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SITE INVESTIGATION REPORT

LAND ADJACENT SILVERDENE

BOSTON ROAD

GOSBERTON

SPALDING

LINCOLNSHIRE

Report Reference C15602A

On behalf of:-

**RTW Construction & Developments Limited
Enterprise Way
Pinchbeck
Spalding
Lincolnshire
PE11 3YR**

May 2022

RTW CONSTRUCTION & DEVELOPMENTS LIMITED

STUDIO 11 ARCHITECTURE

SITE INVESTIGATION REPORT

FOR

PROPOSED RESIDENTIAL DEVELOPMENT

AT

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INTRODUCTION

The client, RTW Construction & Developments Limited, is proposing to construct a residential development on land adjacent Silverdene, Boston Road, Gosberton near Spalding in Lincolnshire. The proposed development layout was provided by the architects, a copy of which is presented to the rear of this report text.

Ground Engineering Limited was commissioned by the client, under the direction of architects Studio 11 Architecture, to carry out a site investigation to determine the nature and properties of the underlying soils, and provide a geotechnical and contamination assessment report. A desk study report on the site for the client was previously undertaken by Ground Engineering Limited, report reference C15602 dated March 2022, which should be consulted for further details. Information from the desk study is summarised within this report.

LOCATION, TOPOGRAPHY AND GEOLOGY OF THE SITE

The approximately 2hectare site, which is centred on National Grid Reference TF 2451 3183 is located on the western side of Boston Road (B1397), immediately north of a bungalow named Silverdene, approximately 500m north-east of Gosberton village, as shown on the site location plan following this report text. Gosberton is approximately 8km north of Spalding in Lincolnshire.

The site comprises two parcels of land, separated by a drain. A disused glass house is located to the south of the drain, otherwise the site is vegetated and contains numerous trees. The site is bounded by Boston Road to the east. A track (Mill Lane) is present along the south-eastern boundary, beyond which are properties fronting Boston Road. A track is also present along the northern boundary of the site adjacent a bungalow named Arosfa. Drains and a stream are present along the western and north-western edges of the site. The irregular shaped site was approximately 50m wide fronting Boston Road, and extended 170m west. Photographs of the site are presented within the desk study report.

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 initially clay, becoming silt and fine sand soils are indicated to rest on the solid geology of the Oxford Clay Formation at depth. Previous work in the vicinity has found a glacial Boulder Clay or 'Till' beneath the surface layer of Tidal Flat Deposits. Boston Road to the east, and the track Mill Lane to the south-east are banks defining the limits of reclamation between c.1000AD and 1300AD. The site is to the east of the probable Saxon coastline.

SUMMARY OF HISTORICAL INFORMATION

The Ordnance Survey map of 1887 showed that the site was undeveloped within a rural area to the east of Gosberton. A glasshouse had been built on the site by 1973, which remained on-site but in a derelict condition at the time of this investigation in March 2022. A drain crossed the site from Boston Road in the east to join a stream to the north-west, and the site has remained in this configuration to the present day.

Off-site, to the south-east were houses and a corn windmill (demolished by 1905). A pond close to the windmill was shown as a marsh on the 1932 map and had been infilled prior to 1973. To the north-east of the site was Gosberton Brick & Tile Works, which has 'old kiln' denoted on the 1932 map extract indicating it had closed. Ponds and a marsh associated with the brickworks were also present to the north-east of the site.

SUMMARY OF ENVIRONMENTAL DATA

A corn mill was present to the south-east of the site. The brick and tile works, together with associated pits, are identified 17m to 105m east and north-east of the site. The closest electricity sub-station is 208m west of the site (1995). No petrol stations, tanks or garages are recorded within 250m of the site. No landfills or waste sites are recognised within 250m of the site.

Current land uses recorded within 250m of the site comprise 'Tyres 4 Bikes Limited' 78m west, and a sewage pumping station and electricity sub-station 203m to the west. There were two licensed discharges to controlled waters recorded within 250m of the site, both of which were revoked in 1996.

No artificial or made ground deposits are recorded beneath the site. The site is underlain by superficial Tidal Flat Deposits, which are classified by the Environment Agency (EA) as an 'unproductive' stratum. The superficial deposits are underlain by the solid geology Oxford Clay Formation at depth, which is also classified by the EA as an 'unproductive' stratum. The closest surface water features are drains crossing the site, and around the boundaries of the site, from which there is a surface water abstraction permit to extract water for spray irrigation. There are no groundwater abstractions within 250m of the site. The site is not within a source protection zone.

The site is within a Zone 2 and Zone 3 floodplain, and has a medium risk of flooding from rivers and/or the sea, and a negligible risk of groundwater flooding. The site is within a SSSI impact zone and nitrate vulnerable zone, both environmentally sensitive areas.

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 an area where underground mining or brine extraction is recorded.

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

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/Buildings	Drains could provide a contaminant source. The existing and former buildings may have had asbestos containing materials.
Soil Beneath Site	Contamination may be present within 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 could provide a contamination source, such as the former brick works to the north-east of the site.

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 ***Targets 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 Superficial Tidal Flat Deposits are recorded on the site, which are indicated by the EA to be an ‘unproductive’ stratum. The underlying solid geology Oxford 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 Surface water features are present both crossing and bordering the site. There is a historical permit to extract water for spray irrigation from these drains. Gosberton Pits (Nature Trust) is present to the east of Boston Road.	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/ Buildings	Soil Beneath Site	Soil Gas	Ground Contamination Outside Site Boundary
Human Health – ground or construction workers	Ingestion and Inhalation of contaminated Soil, Dust and Vapour	Low likelihood/ Likely (asbestos)	Low likelihood	Low likelihood	Low likelihood
Human Health – 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
<u>Key to Table 4</u> 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 on 28th March 2022 comprised eight machine excavated trial pits (TP1 to TP8). 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 and the groundwater conditions observed during and on completion of excavation.

Machine Excavated Trial Pits

Trial pits TP1 to TP8 were excavated using a JCB 3CX to depths of between 1.00m and 3.20m. 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.

Soakaway testing was carried out within trial pits TP4 and TP7 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 pits with vertical sides trimmed square to the base. The dimensions were accurately measured and recorded, and the pits were then filled with clean water from a large container. The rate of water dissipation from the pits was measured by recording the depth of water relative to a datum at frequent time intervals. As the water was slow to drain away the tests were monitored for 300 minutes (TP4) and 360

minutes (TP7), and no additional fillings were possible within the day. The results are presented and follow the respective trial pit records.

On completion, the trial pits were emptied of any remaining water, backfilled with arisings and the surfaces reinstated.

LABORATORY WORK

The samples were inspected in the laboratory and assessments of the soil characteristics have been taken into account during preparation of the 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 a selected sample of silt and sand was determined by sieve analysis. The particle size distribution passing the 63µm sieve was obtained by pipette sedimentation on the selected sample. Results of this test have been combined and is presented as particle size distribution curve 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 10N 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 were analysed to determine the concentration of soluble sulphates. The pH values were also determined.

Chemical analysis of 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'.
Two of the selected samples were also screened for the presence of asbestos, and tested for total petroleum hydrocarbons (TPH).

GROUND CONDITIONS

The ground conditions have been plotted as a soil profile in Figure 3. The ground conditions comprised a 0.20m to 0.30m thick surface layer of topsoil, and locally made ground to 0.60m depth in TP2 associated with an old drain, which were in turn underlain by the expected firm, becoming soft clay soils of superficial Tidal Flat Deposits, with very soft, slightly organic clay Tidal Flat Deposits below 2.00m to 2.60m depth, which was proved to at least the base of the trial pits at a maximum depth of 3.20m. Groundwater seepages were recorded as shallow as 2.20m below ground level.

Made Ground/Topsoil

A 0.20m to 0.30m thick surface layer of soft or firm, dark brown, slightly sandy, locally slightly gravelly, silty clay topsoil, was encountered across the site. The gravel fraction comprised angular to rounded flint.

Beneath the topsoil at 0.30m depth in TP2, firm, orange brown and brown, slightly sandy, slightly gravelly, silty clay fill, associated with an old drain, was encountered to 0.60m depth. The gravel fraction comprised angular to rounded flint and pipe fragments.

Tidal Flat Deposits

Beneath the made ground and topsoil at between 0.20m and 0.60m depth, the expected Tidal Flat Deposit was a firm, light brown, light grey and orange brown, slightly sandy, silty clay, with occasional orange brown sand partings. The Tidal Flat Deposits typically became soft below 1.80m to 2.30m depth, and very soft and organic below 2.00m to 2.60m depth.

In trial pit TP2, between 1.40m and 2.00m depth, orange brown and light grey, clayey, very silty fine grained sand was encountered, which was also considered to represent a Tidal Flat Deposit.

The Tidal Flat Deposits were encountered to at least the base of the trial pits, and to a maximum 3.20m below ground level.

