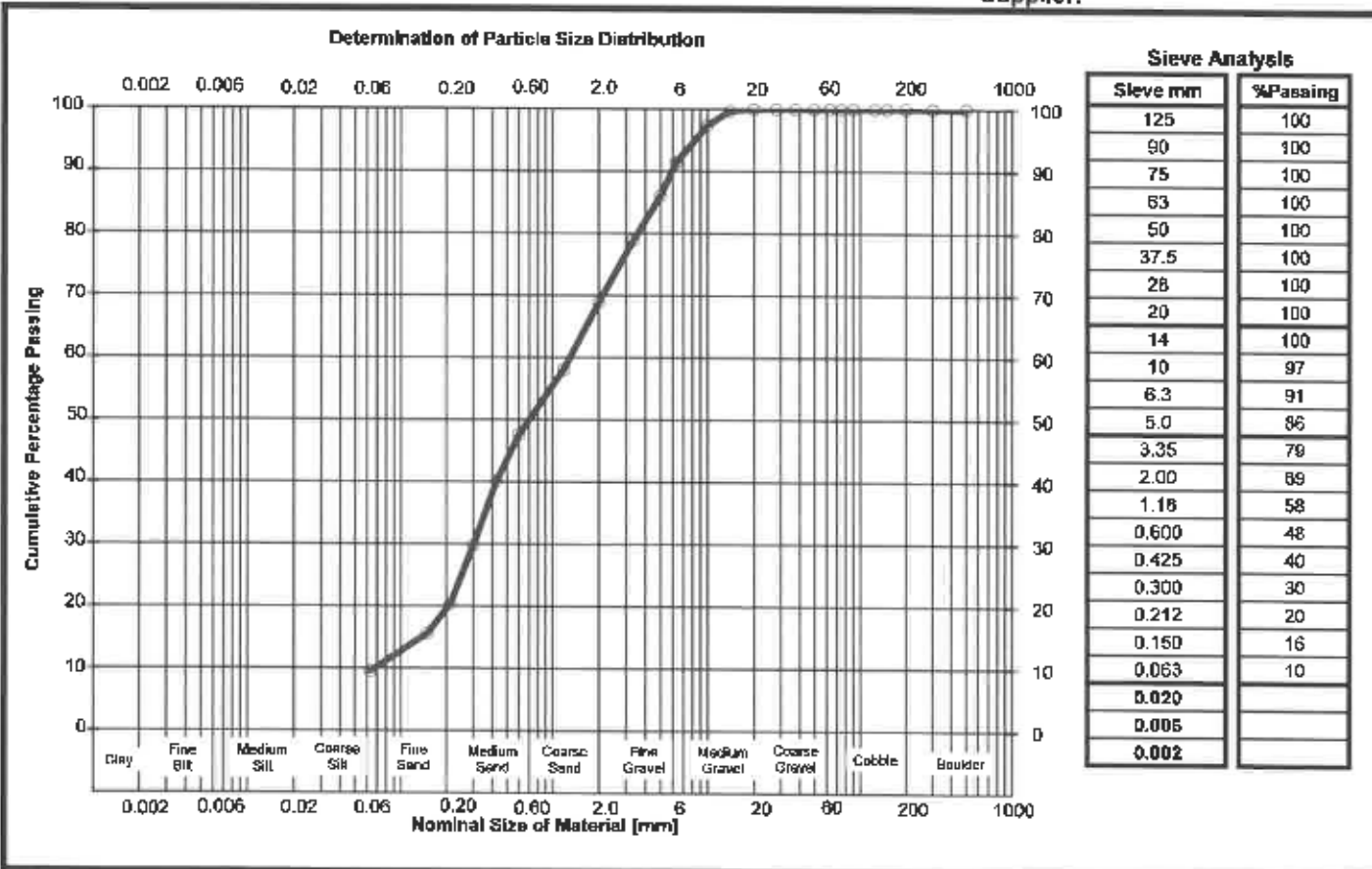
Location: BH2

Source:

Depth Top: 14.60m

Depth Base: 15.10m

Supplier:



Comments:

Approved Signatory: M. Hartnup - Laboratory Manager

Signed:

Date Reported: 31.01.2018 Page 1 of 1

Form Number: GELab/C/709-2 Version 47

for and on behalf of Ground Engineering Ltd

Opinions and interpretations expressed herein are outside of the scope of the UKAS Accreditation  
This report may not be reproduced other than in full without the prior written approval of the issuing laboratory

Registered in England & Wales  
Registration Number: 6929574  
Reg Office: Ground Engineering Ltd  
Newark Rd, Peterborough PE1 5UA



B180

**TEST CERTIFICATE**

Newark Road Peterborough  
t: 01733 566566 f: 01733 315280  
e: admin@groundengineering.co.uk

**Determination of Particle Size Distribution**

Tested in Accordance with BS 1377-2: 1990: Clause 9.2  
Sieved Grading

Client: Ground Engineering Ltd  
Client Address: Newark Road  
Peterborough  
PE1 5UA

Certificate Number: PL6119-1/18/710-2

Client Reference: C14022

Lab Job Number: PL6119-1

Date Sampled: Unknown

Date Received: 11.01.2018

Date Tested: 24.01.2018

Contact: Chris Ebeling

Site Name: Small Drove  
Site Address: Weston

Certificate of Sampling: N/A

Sampling Certificate No.: N/A

Sampled By: Client

**TEST RESULTS**

Laboratory Reference: PL6119-1/18

Pre-treatment for  
organic material:

N/A

Client Reference: B10

Sample Description: Brown SAND and GRAVEL. Gravel consists of bivalve fragments and flint

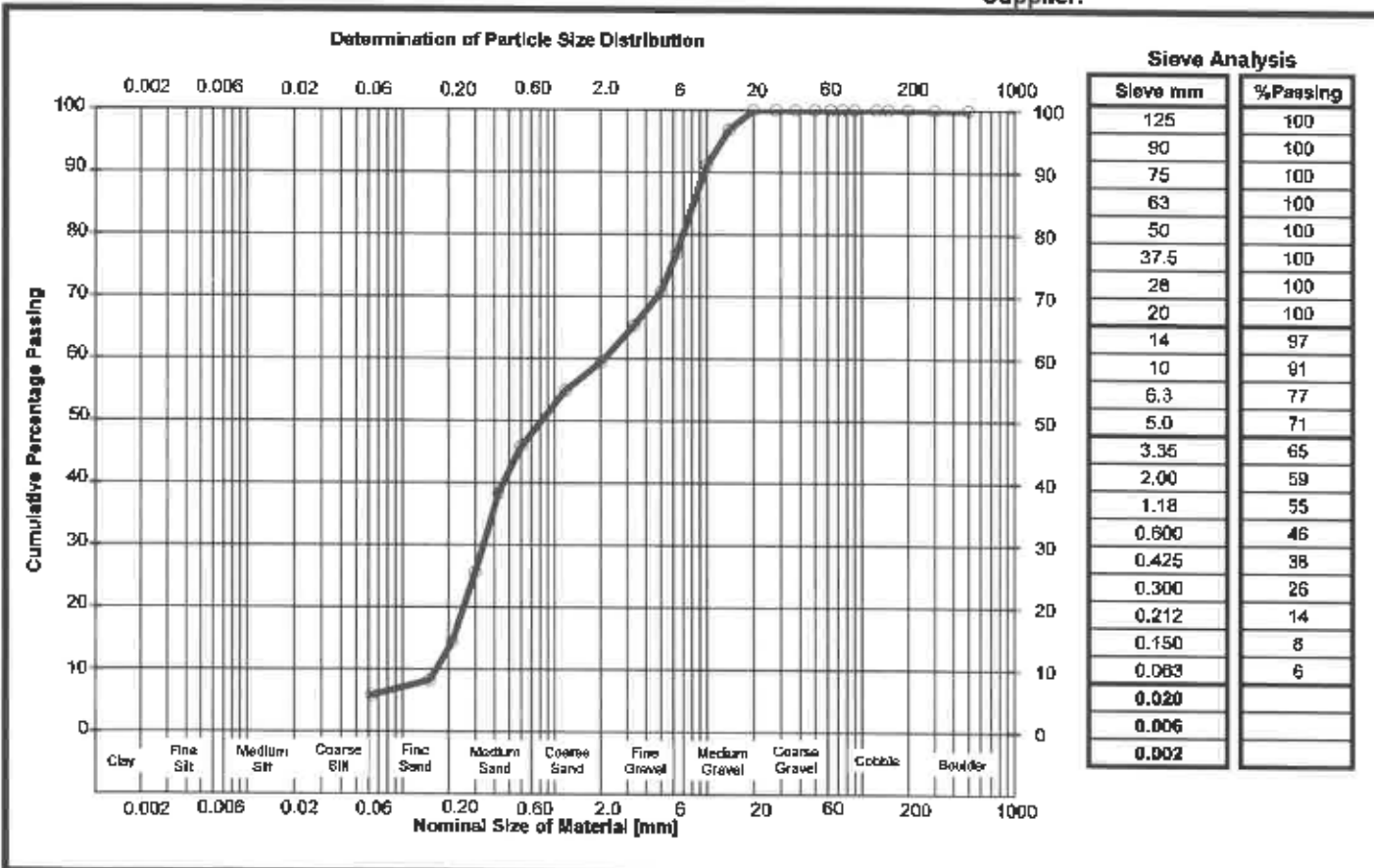
Material Specification: Not Required  
Location: BH2

