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GROUND INVESTIGATION REPORT

LAND OFF FLEET ROAD
HOLBEACH
LINCOLNSHIRE

Report Reference C15102A

On behalf of:-

Kaplan Property Group
Unit 6
Kibworth Business Park
Nursery Court
Kibworth
LE8 0EZ

December 2020

KAPLAN PROPERTY GROUP

GROUND INVESTIGATION REPORT

FOR

PROPOSED RESIDENTIAL DEVELOPMENT

AT

LAND OFF FLEET ROAD

FLEET

HOLBEACH

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INTRODUCTION

The client, Kaplan Property Group, propose to build a new residential development at land off Fleet Road, Fleet, Holbeach near Spalding in Lincolnshire. The proposed development layout is presented on a plan following this report text.

Ground Engineering Limited was commissioned by the client to carry out a ground investigation to determine the nature and geotechnical properties of the underlying soils, and provide information for the design and construction of the foundations. A contamination assessment was also included within the scope of this report. Ground Engineering Limited had previously undertaken a desk study for the client on this site, report C15102 dated August 2020, which should be consulted for further details. A summary of the desk study is included within this report.

LOCATION, TOPOGRAPHY AND GEOLOGY OF THE SITE

The 2.2hectare site lies along the south side of Fleet Road (B1515), Fleet, Holbeach, near Spalding in Lincolnshire. The site is centred at National Grid Reference TF 3730 2481. The site location is shown on plans following this report text.

The site, within the north-western part of a field, was split into two areas by a north-south aligned drain. The western area was grass, and the eastern area had previously been cut for hay. The drain sub-dividing the site was overgrown. There was a small allotment area adjacent the northern boundary of the site. The site also included a detached house on the western side of a concrete surfaced access road from Fleet Road to the north of the site. The irregular shaped site was bounded by houses fronting Fleet Road and Chapman Mews to the north; by houses fronting Branchô Lane to the west, and was undefined within the field to the south and east. Photographs from the site walkover in July 2020 are presented within the desk study report.

There were trees along the western side of the access road, in the garden of the detached house, which were proposed to be cleared to make way for a new access road for the new development. There were also mature trees and hedges along the western and northern boundaries of the site, as well as in the adjacent gardens to the west and north.

The site stands at an elevation of approximately 3mOD, on level ground within the Lincolnshire Fens.

The geological map for the area, sheet 144 at 1:50,000 scale, shows the site to be underlain by a thick succession of Terrington Beds, more recently identified as Tidal Flat Deposits. These silt and fine sand soils are indicated to rest on the solid geology of the Ampthill Clay Formation at depth. Fleet Road to the north of the site is indicated to be location of the ôprobable Saxon coastlineô Previous work in the vicinity has found a Marine Sand and in turn glacial Boulder Clay or ôTillôbeneath the surface layer of Tidal Flat Deposits.

SUMMARY OF HISTORICAL INFORMATION

The Ordnance Survey map of 1887 showed that the site was undeveloped within fields. A small pond was shown adjacent the north-western corner of the site on the 1904 map extract. The eastern part of the site was denoted to be an orchard in the 1930s, which was no longer denoted by the 1950s. The site has remained undeveloped to the present day, with the exception of the detached house 'Denmaric' fronting Fleet Road, and cloches associated with a small allotment area in the northern part of the site. A north-south aligned drain was shown dissecting the site in the 1960s, and an overgrown truncated part of this drain remained on the site at the time of the site walkover in July 2020.

Off-site, the immediately surrounding area to the west was developed with housing in the 1930s; a house and depot had been built to the north by the late 1930s, with further housing constructed to the north in the 1950s and 1960s. The depot to the north had been extended to the site boundary by the late 1960s, by which time a garage was shown to the north-west of the site. The garage site to the north-west had been redeveloped with housing and a nursery by the early 2000s, and the depot site to the north redeveloped with housing off Chapman Mews by 2010.

SUMMARY OF ENVIRONMENTAL DATA

Historical maps identify a depot on the site, which was actually adjacent and off-site to the north. Historical maps also identify an industrial estate 84m to the north-west; workhouses 96m north-west and 155m west; and hospital/infirmarary 155m west. An unspecified tank is recorded 68m west of the site at a former garage site. An electricity sub-station is recorded 156m west of the site. Historical garages are recorded 1m and 72m west of the site. No areas of potentially infilled land, landfills or waste sites are recognised within 250m of the site.

Current land uses around the site are businesses within the industrial estate to the north-west, and an electricity sub-station. An active petrol station is identified 79m west of the site. A historical COMAH site is identified within the industrial estate to the north-west, as well as a hazardous substance storage site although there are no further details available. A licensed waste oil burner is also recorded at a A&J Services 147m north-west of the site.

A pollution incident for 'smoke' was recorded 40m west of the site in 2003, which had a minor impact on air and no impact on water or land.

No made ground is recorded beneath the site. Superficial Tidal Flat Deposits are recorded beneath the site, which are classified by the EA as an 'unproductive' stratum. The underlying solid geology Ampthill Clay Formation is also classified by the Environment Agency (EA) as an 'unproductive' stratum. There are no groundwater abstractions within 250m of the site. The site is not within a source protection zone.

A surface water drain is identified crossing the site, and other drains are recorded along field and road edges around the site. The site is within a Zone 2 and Zone 3 floodplain, and has a low risk of flooding. The site is within a SSSI impact zone, an environmentally sensitive area.

There is a moderate hazard from running sand and compressible ground; a low hazard from shrinking and swelling clay; a very low hazard from landslides; and a negligible hazard from collapsible rocks and soluble rocks.

The site is not in a radon affected area and no radon protection measures are required for new dwellings on the site.

The site is not in an area where underground mining or brine extraction may have occurred.

PRELIMINARY RISK ASSESSMENT

Potential sources of contamination present on or beneath the site would relate primarily to; the historical use of the site; the presence of contaminated soil; and the potential presence of hazardous or ground gas beneath the site.

In order to assess the risks associated with the presence of ground contamination the linkages between the sources and potential receptors to contamination need to be established and evaluated. This is in accordance with the Environmental Protection Act 1990, which provides a statutory definition of Contaminated Land. To fall within this definition it is necessary that, as a result of the condition of the land, substances may be present on or under the land such that;

- *Significant harm is being caused or there is a significant possibility of such harm being caused; or*
- *Pollution of controlled waters is being, or is likely to be, caused.*

There are three principal factors that are assessed whilst undertaking a qualitative risk assessment for any site. These are the presence of a contamination source, the existence of migration pathways and the presence of a sensitive target(s). It should be noted that it is necessary for each element of source, pathway and target to be present in order for exposure of a human or environmental receptor to occur.

UK Government guidance on the assessment of contaminated land, requires risk to human health and the environment to be reviewed using source ÷ pathway ÷ target relationships. If each of these elements is present, the linkage provides a potential risk to the identified targets.

Contaminants or ***potential pollutants*** identified as ***sources*** in relation to the identified previous uses are listed overleaf in Table 1.

Table 1: Identified Potential Contaminant Sources

<i>Contaminant Source</i>	<i>Comments</i>
Drainage/House	The drain could provide a contaminant source. The existing house may have asbestos containing materials.
Soil Beneath Site	Contamination may be present within any made ground on the site.
Soil Gas	Potential soil gas generated from made ground or natural soils.
Ground Contamination Outside Site Boundary	Ground contamination migrating from adjoining sites, such as the depot to the north or the garage to the west.

A ***Pathway*** is defined as one or more routes through which a receptor is being, or could be, exposed to, or affected by, a given contaminant.

Potential ***Target or Receptors*** fall within the categories of Human Health, Water Environment, Flora and Fauna, and Building Materials.

There are a number of possible pathways for the contaminants identified on the site to impact human and/or environmental receptors and these are summarised in Tables 2 and 3.

Table 2: Human Receptors and Pathways

<i>Human Receptor-Mechanism</i>	<i>Typical Exposure Pathway</i>
Human Inhalation	Breathing Dust and Fumes Breathing Gas emissions
Human Ingestion	Eating -contaminated soil, for example by small children -produce grown on contaminated soil Ingesting dust or soil on vegetables Drinking contaminated water
Human Contact	Direct skin contact with contamination Direct skin contact with contaminated liquids

Table 3: Water Receptors and Pathways

<i>Receptor-Water Environment</i>	<i>Typical Exposure Pathway</i>
Groundwater The superficial Tidal Flat Deposits are indicated to be an 'unproductive' stratum. The underlying solid geology Ampthill Clay Formation is also indicated to be an 'unproductive' stratum. The site is not within a Source Protection Zone.	Surface infiltration of atmospheric waters into the soils beneath the site could wash or dissolve potential contaminants and migrate to underlying groundwater. Contamination leads to restriction/prevention of use as a resource, for example, drinking water, and can have secondary impacts on other resources, which depend on it.
Surface Water/Watercourses A surface water drain crosses the site aligned north-south.	Surface infiltration of atmospheric waters into the soils beneath the site could wash or dissolve potential contaminants and laterally migrate. Contamination leads to a restriction/prevention of use: -as drinking water resource -for amenity use Effects on aquatic life.

Preliminary Conceptual Model

Assessment of the potential linkage between ground contamination sources, human and environmental receptors have been assessed based on the desk study research documented in the preceding sections of this report.

A generalised preliminary conceptual model is presented below in Table 4.

Table 4: Preliminary Conceptual Model Relative to Residential Development

Receptors	Pathway	Estimated Potential for Linkage with Contaminant Sources			
		Drainage/ House	Soil Beneath Site	Soil Gas	Ground Contamination Outside Site Boundary
Human Health i ground workers	Ingestion and Inhalation of contaminated Soil, Dust and Vapour	Low likelihood/ Likely (asbestos)	Low likelihood	Low likelihood	Low likelihood
Human Health i end users	Ingestion and Inhalation of contaminated Soil, Dust and Vapour	Unlikely	Unlikely	Low likelihood	Low likelihood
Water Environment	Migration through ground into surface water or surrounding groundwater	Low likelihood	Low likelihood	Unlikely	Low likelihood
Flora	Vegetation on site growing on contaminated soil	Low likelihood	Low likelihood	Low likelihood	Unlikely
Building Materials	Contact with contaminated soil	Low likelihood	Low likelihood	Low likelihood	Low likelihood
Key to Table 4 Estimated Potential for Linkage with Contaminant Source		Definition			
High likelihood		There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution.			
Likely		There is a pollution linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.			
Low likelihood		There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such an event would take place, and is less likely in the shorter term.			
Unlikely		There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term.			
N/A		Not Applicable.			

SITE WORK

The site work conducted between 4th and 9th November 2020 comprised two cable percussion boreholes (BH1 and BH2) and four hand excavated trial pits (TP1 to TP4). The positions are shown on the exploratory hole location plan following this report text.

Public utility service drawings were sourced and consulted prior to determining the exploratory hole positions. Prior to excavation, a service 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.

The exploratory hole records, presented following the plans, give the descriptions and depths of the various strata encountered, details of all samples taken, in-situ tests, installation details and the groundwater conditions observed during and on completion of boring, and subsequent monitoring.

Cable Percussion Boreholes

The boreholes BH1 and BH2 were undertaken by a standard cable percussive boring rig, using claycutter and shell boring tools within 150mm diameter casing installed to a maximum 15.00m depth. The boreholes were sunk to depths of 15.00m below ground level.

Representative small disturbed and bulk samples of soil were taken from the boring tools at regular intervals throughout the depth of the boreholes.

Standard penetration tests (SPT) were undertaken in order to give an indication of the in-situ density of the soils. The tests were made by driving a split spoon (S) attachment 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 460mm into the soil ahead of the borehole. The SPT test is fully described in BS EN22476:3:2005, the results of these tests are presented on the borehole records, tabulated following the borehole records, and have been plotted against depth in Figure 1 and the soil profile Figure 2.

On completion of both boreholes, gas and groundwater monitoring standpipes were installed to 6.00m depth at each location, with clean arisings below to the base of the boreholes.

The pipes were perforated to within 1.00m of ground level and the annulus backfilled with pea gravel. A bentonite seal was placed from ground surface to 1.00m depth and a gas tap fitted in each installation. Protective stopcock covers were concreted in place at ground level above the installations.

Hand Excavated Trial Pits

Trial pits TP1 to TP4 were excavated using hand tools to either 1.00m or 1.20m depth. The exposed strata were sampled and recorded by a Geoenvironmental Engineer. Representative small, bulk and environmental jar samples of soil were taken at regular intervals throughout the depth of each trial pit.

An immediate assessment of the apparent shear strength of clay was made within the trial pits using a hand shear vane. The apparent cohesion results are presented in kpa on the trial pit records.

A Mackintosh Probe (MP) was used to provide an indication of the density of the soils at regular depth intervals within selected trial pits. The 25mm diameter solid cone point of the probe was screwed onto the rods and driven into the ground by repeated blows of a 4.5kg slide hammer with a fall of 0.30m. The number of blows to penetrate 0.30m depth, or the depth penetrated for 100 blows was recorded and is presented on the trial pit records.

A soakaway test was carried out within trial pit TP1, in broad accordance with BRE Digest 365 (2016) in order to allow the assessment of the soil infiltration rate. The general method of the test was to excavate the trial pit with vertical sides trimmed square to the base. The dimensions were accurately measured and recorded, and the pit was then filled with clean water. The rate of water dissipation from the pit was measured by recording the depth of water relative to a datum at frequent time intervals. Once the water had drained away, the pit was refilled with water and the test repeated on a second and third occasion. The results are presented and follow the trial pit record.

The trial pits were backfilled with compacted arisings upon completion.

Gas and Groundwater Monitoring Visits

As part of the investigation three return visits were made to site on 13th, 20th and 27th November 2020, when the standpipes installed within boreholes BH1 and BH2 were monitored for a standing groundwater level and for landfill type gases using a Gasdata GFM436 analyser. The results of the monitoring visits are presented following the exploratory records.

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 and trial pit records. The soil descriptions have been made in accordance with BS5930:2015+A1:2020. The geotechnical test results, undertaken in accordance with BS1377:1990 & 2016, are presented following the exploratory hole records. The chemical test results follow the geotechnical test results.

The moisture content and index properties of selected soil samples were determined as a guide to soil classification and behaviour. The liquid limit was determined by a cone penetrometer.

The particle size distribution of selected samples of silt and sand were determined by sieve analysis. The particle size distribution passing the 63µm sieve was obtained by pipette sedimentation on selected samples. Results of these tests have been combined and are presented as particle size distribution curves at the end of this report.

California Bearing Ratio (CBR) tests were performed on selected recompacted near surface samples in accordance with Lincolnshire County Council's specification. The samples were recompacted using a 2.5kg rammer (BS light), and the test consisted of jacking into the soil a cylindrical plunger with a cross sectional area of 1935mm². A force of 50N was applied initially to seat the plunger on the soil surface and then the plunger was made to penetrate the soil at a uniform rate of 1mm/min. Readings of force were taken at intervals of penetration of 0.25mm to a penetration not exceeding 7.50mm. The CBR value is the ratio of the force required to achieve 2.5mm or 5.0mm penetration to standard forces expressed as a percentage.

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

Chemical analysis of five soil samples recovered from the exploratory holes was undertaken, by an independent laboratory, primarily for characterisation purposes. The samples were tested for a suite encompassing a wide range of potential contaminants outlined by the

Environment Agency (EA) and National House Building Council (NHBC) document R&D 66;
2008 'Guidance for the Safe Development of Housing on Land Affected by Contamination'

GROUND CONDITIONS

The ground conditions have been plotted as a soil profile in Figure 2. The ground conditions comprised a surface layer of made ground to between 0.20m and 0.75m depth, underlain by superficial Tidal Flat Deposits comprising sandy, silty clay to between 0.70m and at least 1.20m depth, and in turn loose Marine Sand which became medium dense with depth. The anticipated Till (Boulder Clay) was not encountered in the boreholes within 15.00m depth. Groundwater was recorded between 1.25m and 1.35m depth during the investigation.

Made Ground

Made ground was encountered to between 0.20m and 0.75m depth. The made ground generally comprised firm or stiff, brown and dark brown, slightly gravelly, sandy, silty clay. The gravel fraction comprised angular to rounded flint, quartzite, igneous rock, and locally (TP1 and TP2) with occasional ash, concrete, brick and plastic fragments.

Tidal Flat Deposits

Beneath the surface made ground at between 0.20m and 0.75m depth, firm or stiff, orange brown, light brown and light grey, sandy, silty clay was encountered. These soils were considered to represent the anticipated superficial Tidal Flat Deposits, and were encountered to depths of between 0.70m (BH2 & TP2) and at least 1.20m (TP3). Trial pits TP1 and TP3 were completed within the Tidal Flat Deposit soils.