Groundwater

The trial pits were generally dry during excavation and on completion, however groundwater seepages were encountered at 2.20m depth in TP3, and 2.70m depth in TP1, associated with very soft and slightly organic clay. A minimal amount of water was observed at the base of the trial pits on completion.

Observations

Live roots were observed in all of the trial pits, and to a maximum 2.00m depth in TP1.

Excavation Stability

The trial pit sides were stable during excavation and on completion.

Evidence of Contamination

The made ground encountered during this investigation was not noted to have olfactory or visual evidence of fuel contamination. No asbestos containing materials were noted in the soils during this investigation, or during testing.

COMMENTS ON THE GROUND CONDITIONS IN RELATION TO THE PROPOSED RESIDENTIAL DEVELOPMENT

This investigation found topsoil and made ground to depths of between 0.20m and 0.60m, covering superficial firm becoming soft below 1.80m depth, and very soft organic clay Tidal Flat Deposits, which locally varied to sand in TP2 between 1.40m and 2.00m depth. Groundwater seepages were met as shallow as 2.20m depth during the investigation.

The client is proposing to construct a residential development, with associated parking, access road, gardens, and area of public open space. The proposed development plan is presented to the rear of the report text. Excavations below 2.00m depth may encounter groundwater which would need to be controlled.

The superficial slightly sandy, silty clay was initially firm at shallow depths, which may be capable of supporting lightly loaded traditional foundations for the proposed dwellings.

The clay became soft below 1.80m depth, and very soft and organic with increasing depth, which would offer very limited support for lightly loaded traditional foundations for the proposed development, and the prospect of high total settlements, with potentially damaging differential movements. Piled foundations may be required if the proposed dwellings are not uniformly loaded and sensitive to settlement.

Localised deepening of traditional foundations will be required if the proposed dwellings are located close to the existing trees on the site and around the boundaries. Foundations will need to penetrate the zones of root influence within the clay soils. The underlying soft and slightly organic clays were found as shallow as 1.80m depth, are poorly consolidated, variable and unlikely to provide adequate support for deepened traditional strip foundations. Thus, some of the deepened foundations could overstress the underlying very soft, grey, slightly organic clay soils, which offer very limited support for traditional foundations. The proposed dwellings should not be supported on traditional foundations unless the structures are

lightly loaded, regular in shape, and could tolerate potentially significant total and differential consolidation movements.

For any proposed buildings close to existing trees, a piled foundation scheme will be required in order to transfer loads into the anticipated underlying Till at depth.

Floor slabs could be ground bearing in areas where they are well away from the influence of trees, although differential movements are likely to occur if unevenly loaded.

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 0.60m. The made ground and root affected clay soils should both be avoided as bearing strata.

Samples of the near surface Tidal Flat Deposit had modified plasticity indices of between 33% and 43%, which rate the soils as having a medium to high volume change potential based on NHBC Standards Chapter 4.2 'Building near trees' (2022). A minimum foundation depth of 1.00m 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 1.00m deep, but must be deepened in order to penetrate any root affected clay. Based on an assumed high water demand Hawthorn tree, a minimum foundation depth of 1.50m would be required in such clay soils based on NHBC Standards at 10m distance, increasing to 2.50m depth at 5m distance, and for an assumed moderate water demand Ash tree, a minimum foundation depth of 1.55m would be required based on NHBC Standards at 10m distance, increasing to 2.00m depth at 5m distance. Foundations would need to be at least 12m from a fully mature Hawthorn tree, and 16m from a fully mature Ash tree, for the adoption of the minimum foundation depth of 1.00m on this site in clay soils. Within these distances, foundation depths

will depend on the proximity of trees to foundations and depths should be determined using the NHBC Standards where clay forms the base of foundation excavations. In addition, void forming or compressible material should be placed alongside foundations and ground beams within root affected clay.

Bearing Capacity

The firm clay soils at 1.00m depth, offer a maximum safe bearing capacity of 115kN/m² beneath a 0.60m wide strip footing, with a factor of safety of 3.0 applied against shear failure, with settlement likely to exceed 30mm, and may be sufficient to support the loads of the structures. Deepened foundations at 2.00m depth would have a reduced safe bearing pressure in the order of only 50kN/m², with settlements likely to exceed 40mm, which may not be sufficient to support the proposed dwellings. Any regular shaped buildings could be supported by raft foundations, the Tidal Flat Deposits beneath a nominal 12m by 8m raft foundation would have a maximum safe bearing capacity of 20kN/m² with the same factor of safety of 3.0 incorporated. Estimated consolidation settlement beneath such a raft is likely to exceed 50mm.

Structures founded within the Tidal Flat Deposits would have to tolerate potentially large total and differential settlements, which may be exaggerated where the foundations cross any natural variation different soil types. Differential movements will occur if and where foundation pressures locally increase along foundation runs. Movements could be further exacerbated by effects of desiccation, which could also locally generate upward heave movements. New strip foundations should incorporate reinforcement in order to minimise differential movements along or between them.

Piled Foundations

Piled foundations could support the proposed dwellings and avoid the potential problems with limited bearing pressures and differential settlement. The ground conditions should be proved by cable percussion boreholes to an estimated 15m to 20m below ground level to provide the soil properties for piled foundation design. The advice of a specialist piling

contractor should be sought with regard to suitable methods of pile installation. The superficial deposits will require use of casing for bored piles and attention should be made to the possibility of ‘necking’ of concrete within such very soft soils. Driven, bored or Continuous Flight Augered (CFA) piles could be used.

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

Excavations

The underlying soils should be easily removed within excavations for the proposed residential development. Footings associated with the relict greenhouse may be more difficult to remove and require the use of a breaker. The sides of excavations within any made ground and Tidal Flat Deposits are likely to be unstable and should not be relied upon to stand unsupported.

Excavations could be expected to encounter groundwater seepages below 2.00m depth, but may be shallower and reflect the water level in nearby drains. The groundwater levels may fluctuate seasonally and such inflows would locally be accompanied by resulting 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 and side support by interlocking sheeting. The silty clay and sand are prone to softening, deterioration and loosening in the presence of water, with loss of their already limited 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.

Floor Slab

A ground bearing floor slab could be adopted for the new dwellings where it is beyond the zones of influence from trees, and the naturally deposited clay soils are present at shallow depth.

A ground bearing floor slab could be adopted for proposed buildings, even within influencing distance of neighbouring trees, if root infested clays are removed and replaced with suitable well-graded coarse-grained fill. If such clay is left, damaging differential heave movements could occur across such a slab, particularly where it covers any clay affected by recently severed tree roots. A suspended floor slab could be adopted with piled foundations and will 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 (2022), are adopted.

Hardstanding

Naturally deposited firm, silty clays were encountered at sub-grade level across this site.

Based on IAN 73/06, Table 5.1 recommends a design CBR value of 2.5% for silty clay with a plasticity index of 40%, and 3.0% for silty clay with a plasticity index of 30%.

Laboratory CBR tests on selected near surface soils yielded CBR values ranging between 2.9% and 3.8%. A design CBR value of 2.5% for the naturally deposited silty clay should be adopted for hardstanding design on this site.

The sub-grade should be suitably compacted and inspected, with any made ground, topsoil, very soft, organic or desiccated clays, being removed and replaced with a suitable thickness of 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 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.

Drainage

The soakaway test in TP7 determined an extrapolated soil infiltration rate (f) of 5.61×10^{-8} m/s, for the slightly sandy, silty clay. A soil infiltration rate could not be determined

from the soakaway test in TP4, as the water level remained constant during the 300 minute duration of the test. These results rate the soil as having a ‘practically impervious’ drainage potential according to BS8004:1986 Figure 6.

Groundwater seepages were met during excavation of the trial pits at depths of 2.20m and 2.70m. Any soakaway drainage is likely to deteriorate over time as the chambers become blocked with silt. Provision should be made for regular cleaning. There would be no advantage in excavating soakaway chambers below the groundwater level, which reduces the effective volume of the soakaway.

Sulphate Conditions

Sulphate analysis of selected samples of soil 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 7.5 and 8.2 indicating 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.

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.

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			Measured 95 th Percentile mg/kg	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	2.1%	3.1%	-	-	-	-	-	-	-	-
Arsenic	5	7.5	11	0	0	0	10.65	S4UL	37	40	640
Cadmium	5	<0.10	0.10	0	0	0	0.10	S4UL	11	85	190
Chromium (III)	5	14	22	0	0	0	21.58	S4UL	910	910	8600
Chromium (VI)	5	<0.50	<0.50	0	0	0	<0.50	S4UL	6	6	33
Lead	5	13	18	0	0	0	17.89	C4SL	200	310	2330
Mercury	5	<0.10	<0.10	0	0	0	<0.10	S4UL	11	15	320
Selenium	5	<0.20	<0.20	0	0	0	<0.20	S4UL	250	430	12,000
Nickel	5	12	20	0	0	0	19.32	S4UL	130	180	980
Phenols	5	<0.10	<0.10	0	0	0	<0.10	S4UL	120	440	440
Benzo[a]pyrene	5	<0.10	<0.10	0	0	0	<0.10	S4UL	0.79	1.2	15
Copper	5	6.9	10	0	0	0	9.56	S4UL	2400	7100	68,000
Zinc	5	37	48	0	0	0	47.10	S4UL	3700	40,000	730,000
Free Cyanide	5	<0.50	<0.50	0	0	0	<0.50	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.