Depth Top: 16.10m

Depth Base: 16.60m

Source:

Supplier:



Comments:

Approved Signatory: M. Hartnup - Laboratory Manager

Signed:

Date Reported: 31.01.2018 Page 1 of 1  
Form Number: GELab/C/709-2 Version 47

for and on behalf of Ground Engineering Ltd

Opinions and interpretations expressed herein are outside of the scope of the UKAS Accreditation  
This report may not be reproduced other than in full without the prior written approval of the issuing laboratory

Registered in England & Wales  
Registration Number: 8929574  
Reg Office: Ground Engineering Ltd  
Newark Rd, Peterborough PE1 5UA



B180

**TEST CERTIFICATE****GROUND ENGINEERING**

Newark Road Peterborough  
 t: 01733 566566 f: 01733 315280  
 e: admin@groundengineering.co.uk

**Determination of Particle Size Distribution**

Tested in Accordance with BS 1377-2: 1990: Clause 9.2 & 9.4  
 Sieved Grading and Sedimentation by Pipette

Client: Ground Engineering Ltd  
 Client Address: Newark Road  
 Peterborough  
 PE1 5UA

Certificate Number: PL6119-1/26/710-2

Client Reference: C14022

Lab Job Number: PL6119-1

Date Sampled: Unknown

Date Received: 11.01.2018

Date Tested: 24.01.2018

Contact: Chris Ebeling

Site Name: Small Drove  
 Site Address: Weston

Certificate of Sampling: N/A

Sampling Certificate No.: N/A

Sampled By: Client

**TEST RESULTS**

Laboratory Reference: PL6119-1/26

Client Reference: B4

Pre-treatment for  
organic material:

No

Sample Description: Gray-brown clayey SAND

Material Specification: Not Required

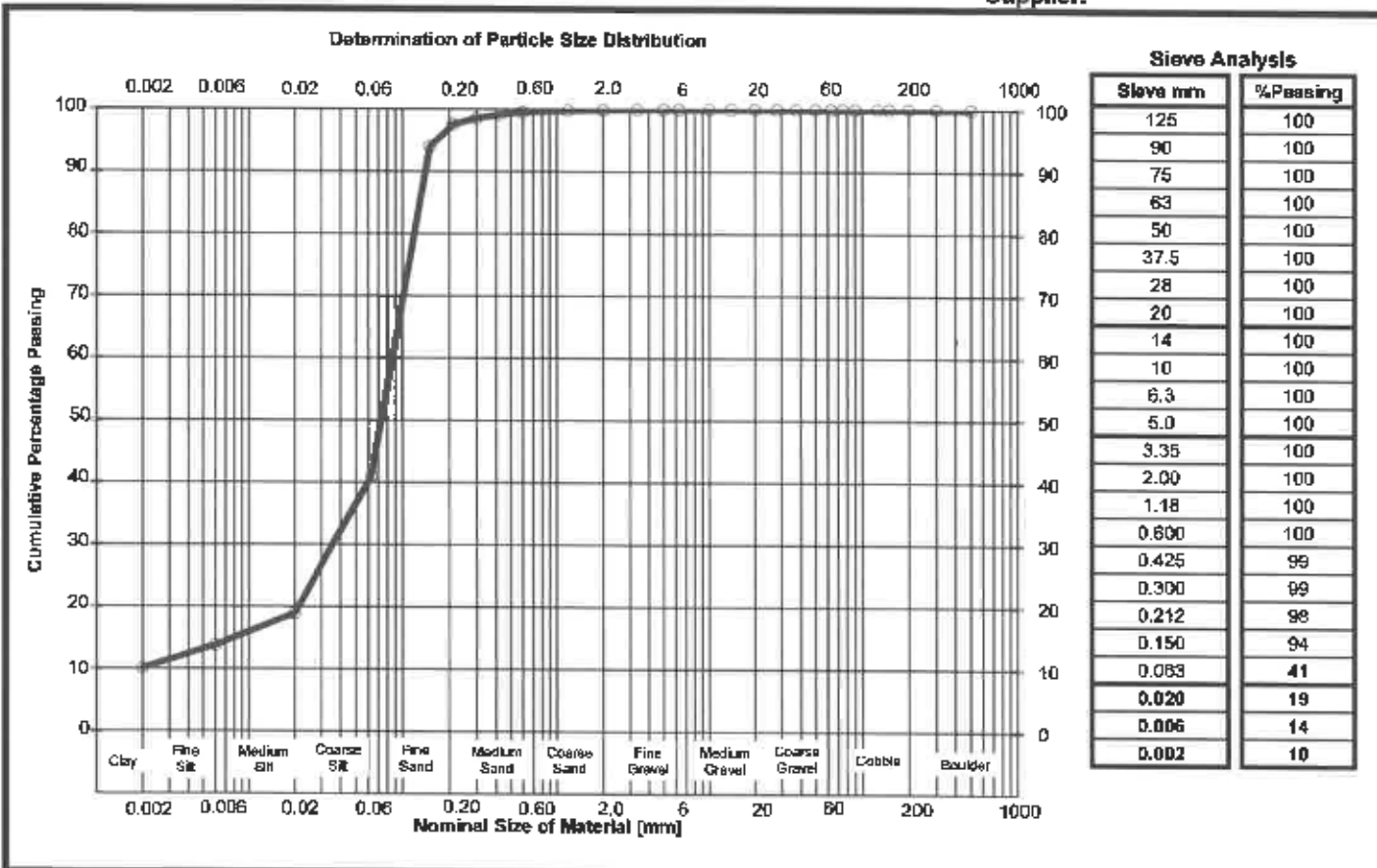
Location: BH3

Depth Top: 11.80m

Depth Base: 12.30m

Source:

Supplier:



Comments: Data relevant to material below 63 microns is outside the current scope of UKAS accreditation

Approved Signatory: M. Hartnup - Laboratory Manager

Signed:

for and on behalf of Ground Engineering Ltd

Date Reported: 31.01.2018 Page 1 of 1  
 Form Number: GELab/C/709-2 Version 47

Opinions and Interpretations expressed herein are outside of the scope of the UKAS Accreditation  
 This report may not be reproduced other than in full without the prior written approval of the issuing laboratory

Registered in England & Wales  
 Registration Number: 6929574  
 Reg Office: Ground Engineering Ltd  
 Newark Rd, Peterborough PE1 5UA



8180

**GROUND ENGINEERING**

Newark Road Peterborough  
t: 01733 568566 f: 01733 315280  
e: admin@groundengineering.co.uk

**TEST CERTIFICATE****Determination of Particle Size Distribution**

Tested in Accordance with BS 1377-2: 1990: Clause 9.2  
Sieved Grading

Client: Ground Engineering Ltd  
Client Address: Newark Road  
Peterborough  
PE1 5UA

Certificate Number: PL6119-1/28/710-2

Client Reference: C14022

Lab Job Number: PL6119-1

Date Sampled: Unknown

Date Received: 11.01.2018

Date Tested: 24.01.2018

Certificate of Sampling: N/A

Sampling Certificate No.: N/A

Sampled By: Client

Contact: Chris Ebeling

Site Name: Small Drive  
Site Address: Weston

**TEST RESULTS**

Laboratory Reference: PL6119-1/28

Client Reference: B7

Pre-treatment for  
organic material: N/A

Sample Description: Brown clayey gravelly SAND. Gravel consists of bivalve fragments