Marine Sand

At depths of between 0.70m and 0.85m, light brown, orange brown and light grey, slightly clayey, silty to very silty fine sand, varying to clayey, very sandy silt (BH2), was encountered. These sand soils were initially loose becoming medium dense below about 5.00m depth, which were considered to represent superficial Marine Sand. Below 5.00m depth the

Marine Sand comprised a brown, silty fine sand with occasional shell fragments, which was encountered to at least the base of the boreholes at a depth of 15.00m.

Groundwater

Groundwater seepages were recorded during boring at 3.30m and 3.50m depth. No groundwater was recorded during excavation or on completion of the shallow trial pits. Groundwater was recorded at 1.50m depth in BH2, and was recorded at 2.00m below ground level in BH1, on completion of the boreholes and removal of the casing, however these levels may have still been rising. During monitoring of the standpipes in November 2020 groundwater was recorded at between 1.35m depth (BH1) and 1.25m depth (BH2).

Observations

Live roots were observed to a maximum depth of 0.60m in TP4.

Excavation Stability

The shallow trial pit sides were stable during excavation and on completion to 1.20m depth.

Evidence of Contamination

The made ground encountered during this investigation was not noted to have olfactory or visual evidence of fuel contamination. The made ground contained occasional fragments of ash, concrete, brick and plastic. No asbestos containing materials were noted in the soils during this investigation, or during testing.

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

This investigation found made ground to depths of between 0.20m and 0.75m, covering superficial firm or stiff, Tidal Flat Deposits, and in turn loose becoming medium dense, Marine Sand to at least 15.00m depth. Groundwater was recorded as shallow as 1.25m depth during the investigation. The superficial deposits (clay, silt and sand) could offer support for lightly to modest loaded traditional foundations for the proposed housing development, however large irregular shaped buildings and heavy loads are likely to require piled foundations.

The proposed development was understood to comprise construction of new semi-detached and terraced dwellings, with associated access roads and gardens. Foundations will need to extend through the root affected, stiff and cohesive Tidal Flat Deposits, into the water bearing, loose, very sandy silt/silty sand of the Marine Sand, or possibly piled into the Marine Sand at depth. Excavations below 1.25m depth are likely to encounter groundwater which will need to be controlled.

Traditional Shallow 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. The made ground had variable bearing properties and was found to a maximum depth of 0.75m, but may be deeper along the line of the infilled drain. The made ground should be avoided as bearing strata.

Samples of the near surface clay had modified plasticity indices of between 8% and 23%, and the silty clay is rated as 'non-shrinkable' to having a low or medium volume change potential based on NHBC Standards Chapter 4.2 'Building near trees' (2020). A minimum foundation depth of 0.90m in the naturally deposited clay soils beneath this site, where remote from trees, would be considered appropriate in order to penetrate the zone affected by seasonal moisture content and volume change.

In summary, foundations for the new dwellings will need to be a minimum of 0.90m deep, and preferably extended into non-shrinkable silty sand soils where present. Piled foundations may provide an economic alternative to support the proposed dwellings, particularly as foundations greater than 1.25m deep will extend below the groundwater table.

Bearing Capacity

Foundations should be extended to bear within the non-shrinkable, loose and medium dense silty fine sand Tidal Flat Deposits, encountered below 0.70m to 1.20m depth, which could provide a suitable founding stratum. The naturally deposited silty sand has an allowable bearing pressure of 80kN/m² for foundations up to 1.20m wide, and 75kN/m² for foundations up to 2.00m wide. These bearing pressures should limit immediate settlement to 25mm. Similarly, the Tidal Flat Deposits beneath a nominal 12m by 8m raft foundation would have an allowable bearing pressure of 30kN/m² which should limit the immediate settlement to 50mm.

Excavations

The made ground together with the underlying soils should be easily removed within excavations for the proposed buildings. The sides of excavations within any made ground, Tidal Flat Deposits and Marine Sand, may be unstable and should not be relied upon to stand unsupported.

Excavations could be expected to encounter groundwater at depths between 1.25m and 1.35m. The groundwater levels may fluctuate seasonally and such inflows would locally be accompanied by 'running sand' conditions and resulting side instability. Care should be taken not to excavate below the water table in the absence of suitable groundwater control, such as dewatering via screened sumps or well points and side support by interlocking sheeting. The clays, and silty sands are prone to softening, deterioration and loosening in the presence of water, with loss of their modest bearing properties. Care should be taken to keep the excavations dry.

Attention should be given where personnel are to enter deep excavations, when sides should either be safely battered back, or close side support provided, in order to comply with statutory safety requirements and prevent sidewall collapse.

Piled Foundations

If foundations are required below 1.25m deep, and extending below the groundwater table, then piled foundations may be preferable. The underlying Marine Sand would provide a suitable pile bearing stratum. The advice of a specialist piling contractor should be sought with regard to suitable methods of pile installation. The silty Marine Sand will require use of casing for bored piles and attention should be made to the possibility of necking of concrete within such soils. Driven, bored or Continuous Flight Augered (CFA) piles could be used.

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

1. The ultimate load on a pile would be the sum of the adhesion in clay, and friction in sand, acting on the shaft of the pile together with the end bearing load.
2. The adhesion acting on the shaft of a pile is a function of the values of apparent cohesion within the clay, presented on the laboratory test results.
3. The friction acting on the shaft of a pile is a function of the density of silt and sand, taken from the SPT N values presented on the borehole records, plotted against depth in Figure 1 and on the soil profile in Figure 2, together with the effective overburden pressure.
4. The end bearing load in Marine Sand would be a function of the in-situ test results presented on the borehole records, plotted against depth in Figure 1, on the soil profile Figure 2, and the effective overburden pressure.
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 (F) would be

increased to at least 2.5. A factor of safety of 3.0 would be used on predominantly end bearing piles, as would be the case on this site.

6. Where piles are installed in groups it will be necessary to position them at least 3.0 diameters apart, centre-to-centre, otherwise a reduction in individual working load will need to be taken into account.

Item	Ultimate Pile Bearing Value (kN/m ²)
Adhesion in made ground or root affected clay	Ignored
Adhesion/friction in Tidal Flat Deposits to 1.20m	25
Friction in Marine Sand to 7.00m depth	15
Friction in Marine Sand 7.00m to 15.00m depth	20
End bearing in medium dense Marine Sand below 7.00m depth	3200
End bearing in medium dense Marine Sand below 10.00m depth	5200

Based on these coefficients at BH1, it is estimated that a single 450mm diameter bored pile installed to 7m depth within the medium dense Marine Sand, would have a working load of 200kN (F=3.0), increasing to 330kN (F=3.0) at 10m depth.

Larger diameter piles would have increased working loads. For example, the same 7m and 10m length piles at 600mm diameter would have working loads of 340kN and 565kN respectively, both with a factor of safety of 3.0 applied.

The advice of a specialist piling contractor should be sought prior to design.

Floor Slabs

Ground bearing floor slabs could be adopted for the new properties where they are beyond the zones of influence from trees, and the naturally deposited clay/silt and non-shrinkable silty sand soils are present at shallow depth.

Ground bearing floor slabs should not be adopted for proposed buildings within influencing distance of neighbouring trees, particularly where buildings are proposed close to the

site margins. Damaging differential heave movements could occur across such slabs, particularly where they cover any clay affected by recently severed tree roots. Suspended floor slabs will be required to avoid the anticipated large total and differential consolidation settlements, together with any volume change movements within root affected clays, providing that the sub-floor gaps recommended in Table 7 of the NHBC Standards Chapter 4.2 (2020), are adopted.

Raft foundations should avoid problems associated with shallow root affected clays, since they will require a minimum depth of 0.75m and in areas close to trees they will need to be placed on a compacted stone blanket extending up to 1.25m below ground level.

Hardstanding

Naturally deposited, generally firm or stiff, silty clays or loose, clayey or silty fine sand was encountered at sub-grade level across this site.

Based on IAN 73/06, Table 5.1 recommends a design CBR value of 1% for silt, and 3% for sandy clay with a plasticity index of 10%.

Laboratory CBR tests yielded CBR values ranging between 0.6% and 2.5%. A design CBR value of 1.0% for the naturally deposited sandy, silty clay should be adopted for hardstanding design on this site, although the pavement construction will need to be at least 450mm thick since the silty soils are considered to be potentially frost susceptible in accordance with Road Note 29, Appendix 1.

The sub-grade should be suitably compacted and inspected, with any topsoil, very soft, organic or desiccated clays being removed and replaced with suitable well-graded coarse-grained fill. Care should be taken not to allow exposed silt/clay soils at sub-grade level to become exposed to inclement weather conditions, since they are prone to rapid softening and deterioration. 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.

Sulphate Conditions

Sulphate analysis of selected samples of soil and groundwater yielded soluble sulphate concentrations within Design Sulphate Class DS-1 of the BRE Special Digest 1, Table C1 (2001), presented in Appendix 1. The pH results of the samples ranged between 6.7 and 8.2 indicating slightly acidic to alkaline conditions.

These results indicate an Aggressive Chemical Environment for Concrete (ACEC) Class of AC-1 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.

Drainage

The soakaway test in the northern part of the site (TP1) gave soil infiltration rates (f) between $2.54 \times 10^{-5} \text{m/s}$ and $4.12 \times 10^{-5} \text{m/s}$ within the sandy, silty clay Tidal Flat Deposits. These results rate the ground as having a 'good' drainage potential according to Figure 6 of BS8004:1986.

The shallow groundwater table, standing below around 1.25m depth, will limit the effective depth of soakaway drainage on this site. Soakaways should not be located within, or discharged into, thick made ground, since the fill would be susceptible to volume loss on inundation, with resulting subsidence of any structures or hardstanding built on it. There is also potential for movements either due to the removal of fines and subsequent settlement of structures based upon these soils.

Soakaway chambers should have provision for cleaning since they are prone to silting up within the Tidal Flat Deposits.

COMMENTS ON THE SOIL CHEMICAL TEST RESULTS

The results of the laboratory chemical testing on near surface soil samples have primarily been compared to soil screening values (SSVs) produced by Land Quality Management Limited (LQM) and the Chartered Institute for Environmental Health (CIEH) presented in their document 'The LQM/CIEH S4ULs for Human Health Risk Assessment: 2015 (Publication Number S4UL3608)'. The LQM/CIEH S4ULs are intended for use in assessing the potential risks posed to human health by contaminants in soil and are transparently-derived and cautious 'trigger values' above which further assessment of the risks or remedial action may be needed. The S4ULs (Suitable for Use Levels) have been derived, in accordance with UK legislation and Environment Agency policy, using a modified version of the Environment Agency CLEA 1.06 software.

Reference has also been given to ATRISKsoil soil screening values produced by Atkins Limited and provided under licence to Ground Engineering Limited. Atkins SSVs have been derived in line with the Environment Agency 2009 guidance using the CLEA 1.071 software. With the absence of a S4UL for cyanide the ATRISKsoil SSV has been used as the soil screening criteria within this report.

In 2014 the Department for Environment Food and Rural Affairs (DEFRA) published, in their document SP1010, Category 4 Screening Levels (C4SL) for several contaminants including lead. The C4SL represent screening levels below which the land could be considered suitable for a specified use and definitely not contaminated land in respect of those determinands. With the absence of S4UL for lead the C4SL has been used as the soil screening criteria within this report.

For each contaminant the adopted soil screening criteria have been calculated for the following land uses:

- Residential use with home grown produce
- Residential use without home grown produce
- Commercial and industrial usage

The intended purpose of the SSVs are as 'intervention values' in the regulatory framework for assessment of human health risks in relation to land use. These values are not binding standards, but are intended to inform judgements about the need for action to ensure that a new use of land does not pose any unacceptable risks to the health of the intended users.

Table 5 compares the test results for the made ground with the SSVs in relation to the specified uses. The number of test results, which exceed these values, are also provided. Statistical analysis would not be meaningful for the small dataset and has not been undertaken.

Table 5: Comparison of Chemical Test Results with SSVs for Near Surface Soils

Determinand	Number of Samples	Min Value mg/kg	Max Value mg/kg	Number of Samples Exceeding SSV for			Assessment Method	Soil Screening Criteria 1.0% SOM		
				Residential with home grown produce	Residential without home grown produce	Commercial/ Industrial		Residential with home grown produce mg/kg	Residential without home grown produce mg/kg	Commercial/ Industrial mg/kg
Organic Matter	5	1.8%	3.0%	-	-	-	-	-	-	-
Arsenic	5	15	19	0	0	0	S4UL	37	40	640
Cadmium	5	<0.2	<0.2	0	0	0	S4UL	11	85	190
Chromium (III)	5	21	31	0	0	0	S4UL	910	910	8600
Chromium (VI)	5	<4.0	<4.0	0	0	0	S4UL	6	6	33
Lead	5	26	44	0	0	0	C4SL	200	310	2330
Mercury	5	<0.3	<0.3	0	0	0	S4UL	11	15	320
Selenium	5	<1.0	<1.0	0	0	0	S4UL	250	430	12,000
Nickel	5	17	21	0	0	0	S4UL	130	180	980
Phenols	5	<1.0	<1.0	0	0	0	S4UL	120	440	440
Benzo[a]pyrene	5	<0.05	<0.05	0	0	0	S4UL	0.79	1.2	15
Copper	5	12	33	0	0	0	S4UL	2400	7100	68,000
Zinc	5	50	130	0	0	0	S4UL	3700	40,000	730,000
Free Cyanide	5	<1	<1	0	0	0	ATRISK	34	34	34

Notes

S4UL and C4SL for metals were derived using 6% SOM. These values are not sensitive to SOM and would also be applicable for 1% SOM and 2.5% SOM.

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ATRISKsoil SSVs produced by Atkins Limited and provided under licence to Ground Engineering Limited.

Discussion of Soil Results

The results of the laboratory analysis indicate that the levels of all elements and compounds in the samples tested were within the associated soil screening values for both residential end uses and for commercial/industrial end use.

The made ground encountered during this investigation was not noted to have olfactory or visual evidence of fuel contamination.

No asbestos containing materials (ACM) were observed within the made ground soils during site work or testing in the laboratory.

In conclusion, the near surface soils would be suitable in the proposed gardens and landscaped areas of the residential development, and if geotechnically suitable could be used beneath buildings and areas of permanent hardstanding.

SOIL GAS MONITORING RESULTS

The results of soil gas monitoring of the installations within WS1 and WS3 during the return visits in November 2020, found up to 0.2% methane and up to 1.8% carbon dioxide, with near atmospheric oxygen levels. The in-situ measurements recorded flow rates of less than 0.10l/hr. The results are tabulated following the borehole and trial pit records. These in-situ measurements indicate a gas screening value (GSV) of 0.0018l/h.

This GSV falls within Characteristic Situation CS1 as defined by BS8485:2015+A1:2019 'Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings'. Based on these levels, gas protectionary measures are not required for the proposed dwellings on this site.

UPDATED CONCEPTUAL MODEL

Assessment of the potential linkage between ground contamination sources, human and environmental receptors have been assessed based on the desk study research and the intrusive ground investigation documented in the preceding sections of this report.

A generalised conceptual model relative to the existing site and proposed residential use of the site is presented in Table 6 below.

Table 6: General Conceptual Model Relative to Future Residential Development

Receptors	Pathway	Estimated Potential for Linkage with Contaminant Sources			
		Drainage/ House	Soil Beneath Site	Soil Gas	Ground Contamination Outside Site Boundary
Human Health i ground workers	Ingestion and Inhalation of contaminated Soil, Dust and Vapour	Low/ Moderate	Low	Low	Very Low
Human Health i users of completed development	Ingestion and Inhalation of contaminated Soil, Dust and Vapour	N/A	Very Low	Very Low	Very Low
Water Environment	Migration through ground into surface water or groundwater	Low	Very Low	Very Low	Low
Flora	Vegetation on site growing on contaminated soil	Very Low	Very Low	Very Low	Very Low
Building Materials	Contact with contaminated soil	Very Low	Very Low	Very Low	Very Low

<u>Key to Table 6</u> Risk	Definition
Very High	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, or, there is evidence that severe harm to a designated receptor is currently happening. The risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.
High	Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) and remedial works may be necessary in the short term and likely over the long term.
Moderate	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild.
Low	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.
Very Low	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.
N/A	Not Applicable because the proposed development will remove the source.

COMMENTS ON GROUND CONTAMINATION IN RELATION TO PROPOSED DEVELOPMENT

Anticipated exposure scenarios relating to the existing site, the site history and proposed residential end use of the site, in the context of the conceptual model, are discussed as follows.

This investigation may not have revealed the full extent of contamination on the site and appropriate professional advice should be sought if subsequent site work reveals materials that may appear to be contaminated.

Contaminated Soil

On the basis of the ground investigation, the site is underlain by between 0.20m and 0.75m of made ground. The chemical testing has not identified elevated concentrations of contaminants and the soils would be suitable for use in respect to the proposed gardens or soft landscaping in the residential development, and if geotechnically suitable beneath buildings or areas of permanent hardstanding. The absence of elevated contaminants in the made ground indicates that there is a low risk of contaminants affecting groundworkers during any construction works, and there will be a very low risk of affecting future end users of the site.