LQM/CIEH S4ULs 'Copyright Land Quality Management Limited reproduced with permission; Publication Number S4UL3608. All rights reserved'.

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

Discussion of Soil Results

Levels of all elements and compounds were within the associated soil screening values for both residential and commercial/industrial end uses.

The US95 values did not exceed the screening values for either of the residential end uses, or for a commercial or industrial usage.

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 noted within the near surface soils during sampling, or during analysis in the chemical laboratory.

In conclusion, the near surface soils would be suitable for use in any proposed garden or landscaped areas of the residential development, and also beneath buildings and areas of permanent hardstanding if geotechnically suitable.

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 including report C15602 and the intrusive ground investigation documented in the preceding sections of this report.

A generalised conceptual model relative to the existing site and future 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/ Buildings	Soil	Soil Gas	Off-Site Sources
Human Health – ground workers	Ingestion and Inhalation of contaminated Soil, Dust and Vapour	Low/ Moderate	Very Low	Low	Very Low
Human Health – 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	Very 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 Risk</u>	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 plot, the site history and a proposed residential end use of the site, in the context of the conceptual model, are discussed as follows.

The client is proposing to construct a residential development, with associated parking, access road, gardens, and area of public open space.

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 0.60m of made ground and topsoil resting on naturally deposited Tidal Flat Deposits. The chemical testing has identified no elevated concentrations within the soils in respect to the proposed residential end use.

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

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

Drainage

Redundant field, 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.

Buildings

The existing derelict greenhouse within the site may have asbestos containing materials within it and an asbestos survey should be undertaken prior to demolition for 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 (if present), during the site clearance and redevelopment phases.

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

Soil Gas

A small infilled pond had been noted off-site to the south-east of the site, and ponds and marsh associated with the former brick and tile works are present to the north-east of the site. No landfills were recorded within 250m of the site. The site is underlain by a layer of topsoil, covering silty clay and slightly organic clay at depth of the superficial Tidal Flat Deposits.

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

The site lies within an area where less than 1% of homes are above the BRE action level for radon and that no radon protection measures are required.

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) Consideration should be given to gas monitoring within deep or confined spaces to ensure safety of personnel entering them, since carbon dioxide could accumulate within any excavations, service chambers or sub-structures.

Human Health - Users of Completed Development

The risk of the made ground affecting the site users in a residential setting, would be considered to be very low.

The results of the chemical analysis undertaken would indicate that the made ground should be considered suitable for re-use at the surface in any gardens or landscaped areas. No scheme of remediation would be considered necessary for the residential setting.

For areas to be covered by buildings or hard surfaced areas, the made ground should be removed if it is not suitable for engineering purposes.

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

Water Environment

The site is underlain by superficial Tidal Flat Deposits, indicated by the EA to be an 'unproductive' stratum, which covers the solid geology Oxford Clay at depth, also indicated by the EA to be an 'unproductive' stratum. The nearest surface water features are drains which cross and surround the site and a Nature Reserve to the east. The site is not within a source protection zone.

Groundwater seepages were recorded locally at 2.20m and 2.70m depth in the trial pits.

The risk to the water environment from soil contamination is considered very low as it is unlikely that the proposed development would impact the quality of the water environment.

Effects on Buried Services

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

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.

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

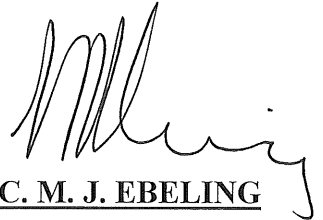


S. WEATHERLEY

B.Eng.(Hons.),

C.Geol., F.G.S.

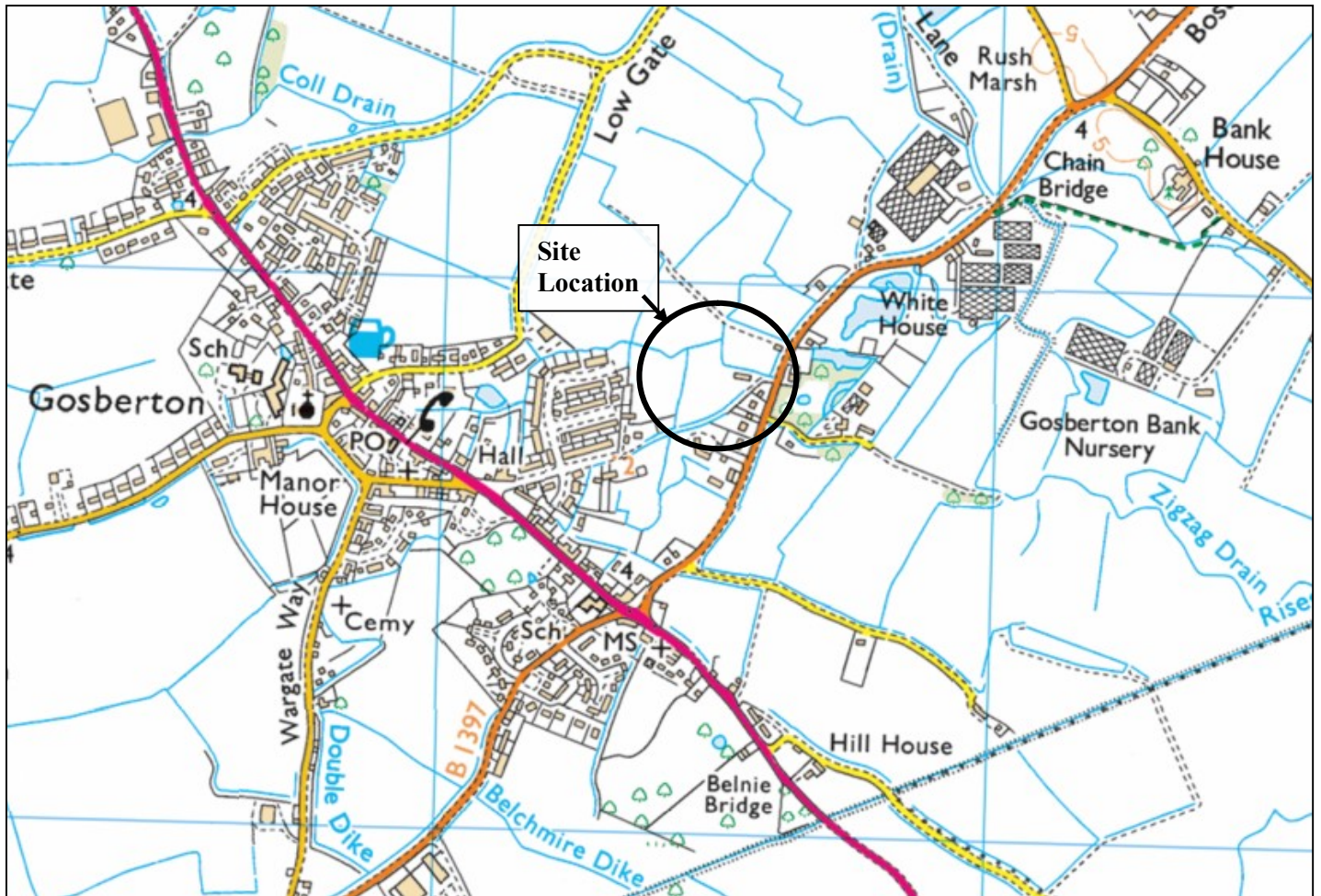
Senior Geo-Environmental Engineer



C. M. J. EBELING
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 Adjacent Silverdene, Boston Road,
Gosberton, Spalding, Lincolnshire