Material Specification: Not Required

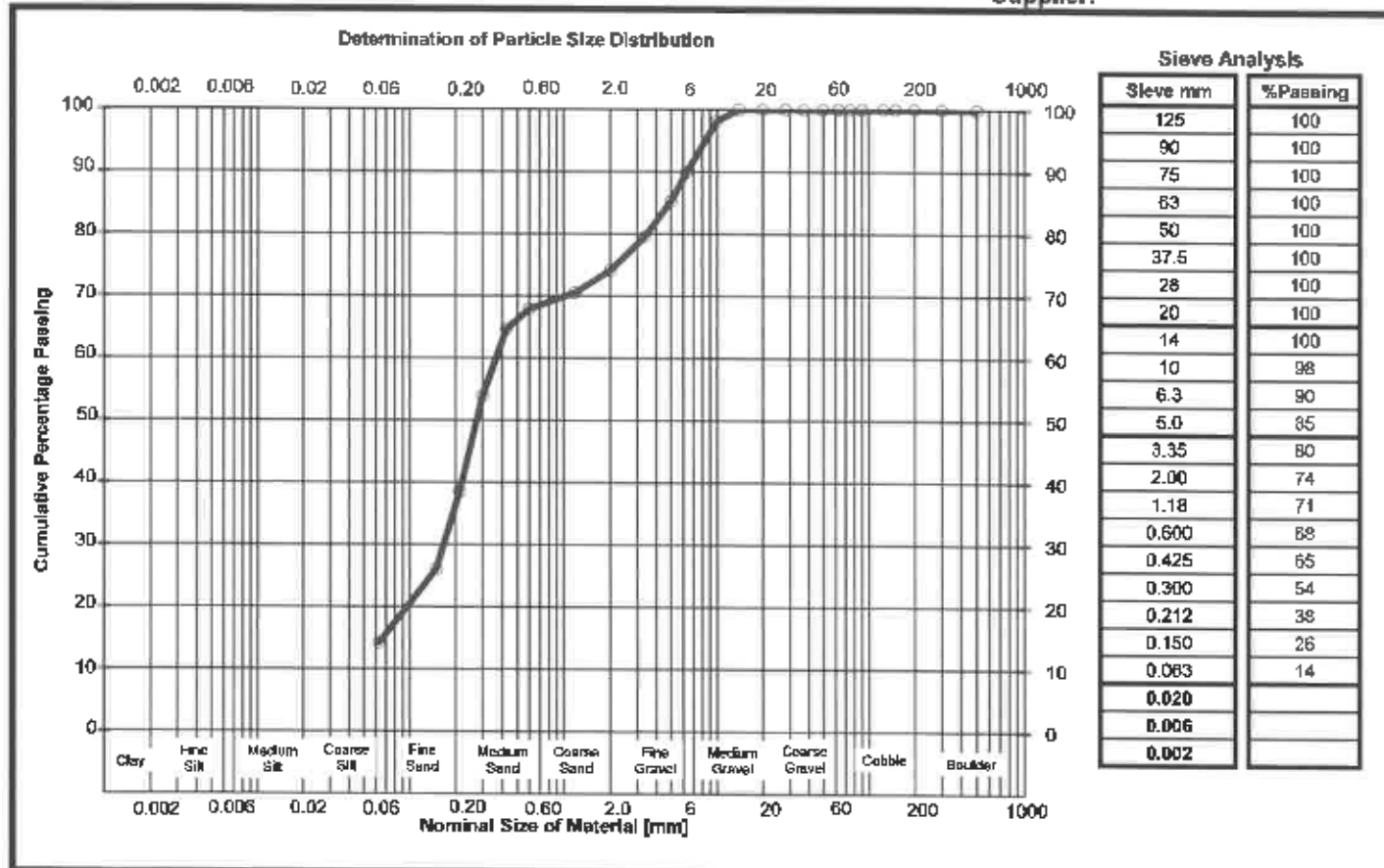
Location: BH3

Depth Top: 14.50m

Depth Base: 15.00m

Source:

Supplier:



Comments:

Approved Signatory: M. Hartnup - Laboratory Manager

Signed:

Date Reported: 31.01.2018 Page 1 of 1  
Form Number: GELab/C/709-2 Version 47

for and on behalf of Ground Engineering Ltd

Opinions and interpretations expressed herein are outside of the scope of the UKAS Accreditation  
This report may not be reproduced other than in full without the prior written approval of the issuing laboratory

Registered in England & Wales  
Registration Number: 6929574  
Reg Office: Ground Engineering Ltd  
Newark Rd, Peterborough PE1 5UA

**TEST CERTIFICATE****One-Dimensional Consolidation Properties**

(Tested in accordance with BS1377 : Part 5 1990)

Client: Ground Engineering Ltd  
 Client Address: Newark Road  
 Peterborough  
 Cambridgeshire  
 Postcode: PE1 5UA  
 Contact: Chris Ebeling  
 Site Name: Small Drive  
 Site Address: Weston

Newark Road Peterborough  
 t:01733 566568 f:01733 315280  
 e: admin@groundengineering.co.uk

---

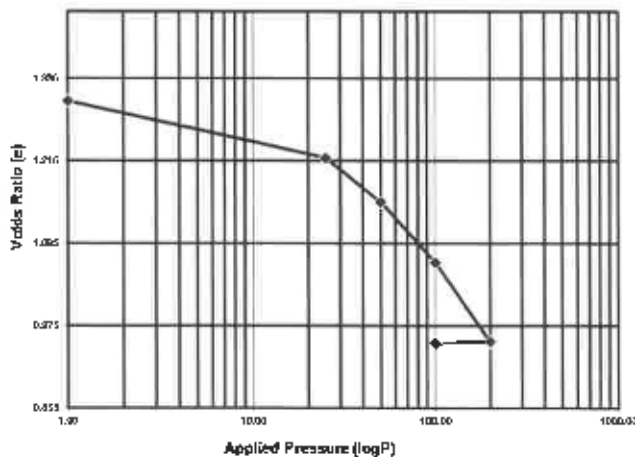
Certificate Number: PL6119-1-2/731  
 Client Reference Number: C14022  
 Date Sampled: Unknown  
 Date Received: 11.01.2018  
 Date Tested: 18.01.2018  
 Sampling Certificate No: N/A  
 Certificate of Sampling: N/A  
 Sampled By: Client

**Test Details**

Location: BH1  
 Sample Ref: U3  
 Sample Description: Soft dark brown dark grey black organic CLAY  
 Particle Density (  $\text{Mg/m}^3$  ): 2.7 Assumed  
 Mean Lab Temp. (  $^{\circ}\text{C}$  ): 22  
 Variations from Standard: None  
 Lab Reference: PL6119-1-2  
 Depth: 8.10 m

**Specimen Details**

|                                   | INITIAL  | FINAL |
|-----------------------------------|----------|-------|
| Height ( mm ):                    | 18.95    | 16.05 |
| Bulk Density ( $\text{Mg/m}^3$ ): | 1.74     | 1.91  |
| Moisture Content ( % ):           | 48       | 38    |
| Dry Density ( $\text{Mg/m}^3$ ):  | 1.17     | 1.38  |
| Voids Ratio:                      | 1.302    | 0.950 |
| Degree of Saturation ( % ):       | 99.9     | 100.0 |
| Diameter ( mm ):                  | 75.03    | N/A   |
| Swelling Pressure ( kPa ):        | 1        | N/A   |
| Method of time fitting used:      | Log Time | N/A   |

**Voids Ratio against logarithm of Applied Pressure**

| Applied Pressure (kPa) | Coefficient of Compressibility $m_v$ ( $\text{m}^2/\text{MN}$ ) | Coefficient of Consolidation $c_v$ ( $\text{m}^2/\text{year}$ ) |
|------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------|
| 1                      | 1.50                                                            | 3.45                                                            |
| 25                     | 1.15                                                            | 1.83                                                            |
| 50                     | 0.82                                                            | 1.77                                                            |
| 100                    | 0.55                                                            | 1.74                                                            |
| 200                    | 0.00                                                            | ---                                                             |
| 100                    |                                                                 |                                                                 |
|                        |                                                                 |                                                                 |
|                        |                                                                 |                                                                 |

**Comments:**

Approved: [x] M.Hartnup - Laboratory Manager  
 Signatory: [ ] L.Petch - Team Leader

Signed:

for and on behalf of Ground Engineering Ltd

Date Reported: 31/01/2018

Opinions and interpretations expressed herein are outside the scope of the UKAS Accreditation.  
 This report may not be reproduced other than in full without the prior written approval of the issuing laboratory.