The underlying naturally deposited soils encountered beneath the site would also be considered suitable for retention and re-use within the development if required.

Existing Drainage

Redundant foul or surface water drain runs, if present, should be removed where encountered from beneath the site and precautions should ensure that any remaining effluent or sediment is directly disposed off-site. The integrity of the existing drains should be checked, and where they are to be retained, any damaged sections should be replaced prior to development.

The ditch crossing the site should be cleared of debris and culverted prior to the proposed development.

Buildings

The existing building within the site may have asbestos containing materials within it and an asbestos survey should be undertaken prior to the proposed redevelopment. Suitable precautions, in line with current best practice, should be put in place to protect workers from the effects of asbestos material, during the site clearance and redevelopment phases.

There is a very low risk of contamination affecting the existing and proposed structures, and their foundations.

Soil Gas

According to the environmental database there are no landfills recorded within 250m of the site. The site is generally underlain by a thin layer of made ground, covering variable Tidal Flat Deposits and in turn Marine Sand at depth.

There is a low risk that hazardous gases would affect groundworkers during the construction phase and a very low risk of hazardous gases affecting future users of the site.

Consideration should be given to gas monitoring within deep or confined spaces, particularly where thick made ground and organic soils are present, to ensure safety of personnel entering them, since carbon dioxide could accumulate within any excavations, service chambers or sub-structures.

The site is not in a radon affected area, and no radon protection measures are required for new properties on the site.

Human Health - Construction Workers

Based on the chemical test results, no special precautions would be required during the development of the site by workers who may come into contact with the soil during groundworks, providing standard precautions are adopted which should generally include the procedures given by the Health and Safety Executive (The Blue Book) HS(G)66.

For the protection of workers during groundworks the following is recommended:

a) Limit repeated or prolonged skin contact with soils by wearing gloves with sleeves rolled down.

b) Washing facilities should be made available to groundworkers, so as to minimise the potential for inadvertent ingestion of soil.

c) If any soils are revealed which are different to those encountered by this ground investigation, the advice of a specialist should be sought in view of classifying the material and ascertaining its risk to groundworkers.

d) Suitable precautions, in line with current best practice, should be put in place to protect workers from the effects of asbestos containing material, during the site clearance phase.

e) Consideration should be given to gas monitoring within deep or confined spaces to ensure safety of personnel entering them, since carbon dioxide generated from the made ground soils beneath this site could accumulate within any confined excavations, service chambers or sub-structures. Such precautions would reduce the exposure of groundworkers to gas to a low likelihood.

Human Health - Users of Completed Development

The results of the chemical analysis undertaken would indicate that the made ground and near surface soils should be considered suitable for re-use at the surface in any new garden, landscaped or planted areas.

The made ground could be considered for re-use beneath proposed buildings and permanent hardstanding, if suitable for engineering purposes, where there is a very low risk to affect future users of the site, however these soils could affect buried services.

Any soil imported to site must be certified as "suitable for use".

Water Environment

Superficial Tidal Flat Deposits are recorded beneath the site, which are classified by the EA as an 'unproductive' stratum. The underlying solid geology Ampthill Clay Formation is

also classified by the EA as an ‘unproductive’ stratum. There are no groundwater abstractions within 250m of the site. The site is not within a source protection zone.

A surface water drain is identified crossing the site, and other drains are recorded along field and road edges around the site. The site is within a Zone 2 and Zone 3 floodplain, and has a low risk of flooding. The site is within a SSSI impact zone, an environmentally sensitive area.

Groundwater was recorded as shallow as 1.25m below ground level during the investigation.

There is a very low risk that the proposed development and contaminants within the made ground soils would impact the quality of the water environment.

Effects on Building Materials and Buried Services

The sulphate requirements for buried concrete have been discussed in the previous section of this report.

The local water supply company should be consulted if new buried plastic water pipes are to be installed within the made ground soils on this site.

Off-Site Disposal of Soil Arisings

The results of chemical analysis are provided following the exploratory hole records and can be used within the information necessary for basic characterisation of the soil destined for landfill. The Environment Agency publication Hazardous Waste, Technical Guidance WM3 outlines the methodology for classifying wastes and should be referenced for guidance. The test results (total metals, hydrocarbons and cyanide) should be compared to the relevant thresholds to determine whether they fall into the primary categories of non-hazardous or hazardous waste and will help indicate the likely European Waste Catalogue (EWC) code which is determined by the waste type. Asbestos containing materials would be considered hazardous and should be appropriately disposed of.

Excavated material and excess spoil should always be classified prior to removal from site as required by 'Duty of Care' (Environmental Protection Act, 1990) legislation. This means that material has to be given a proper description and waste classification prior to removal. Basic characterisation is the responsibility of the waste producer, whilst compliance checking and on-site verification are generally the responsibility of the landfill operator. The landfill operator will need to liaise with the waste producer, as the approach relies on the information from basic characterisation.

It is expected that arisings of natural soils from the excavations across this site would fall into the inert category under the European Waste Catalogue description 'Soil and Stones', EWC code 17 05 04 with restrictions excluding topsoil and peat.

GROUND ENGINEERING LIMITED

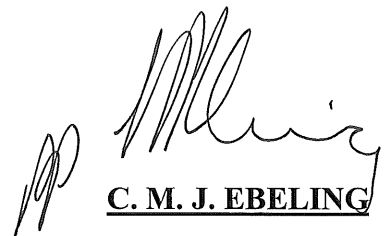


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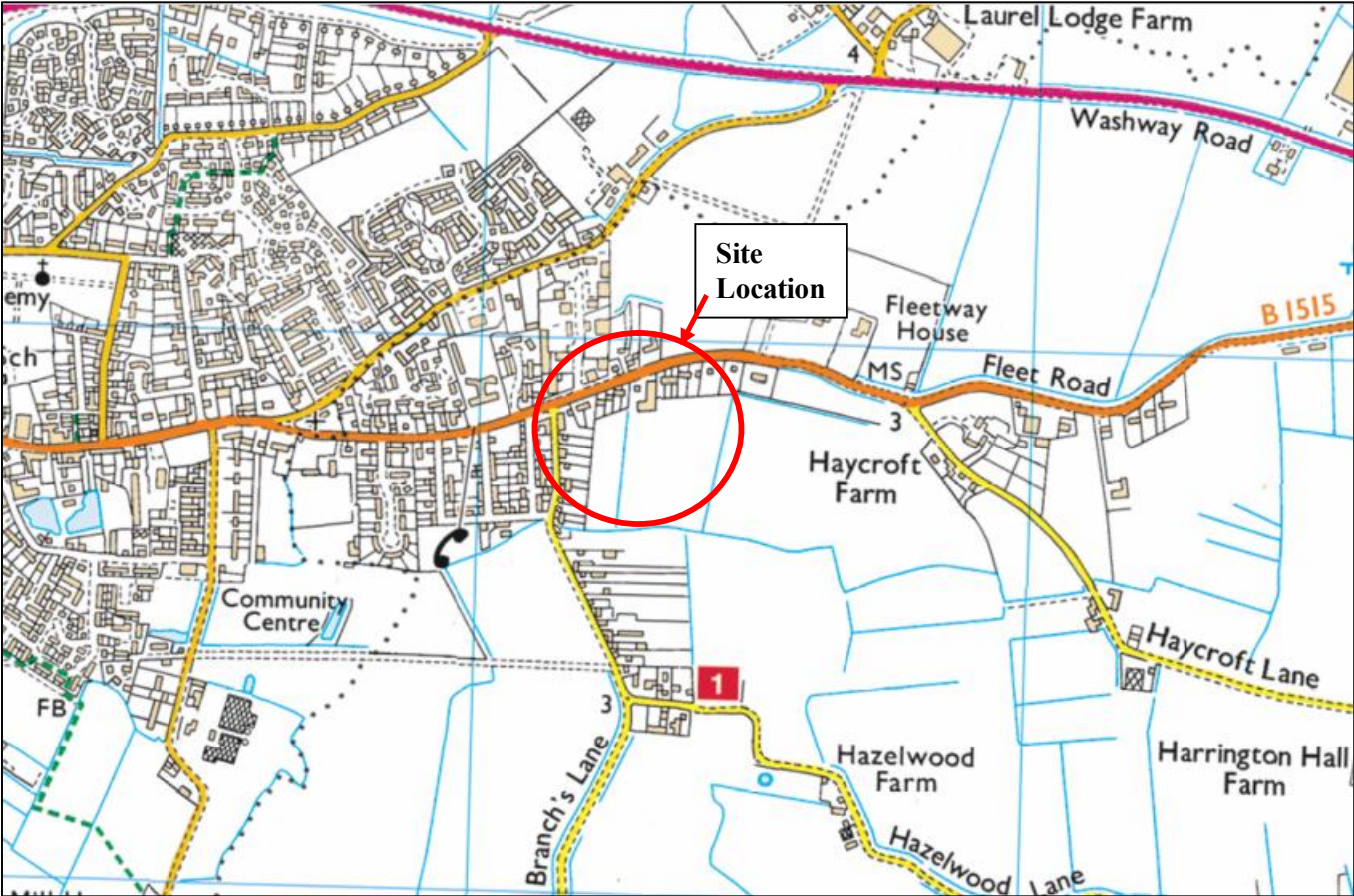
M.Sc.(Eng.), M.A.E.G.,

C.Geol., F.G.S.

Director

Site Location Plan

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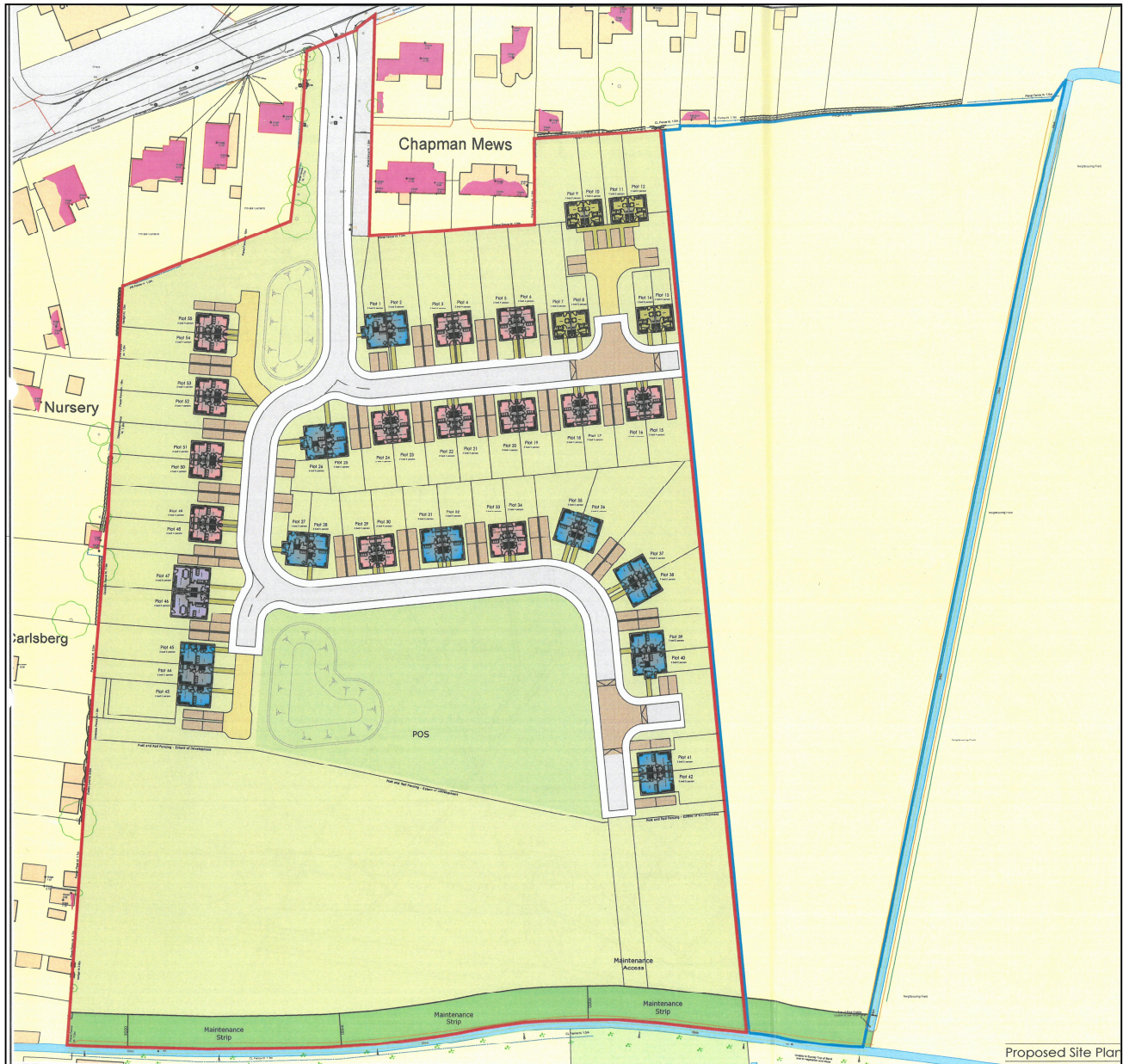


Not To Scale

Project : Land off Fleet Road, Fleet, Holbeach	GROUND ENGINEERING LIMITED	Project No.
Client : Kaplan Property Group	Peterborough	C15102A
	Tel : 01733 566566	

Proposed Site Plan

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Project : Land off Fleet Road, Fleet, Holbeach

Client : Kaplan Property Group

**GROUND
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LIMITED**

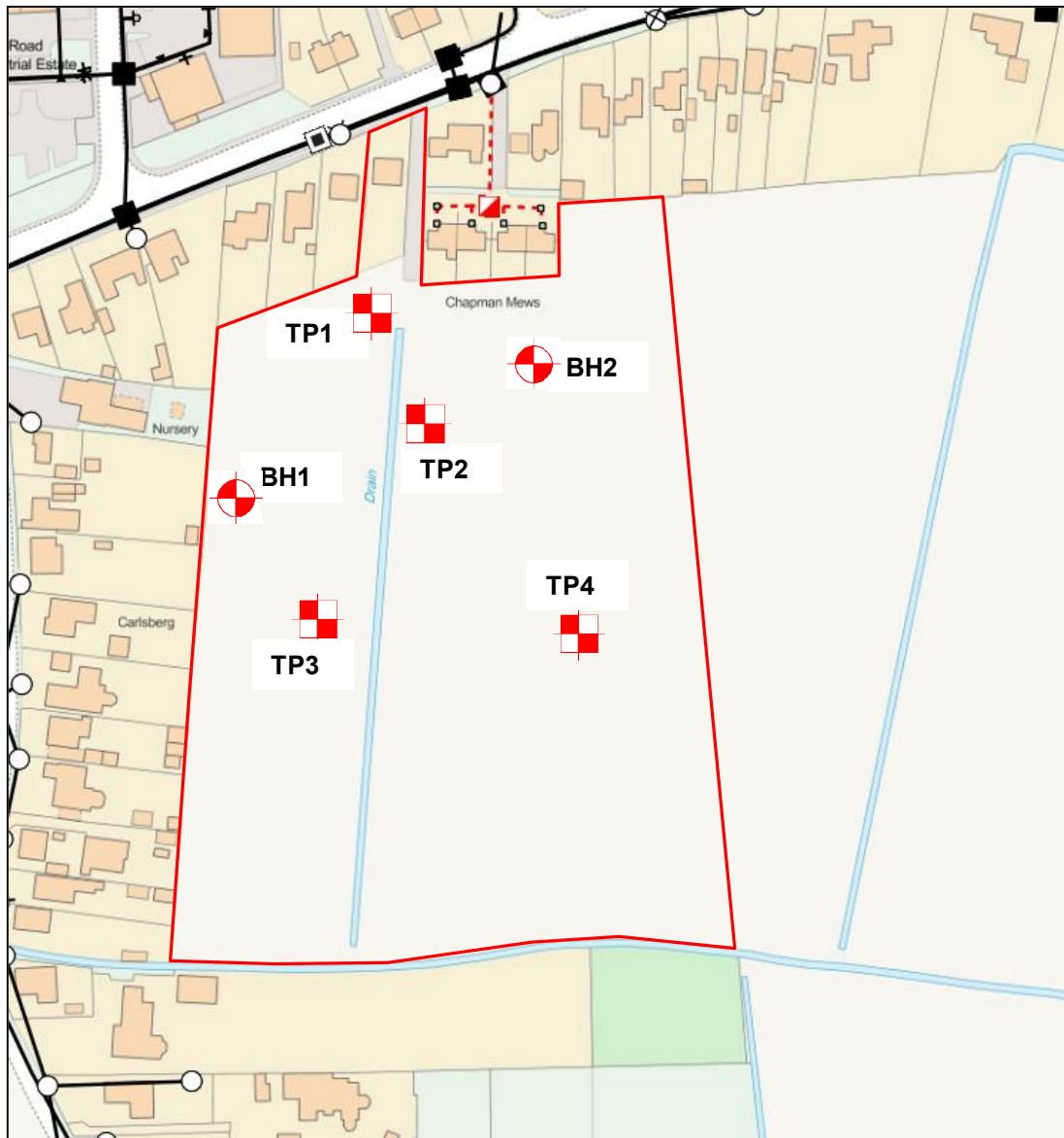
Peterborough

Tel : 01733 566566

**Project No.
C15102A**

Exploratory Hole Location Plan

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Project : Fleet Road, Holbeach, Lincolnshire.