Client : RTW Construction & Developments Limited

**GROUND
ENGINEERING
LIMITED**

Peterborough

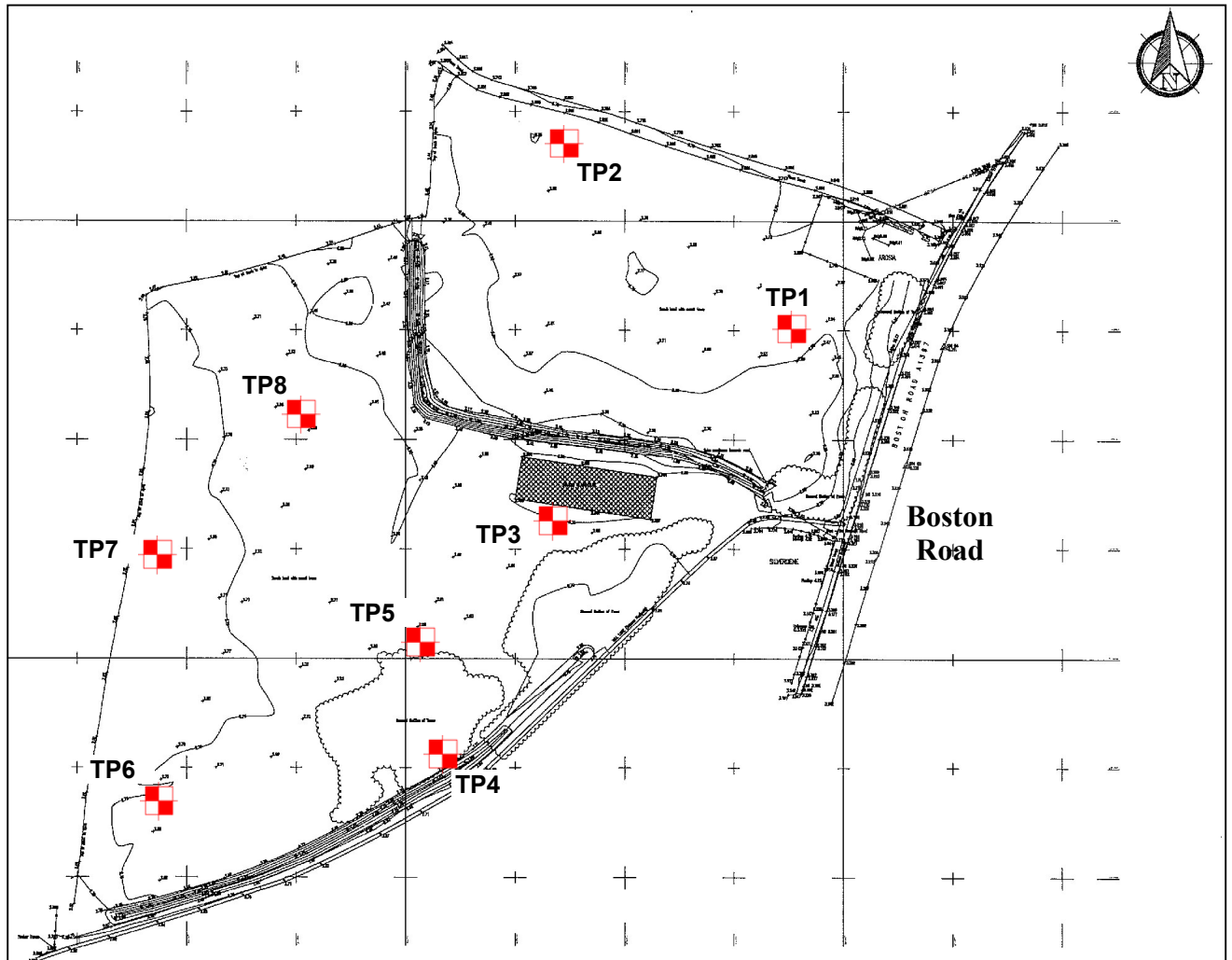
Tel : 01733 566566

Project No.

C15602A

Exploratory Hole Location Plan

Based on plan provided by client.



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Project : Land Adjacent Silverdene, Boston Road,
Gosberton, Spalding, Lincolnshire

Client : RTW Construction & Developments Limited

**GROUND
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Peterborough Tel : 01733 566566

Project No.
C15602A

Proposed Development Plan

Based on plan provided by client.



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**Project : Land Adjacent Silverdene, Boston Road,
Gosberton, Spalding, Lincolnshire**

Client : RTW Construction & Developments Limited

**GROUND
ENGINEERING
LIMITED**

Peterborough Tel : 01733 566566

**Project No.
C15602A**

GROUND ENGINEERING L I M I T E D Tel: 01733-566566 www.groundengineering.co.uk			Site: SITE ADJACENT SILVERDENE, BOSTON ROAD, GOSBERTON		TRIAL PIT TP1	
			Date: 28/03/22	Pit Size: 2.20m L x 0.50m W x 3.00m D.		Ground Level:
Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m O.D. Level m
Depth m	Type	Result				
0.20 0.20	D1 ES1			TOPSOIL - Firm, dark brown, slightly sandy, silty CLAY.		0.30
0.50	D2			Firm, light brown and orange brown, slightly sandy, silty CLAY. (TIDAL FLAT DEPOSIT)		0.60
0.70 0.80	D3 V1	(55)		Firm, light grey and light brown, slightly sandy, silty CLAY. (TIDAL FLAT DEPOSIT)		1.00
1.50	D4			Firm, light brown, orange brown and light grey, slightly sandy, silty CLAY. Sand is fine grained. (TIDAL FLAT DEPOSIT)		1.90
2.00 2.00	D5 V2	(35)		Soft, light grey and light brown, slightly sandy, silty, slightly organic CLAY. (TIDAL FLAT DEPOSIT)		2.20
2.70	D6		1 √	Very soft, light brown and grey, slightly sandy, silty, slightly organic CLAY with black carbonaceous specks. (TIDAL FLAT DEPOSIT)		3.00
				Pit completed at 3.00m depth		
KEY D - Disturbed Sample B - Bulk Sample U - Undisturbed Sample R - Root Sample W - Water Sample ES - Environmental Sample √ - Water Strike √ - Water Rise √c - Level on completion MP - Mackintosh Probe P() - Hand Penetrometer Cohesion () kPa V - Vane Shear Test Cohesion () kPa			REMARKS 1. Live roots observed to 2.00m depth 2. Water seepage at 2.70m depth 3. Pit sides stable			
						Project No 15602
						Scale 1:25
						Page 1/1

GROUND ENGINEERING L I M I T E D Tel: 01733-566566 www.groundengineering.co.uk			Site: SITE ADJACENT SILVERDENE, BOSTON ROAD, GOSBERTON		TRIAL PIT TP2		
Date: 28/03/22			Pit Size: 2.30m L x 0.50m W x 3.00m D.		Ground Level:		
Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m	O.D. Level m
Depth m	Type	Result					
0.20	D1			TOPSOIL - Firm, dark brown, slightly sandy, silty CLAY.		0.30	
0.20	ES1						
0.50	D2			MADE GROUND - Firm, orange brown and brown, slightly sandy, slightly gravelly, silty CLAY. Gravel is angular to rounded flint and occasional pipe fragments.		0.60	
0.50	ES2						
0.80	D3			Firm, light grey and light brown, slightly sandy, silty CLAY. (TIDAL FLAT DEPOSIT)		1.40	
1.40	D4						
1.80	D5			Orange brown and light grey, clayey, very silty SAND. Sand is fine grained. (TIDAL FLAT DEPOSIT)		2.00	
2.20	D6						
2.60	D7			Very soft, grey, silty, slightly organic CLAY with black carbonaceous specks. ...Becoming sandy below 2.60m depth. (TIDAL FLAT DEPOSIT)		3.00	
3.00	D8						
				Pit completed at 3.00m depth			

KEY
 D - Disturbed Sample
 B - Bulk Sample
 U - Undisturbed Sample
 R - Root Sample
 W - Water Sample
 ES - Environmental Sample
 ∇ - Water Strike
 ∇ - Water Rise
 ∇c - Level on completion
 MP - Mackintosh Probe
 P() - Hand Penetrometer
 Cohesion () kPa
 V - Vane Shear Test
 Cohesion () kPa

REMARKS
 1. old yellow plastic pipe met at 0.30m depth
 2. Live roots observed to 1.40m depth
 3. Pit dry
 4. Pit sides stable

Project No 15602	
Scale 1:25	Page 1/1

GROUND ENGINEERING L I M I T E D Tel: 01733-566566 www.groundengineering.co.uk			Site: SITE ADJACENT SILVERDENE, BOSTON ROAD, GOSBERTON		TRIAL PIT TP3		
Samples and in-situ Tests			Date: 28/03/22	Pit Size: 2.30m L x 0.50m W x 3.00m D.		Ground Level:	
Depth m	Type	Result	(Date) Water	Description of Strata	Legend	Depth m	O.D. Level m
0.10 0.10	D1 ES1			TOPSOIL - Soft, dark brown, slightly sandy, silty CLAY.		0.20	
0.40-0.60 0.40	B1 D2			Firm, brown, orange brown and light grey, slightly sandy, silty CLAY with occasional sand partings.			
0.70	D3						
1.20 1.20	D4 V1	(57)		(TIDAL FLAT DEPOSIT)			
1.40	D5						
1.60	V2	(48)					
1.80-2.20 1.80	B2 D6						
2.30	V3	(20)	1 V			2.30	
2.40	D7			Soft, light grey and brown, silty, slightly organic CLAY with black organic specks.			
2.70-3.00 2.80	B3 D8			(TIDAL FLAT DEPOSIT)			
				Pit completed at 3.00m depth		3.00	