Registered in England Wales  
 Reg Number 6929574  
 Reg Office: Ground Engineering Ltd  
 Newark Rd  
 Peterborough PE1 5UA

**TEST CERTIFICATE****One-Dimensional Consolidation  
Properties**

(Tested in accordance with BS1377 : Part 5 1990)

Client: Ground Engineering Ltd  
 Client Address: Newark Road  
 Peterborough  
 Cambridgeshire  
 Postcode: PE1 5UA  
 Contact: Chris Ebeling  
 Site Name: Small Drove  
 Site Address: Weston

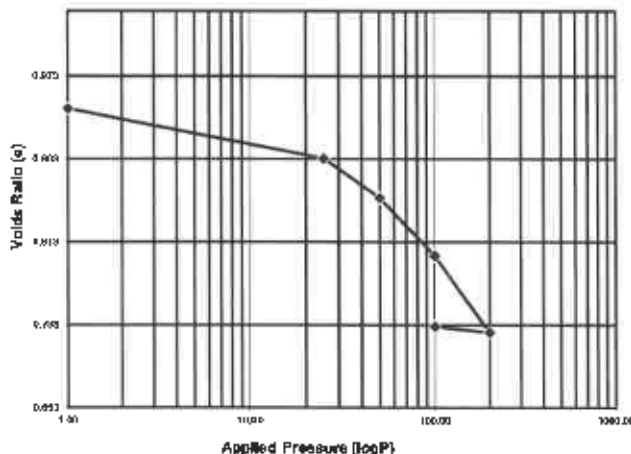
Newark Road Peterborough  
 t:01733 566566 f:01733 315280  
 e: admin@groundengineering.co.uk  
 Certificate Number: PL6119-1-11/731  
 Client Reference Number: C14022  
 Date Sampled: Unknown  
 Date Received: 11.01.2018  
 Date Tested: 18.01.2018  
 Sampling Certificate No: N/A  
 Certificate of Sampling: N/A  
 Sampled By: Client

**Test Details**

Location: BH2  
 Sample Ref: U1  
 Sample Description: Firm brown orange-brown silty sandy CLAY  
 Particle Density ( $\text{Mg/m}^3$ ): 2.65 Assumed  
 Mean Lab Temp. ( $^{\circ}\text{C}$ ): 22  
 Variations from Standard: None  
 Lab Reference: PL6119-1-11  
 Depth: 1.25 m

**Specimen Details**

|                                   | INITIAL  | FINAL |
|-----------------------------------|----------|-------|
| Height (mm):                      | 18.52    | 16.52 |
| Bulk Density ( $\text{Mg/m}^3$ ): | 1.83     | 1.97  |
| Moisture Content (%):             | 34       | 29    |
| Dry Density ( $\text{Mg/m}^3$ ):  | 1.36     | 1.53  |
| Voids Ratio:                      | 0.942    | 0.732 |
| Degree of Saturation (%):         | 96.4     | 100.0 |
| Diameter (mm):                    | 75.12    | N/A   |
| Swelling Pressure (kPa):          | 1        | N/A   |
| Method of time fitting used:      | Log Time | N/A   |

**Voids Ratio against logarithm of Applied Pressure**

| Applied Pressure (kPa) | Coefficient of Compressibility $m_v$ ( $\text{m}^2/\text{MN}$ ) | Coefficient of Consolidation $c_v$ ( $\text{m}^2/\text{year}$ ) |
|------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------|
| 1                      |                                                                 |                                                                 |
| 25                     | 1.02                                                            | 0.66                                                            |
| 50                     | 0.81                                                            | 0.51                                                            |
| 100                    | 0.60                                                            | 0.56                                                            |
| 200                    | 0.41                                                            | 0.67                                                            |
| 100                    | 0.03                                                            | --                                                              |
|                        |                                                                 |                                                                 |
|                        |                                                                 |                                                                 |
|                        |                                                                 |                                                                 |

**Comments:**

Approved: [x] M.Hartnup - Laboratory Manager  
 Signatory: [ ] L.Petch - Team Leader

Signed: *MHA*

**for and on behalf of Ground Engineering Ltd****Date Reported: 31/01/2018**

Opinions and interpretations expressed herein are outside the scope of the UKAS Accreditation.  
 This report may not be reproduced other than in full without the prior written approval of the issuing laboratory.

Form No: GELab/C/731 Issue 1

Registered in England Wales  
 Reg Number 6829574  
 Reg Office: Ground Engineering Ltd  
 Newark Rd  
 Peterborough PE1 5UA

**TEST CERTIFICATE****One-Dimensional Consolidation  
Properties**

(Tested in accordance with BS1377 : Part 5 1990)

Newark Road Peterborough

t:01733 566566 f:01733 315280

e: admin@groundengineering.co.uk

Client: Ground Engineering Ltd  
 Client Address: Newark Road  
 Peterborough  
 Cambridgeshire  
 Postcode: PE1 5UA  
 Contact: Chris Ebeling  
 Site Name: Small Drove  
 Site Address: Weston

Certificate Number: PL6119-1-12/731  
 Client Reference Number: C14022  
 Date Sampled: Unknown  
 Date Received: 11.01.2018  
 Date Tested: 18.01.2018  
 Sampling Certificate No: N/A  
 Certificate of Sampling: N/A  
 Sampled By: Client

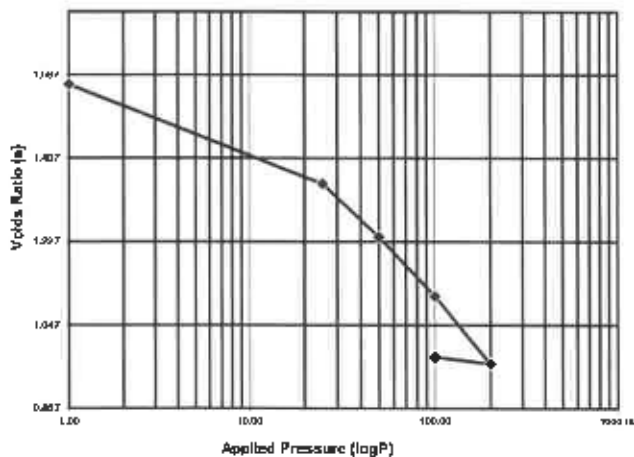
**Test Details**

Location: BH2  
 Sample Ref: U3  
 Sample Description: Soft dark brown dark grey organic CLAY with peaty pockets  
 Particle Density ( $\text{Mg/m}^3$ ): 2.5 Assumed  
 Mean Lab Temp. ( $^{\circ}\text{C}$ ): 22  
 Variations from Standard: None  
 Lab Reference: PL6119-1-12  
 Depth: 3.25 m

**Specimen Details**

|                                   | INITIAL  | FINAL |
|-----------------------------------|----------|-------|
| Height (mm):                      | 18.67    | 14.40 |
| Bulk Density ( $\text{Mg/m}^3$ ): | 1.62     | 1.88  |
| Moisture Content (%):             | 67       | 48    |
| Dry Density ( $\text{Mg/m}^3$ ):  | 0.97     | 1.26  |
| Voids Ratio:                      | 1.586    | 0.978 |
| Degree of Saturation (%):         | 100.0    | 100.0 |
| Diameter (mm):                    | 74.98    | N/A   |
| Swelling Pressure (kPa):          | 1        | N/A   |
| Method of time fitting used:      | Log Time | N/A   |

Voids Ratio against logarithm of Applied Pressure



| Applied Pressure (kPa) | Coefficient of Compressibility $m_v$ ( $\text{m}^2/\text{MN}$ ) | Coefficient of Consolidation $c_v$ ( $\text{m}^2/\text{year}$ ) |
|------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------|
| 1                      |                                                                 |                                                                 |
| 25                     | 3.47                                                            | 0.37                                                            |
| 50                     | 1.96                                                            | 0.20                                                            |
| 100                    | 1.14                                                            | 0.23                                                            |
| 200                    | 0.69                                                            | 0.24                                                            |
| 100                    | 0.08                                                            | --                                                              |
|                        |                                                                 |                                                                 |
|                        |                                                                 |                                                                 |
|                        |                                                                 |                                                                 |

**Comments:**

Approved: [x] M.Hartnup - Laboratory Manager  
 Signatory: [ ] L.Petch - Team Leader

Signed:

for and on behalf of Ground Engineering Ltd

Date Reported: 31/01/2018

Opinions and interpretations expressed herein are outside the scope of the UKAS Accreditation.  
 This report may not be reproduced other than in full without the prior written approval of the issuing laboratory.