Client : Kaplan Property Limited

**GROUND
ENGINEERING
LIMITED**

Peterborough Tel : 01733 566566

Project No.

C15102A

GROUND ENGINEERING			Site: LAND OFF FLEET ROAD, HOLBEACH				BOREHOLE BH1					
L I M I T E D Tel: 01733-566566 www.groundengineering.co.uk			Date: 05/11/20 to 06/11/20		Hole Size: 150mm dia to 15.00m		Ground Level:					
Samples and in-situ Tests			(Date)	Inst.	Description of Strata	Legend	Depth m	O. D. Level m				
Depth m	Type	Blows	Casing									
0.10 0.20-0.60	D1 B1	N6	1.20 ▼s		MADE GROUND - Firm, brown, slightly gravelly, sandy, silty CLAY. Gravel is sub-angular to rounded flint and ash. Firm, light brown, sandy, silty CLAY. (TIDAL FLAT DEPOSIT)		0.20					
0.75 0.80-1.20	D2 B2				Loose, light brown, orange brown and light grey, clayey, very silty fine SAND.		0.75					
1.20-1.70 1.35-1.65	B3 S											
1.65	D3											
2.20-2.70 2.35-2.65	B4 S	N6	1.60		...Becoming slightly clayey below 2.20m depth.							
2.65	D4											
3.20-3.70 3.20 3.35-3.65	B5 W1 S	N7	3.10 ▼c		(MARINE SAND)							
3.65	D5											
4.20-4.70 4.35-4.65	B6 S	N8	4.20									
4.65	D6											
5.10-5.60 5.25-5.55	B7 S	N10	5.10		Medium dense, locally loose, brown, silty fine SAND with rare shell fragments.		5.00					
5.55	D7											
6.60-7.10 6.75-7.05	B8 S	N9	6.60									
7.05	D8											
8.10-8.60 8.25-8.55	B9 S	N12	8.10									
8.55	D9											
9.60-10.10 9.75-10.05	B10 S	N13	9.60				10.00					
REMARKS 1. Excavating a pit from 0.00m to 1.20m for 1 hour 2. Water added from 2.70m to 15.00m 3. Borehole cased to 15.00m depth 4. Gas monitoring standpipe installed to 6.00m depth							Project No 15102A					
							Scale 1:50	Page 1/2				
KEY			Groundwater Strikes			Groundwater Observations						
N/* - 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 ES - Environmental Sample			1	3.30	3.30	very slow	3.10	not	05/11/20	6.00	6.00	3.60
U - Undisturbed Sample V - Vane Shear Test									06/11/20	6.00	6.00	2.00
W - Water Sample Cohesion () kPa									06/11/20	15.00	15.00	1.20
S/C - SPT Spoon/Cone ▼c Level on completion									06/11/20	15.00	0.00	2.00
▼ Water Strike c▼w Level casing withdrawn									13/11/20	6.00	1.00	1.35
▼ Water Rise ▼s Standpipe Level												

L I M I T E D
Tel: 01733-566566
www.groundengineering.co.uk

Date: 05/11/20
to 06/11/20

Ground
Level:

REMARKS	Project No 15102A	
	Scale 1:50	Page 2/2

KEY		Groundwater Strikes						Groundwater Observations			
		Depth m							Depth m		
		No	Struck	Rose to	Rate	Cased	Sealed	Date	Hole	Casing	Water
D - Disturbed Sample	N/* - SPT Blows for 0.3m or given penetration							20/11/20	6.00	1.00	1.35
B - Bulk Sample	ES - Environmental Sample							27/11/20	6.00	1.00	1.35
U - Undisturbed Sample	V - Vane Shear Test										
W - Water Sample	Cohesion () kPa										
S/C - SPT Spoon/Cone	Level on completion										
☒ Water Strike	c/w Level casing withdrawn										
☒ Water Rise	s Standpipe Level										

Borehole Number	Depth (m)	Casing Depth (m)	Depth to Water (m)	Type of Test *	Seating Drive Blows/ Penetration (mm)	Test Drive: 300mm Blows for each successive 75 mm Penetration				N Value	Extra-polated Value
BH1	1.20 - 1.65	1.20		S	2/150	1	1	2	2	6	
	2.20 - 2.65	1.60		S	2/150	2	1	1	2	6	
	3.20 - 3.65	3.10	2.80	S	2/150	1	2	2	2	7	
	4.20 - 4.65	4.20	3.30	S	2/150	2	2	2	2	8	
	5.10 - 5.55	5.10	3.90	S	2/150	2	2	3	3	10	
	6.60 - 7.05	6.60	0.70	S	3/150	2	2	2	3	9	
	8.10 - 8.55	8.10	0.70	S	3/150	3	3	3	3	12	
	9.60 - 10.05	9.60	0.60	S	4/150	3	3	3	4	13	
	11.10 - 11.55	11.10	0.80	S	5/150	3	3	4	5	15	
	12.60 - 13.05	12.60	0.80	S	5/150	3	4	5	6	18	
	13.50 - 13.95	13.50	0.90	S	5/150	4	5	6	6	21	
	14.50 - 14.95	14.50	0.90	S	6/150	6	6	7	7	26	
BH2	1.20 - 1.65	1.20		S	2/150	1	1	2	2	6	
	2.20 - 2.65	1.60		S	2/150	1	1	1	2	5	
	3.20 - 3.65	3.10	2.50	S	2/150	1	1	2	2	6	
	4.20 - 4.65	4.20	3.00	S	2/150	1	2	2	2	7	
	5.20 - 5.65	5.20	3.50	S	2/150	2	2	3	4	11	
	6.70 - 7.15	6.70	4.20	S	2/150	1	2	2	3	8	
	8.20 - 8.65	8.20	0.40	S	4/150	2	3	3	4	12	
	9.70 - 10.15	9.70	0.30	S	4/150	2	3	3	5	13	
	11.20 - 11.65	11.20	0.40	S	5/150	3	4	4	6	17	
	12.70 - 13.15	12.70	0.50	S	5/150	5	5	6	6	22	
	13.50 - 13.95	13.50	0.80	S	6/150	5	6	7	7	25	
	14.50 - 14.95	14.50	0.80	S	7/150	6	7	7	8	28	

L I M I T E D
Tel: 01733-566566
www.groundengineering.co.uk

Date: 04/11/20
to 05/11/20

BOREHOLE
BH2

Ground
Level:

REMARKS	1. Excavating a pit from 0.00m to 1.20m for 1 hour 2. Water added from 2.20m to 12.70m 3. Water added from 13.75m to 14.50m 4. Borehole cased to 15.00m depth 5. Gas monitoring standpipe installed to 6.00m depth
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Project No
15102A

Scale 1:50	Page 1/2
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KEY		N/* - SPT Blows for 0.3m or given penetration	Groundwater Strikes						Groundwater Observations							
			Depth m						Date	Depth m						
			No	Struck	Rose to	Rate	Cased	Sealed		Hole	Casing	Water				
D - Disturbed Sample	B - Bulk Sample	ES - Environmental Sample	U - Undisturbed Sample	V - Vane Shear Test	W - Water Sample	S/C - SPT Spoon/Cone	1	3.50	3.50	very slow	3.20	not	04/11/20	13.20	13.20	0.80
													05/11/20	13.20	13.20	2.80
													05/11/20	15.00	15.00	1.30
													05/11/20	15.00	0.00	1.50
													13/11/20	6.00	1.00	1.30
W - Water Sample																
S/C - SPT Spoon/Cone	W - Water Strike	W - Water Rise														
			</													

GROUND ENGINEERING L I M I T E D Tel: 01733-566566 www.groundengineering.co.uk			Site: LAND OFF FLEET ROAD, HOLBEACH				BOREHOLE BH2			
			Date: 04/11/20 to 05/11/20		Hole Size: 150mm dia to 15.00m			Ground Level:		
Samples and in-situ Tests			(Date) Casing	Inst.	Description of Strata	Legend	Depth m	O.D. Level m		
Depth m	Type	Blows								
10.15	D10			BENEATH INSTALLATION BENEATH INSTALLATION BENEATH INSTALLATION BENEATH INSTALLATION BENEATH INSTALLATION BENEATH INSTALLATION BENEATH INSTALLATION BENEATH INSTALLATION BENEATH INSTALLATION BENEATH INSTALLATION	Medium dense, grey brown, silty fine SAND with rare shell fragments.		10.00			
11.20-11.70 11.35-11.65	B11 S	N17	11.20							
11.65	D11									
12.70-13.20 12.85-13.15	B12 S	N22	12.70		(MARINE SAND)					
13.15	D12									
13.50-14.00	B13									
13.65-13.95	S	N25	13.50							
13.95	D13									
14.50-15.00	B14									
14.65-14.95	S	N28	14.50							
14.95	D14					15.00				
Borehole completed at 15.00m depth										
REMARKS							Project No 15102A			
							Scale 1:50	Page 2/2		
KEY D - Disturbed Sample B - Bulk Sample U - Undisturbed Sample W - Water Sample S/C - SPT Spoon/Cone ∇ - Water Strike ∇ - Water Rise N/* - SPT Blows for 0.3m or given penetration ES - Environmental Sample V - Vane Shear Test Cohesion () kPa Level on completion Level casing withdrawn Standpipe Level			Groundwater Strikes Depth m No Struck Rose to Rate Cased Sealed				Groundwater Observations Date Depth m Hole Casing Water			
							20/11/20 6.00 1.00 1.25 27/11/20 6.00 1.00 1.25			

GROUND ENGINEERING L I M I T E D Tel: 01733-566566 www.groundengineering.co.uk			Site: LAND OFF FLEET ROAD, HOLBEACH		TRIAL PIT TP1	
			Date: 09/11/20	Pit Size: 1.00m L x 0.30m W x 1.00m D.		Ground Level:
Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m
Depth m	Type	Result				
0.10 0.10	D1 ES1			MADE GROUND - Firm, friable, dark brown, slightly gravelly, sandy, silty CLAY. Gravel is fine and medium, angular to rounded flint, quartzite and igneous rock.		0.25
0.30 0.30	D2 ES2			MADE GROUND - Firm, brown and dark brown, slightly sandy, slightly gravelly, silty CLAY. Gravel is angular to rounded flint, quartzite, plastic, concrete and brick fragments.		
0.65 0.65	D3 ES3			Firm, brown and orange brown, sandy, silty CLAY. (TIDAL FLAT DEPOSIT)		0.75
1.00	D4			Pit completed at 1.00m depth		1.00
KEY D - Disturbed Sample B - Bulk Sample U - Undisturbed Sample R - Root Sample W - Water Sample ES - Environmental Sample  Water Strike  Water Rise  Level on completion MP - Mackintosh Probe P() - Hand Penetrometer Cohesion () kPa V - Vane Shear Test Cohesion () kPa			REMARKS 1. Live roots observed to 0.30m depth 2. Pit dry 3. Pit sides stable 4. Soakaway test undertaken at 1.00m depth			
			Project No 15102A			
			Scale 1:25			
			Page 1/1			

SOAKAWAY TEST RESULTS

BRE DIGEST 365 - SOIL INFILTRATION RATE

Project: Fleet Road, Holbeach

Project No: C15102A

Sheet No: 1/3

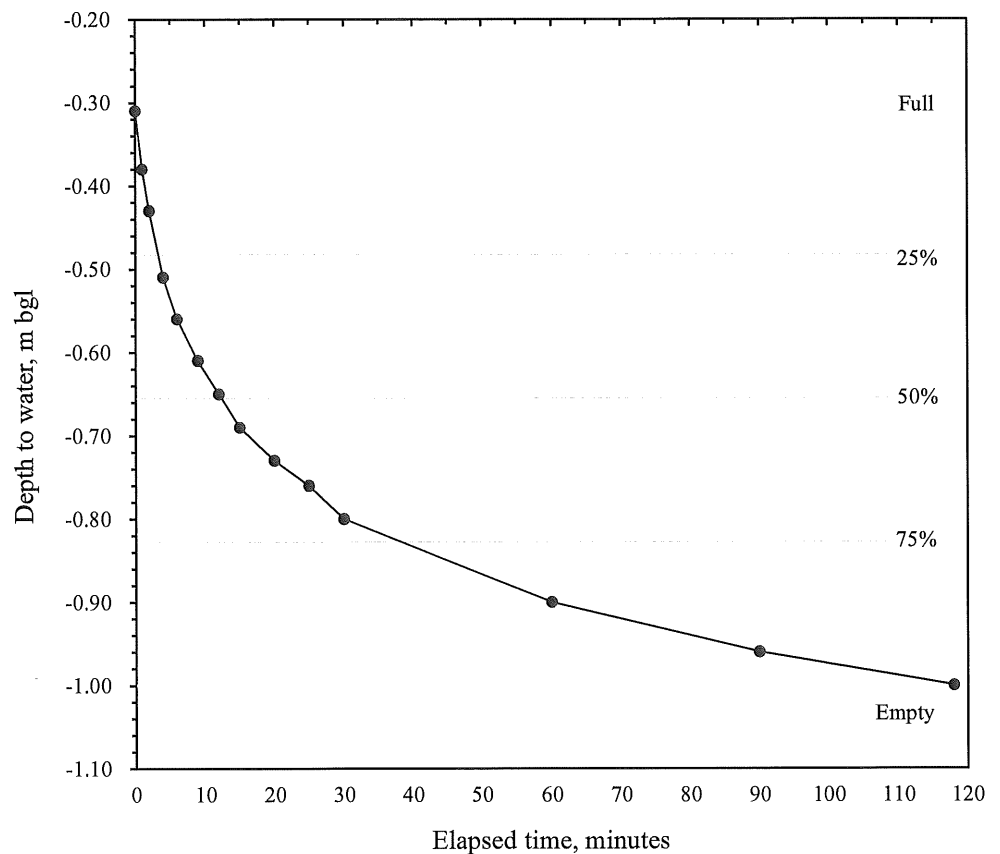
Trial Pit: TP1
Depth: 1.00
Length: 1.00
Width: 0.30

Description of Stratum under test: Firm, brown and orange brown, sandy, silty CLAY

Depth to water prior to test: Dry
(below ground level)

DEPTH TO WATER vs ELAPSED TIME

Elapsed Time min	Depth to Water m
0	0.31
1	0.38
2	0.43
4	0.51
6	0.56
9	0.61
12	0.65
15	0.69
20	0.73
25	0.76
30	0.80
60	0.90
90	0.96
118	1.00



All dimensions given in metres

$$f = (V_{75} - V_{25}) / A_{50}(T_{75} - T_{25})$$
$$V_{75} - V_{25} = 0.10$$
$$A_{50} = 1.20$$
$$T_{75} - T_{25} = 35$$
$$f = \underline{4.12E-05} \text{ m/s}$$

Soil Infiltration Rate

SOAKAWAY TEST RESULTS

BRE DIGEST 365 - SOIL INFILTRATION RATE

Project: Fleet Road, Holbeach

Project No: C15102A

Sheet No: 2/3

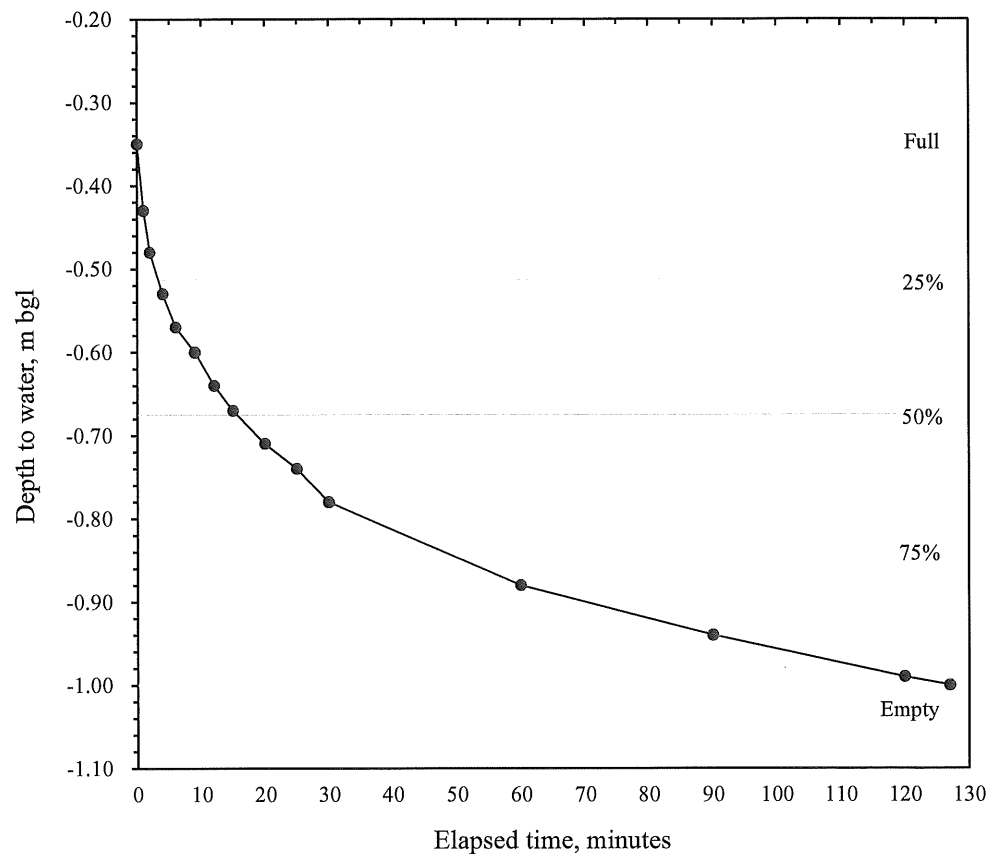
Trial Pit: TP1
Depth: 1.00
Length: 1.00
Width: 0.30