KEY

- D - Disturbed Sample
- B - Bulk Sample
- U - Undisturbed Sample
- R - Root Sample
- W - Water Sample
- ES - Environmental Sample
- ∇ - Water Strike
- ∇ - Water Rise
- ∇c - Level on completion
- MP - Mackintosh Probe
- P () - Hand Penetrometer
- Cohesion () kPa
- V - Vane Shear Test
- Cohesion () kPa

REMARKS

- Live roots observed to 1.20m depth
- Water seepage at 2.20m depth
- Pit sides stable

Project No
15602

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L I M I T E D
Tel: 01733-566566
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Date: 28/03/22

TRIAL PIT
TP4

Ground
Level:

KEY	D - Disturbed Sample	REMARKS	1. Live roots observed to 0.90m depth	
	B - Bulk Sample		2. Pit dry	
	U - Undisturbed Sample		3. Pit sides stable	
	R - Root Sample		4. Soakaway test undertaken at 1.00m depth	
	W - Water Sample			
	ES - Environmental Sample			
	☒ Water Strike			
	☒ Water Rise			
	☒c Level on completion			
	MP - Mackintosh Probe			
P() - Hand Penetrometer				
	Cohesion () kPa			
V - Vane Shear Test				
	Cohesion () kPa			
			Project No 15602	
			Scale 1:25	Page 1/1

SOAKAWAY TEST RESULTS

BRE DIGEST 365 - SOIL INFILTRATION RATE

Project: Site adj. Silverdene, Boston Road, Gosberton
Client: RTW Construction & Developments Limited

Project No: C15602
Sheet No: 1/1

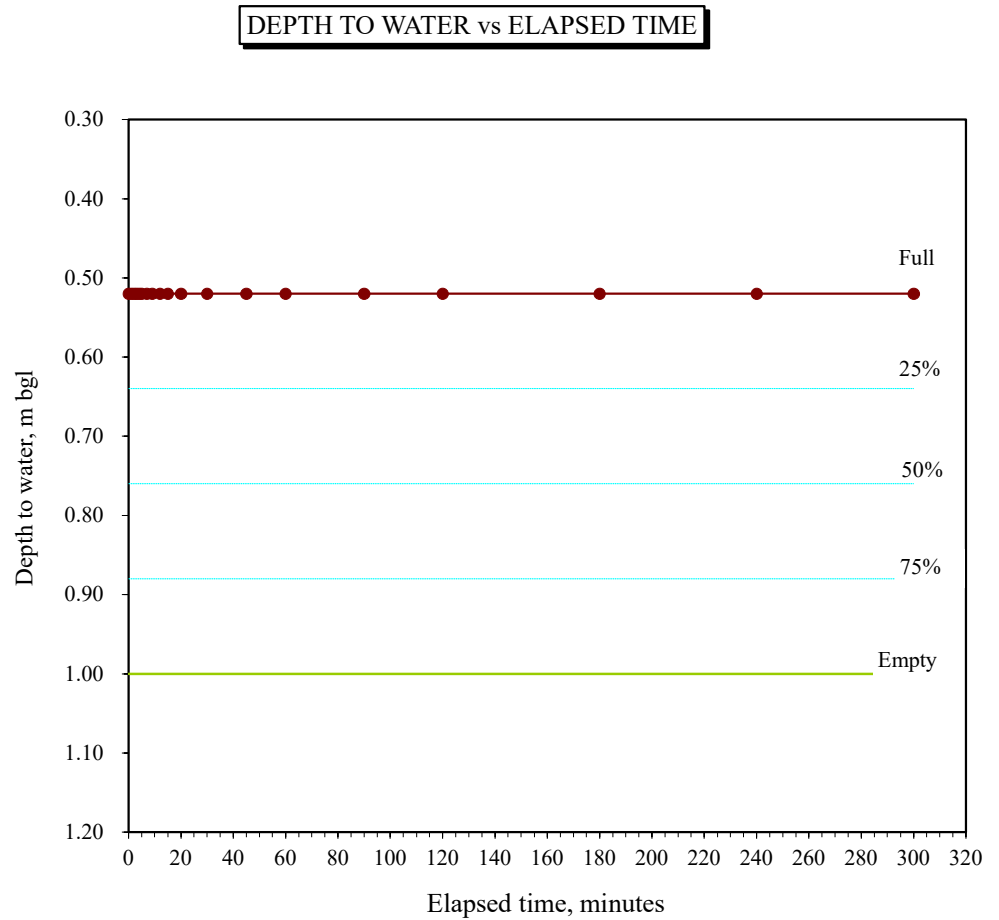
Trial Pit: TP4 FIRST FILLING
Depth: 1.00
Length: 1.20
Width: 0.50

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

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

Elapsed Time min	Depth to Water m
0	0.52
1	0.52
2	0.52
3	0.52
4	0.52
5	0.52
7	0.52
9	0.52
12	0.52
15	0.52
20	0.52
30	0.52
45	0.52
60	0.52
90	0.52
120	0.52
180	0.52
240	0.52
300	0.52

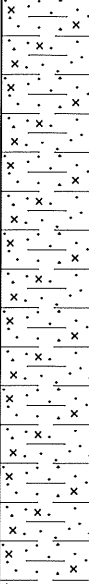
All dimensions given in metres



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

V75-V25 = 0.144
A50 = 1.416
T75-T25 = Not Determined

Soil Infiltration Rate $f =$ m/s

GROUND ENGINEERING L I M I T E D Tel: 01733-566566 www.groundengineering.co.uk			Site: SITE ADJACENT SILVERDENE, BOSTON ROAD, GOSBERTON		TRIAL PIT TP5	
Date: 28/03/22			Pit Size: 2.20m L x 0.50m W x 3.00m D.		Ground Level:	
Samples and in-situ Tests			(Date) Water	Description of Strata	Legend	Depth m
Depth m	Type	Result				
0.20 0.20	D1 ES1	(60)		TOPSOIL - Soft, dark brown, silty CLAY.		0.30
0.40 0.50-0.80	D2 B1			Firm, brown and orange brown, slightly sandy, silty CLAY.		
0.70 0.80	V1 D3			(TIDAL FLAT DEPOSIT)		
1.10	D4					
1.40 1.40	D5 V2	(52)				
1.70 1.80-2.20	D6 B2					
2.10	D7					
2.50	D8	Very soft, light grey and brown, slightly sandy, silty, slightly organic CLAY with sand lenses, occasional shells and black carbonaceous specks. (TIDAL FLAT DEPOSIT)		2.60		
2.70-3.00 2.70	B3 D9					
3.00	D10					
				Pit completed at 3.00m depth		3.00
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 1.40m depth 2. Pit dry 3. Pit sides stable			
			Project No 15602		Scale 1:25	
			Page 1/1			

GROUND ENGINEERING LIMITED Tel: 01733-566566 www.groundengineering.co.uk			Site: SITE ADJACENT SILVERDENE, BOSTON ROAD, GOSBERTON		TRIAL PIT TP6		
Date: 28/03/22			Pit Size: 2.20m L x 0.50m W x 3.20m D.		Ground Level:		
Samples and in-situ Tests			(Date)	Description of Strata	Legend	Depth m	O.D. Level m
Depth m	Type	Result	Water				
0.10 0.10	D1 ES1			TOPSOIL - Soft, dark brown, sandy, silty CLAY.		0.20	
0.30	D2			Firm, brown, orange brown and light grey, slightly sandy, silty CLAY with occasional sand lenses.			
0.40-0.80	B1	(49)					
0.40	V1						
0.50	D3						
0.50	V2	(57)					
0.70	D4						
1.00	D5						
1.00	V3	(51)					
				(TIDAL FLAT DEPOSIT)			
1.60	D6						
1.70	V4	(41)					
1.80-2.20	B2						
						2.30	
2.40	D7			Soft, brown and grey, silty CLAY.			
2.50	V5	(27)		(TIDAL FLAT DEPOSIT)			
						2.60	
2.70-3.20	B3			Very soft, light grey and brown, slightly sandy, silty, slightly organic CLAY with occasional shells and black carbonaceous specks.			
2.80	D8						
				(TIDAL FLAT DEPOSIT)			
3.10	D9						
3.10	V6	(18)				3.20	
				Pit completed at 3.20m 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. Live roots observed to 1.60m depth 2. Pit dry 3. Pit sides stable	Project No 15602	
		Scale 1:25	Page 1/1

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

Date: 28/03/22

Pit Size: 1.50m L x 0.50m W x 1.00m D.