Registered in England Wales  
 Reg Number 6929574  
 Reg Office: Ground Engineering Ltd  
 Newark Rd  
 Peterborough PE1 5UA

**TEST CERTIFICATE****One-Dimensional Consolidation  
Properties**

(Tested in accordance with BS1377 : Part 5 1990)

Client: Ground Engineering Ltd  
 Client Address: Newark Road  
 Peterborough  
 Cambridgeshire  
 Postcode: PE1 5UA  
 Contact: Chris Ebeling  
 Site Name: Small Drove  
 Site Address: Weston

Newark Road Peterborough

t:01733 566566 f:01733 315280

e: admin@groundengineering.co.uk

Certificate Number: PL6119-1-24/731

Client Reference Number: C14022

Date Sampled: Unknown

Date Received: 11.01.2018

Date Tested: 18.01.2018

Sampling Certificate No: N/A

Certificate of Sampling: N/A

Sampled By: Client

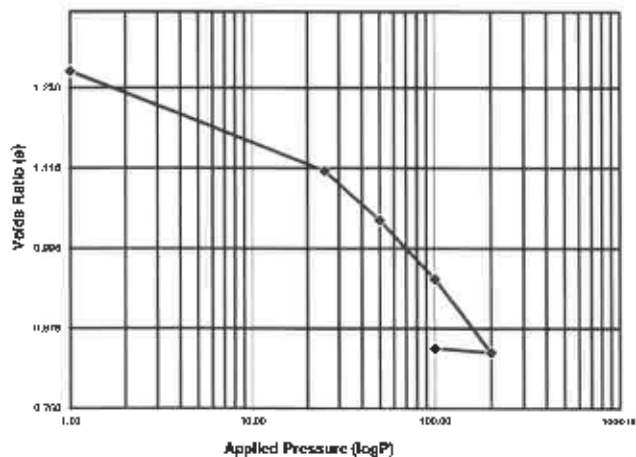
**Test Details**

Location: BH3  
 Sample Ref: U3  
 Sample Description: Soft dark brown dark grey organic CLAY  
 Particle Density ( $\text{Mg/m}^3$ ): 2.7 Assumed  
 Mean Lab Temp. ( $^{\circ}\text{C}$ ): 22  
 Variations from Standard: None  
 Lab Reference: PL6119-1-24  
 Depth: 5.25 m

**Specimen Details**

|                                   | INITIAL  | FINAL |
|-----------------------------------|----------|-------|
| Height (mm):                      | 18.95    | 15.47 |
| Bulk Density ( $\text{Mg/m}^3$ ): | 1.75     | 1.97  |
| Moisture Content (%):             | 47       | 35    |
| Dry Density ( $\text{Mg/m}^3$ ):  | 1.19     | 1.46  |
| Voids Ratio:                      | 1.261    | 0.846 |
| Degree of Saturation (%):         | 100.0    | 100.0 |
| Diameter (mm):                    | 74.91    | N/A   |
| Swelling Pressure (kPa):          | 1        | N/A   |
| Method of time fitting used:      | Log Time | N/A   |

Voids Ratio against logarithm of Applied Pressure



| Applied Pressure (kPa) | Coefficient of Compressibility $m_v$ ( $\text{m}^2/\text{MN}$ ) | Coefficient of Consolidation $c_v$ ( $\text{m}^2/\text{year}$ ) |
|------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------|
| 1                      |                                                                 |                                                                 |
| 25                     | 2.74                                                            | 0.37                                                            |
| 50                     | 1.39                                                            | 0.22                                                            |
| 100                    | 0.86                                                            | 0.22                                                            |
| 200                    | 0.57                                                            | 0.31                                                            |
| 100                    | 0.03                                                            | --                                                              |
|                        |                                                                 |                                                                 |
|                        |                                                                 |                                                                 |

**Comments:**

Approved: [x] M.Hartnup - Laboratory Manager  
 Signatory: [ ] L.Petch - Team Leader

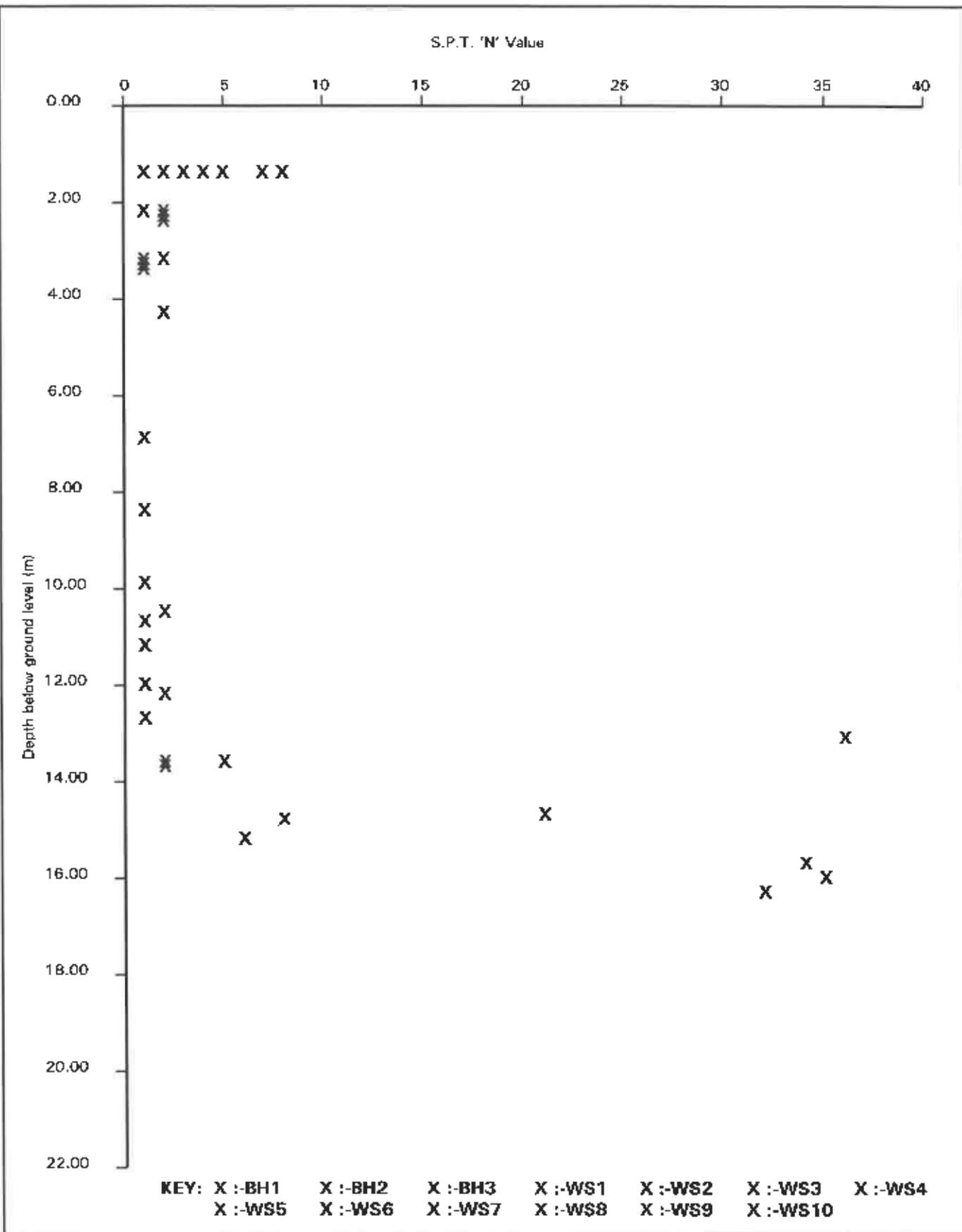
Signed:

for and on behalf of Ground Engineering Ltd

Date Reported: 31/01/2018

Opinions and interpretations expressed herein are outside the scope of the UKAS Accreditation.  
 This report may not be reproduced other than in full without the prior written approval of the issuing laboratory.