Description of Stratum under test: Firm, brown and orange brown, sandy, silty CLAY

Depth to water prior to test: Dry
(below ground level)

DEPTH TO WATER vs ELAPSED TIME

Elapsed Time min	Depth to Water m
0	0.35
1	0.43
2	0.48
4	0.53
6	0.57
9	0.60
12	0.64
15	0.67
20	0.71
25	0.74
30	0.78
60	0.88
90	0.94
120	0.99
127	1.00



All dimensions given in metres

$$f = (V75 - V25) / A50(T75 - T25)$$

$$V75 - V25 = 0.10$$

$$A50 = 1.15$$

$$T75 - T25 = 44$$

$$f = \underline{3.23E-05} \text{ m/s}$$

Soil Infiltration Rate

SOAKAWAY TEST RESULTS

BRE DIGEST 365 - SOIL INFILTRATION RATE

Project: Fleet Road, Holbeach

Project No: C15102A

Sheet No: 3/3

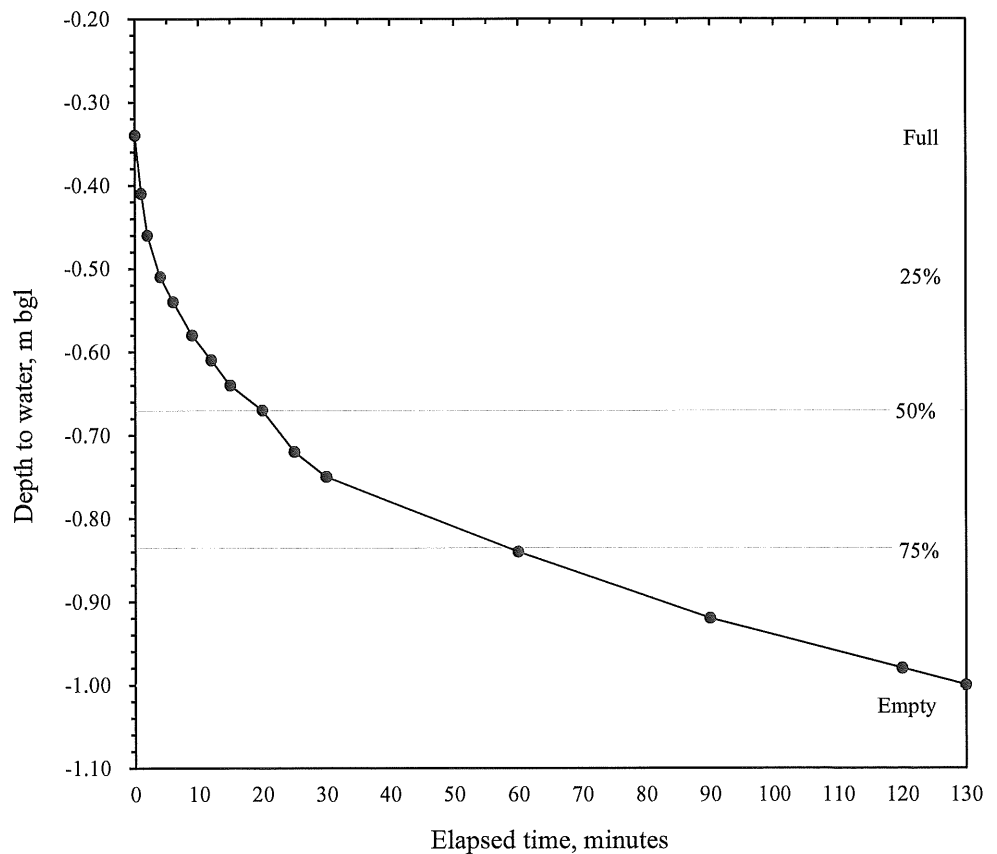
Trial Pit: TP1
Depth: 1.00
Length: 1.00
Width: 0.30

Description of Stratum under test: Firm, brown and orange brown, sandy, silty CLAY

Depth to water prior to test: Dry
(below ground level)

DEPTH TO WATER vs ELAPSED TIME

Elapsed Time min	Depth to Water m
0	0.34
1	0.41
2	0.46
4	0.51
6	0.54
9	0.58
12	0.61
15	0.64
20	0.67
25	0.72
30	0.75
60	0.84
90	0.92
120	0.98
130	1.00



All dimensions given in metres

$$f = (V75 - V25) / A50(T75 - T25)$$

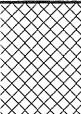
$$V75 - V25 = 0.10$$

$$A50 = 1.16$$

$$T75 - T25 = 56$$

$$f = \underline{2.54E-05} \text{ m/s}$$

Soil Infiltration Rate

GROUND ENGINEERING L I M I T E D Tel: 01733-566566 www.groundengineering.co.uk			Site: LAND OFF FLEET ROAD, HOLBEACH		TRIAL PIT TP2	
Date: 09/11/20			Pit Size: 0.35m L x 0.25m W x 1.00m D.		Ground Level:	
Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m
Depth m	Type	Result				
0.05 0.05 0.10	D1 ES1 V1	(120)		MADE GROUND - Stiff, dark brown, slightly gravelly, silty CLAY. Gravel is angular to rounded flint, quartzite, plastic and brick fragments.		0.40
0.50-0.70 0.50 0.50 0.50-0.72 0.70-0.80 0.80	B1 D2 V2 MP1 B2 D3	(120) 100		Stiff, brown, slightly sandy, silty CLAY. (TIDAL FLAT DEPOSIT)		0.70
0.90-1.15 1.00	MP2 D4	100		Medium dense, brown, very silty fine SAND. (MARINE SAND)		1.00
				Pit completed at 1.00m depth		
KEY D - Disturbed Sample B - Bulk Sample U - Undisturbed Sample R - Root Sample W - Water Sample ES - Environmental Sample  Water Strike  Water Rise  Level on completion MP - Mackintosh Probe P() - Hand Penetrometer Cohesion () kPa V - Vane Shear Test Cohesion () kPa			REMARKS 1. Fibrous live roots observed to 0.50m depth 2. Pit dry 3. Pit sides stable			
Project No 15102A Scale 1:25 Page 1/1						

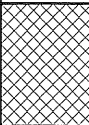
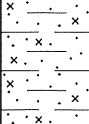
L I M I T E D
Tel: 01733-566566
www.groundengineering.co.uk

Date: 09/11/20

TRIAL PIT
TP3

Ground
Level:

KEY D - Disturbed Sample B - Bulk Sample U - Undisturbed Sample R - Root Sample W - Water Sample ES - Environmental Sample  Water Strike  Water Rise  Level on completion MP - Mackintosh Probe P() - Hand Penetrometer Cohesion () kPa V - Vane Shear Test Cohesion () kPa	REMARKS 1. Fibrous live roots observed to 0.50m depth 2. Pit dry 3. Pit sides stable	Project No 15102A	
		Scale	Page
		1:25	1/1

GROUND ENGINEERING L I M I T E D Tel: 01733-566566 www.groundengineering.co.uk			Site: LAND OFF FLEET ROAD, HOLBEACH		TRIAL PIT TP4	
Date: 09/11/20			Pit Size: 0.37m L x 0.25m W x 1.00m D.		Ground Level:	
Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m
Depth m	Type	Result				
0.10 0.10 0.10	D1 ES1 V1	(80)		MADE GROUND - Stiff, dark brown, slightly gravelly, sandy, silty CLAY. Gravel is angular to rounded flint and quartzite.		0.40
0.50-0.80 0.60	B1 D2			Stiff, brown, orange brown and light grey, sandy, silty CLAY. (TIDAL FLAT DEPOSIT)		0.85
1.00 1.00-1.30	D3 MP1	90		Medium dense, brown and light brown, silty SAND. (MARINE SAND)		1.00
				Pit completed at 1.00m depth		
KEY D - Disturbed Sample B - Bulk Sample U - Undisturbed Sample R - Root Sample W - Water Sample ES - Environmental Sample  Water Strike  Water Rise  Level on completion MP - Mackintosh Probe P() - Hand Penetrometer Cohesion () kPa V - Vane Shear Test Cohesion () kPa			REMARKS 1. Fibrous live roots observed to 0.60m depth 2. Pit dry 3. Pit sides stable			
			Project No 15102A			
			Scale 1:25			
			Page 1/1			

Groundwater & Gas Monitoring Record

Site Land off Fleet Road, Holbeach

Report Ref: C15102A

Date	Borehole No.	Methane (% v/v)		Carbon Dioxide (% v/v)		Oxygen (% v/v)		Flow Rate (l/hr)	Atmosph. Pressure (mb)	Depth of Well (mbgl)	Depth to Groundwater (mbgl)	Comments
		Peak	Steady	Peak	Steady	Min.	Max.					
13/11/20	WS1	0.1	0.1	0.8	0.8	20.2	20.2	<0.1	1010	6.00	1.35	
	WS2	0.2	0.2	1.0	1.0	20.5	20.5	<0.1	1010	6.00	1.30	
20/11/20	WS1	0.1	0.1	0.8	0.8	20.4	20.4	<0.1	1033	6.00	1.35	
	WS2	0.2	0.2	1.6	1.6	19.9	20.0	<0.1	1033	6.00	1.25	
27/11/20	WS1	0.1	0.1	0.8	0.8	20.4	20.4	<0.1	1020	6.00	1.35	
	WS2	0.2	0.2	1.8	1.8	19.5	19.5	<0.1	1020	6.00	1.25	

LEL – Lower Explosive Limit

GROUND ENGINEERING LIMITED, NEWARK ROAD, PETERBOROUGH, PE1 5UA

LABORATORY TEST RESULTS

CONTRACT LAND OFF FLEET ROAD, HOLBEACH

Bore-hole	Sample	Depth m	Classification				Density		Triaxial Compression					Sulphates (SO ₄)				Remarks
			Liquid Limit %	Plastic Limit %	Plasticity Index %	Moisture Content %	Bulk Mg/m ³	Dry Mg/m ³	Type	Principal Stress Difference kPa	Cell Pressure kPa	Shear Strength kPa	Angle of Shear Resistance degrees	Total Dry Wt. %	Soil Aqueous Extract mg/l	Water mg/l	pH	
BH1	D3	1.65													140		7.7	
	W1	3.20														288	7.9	
BH2	D3	1.65													198		7.7	
	W1	2.80													280		8.1	

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

Aqueous Extract 2:1 Water:Soil

15102A

LABORATORY TEST RESULTS

CONTRACT LAND OFF FLEET ROAD, HOLBEACH

Trial- pit	Sample	Depth m	Classification				Density		Triaxial Compression					Sulphates (SO ₄)				C.B.R.		Remarks
			Liquid Limit %	Plastic Limit %	Plasticity Index %	Moisture Content %	Bulk Mg/m ³	Dry Mg/m ³	Type	Principal Stress Difference kPa	Cell Pressure kPa	Shear Strength kPa	Angle of Shear Resistance degrees	Total Dry Wt. %	Soil Aqueous Extract mg/l	Water mg/l	pH	Top %	Base %	
TP1	D4	1.00	38	24	14	29														SOIL CLASSIFICATION = CI 0% retained on 425µm sieve
TP2	B1	0.50 – 0.70	36	22	14	22	2.00	1.63										0.9	1.4	SOIL CLASSIFICATION = CI 0% retained on 425µm sieve 0% retained on 20mm sieve
	D4	1.00												156			8.2			
TP3	B1	0.50 – 0.70	29	21	8	18	2.00	1.67										0.6	0.8	SOIL CLASSIFICATION = CL 0% retained on 425µm sieve 0% retained on 20mm sieve
	D3	0.70	39	20	19	22														SOIL CLASSIFICATION = CI 0% retained on 425µm sieve
TP4	D4	1.20														165		8.0		
	B1	0.50 – 0.80	45	22	23	19	2.01	1.67										1.8	2.5	SOIL CLASSIFICATION = CI 0% retained on 425µm sieve 0% retained on 20mm sieve
	D3	1.00													132		8.0			



8180

Newark Road Peterborough
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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
Wet Sieving Method and Sedimentation by Pipette

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

Certificate Number: PL7247-1/9/710-2

Client Reference: C15102A

Lab Job Number: PL7247-1

Date Sampled: Unknown

Date Received: 11.11.2020

Date Tested: 19.11.2020

Certificate of Sampling: N/A

Sampling Certificate No.: N/A

Sampled By: Client

Contact: Simon Weatherley

Site Name: Land off Fleet Road
Site Address: Holbeach

TEST RESULTS

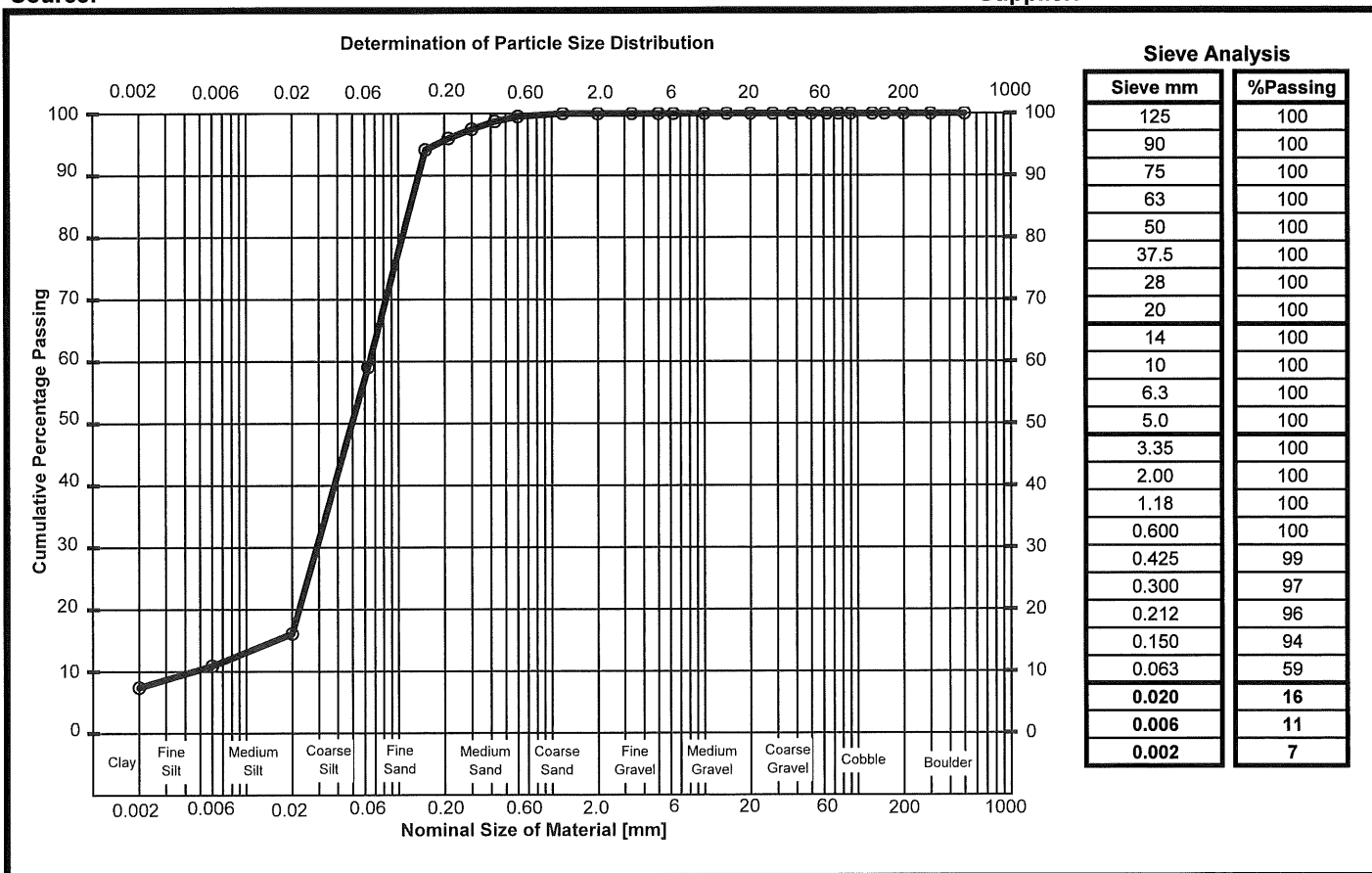
Laboratory Reference: PL7247-1/9
Client Reference: B3

Pre-treatment for
organic material: No

Sample Description: Soft brown orange-brown grey slightly clayey SILT/SAND with rare fine roots.