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 ▮c Level on completion MP - Mackintosh Probe P() - Hand Penetrometer Cohesion () kPa V - Vane Shear Test Cohesion () kPa	REMARKS 1. Live roots observed to 0.80m depth 2. Pit dry 3. Pit sides stable 4. Soakaway test undertaken at 1.00m depth	Project No 15602	
		Scale 1:25	Page 1/1

Scale	Page
1:25	1/1

SOAKAWAY TEST RESULTS

BRE DIGEST 365 - SOIL INFILTRATION RATE

Project: Site adj. Silverdene, Boston Road, Gosberton
Client: RTW Construction & Developments Limited

Project No: C15602
Sheet No: 1/1

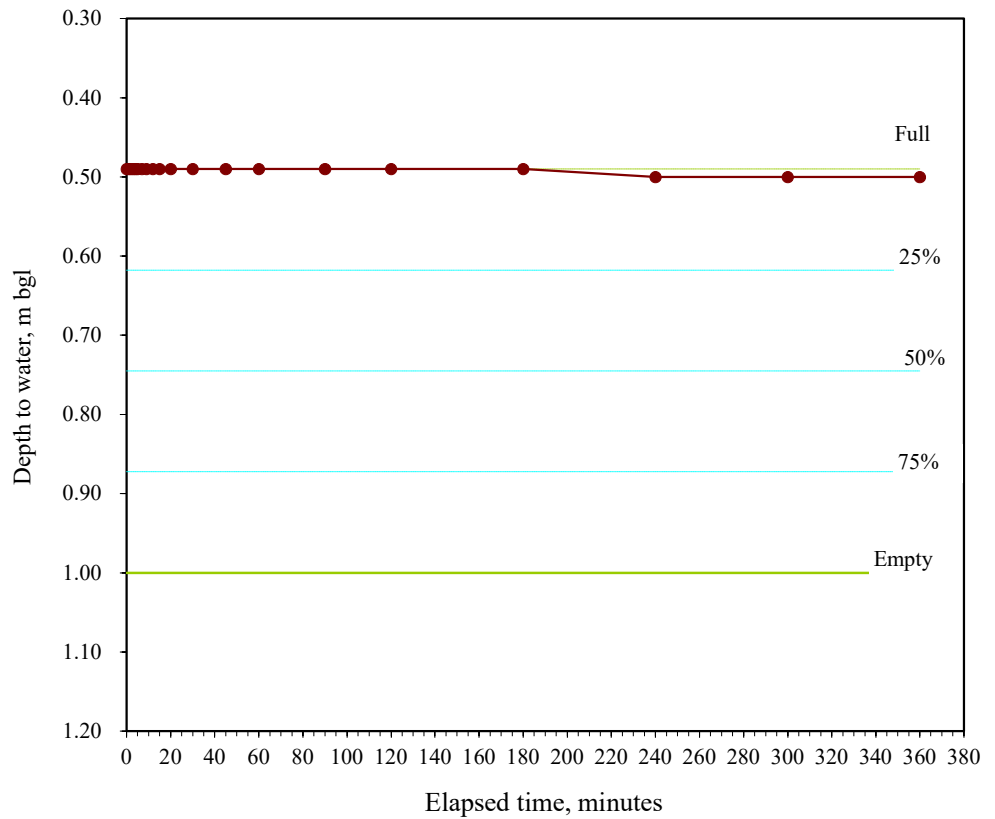
Trial Pit: TP7 FIRST FILLING
Depth: 1.00
Length: 1.20
Width: 0.50

Description of Stratum under test: Firm, light brown & grey, slightly sandy, silty CLAY

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

Elapsed Time min	Depth to Water m
0	0.49
1	0.49
2	0.49
3	0.49
4	0.49
5	0.49
7	0.49
9	0.49
12	0.49
15	0.49
20	0.49
30	0.49
45	0.49
60	0.49
90	0.49
120	0.49
180	0.49
240	0.50
300	0.50
360	0.50

DEPTH TO WATER vs ELAPSED TIME



All dimensions given in metres

$$f = (V75 - V25) / A50(T75 - T25)$$
$$V75 - V25 = 0.153$$
$$A50 = 1.467$$
$$T75 - T25 = 31000$$
$$f = \underline{\underline{5.61E-08}} \text{ m/s}$$

Extrapolated Soil Infiltration Rate

GROUND ENGINEERING L I M I T E D Tel: 01733-566566 www.groundengineering.co.uk			Site: SITE ADJACENT SILVERDENE, BOSTON ROAD, GOSBERTON		TRIAL PIT TP8		
Samples and in-situ Tests			Date: 28/03/22	Pit Size: 2.50m L x 2.20m W x 3.20m D.		Ground Level:	
Depth m	Type	Result	(Date) Water	Description of Strata	Legend	Depth m	O.D. Level m
0.10 0.10	D1 ES1			TOPSOIL - Soft, dark brown, slightly sandy, silty CLAY.		0.20	
0.40 0.50-0.80	D2 B1			Firm, orange brown, brown and light grey, slightly sandy, silty CLAY.			
0.80 0.80	D3 V1	(57)		(TIDAL FLAT DEPOSIT)			
1.20	D4						
1.60 1.70 1.80-2.50	D5 V2 B2	(44)				1.80	
1.90	D6			Soft, light brown and grey, slightly sandy, silty CLAY with orange brown sand partings and black carbonaceous specks.			
2.30	D7			(TIDAL FLAT DEPOSIT)			
2.60 2.70 2.80-3.20	V3 D8 B3	(33)		Soft, light brown and grey, silty, slightly organic CLAY with occasional shell fragments.		2.50	
3.10 3.10	D9 V4	(23)		(TIDAL FLAT DEPOSIT)		3.20	
				Pit completed at 3.20m 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. Live roots observed to 1.00m depth 2. Pit dry 3. Pit sides stable	Project No 15602	
		Scale 1:25	Page 1/1

LABORATORY TEST RESULTS

CONTRACT SITE ADJACENT SILVERDENE, BOSTON ROAD, GOSBERTON

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	Soil		Water mg/l	pH	Top %	Base %	
														Total % Dry Wt.	Aqueous Extract mg/l					
TP1	D3	0.70	71	29	42	41														SOIL CLASSIFICATION = CV 0% retained on 425µm sieve
	D4	1.50													198		8.0			
TP2	D4	1.40													134		8.0			
TP3	D4	1.20	66	29	37	27														SOIL CLASSIFICATION = CH 0% retained on 425µm sieve
	D6	1.80				35														
	D7	2.40				86														
TP4	D4	0.90	65	26	39	34														SOIL CLASSIFICATION = CH 0% retained on 425µm sieve
TP5	B1	0.50 – 0.80	56	23	33	28	1.94	1.53										2.9	2.9	SOIL CLASSIFICATION = CH 0% retained on 425µm sieve 0% retained on 20mm sieve
	D4	1.10													298		7.7			
	D5	1.40				34														
	D7	2.10				29														

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

C.B.R. – CALIFORNIA BEARING RATIO

15602

LABORATORY TEST RESULTS

CONTRACT SITE ADJACENT SILVERDENE, BOSTON ROAD, GOSBERTON

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	Soil		Water	pH	Top %	Base %	
														Total % Dry Wt.	Aqueous Extract mg/l	mg/l				
TP6	B1	0.40 – 0.80	67	29	38	29	1.92	1.50										3.6	3.6	SOIL CLASSIFICATION = CH 0% retained on 425µm sieve 0% retained on 20mm sieve
	D5	1.00				28														
	D6	1.60				39														
	D7	2.40				49														
	D8	2.80												343		7.5				
TP7	D4	0.90	57	24	33	31													SOIL CLASSIFICATION = CH 0% retained on 425µm sieve	
TP8	B1	0.50 – 0.80	69	26	43	29	1.93	1.51										3.5	3.8	SOIL CLASSIFICATION = CH 0% retained on 425µm sieve 0% retained on 20mm sieve
	D4	1.20													33		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
C.B.R. – CALIFORNIA BEARING RATIO

15602

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8180

Newark Road Peterborough
t: 01733 566566
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: PL7797-1/4/710-2
Client Reference: C15602
Lab Job Number: PL7797-1
Date Sampled: Unknown
Date Received: 31.03.2022
Date Tested: 19.04.2022

Contact: Simon Weatherley

Site Name: Site Adjacent Silverdene
Site Address: Boston Road, Gosberton

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

TEST RESULTS

Laboratory Reference: PL7797-1/4
Client Reference: D5
Brown clayey SILT/SAND.