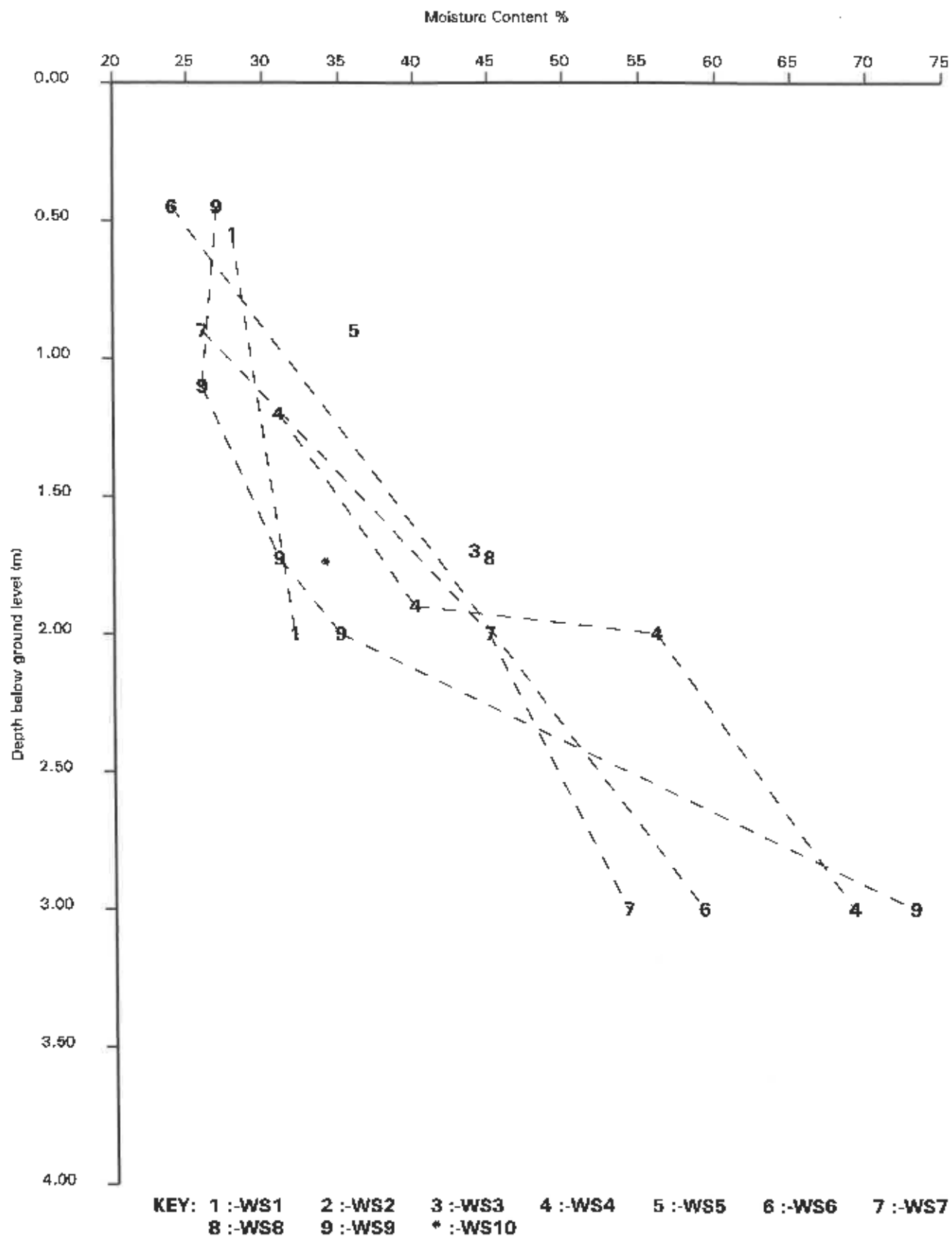
Registered in England Wales  
 Reg Number 6929574  
 Reg Office: Ground Engineering Ltd  
 Newark Rd  
 Peterborough PE1 5UA



S.P.T. 'N' Value vs Depth below ground level (m).

|                                            |  |                                                                                                   |                           |
|--------------------------------------------|--|---------------------------------------------------------------------------------------------------|---------------------------|
| SITE                                       |  | SMALL DROVE, WESTON                                                                               |                           |
| CLIENT                                     |  | SOUTH HOLLAND DISTRICT COUNCIL                                                                    | Contract Number 14022A    |
| <b>GROUND ENGINEERING</b><br>L I M I T E D |  | Tel: 01733-565565<br><a href="http://www.groundengineering.co.uk">www.groundengineering.co.uk</a> | Date 12/02/18<br>Figure 1 |





Moisture Content % vs Depth below ground level (m).