Material Specification: Not Required
Location: BH1
Source:

Depth Top: 1.20m
Depth Base: 1.70m
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: 10.12.2020 Page 1 of 1
Form Number: GELab/C/709-2 Version 54

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Registration Number: 6929574
Reg Office: Ground Engineering Ltd
Newark Rd, Peterborough PE1 5UA



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TEST CERTIFICATE**Determination of Particle Size Distribution**

Tested in Accordance with BS 1377-2: 1990: Clause 9.2 & 9.4
Wet Sieving Method and Sedimentation by Pipette

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

Contact: Simon Weatherley

Site Name: Land off Fleet Road
Site Address: Holbeach

Certificate Number: PL7247-1/11/710-2

Client Reference: C15102A

Lab Job Number: PL7247-1

Date Sampled: Unknown

Date Received: 11.11.2020

Date Tested: 19.11.2020

Certificate of Sampling: N/A

Sampling Certificate No.: N/A

Sampled By: Client

TEST RESULTS

Laboratory Reference: PL7247-1/11

Client Reference: B4

Pre-treatment for
organic material:

No

Sample Description: Brown slightly clayey SILT/SAND.

Material Specification: Not Required

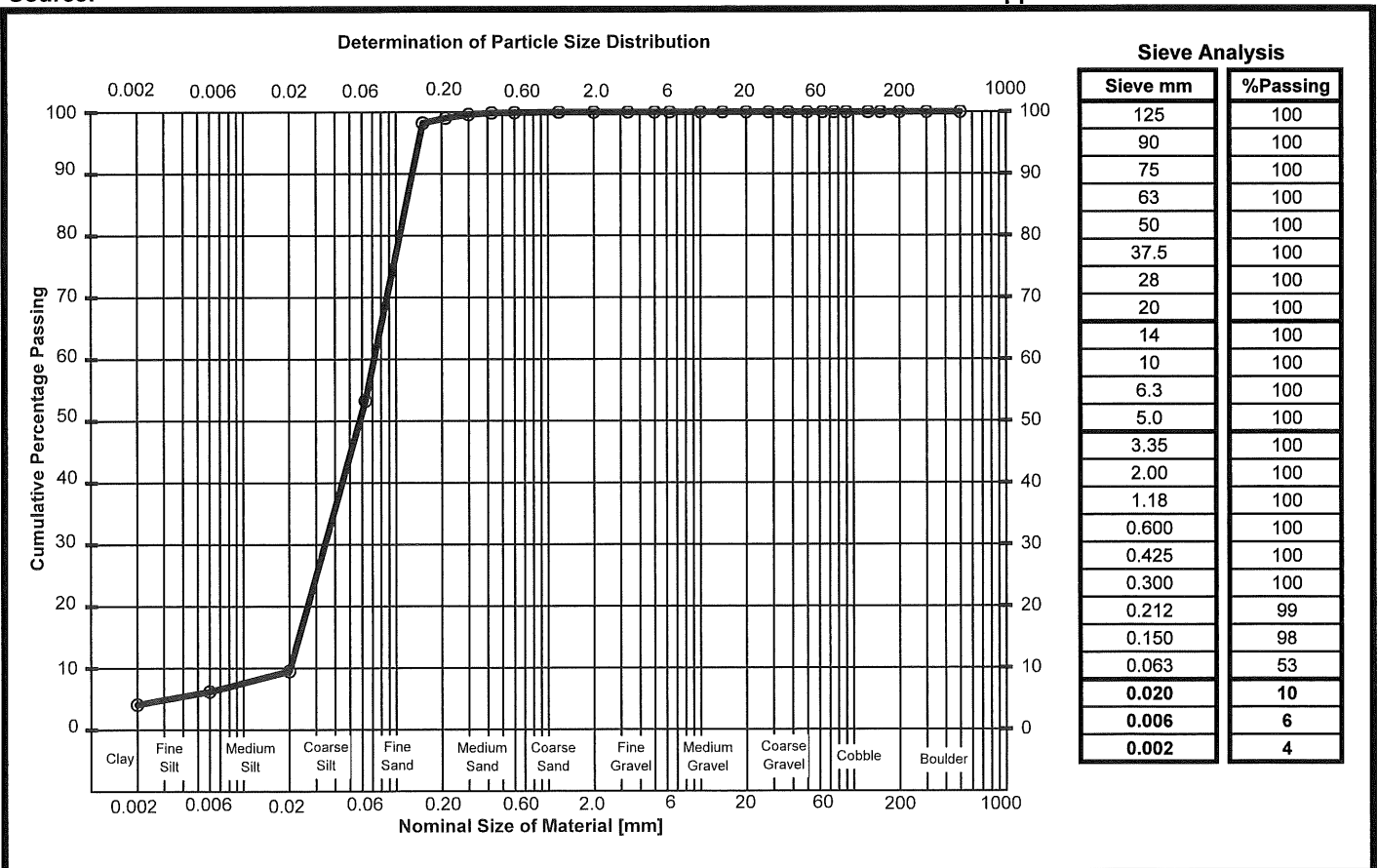
Location: BH1

Source:

Depth Top: 2.20m

Depth Base: 2.70m

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: 10.12.2020 Page 1 of 1

Form Number: GELab/C/709-2 Version 54

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TEST CERTIFICATE**Determination of Particle Size Distribution**

Tested in Accordance with BS 1377-2: 1990: Clause 9.2 & 9.4
Wet Sieving Method and Sedimentation by Pipette

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

Certificate Number: PL7247-1/13/710-2
Client Reference: C15102A
Lab Job Number: PL7247-1
Date Sampled: Unknown
Date Received: 11.11.2020
Date Tested: 19.11.2020

Contact: Simon Weatherley

Site Name: Land off Fleet Road
Site Address: Holbeach

Certificate of Sampling: N/A
Sampling Certificate No.: N/A
Sampled By: Client

TEST RESULTS

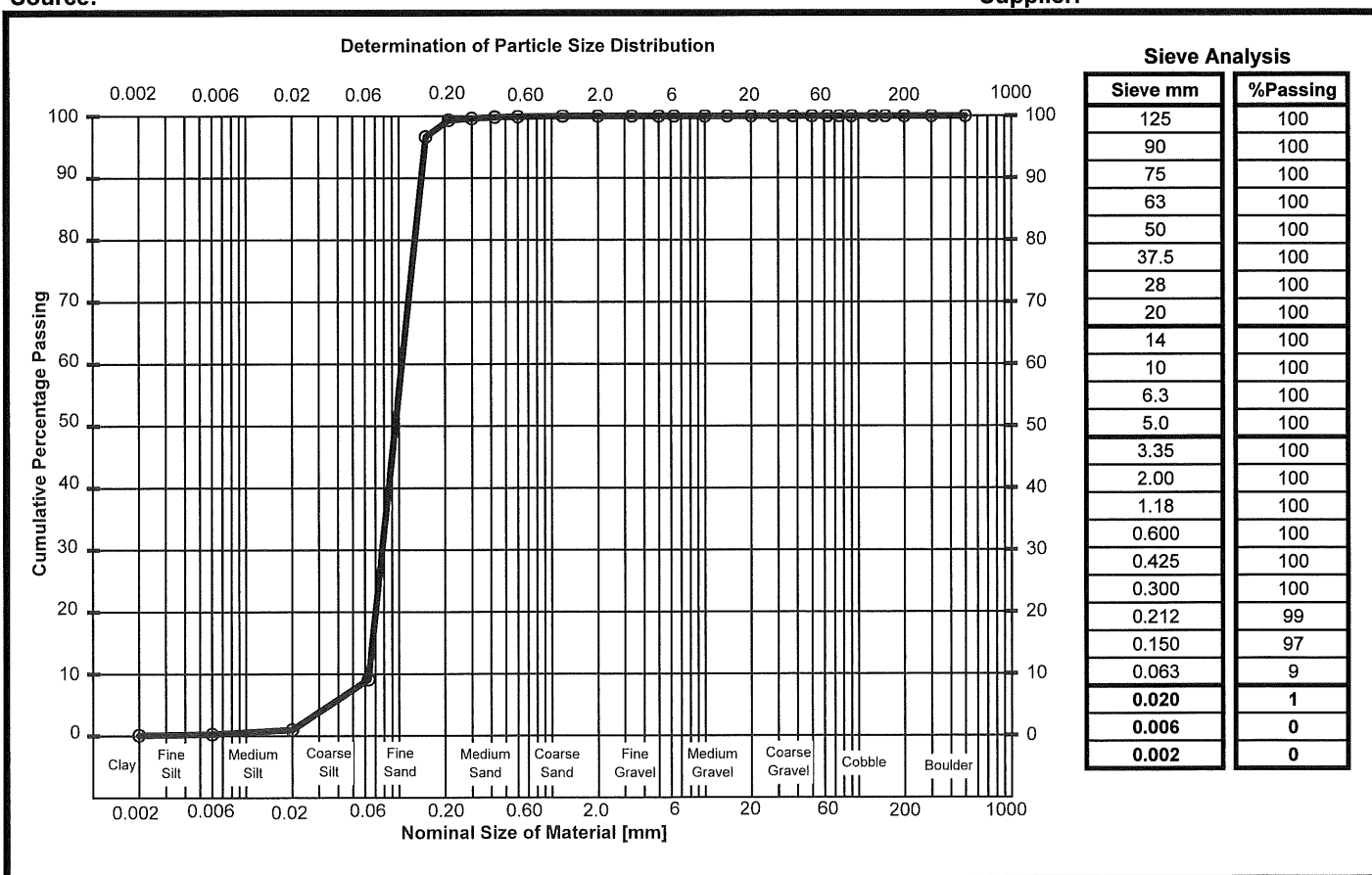
Laboratory Reference: PL7247-1/13
Client Reference: B8

Pre-treatment for organic material: No

Sample Description: Brown slightly silty SAND.

Material Specification: Not Required
Location: BH1
Source:

Depth Top: 6.60m
Depth Base: 7.10m
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: 10.12.2020 Page 1 of 1
Form Number: GELab/C/709-2 Version 54

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GROUND ENGINEERING

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TEST CERTIFICATE**Determination of Particle Size Distribution**

Tested in Accordance with BS 1377-2: 1990: Clause 9.2
Wet Sieving Method

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

Certificate Number: PL7247-1/14/710-2
Client Reference: C15102A
Lab Job Number: PL7247-1
Date Sampled: Unknown
Date Received: 11.11.2020
Date Tested: 19.11.2020

Contact: Simon Weatherley

Site Name: Land off Fleet Road
Site Address: Holbeach

Certificate of Sampling: N/A
Sampling Certificate No.: N/A
Sampled By: Client

TEST RESULTS

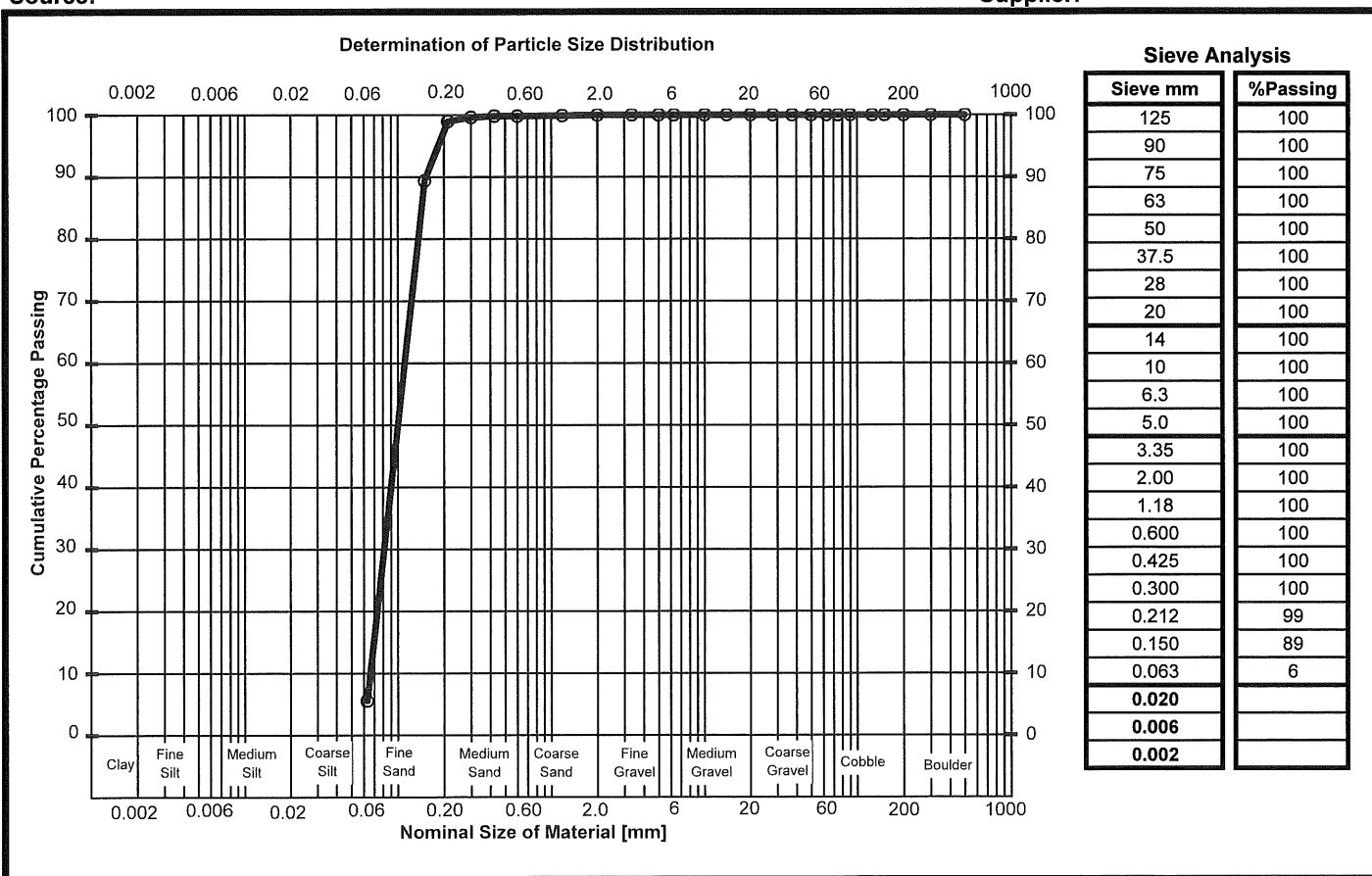
Laboratory Reference: PL7247-1/14
Client Reference: B12

Pre-treatment for organic material: N/A

Sample Description: Brown grey slightly silty slightly organic SAND.