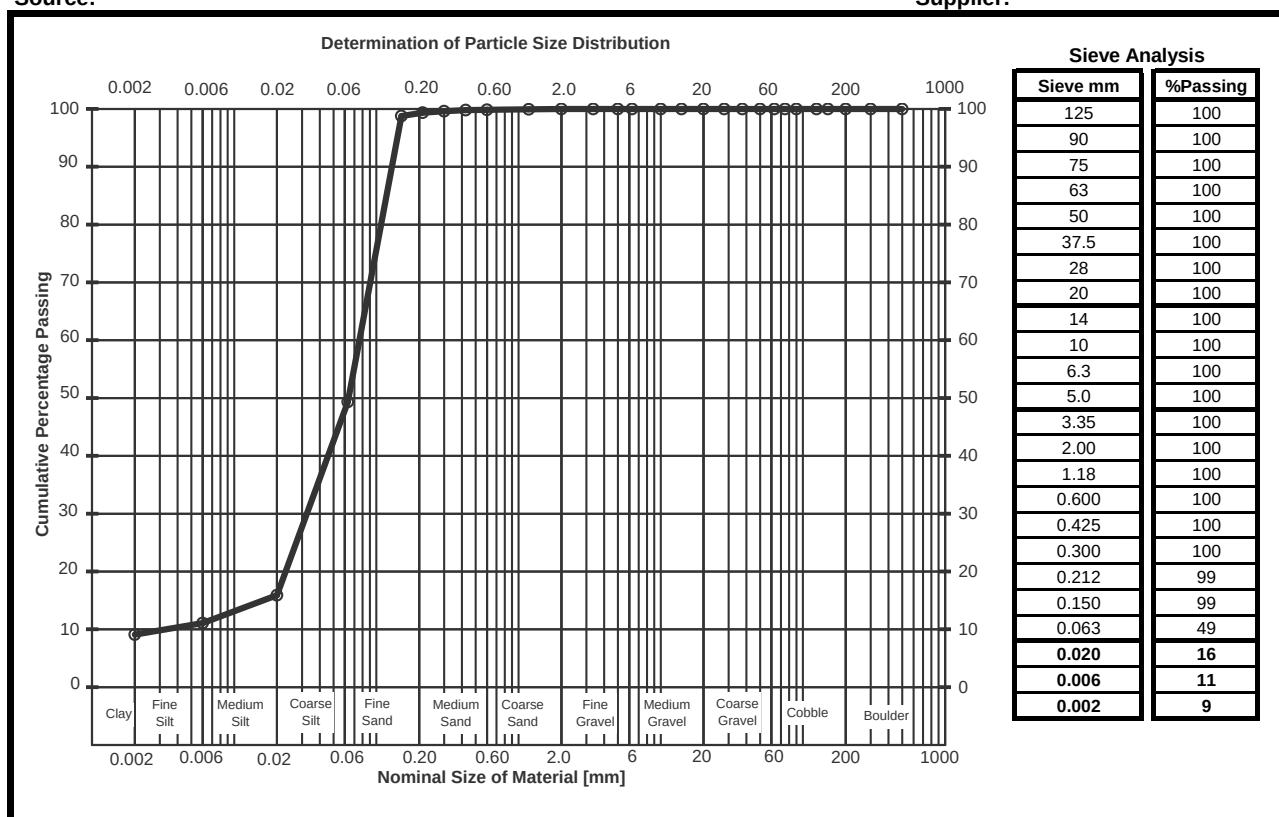
Pre-treatment for organic material: No

Sample Description:

Material Specification: Not Required
Location: TP2
Source:

Depth: 1.80m

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: 26.04.2022 Page 1 of 1
Form Number: GELab/C/709-2 Version 57

Opinions and interpretations expressed herein are outside the scope of UKAS Accreditation. This report may not be reproduced other than in full without the prior written approval of the issuing laboratory. Reported results relate explicitly to the individual sample and/or specimen in its 'as received' condition, unless otherwise stated.

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



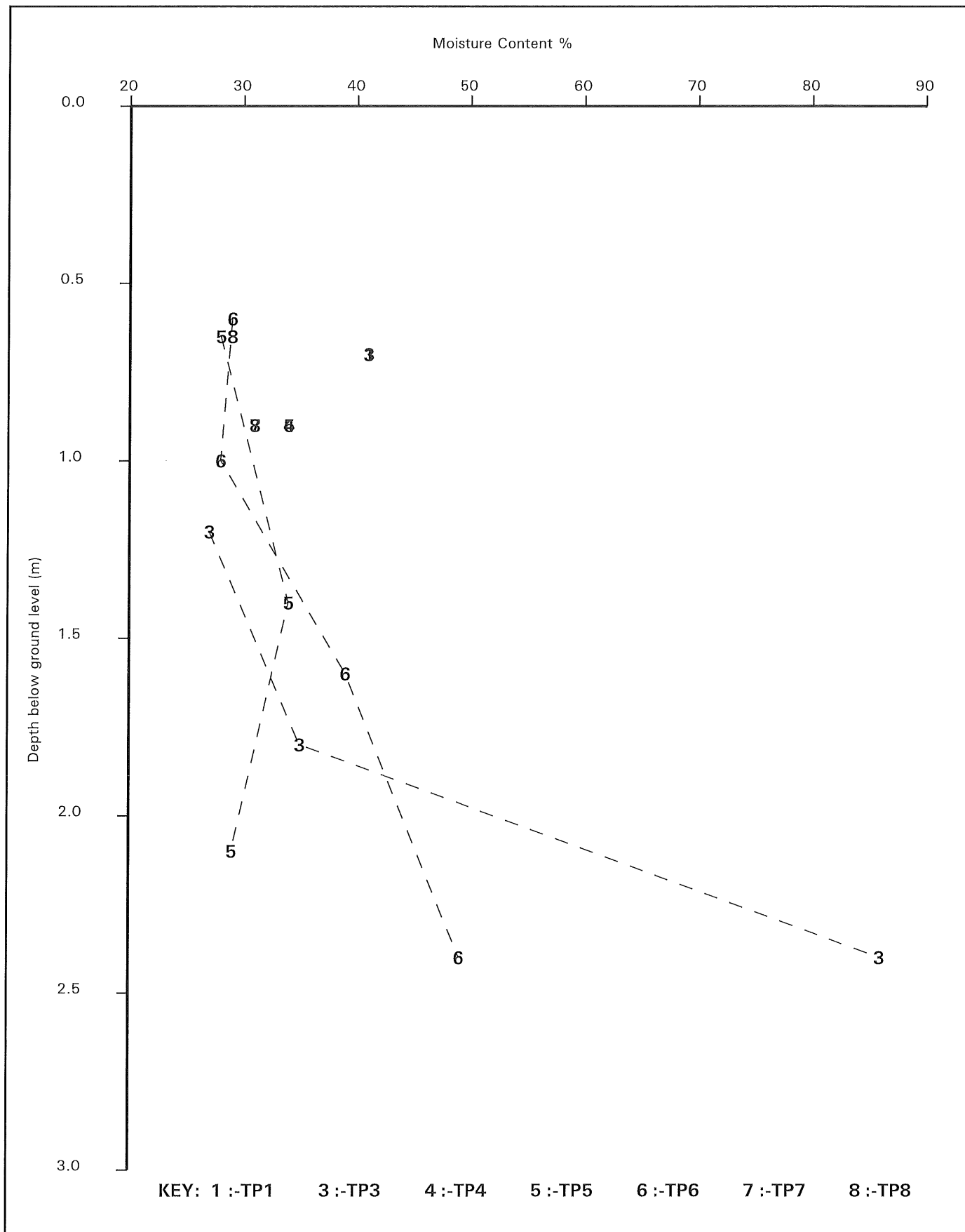
Final Report

Report No.: 22-12309-1
Initial Date of Issue: 07-Apr-2022
Client Ground Engineering Limited
Client Address: Newark Road
Peterborough
Cambridgeshire
PE1 5UA
Contact(s): Simon Weatherley
Project SW/C15602 BOSTON ROAD,
GOSBERTON

Quotation No.:		Date Received:	01-Apr-2022
Order No.:	SW/C15602	Date Instructed:	01-Apr-2022
No. of Samples:	5		
Turnaround (Wkdays):	5	Results Due:	07-Apr-2022
Date Approved:	07-Apr-2022		