SITE

SMALL DROVE, WESTON

CLIENT

SOUTH HOLLAND DISTRICT COUNCIL

Contract  
Number

14022

**GROUND ENGINEERING**

Tel: 01733-666666

Date

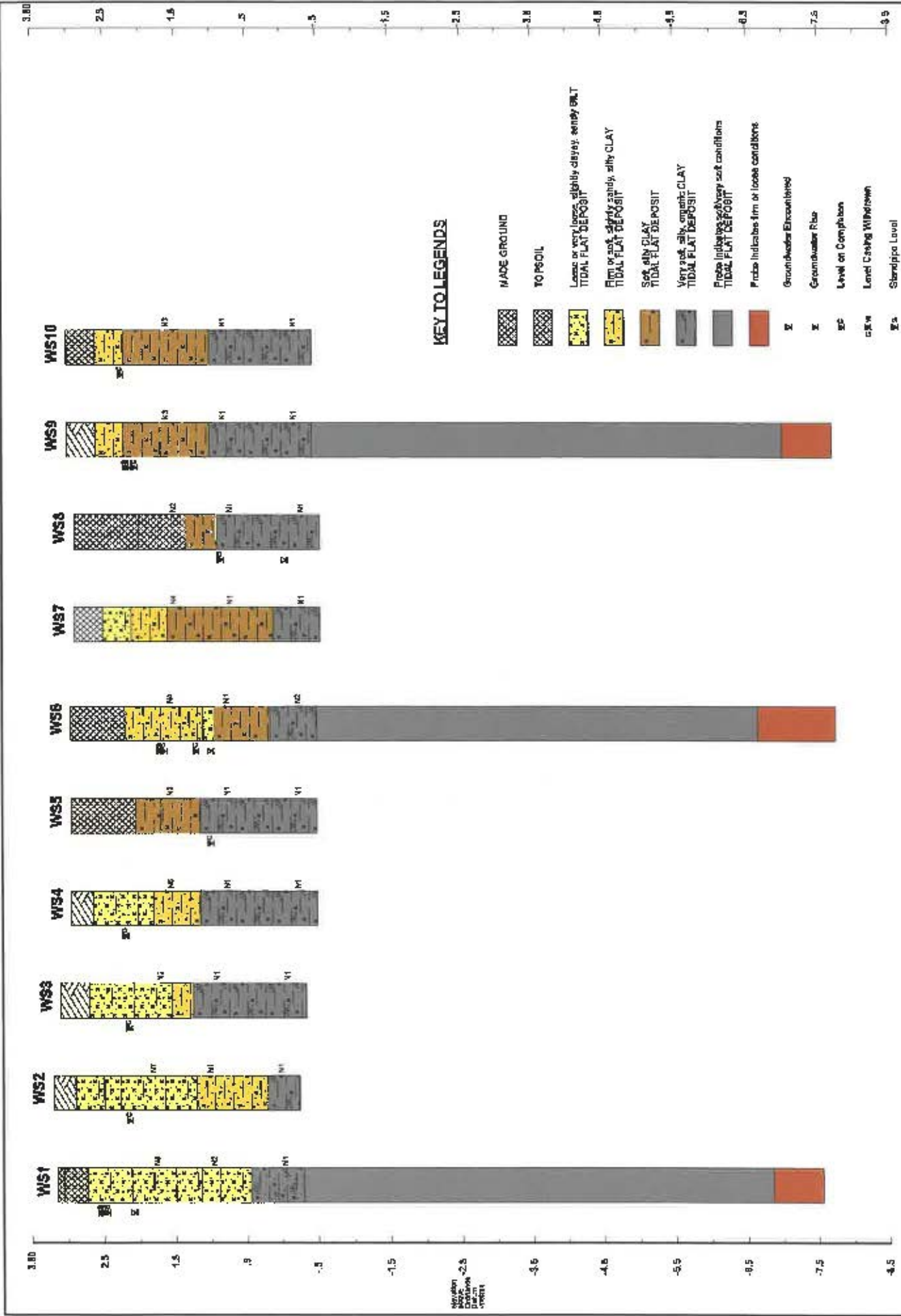
01/03/17

Figure

3

L I M I T E D

www.groundengineering.co.uk

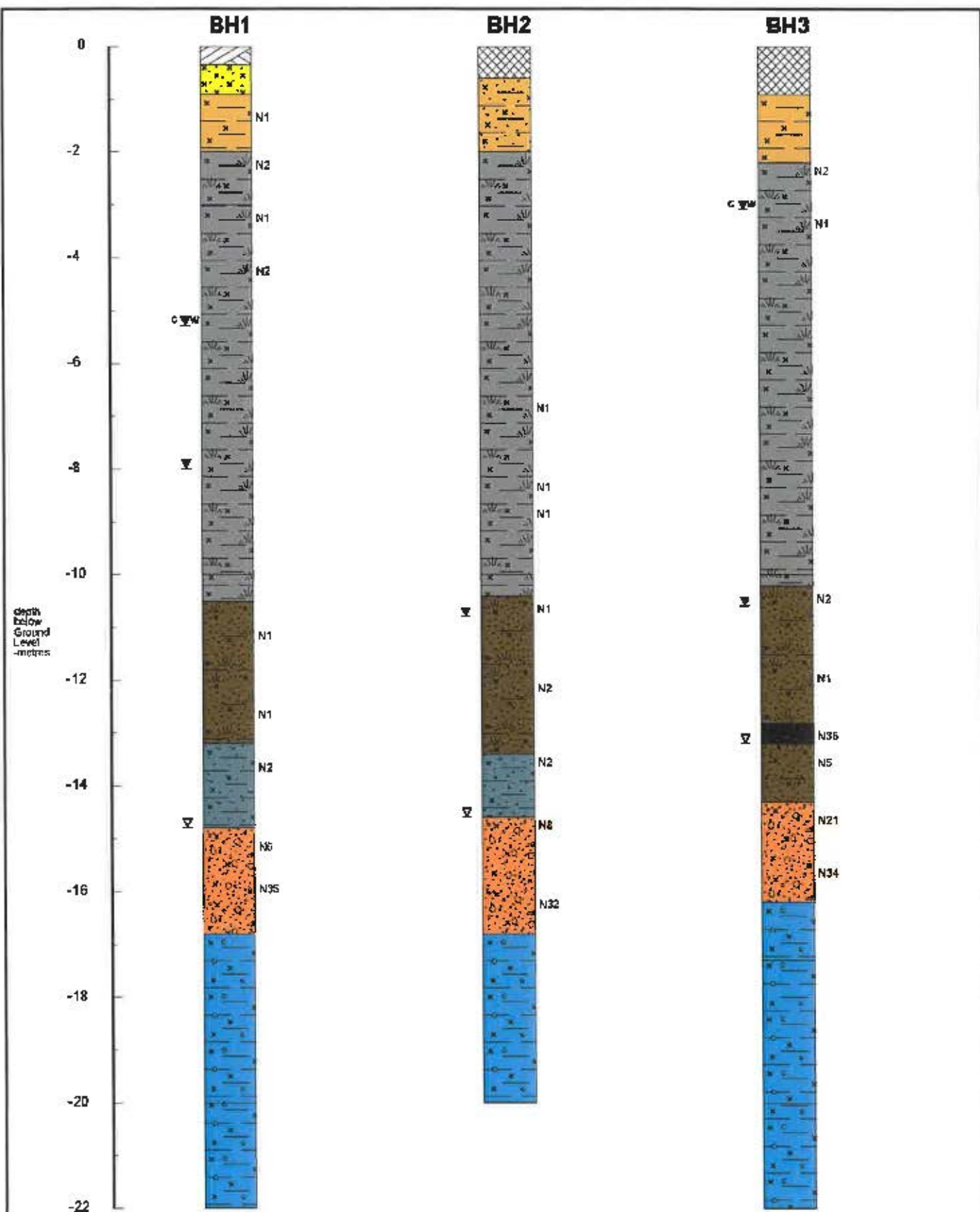


|                                            |                                |                |          |
|--------------------------------------------|--------------------------------|----------------|----------|
| BITE                                       | SMALL DRIVE, WESTON            | Contract No.   | 14022    |
| CLIENT                                     | SOUTH HOLLAND DISTRICT COUNCIL | Vertical Scale | 1:80     |
| S&R ENGINEERING, NEWARK ROAD, PETERBOROUGH | Tel: 01753 588153              | Drawn          | 01/03/17 |
|                                            |                                | Fig. No.       | 4        |

## KEY TO LEGENDS

|                                                                                     |                                                                                                                     |
|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
|    | <b>MADE GROUND</b>                                                                                                  |
|    | <b>TOPSOIL</b>                                                                                                      |
|    | <b>Firm to soft, slightly sandy SILT<br/>TIDAL FLAT DEPOSIT</b>                                                     |
|    | <b>Soft to very soft, silty CLAY<br/>TIDAL FLAT DEPOSIT</b>                                                         |
|    | <b>Very soft, silty organic CLAY<br/>TIDAL FLAT DEPOSIT</b>                                                         |
|    | <b>Very loose, clayey, organic fine SAND<br/>TIDAL FLAT DEPOSIT</b>                                                 |
|    | <b>WOOD<br/>TIDAL FLAT DEPOSIT</b>                                                                                  |
|    | <b>Very soft, slightly sandy, slightly gravelly CLAY/very clayey, slightly gravelly SAND<br/>TIDAL FLAT DEPOSIT</b> |
|    | <b>Medium dense/dense, silty, very gravelly SAND<br/>MARINE SAND AND GRAVEL</b>                                     |
|   | <b>Stiff or very stiff, gravelly CLAY<br/>TILL</b>                                                                  |
|  | <b>Groundwater Encountered</b>                                                                                      |
|  | <b>Groundwater Rise</b>                                                                                             |
|  | <b>Level on Completion</b>                                                                                          |
|  | <b>Level Casing Withdrawn</b>                                                                                       |
|  | <b>Standpipe Level</b>                                                                                              |