Material Specification: Not Required
Location: BH1
Source:

Depth Top: 12.60m
Depth Base: 13.10m
Supplier:



Comments:

Approved Signatory: M. Hartnup - Laboratory Manager

Signed:

for and on behalf of Ground Engineering Ltd

Date Reported: 10.12.2020 Page 1 of 1
Form Number: GELab/C/709-2 Version 54

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TEST CERTIFICATE**GROUND ENGINEERING**

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Determination of Particle Size Distribution

Tested in Accordance with BS 1377-2: 1990: Clause 9.2 & 9.4
Wet Sieving Method and Sedimentation by Pipette

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

Certificate Number: PL7247-1/15/710-2
Client Reference: C15102A
Lab Job Number: PL7247-1
Date Sampled: Unknown
Date Received: 11.11.2020
Date Tested: 19.11.2020

Contact: Simon Weatherley

Site Name: Land off Fleet Road
Site Address: Holbeach

Certificate of Sampling: N/A
Sampling Certificate No.: N/A
Sampled By: Client

TEST RESULTS

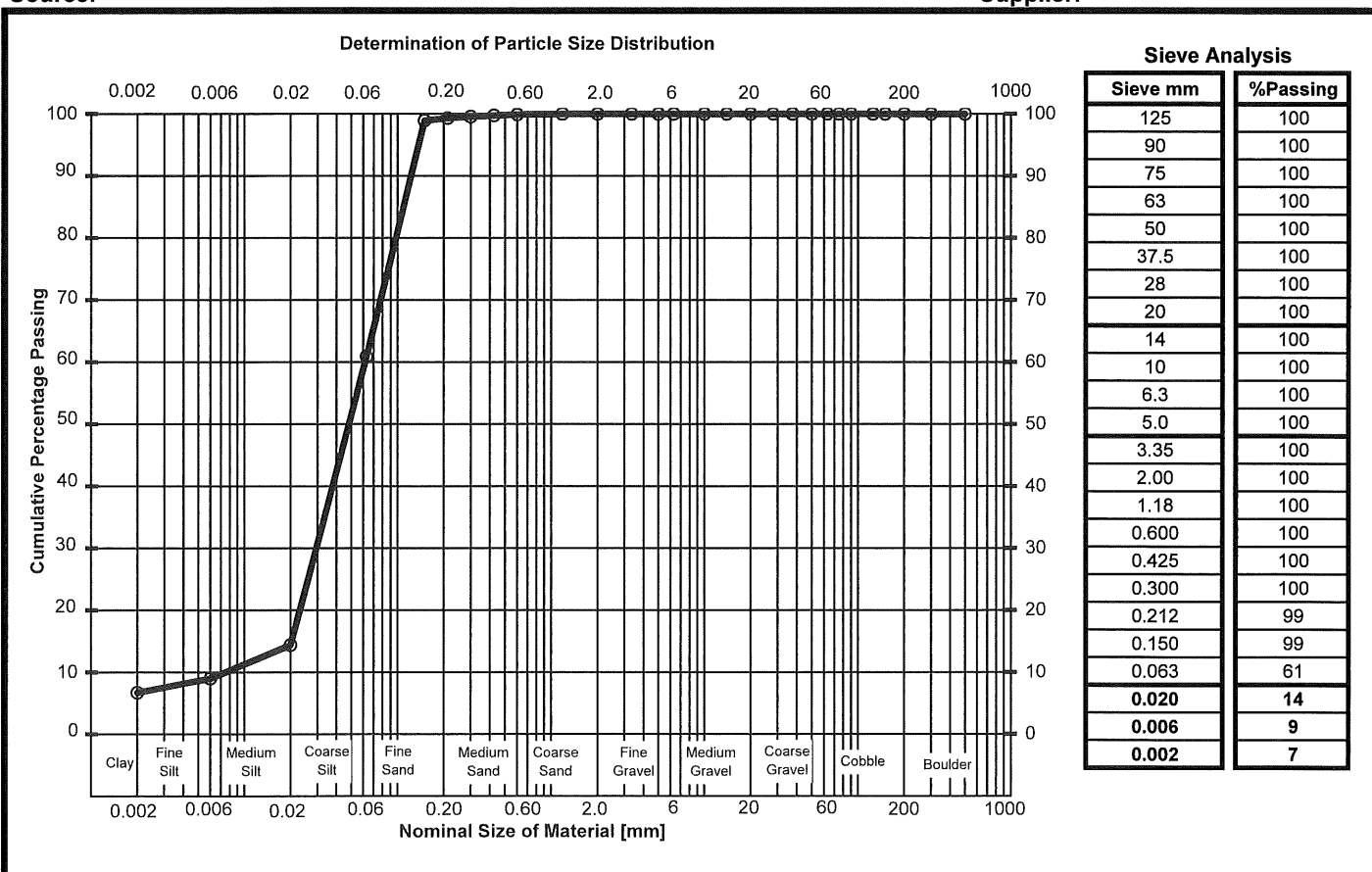
Laboratory Reference: PL7247-1/15
Client Reference: B2

Pre-treatment for organic material: N/A

Sample Description: Brown orange-brown grey slightly clayey SILT/SAND.

Material Specification: Not Required
Location: BH2
Source:

Depth Top: 0.70m
Depth Base: 1.20m
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: 10.12.2020 Page 1 of 1
Form Number: GELab/C/709-2 Version 54

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GROUND ENGINEERING

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TEST CERTIFICATE**Determination of Particle Size Distribution**

Tested in Accordance with BS 1377-2: 1990: Clause 9.2 & 9.4
Wet Sieving Method and Sedimentation by Pipette

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

Certificate Number: PL7247-1/16/710-2
Client Reference: C15102A
Lab Job Number: PL7247-1
Date Sampled: Unknown
Date Received: 11.11.2020
Date Tested: 19.11.2020

Contact: Simon Weatherley

Site Name: Land off Fleet Road
Site Address: Holbeach

Certificate of Sampling: N/A
Sampling Certificate No.: N/A

Sampled By: Client

TEST RESULTS

Laboratory Reference: PL7247-1/16

Pre-treatment for
organic material:

N/A

Client Reference: B3

Sample Description: Brown slightly clayey SILT/SAND.

Material Specification: Not Required

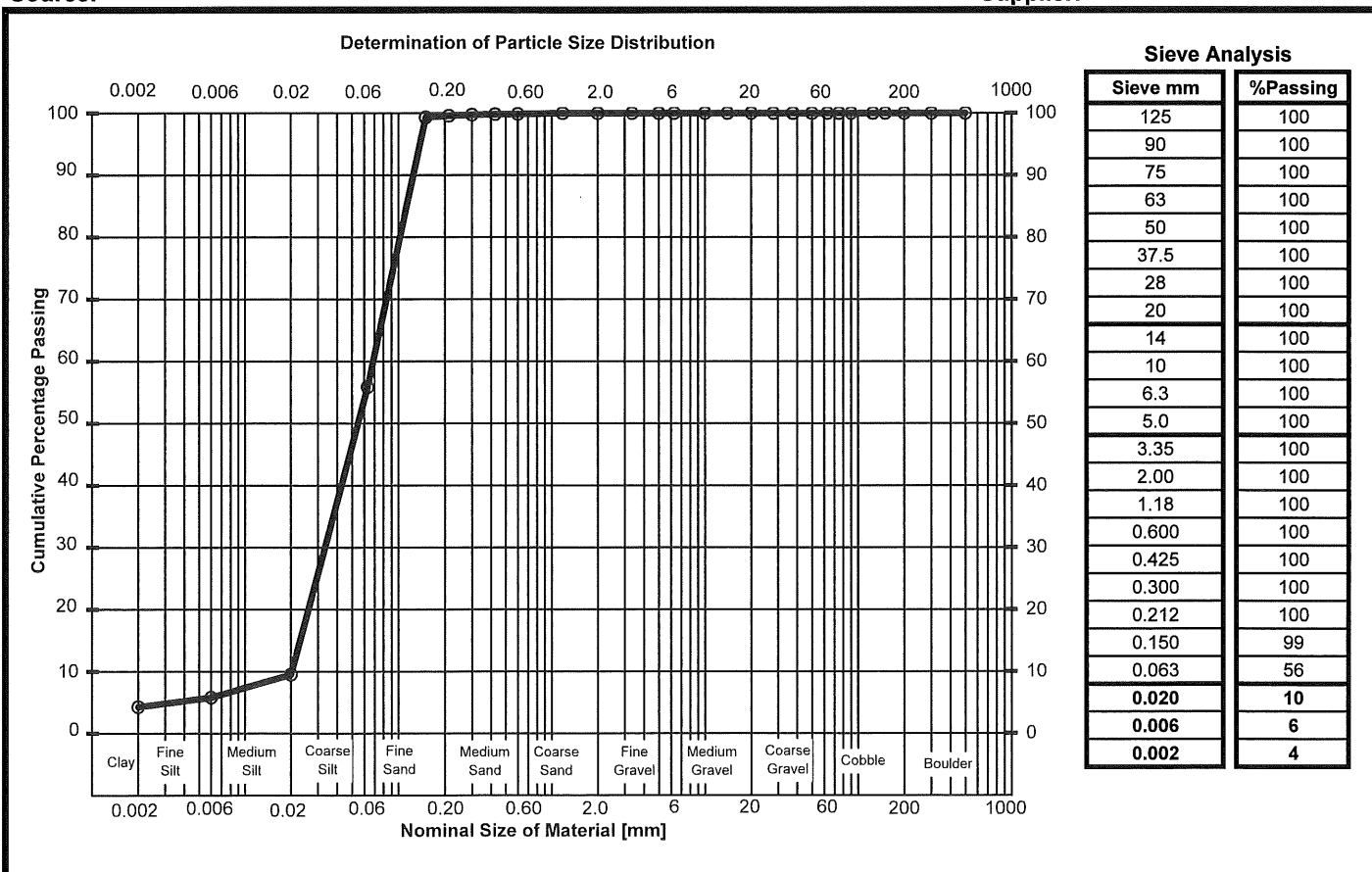
Depth Top: 1.20m

Location: BH2

Depth Base: 1.70m

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: 10.12.2020 Page 1 of 1
Form Number: GELab/C/709-2 Version 54

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GROUND ENGINEERING

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TEST CERTIFICATE**Determination of Particle Size Distribution**

Tested in Accordance with BS 1377-2: 1990: Clause 9.2 & 9.4
Wet Sieving Method and Sedimentation by Pipette

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

Certificate Number: PL7247-1/19/710-2
Client Reference: C15102A
Lab Job Number: PL7247-1
Date Sampled: Unknown
Date Received: 11.11.2020
Date Tested: 19.11.2020

Contact: Simon Weatherley

Site Name: Land off Fleet Road
Site Address: Holbeach

Certificate of Sampling: N/A
Sampling Certificate No.: N/A
Sampled By: Client

TEST RESULTS

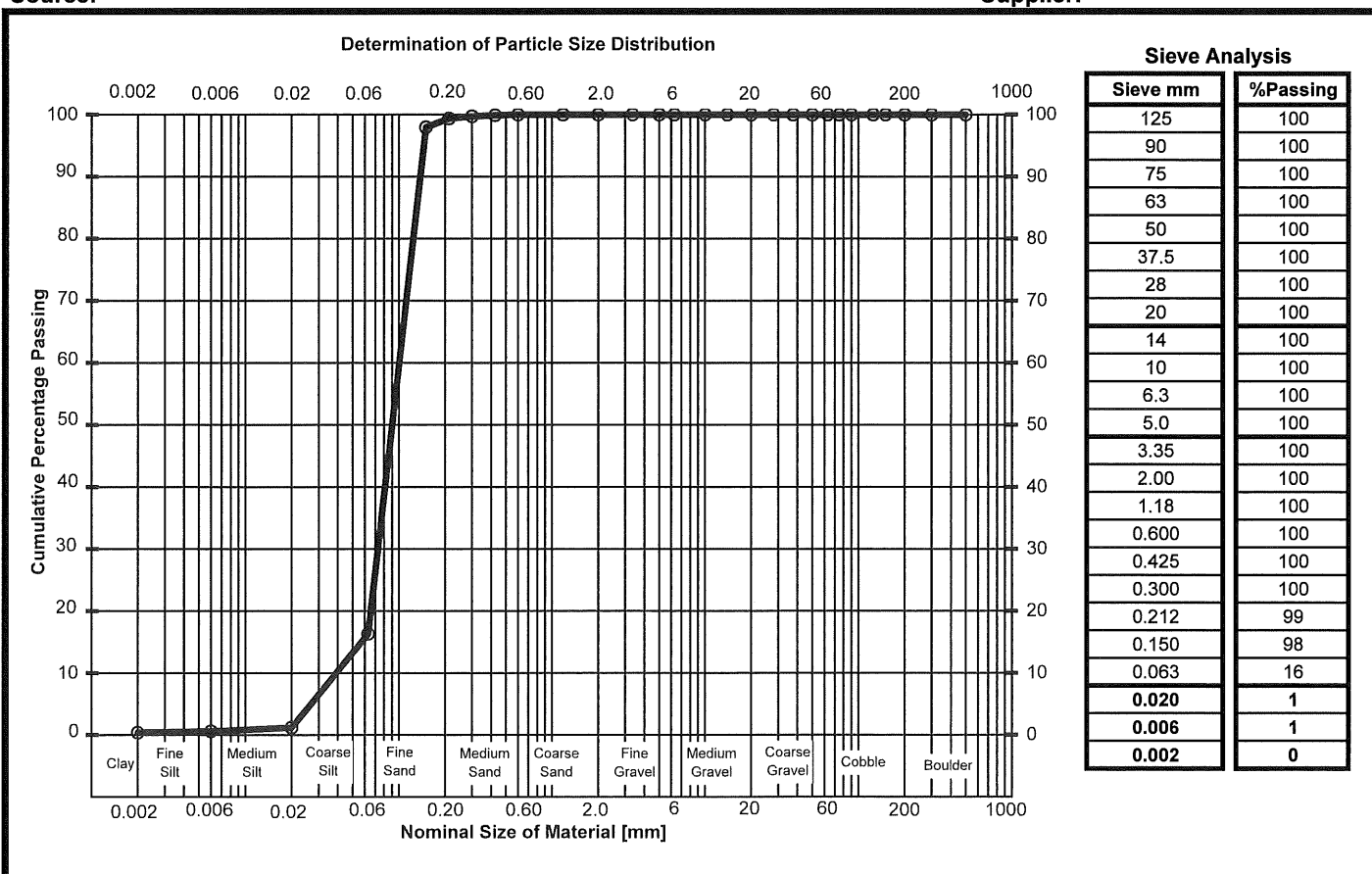
Laboratory Reference: PL7247-1/19
Client Reference: B6

Pre-treatment for organic material: N/A

Sample Description: Brown slightly silty SAND.

Material Specification: Not Required
Location: BH2
Source:

Depth Top: 4.20m
Depth Base: 4.70m
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: 10.12.2020 Page 1 of 1
Form Number: GELab/C/709-2 Version 54

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Registration Number: 6929574
Reg Office: Ground Engineering Ltd
Newark Rd, Peterborough PE1 5UA



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TEST CERTIFICATE**GROUND ENGINEERING**

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

Determination of Particle Size Distribution

Tested in Accordance with BS 1377-2: 1990: Clause 9.2
Wet Sieving Method

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

Certificate Number: PL7247-1/20/710-2
Client Reference: C15102A
Lab Job Number: PL7247-1
Date Sampled: Unknown
Date Received: 11.11.2020
Date Tested: 19.11.2020

Contact: Simon Weatherley

Site Name: Land off Fleet Road
Site Address: Holbeach

Certificate of Sampling: N/A
Sampling Certificate No.: N/A
Sampled By: Client

TEST RESULTS

Laboratory Reference: PL7247-1/20

Pre-treatment for organic material: N/A

Client Reference: B9

Sample Description: Brown silty slightly organic SAND.