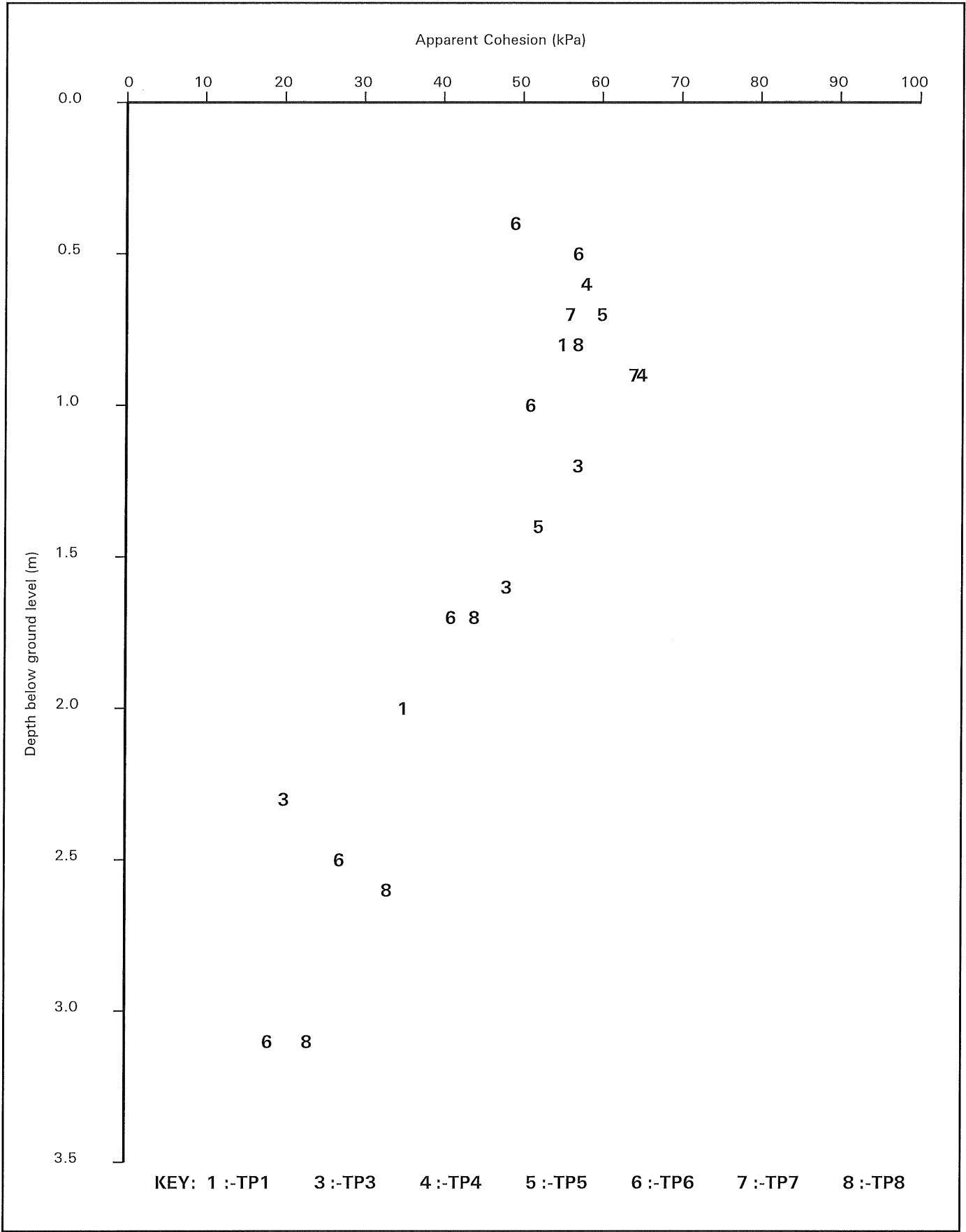
Approved By:

Details: Stuart Henderson, Technical Manager

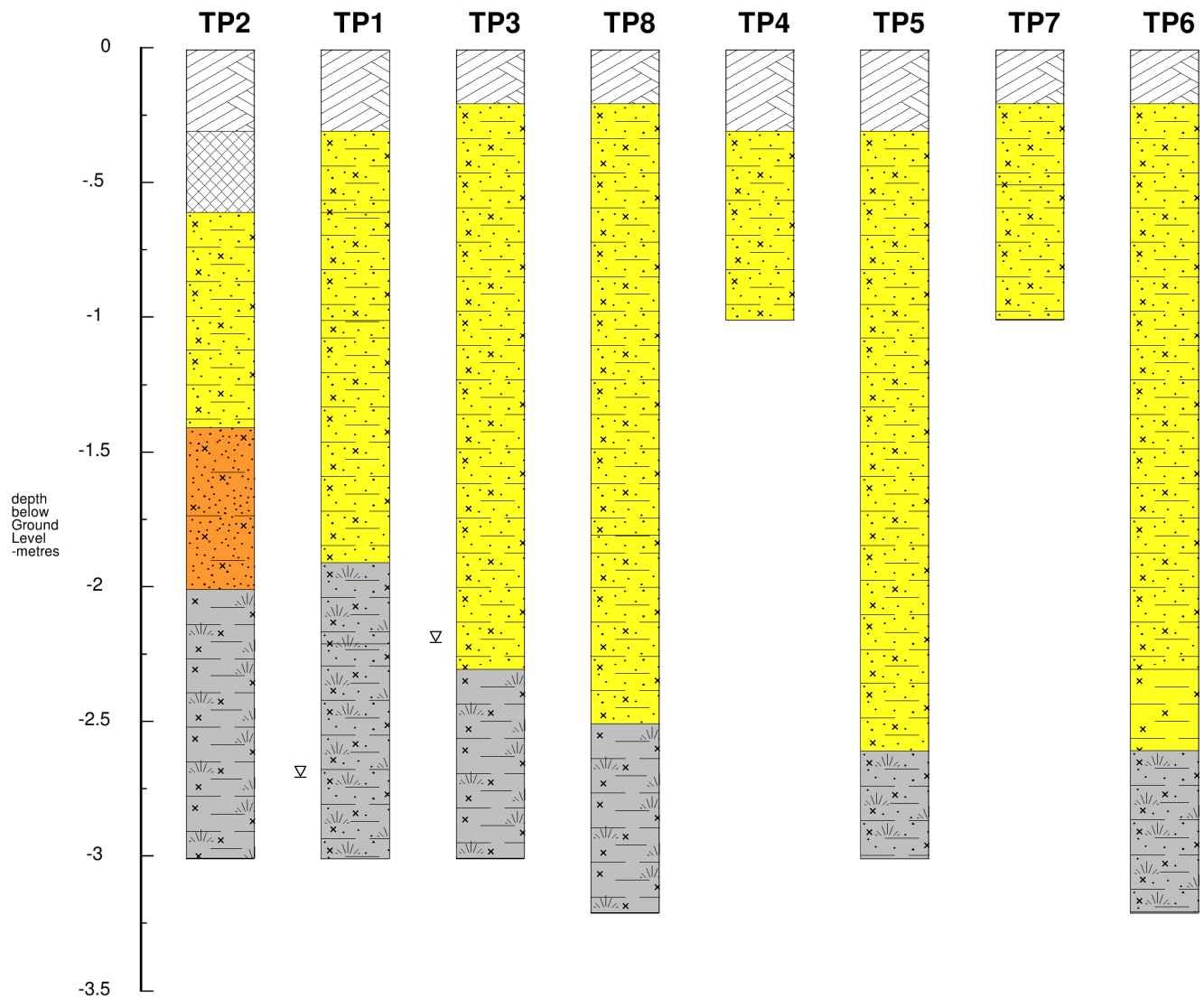


Moisture Content % vs Depth below ground level (m).

SITE			SITE ADJACENT SILVERDENE, BOSTON ROAD, GOSBERTON		
CLIENT			RTW CONSTRUCTION & DEVELOPMENTS LIMITED		Contract Number 15602
GROUND ENGINEERING L I M I T E D			Tel: 01733-566566 www.groundengineering.co.uk		Date 03/05/22 Figure 1



Apparent Cohesion (kPa) vs Depth below ground level (m).		
SITE	SITE ADJACENT SILVERDENE, BOSTON ROAD, GOSBERTON	
CLIENT	RTW CONSTRUCTION & DEVELOPMENTS LIMITED	Contract Number 15602
GROUND ENGINEERING L I M I T E D Tel: 01733-566566 www.groundengineering.co.uk		Date 03/05/22 Figure 2



KEY TO LEGENDS

	MADE GROUND
	TOPSOIL
	TIDAL FLAT DEPOSIT - CLAY
	TIDAL FLAT DEPOSIT - SAND
	TIDAL FLAT DEPOSIT - SLIGHTLY ORGANIC
▽	Groundwater Encountered

Project : Site Adjacent Silverdene, Boston Road, Gosberton

Client : RTW Construction & Developments Ltd

**GROUND
ENGINEERING
LIMITED**
Tel : 01733 566566

Soil Profile

Fig No. 3

Project No

C15602

**Vertical Scale
1:25**

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
Design Sulfate Class for location	2:1 water/soil extract ^b	Groundwater	Total potential sulfate ^c	Static water	Mobile water	Class for location
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	> 5.5 ^d 2.5–5.5	AC-1s AC-1 ^d AC-2z
DS-2	500–1500	400–1400	0.24–0.6	> 3.5 2.5–3.5	> 5.5 2.5–5.5	AC-1s AC-2 AC-2s AC-3z
DS-3	1600–3000	1500–3000	0.7–1.2	> 3.5 2.5–3.5	> 5.5 2.5–5.5	AC-2s AC-3 AC-3s AC-4
DS-4	3100–6000	3100–6000	1.3–2.4	> 3.5 2.5–3.5	> 5.5 2.5–5.5	AC-3s AC-4 AC-4s AC-5
DS-5	> 6000	> 6000	> 2.4	> 3.5 2.5–3.5	≥ 2.5	AC-4s 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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