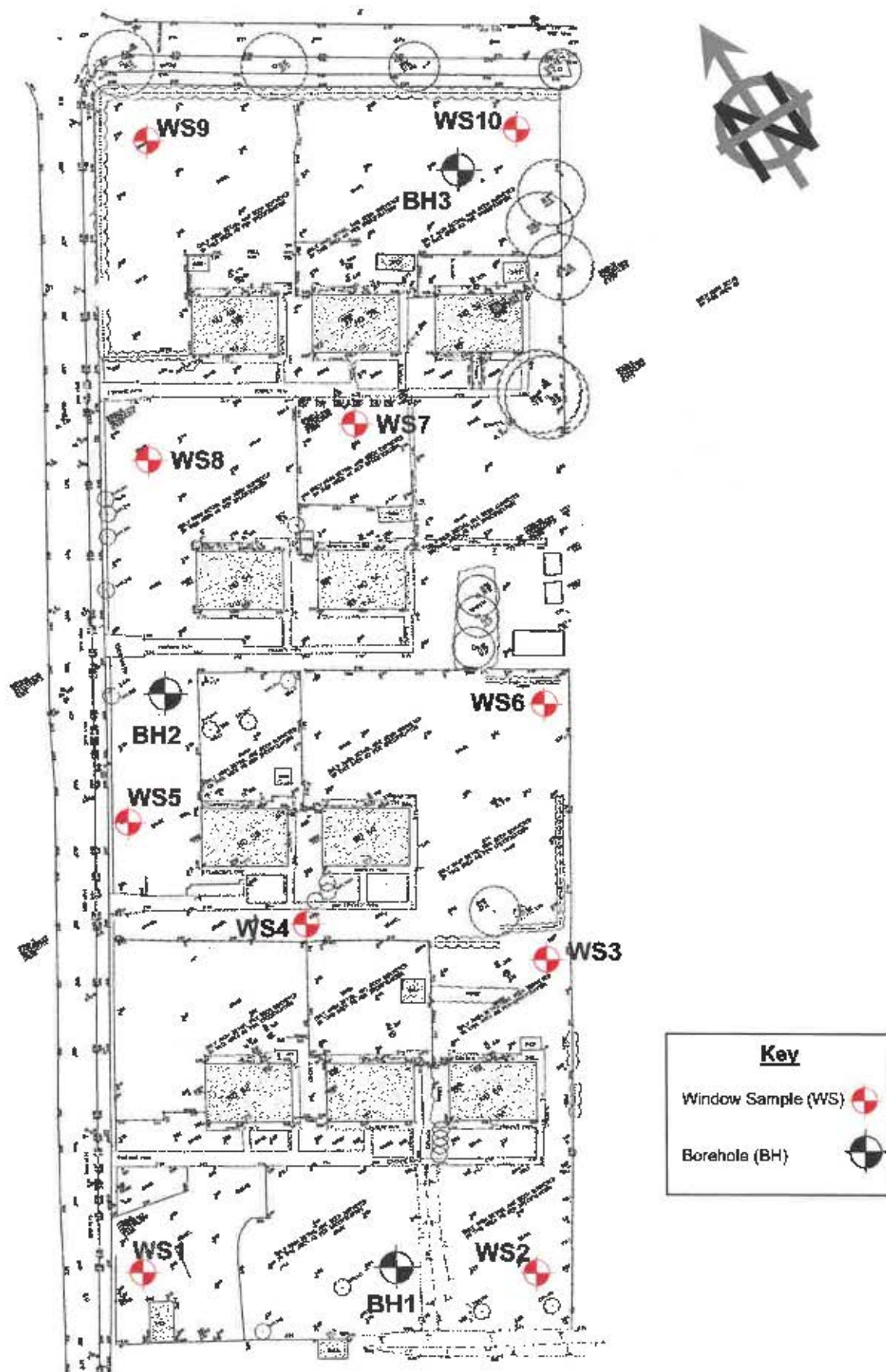
|                                                                                                                                                              |                                       |                     |                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|---------------------|-----------------------------|
| <b>SITE</b>                                                                                                                                                  | <b>SMALL DROVE, WESTON</b>            | <b>Contract No.</b> | <b>14022A</b>               |
| <b>CLIENT</b>                                                                                                                                                | <b>SOUTH HOLLAND DISTRICT COUNCIL</b> | <b>Soil Profile</b> | <b>Vertical Scale 1:100</b> |
|  <b>GROUND ENGINEERING, NEWARK ROAD, PETERBOROUGH. Tel (01733) 566566</b> |                                       |                     | <b>Date 12/02/18</b>        |



|                                                                   |              |                      |
|-------------------------------------------------------------------|--------------|----------------------|
| SITE SMALL DROVE, WESTON                                          |              | Contract No. 14022A  |
| CLIENT SOUTH HOLLAND DISTRICT COUNCIL                             | Soil Profile | Vertical Scale 1:100 |
| GROUND ENGINEERING, NEWARK ROAD, PETERBOROUGH. Tel (01733) 586586 |              | Date 12/02/18        |
|                                                                   |              | Fig. No 5            |

# Borehole Location Plan

Based on a topographic survey plan provided by the client. Not to Scale



Project : Small Drove, Weston

Client : South Holland District Council

**GROUND  
ENGINEERING  
LIMITED**

Peterborough

Tel : 01733 566566

Project No.

**C14022A**

## **APPENDIX 1**

### **CLASSIFICATION OF AGGRESSIVE CHEMICAL ENVIRONMENT FOR BURIED CONCRETE**

**TABLE C1 – AGGRESSIVE CHEMICAL ENVIRONMENT FOR CONCRETE**  
**(ACEC) CLASSIFICATION FOR NATURAL GROUND LOCATIONS<sup>a</sup>**

| Table C1 Aggressive Chemical Environment for Concrete (ACEC) classification for natural ground locations <sup>a</sup> |                            |                         |                            |                    |                    |                   |
|-----------------------------------------------------------------------------------------------------------------------|----------------------------|-------------------------|----------------------------|--------------------|--------------------|-------------------|
| <b>Sulfate</b>                                                                                                        |                            |                         |                            | <b>Groundwater</b> |                    | <b>ACEC</b>       |
| <b>Design Sulfate</b>                                                                                                 | <b>2:1 water/soil</b>      | <b>Groundwater</b>      | <b>Total potential</b>     | <b>Static</b>      | <b>Mobile</b>      | <b>Class for</b>  |
| <b>Class for location</b>                                                                                             | <b>extract<sup>b</sup></b> |                         | <b>sulfate<sup>c</sup></b> | <b>water</b>       | <b>water</b>       | <b>location</b>   |
| <b>1</b>                                                                                                              | <b>2</b>                   | <b>3</b>                | <b>4</b>                   | <b>5</b>           | <b>6</b>           | <b>7</b>          |
|                                                                                                                       | (SO <sub>4</sub> mg/ l)    | (SO <sub>4</sub> mg/ l) | (SO <sub>4</sub> %)        | (pH)               | (pH)               |                   |
| DS-1                                                                                                                  | < 500                      | < 400                   | < 0.24                     | ≥ 2.5              | > 5.5 <sup>d</sup> | AC-1s             |
|                                                                                                                       |                            |                         |                            |                    | 2.5–5.5            | AC-1 <sup>d</sup> |
|                                                                                                                       |                            |                         |                            |                    |                    | AC-2z             |
| DS-2                                                                                                                  | 500–1500                   | 400–1400                | 0.24–0.6                   | > 3.5              | > 5.5              | AC-1s             |
|                                                                                                                       |                            |                         |                            | 2.5–3.5            |                    | AC-2              |
|                                                                                                                       |                            |                         |                            |                    | 2.5–5.5            | AC-2s             |
|                                                                                                                       |                            |                         |                            |                    |                    | AC-3z             |
| DS-3                                                                                                                  | 1600–3000                  | 1500–3000               | 0.7–1.2                    | > 3.5              | > 5.5              | AC-2s             |
|                                                                                                                       |                            |                         |                            | 2.5–3.5            |                    | AC-3              |
|                                                                                                                       |                            |                         |                            |                    | 2.5–5.5            | AC-3s             |
|                                                                                                                       |                            |                         |                            |                    |                    | AC-4              |
| DS-4                                                                                                                  | 3100–6000                  | 3100–6000               | 1.3–2.4                    | > 3.5              | > 5.5              | AC-3s             |
|                                                                                                                       |                            |                         |                            | 2.5–3.5            |                    | AC-4              |
|                                                                                                                       |                            |                         |                            |                    | 2.5–5.5            | AC-4s             |
|                                                                                                                       |                            |                         |                            |                    |                    | AC-5              |
| DS-5                                                                                                                  | > 6000                     | > 6000                  | > 2.4                      | > 3.5              | > 5.5              | AC-4s             |
|                                                                                                                       |                            |                         |                            | 2.5–3.5            | ≥ 2.5              | AC-5              |

**Notes**

- a** Applies to locations on sites that comprise either undisturbed ground that is in its natural state (ie is not brownfield – Table C2) or clean fill derived from such ground.
- b** The limits of Design Sulfate Classes based on 2:1 water/soil extracts have been lowered relative to previous Digests (Box C7).
- c** Applies only to locations where concrete will be exposed to sulfate ions (SO<sub>4</sub>) which may result from the oxidation of sulfides (eg pyrite) following ground disturbance (Appendix A1 and Box C8).
- d** For flowing water that is potentially aggressive to concrete owing to high purity or an aggressive carbon dioxide level greater than 15 mg/l (Section C2.2.3), increase the ACEC Class to AC-2z.

**Explanation of suffix symbols to ACEC Class**

- Suffix 's' indicates that the water has been classified as static.
- Concrete placed in ACEC Classes that include the suffix 'z' primarily have to resist acid conditions and may be made with any of the cements or combinations listed in Table D2 on page 42.