Material Specification: Not Required

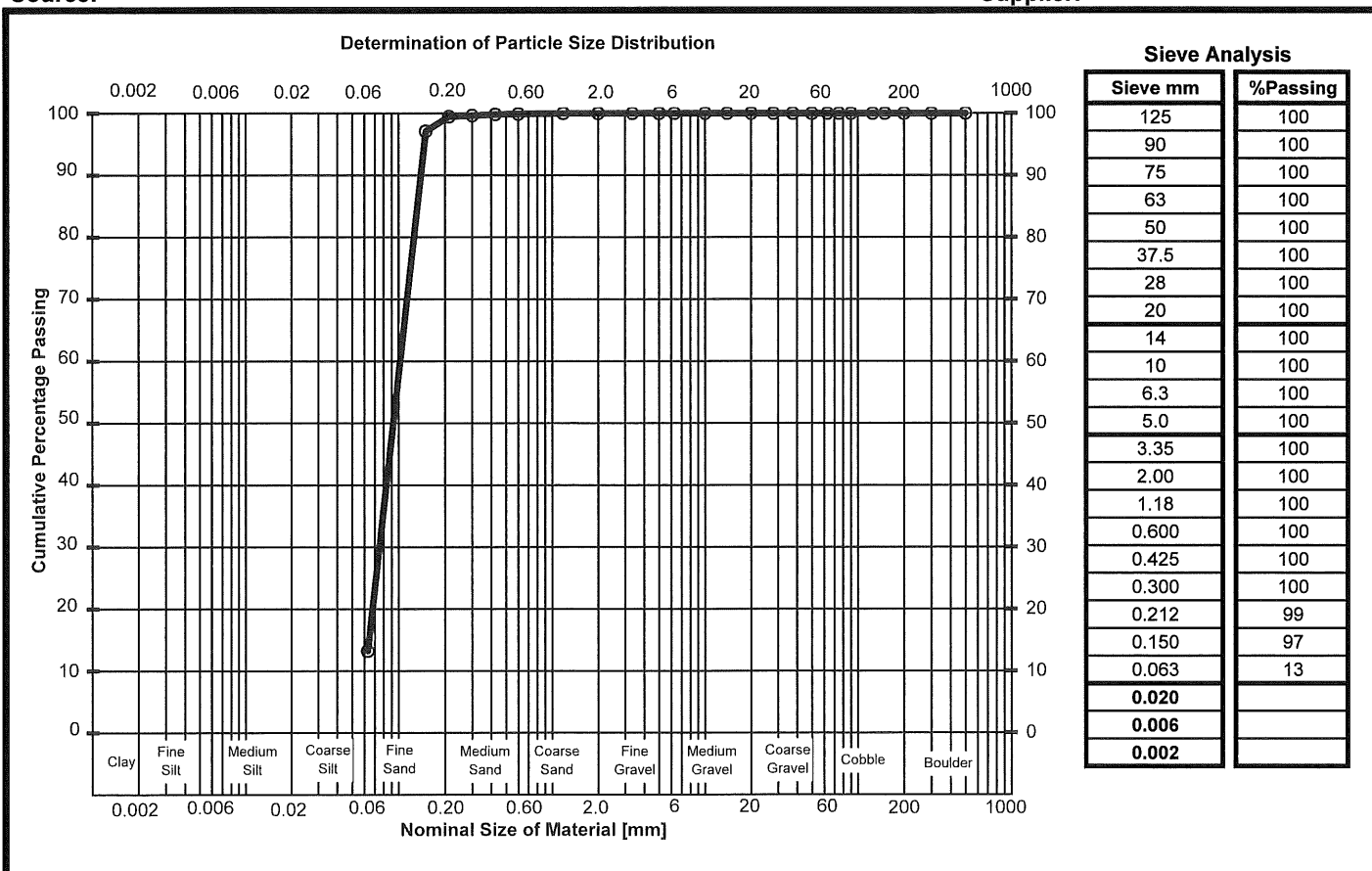
Depth Top: 8.20m

Location: BH2

Depth Base: 8.70m

Source:

Supplier:



Comments:

Approved Signatory: M. Hartnup - Laboratory Manager

Signed:

for and on behalf of Ground Engineering Ltd

Date Reported: 10.12.2020 Page 1 of 1
Form Number: GELab/C/709-2 Version 54

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Analytical Report Number : 20-40988

Project / Site name:	Fleetroad, Holbeach	Samples received on:	12/11/2020
Your job number:	SW-C15102A	Samples instructed on/ Analysis started on:	12/11/2020
Your order number:		Analysis completed by:	18/11/2020
Report Issue Number:	1	Report issued on:	18/11/2020
Samples Analysed:	5 soil samples		

Signed:

Joanna Wawrzeczko
Technical Reviewer (Reporting Team)
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement.
Application of uncertainty of measurement would provide a range within which the true result lies.
An estimate of measurement uncertainty can be provided on request.

Analytical Report Number: 20-40988
Project / Site name: Fleetroad, Holbeach

Lab Sample Number				1681420	1681421	1681422	1681423
Sample Reference				TP1	TP1	TP2	TP3
Sample Number				1	2	1	1
Depth (m)				0.10	0.30	0.05	0.20
Date Sampled				09/11/2020	09/11/2020	09/11/2020	09/11/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status				
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	0.01	NONE	21	23	17	18
Total mass of sample received	kg	0.001	NONE	0.4	0.4	0.4	0.4

General Inorganics

pH - Automated	pH Units	N/A	MCERTS	7.3	7.3	7.7	6.7
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1
Free Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1
Water Soluble Sulphate as SO ₄ 16hr extraction (2:1)	mg/kg	2.5	MCERTS	32	38	29	27
Water Soluble SO ₄ 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.016	0.019	0.014	0.014
Water Soluble SO ₄ 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	15.9	18.8	14.3	13.6
Organic Matter	%	0.1	MCERTS	3	2.4	2.5	2.1

Total Phenols

Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0
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Speciated PAHs

Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05
Pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05
Chrysene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05

Total PAH

Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80	< 0.80	< 0.80	< 0.80
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Analytical Report Number: 20-40988
Project / Site name: Fleetroad, Holbeach

Lab Sample Number				1681420	1681421	1681422	1681423
Sample Reference				TP1	TP1	TP2	TP3
Sample Number				1	2	1	1
Depth (m)				0.10	0.30	0.05	0.20
Date Sampled				09/11/2020	09/11/2020	09/11/2020	09/11/2020
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status				
Heavy Metals / Metalloids							
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	15	16	18	19
Boron (water soluble)	mg/kg	0.2	MCERTS	0.9	1.6	1.9	1
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0
Chromium (III)	mg/kg	1	NONE	26	26	31	21
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	27	26	32	22
Copper (aqua regia extractable)	mg/kg	1	MCERTS	23	33	28	12
Lead (aqua regia extractable)	mg/kg	1	MCERTS	38	38	31	44
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	19	20	21	17
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	67	130	69	50

U/S = Unsuitable Sample I/S = Insufficient Sample

Analytical Report Number: 20-40988
Project / Site name: Fleetroad, Holbeach

Lab Sample Number				1681424
Sample Reference				TP4
Sample Number				1
Depth (m)				0.10
Date Sampled				09/11/2020
Time Taken				None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status	
Stone Content	%	0.1	NONE	< 0.1
Moisture Content	%	0.01	NONE	19
Total mass of sample received	kg	0.001	NONE	0.4

General Inorganics

pH - Automated	pH Units	N/A	MCERTS	7.5
Total Cyanide	mg/kg	1	MCERTS	< 1
Free Cyanide	mg/kg	1	MCERTS	< 1
Water Soluble Sulphate as SO ₄ 16hr extraction (2:1)	mg/kg	2.5	MCERTS	60
Water Soluble SO ₄ 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.03
Water Soluble SO ₄ 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	30.1
Organic Matter	%	0.1	MCERTS	1.8

Total Phenols

Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0
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Speciated PAHs

Naphthalene	mg/kg	0.05	MCERTS	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05
Anthracene	mg/kg	0.05	MCERTS	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05
Pyrene	mg/kg	0.05	MCERTS	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05
Chrysene	mg/kg	0.05	MCERTS	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05

Total PAH

Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80
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Analytical Report Number: 20-40988
Project / Site name: Fleetroad, Holbeach

Lab Sample Number				1681424
Sample Reference				TP4
Sample Number				1
Depth (m)				0.10
Date Sampled				09/11/2020
Time Taken				None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status	
Heavy Metals / Metalloids				
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	16
Boron (water soluble)	mg/kg	0.2	MCERTS	1.2
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0
Chromium (III)	mg/kg	1	NONE	24
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	24
Copper (aqua regia extractable)	mg/kg	1	MCERTS	15
Lead (aqua regia extractable)	mg/kg	1	MCERTS	26
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	18
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	54

U/S = Unsuitable Sample I/S = Insufficient Sample

Analytical Report Number : 20-40988
Project / Site name: Fleetroad, Holbeach

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1681420	TP1	1	0.1	Brown loam and clay with vegetation and gravel
1681421	TP1	2	0.3	Brown loam and clay with vegetation and gravel
1681422	TP2	1	0.05	Brown loam and clay with vegetation and gravel
1681423	TP3	1	0.2	Brown loam and clay with vegetation and gravel
1681424	TP4	1	0.1	Brown loam and clay with vegetation and gravel



Analytical Report Number : 20-40988
Project / Site name: Fleetroad, Holbeach

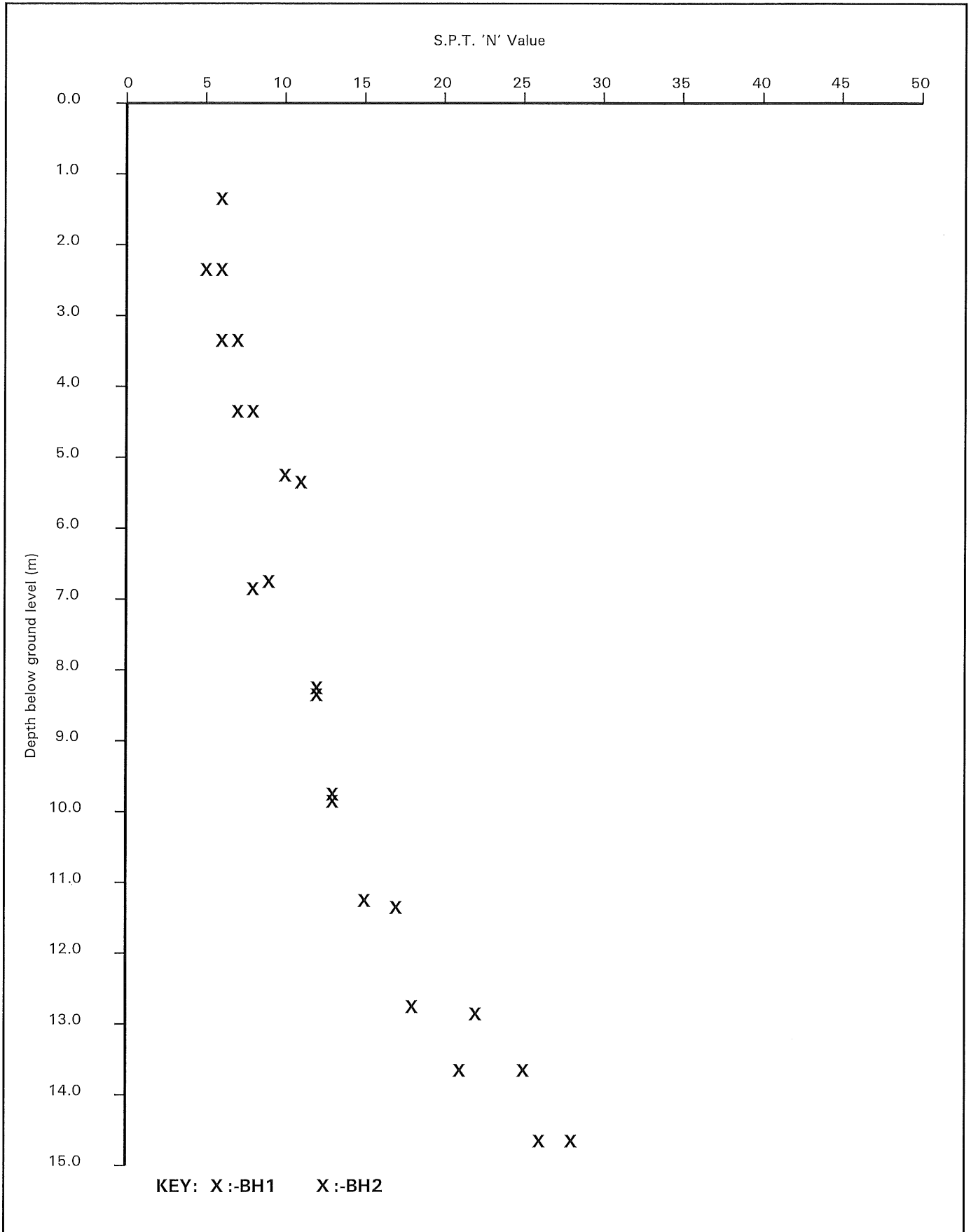
Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Free cyanide in soil	Determination of free cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In house method.	L019-UK/PL	W	NONE
Monohydric phenols in soil	Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	MCERTS
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with Iron (II) sulphate.	In house method.	L009-PL	D	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In house method.	L099-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS
Cr (III) in soil	In-house method by calculation from total Cr and Cr VI.	In-house method by calculation	L080-PL	W	NONE
Sulphate, water soluble, in soil	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In house method.	L038-PL	D	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.

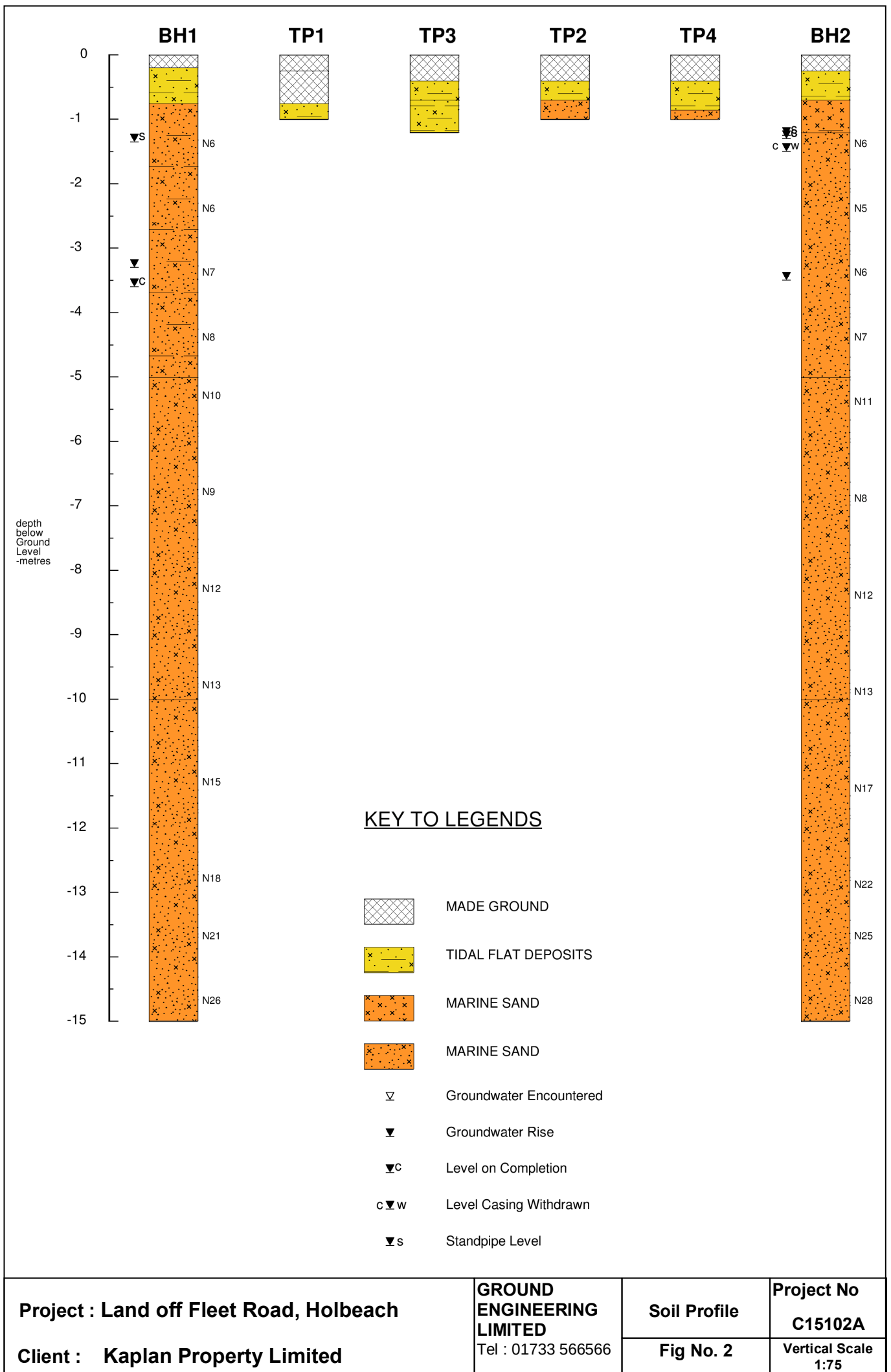
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.

Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.



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

SITE			LAND OFF FLEET ROAD, HOLBEACH		
CLIENT			KAPLAN PROPERTY LIMITED		Contract Number 15102A
GROUND ENGINEERING L I M I T E D			Tel: 01733-566566 www.groundengineering.co.uk		Date 16/12/20 Figure 1



APPENDIX 1

CLASSIFICATION OF AGGRESSIVE CHEMICAL ENVIRONMENT FOR BURIED CONCRETE

TABLE C1 – AGGRESSIVE CHEMICAL ENVIRONMENT FOR CONCRETE

(ACEC) CLASSIFICATION FOR NATURAL GROUND LOCATIONS^a

Table C1 Aggressive Chemical Environment for Concrete (ACEC) classification for natural ground locations ^a						
Sulfate				Groundwater		ACEC Class for location
Design Sulfate Class for location	2:1 water/soil extract ^b	Groundwater	Total potential sulfate ^c	Static water	Mobile water	
1	2 (SO ₄ mg/l)	3 (SO ₄ mg/l)	4 (SO ₄ %)	5 (pH)	6 (pH)	7
DS-1	< 500	< 400	< 0.24	≥ 2.5		AC-1s
					> 5.5 ^d	AC-1 ^d
					2.5–5.5	AC-2z
DS-2	500–1500	400–1400	0.24–0.6	> 3.5		AC-1s
					> 5.5	AC-2
					2.5–3.5	AC-2s
					2.5–5.5	AC-3z
DS-3	1600–3000	1500–3000	0.7–1.2	> 3.5		AC-2s
					> 5.5	AC-3
					2.5–3.5	AC-3s
					2.5–5.5	AC-4
DS-4	3100–6000	3100–6000	1.3–2.4	> 3.5		AC-3s
					> 5.5	AC-4
					2.5–3.5	AC-4s
					2.5–5.5	AC-5
DS-5	> 6000	> 6000	> 2.4	> 3.5		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 (SO₄) 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.

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