Sawtry Colts FC Clubhouse, Green Field Sports Field, Sawtry, Huntingdon, PE28 5XP

Interpretative Ground Investigation Report

Report on behalf of:
Dragon Structural Ltd.

May 2022

FINAL REPORT

R22013/R001

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EXECUTIVE SUMMARY

Purpose of This Report	Interpretative Ground Investigation Report
Client	Report on behalf of Dragon Structural Ltd.
Site	Sawtry Colts FC Clubhouse, Green Field Sports Field, Sawtry, Huntingdon
Site Location	The site is located toward the eastern periphery of Sawtry, Huntingdon, approximately 1km east of the Village centre, and 13km north of Huntingdon. The postcode for the site is PE28 5XN, and the approximate National Grid Reference is 517792, 283455.
Current Land Use & Description	The site is rectangular in shape, aligned north to south, and occupies an area of approximately 0.52 hectares (5,200m^2). At the time of the investigation, the centre of the site was occupied by the clubhouse of Sawtry Colts Football and Cricket Club, a single storey building of brick construction, with a pitched tile roof. The southern and western sections comprised vehicle parking and manoeuvring areas. These areas were not surfaced, and exhibited a compacted gravel substrate. The northern section of the site was predominantly occupied by open, managed grassland.
Proposed Development	Current proposals for redevelopment of the site are understood to involve the construction of extensions to the existing clubhouse along the northern and southern elevations, with associated internal refit and refurbishment. The existing vehicle parking area is to be extended, formalised, and resurfaced although the substrate will remain stone rather than asphalt. A grass overspill car-park is proposed across the northern section of the site.
Ground Investigation Overview	An intrusive ground investigation was undertaken at the site in two phases on 29th and 30th March 2022 involving the excavation of four (4No.) Window Sample boreholes to depths of 4.0m bgl, two (2No.) hand excavated Trial Pits progressed adjacent the existing building to depths of 1.2m and 1.31 bgl respectively, and internal concrete coring in two (2No.) locations. In addition, Dynamic Cone Penetrometer (DCP) testing using a TRL Probe was carried out in three (6No.) locations to determine near surface ground density, and preliminary infiltration (falling head) testing was carried out within one of the excavated boreholes
Findings of the Ground Investigation	<u>Topsoil</u> Topsoil was encountered at the surface in a single location (WS4), and recorded to a depth of 0.6m bgl. This material was described as firm, brown silty slightly gravelly Clay. <u>Made Ground</u> Made Ground was recorded in each of the excavations below the hardstanding. The thickness of the Made Ground varied between 0.4m and 0.8m bgl. Made Ground was encountered at the surface in each of the excavations with the exception of WS4. The thickness of the Made Ground varied between 0.3m and 1.1m. Four principal made ground sub-types were identified during the works: • Dark brown sandy Gravel. The sand was fine to coarse. The gravel was described as fine to coarse, angular to subangular of granite, chert, brick, quartzite, occasional to frequent clinker and slag, and locally carbonaceous mudstone, limestone, and sandstone (HP2 only). • Red cobbly Sand and Gravel Sand is coarse. Gravel is fine to coarse. Gravel and cobbles comprised angular fragments of ex-situ house bricks. • Firm brown locally mottled grey slightly silty slightly gravelly Clay. The gravel was described as fine to coarse, angular to rounded of chert, flint, rare carbonaceous mudstone, and siltstone. • Dark brown clayey Gravel. The gravel was coarse, angular of limestone and brick. <u>Weathered Oxford Clay Formation</u> A sequence of predominantly cohesive strata consistent with Weathered Oxford Clay Formation deposits was encountered below the Made Ground in each of the excavations.

	This sequence typically consisted of an upper layer, generally described as soft becoming firm brown mottled yellowish brown, orange, grey and/or light grey locally slightly gravelly CLAY. Underlying this stratum, encountered at depths of between 1.68m and 3.05m bgl was material described as firm becoming very stiff dark brown/grey or dark grey CLAY, containing frequent shell fragments. Visual/Olfactory Evidence of Contamination Made Ground containing occasional clinker and slag was encountered in three of the exploratory holes progressed during the investigation (WS1, WS2 and WS3). Groundwater In one of the hand excavated pits (HP1) groundwater was encountered at a depth of 0.8m bgl. No groundwater strikes were encountered in any of the remaining excavations undertaken during the site investigation. The strike encountered in HP1 is considered likely to be a result of localised perching and/or a damming effect associated with the presence of adjacent foundation structures. Existing Foundations The foundations of the existing building were found to comprise concrete and brick footings extending to a proven depth of at least 1310mm (1.31m), and 1200mm (1.20m) bgl in HP1 and HP2, respectively.
Contamination Testing	Soils Four samples were taken from the Made Ground, one from the Topsoil, and two from the Weathered Oxford Clay Formation deposits to enable laboratory chemical analysis. The analysis results were screened against Grange GeoConsulting Ltd GAC screening values for a 'Public Open Space (Park)' end use scenario as part of an assessment of potential risks associated with contamination.
Contamination Results	**Soil Contamination** The laboratory chemical analysis results have identified the presence of contamination sources at the site. Laboratory chemical analysis results have identified localised contamination in soils underlying the site. One sample, taken from Made Ground in WS2 (0.0m to 0.4m bgl) proved individual PAH species (benzo(b)fluoranthene, benzo(a)pyrene, and dibenz(a,h)anthracene at concentrations exceeding relevant GACs for a Public Open Space(Park) end use scenario, taking into consideration the appropriate SOM content. None of the remaining samples, including those taken from Made Ground across the site recorded any inorganic or organic determinands at concentrations which exceeded adopted GACs. **Waste Acceptance Testing (WAC)** A programme of WAC testing was undertaken as part of the investigation. The subsequent results indicated that arisings generated from the Oxford Clay Formation are considered likely to be classified as either 'Inert', or 'Non-Hazardous' (stable non-reactive hazardous waste in a non-hazardous landfill) for purposes of disposal, depending on location (due to the presence of elevated sulphate concentrations), and subject to further testing. It may be possible to retain excavated arisings at the site, depending on material source, and providing these activities are undertaken in accordance with the CL:aire Definition of Waste Code of Practice (DoWCoP) or equivalent, and current Waste Management Regulations.
Recommended Further works/ Remediation	A risk assessment was subsequently carried out in order to examine and evaluate plausible contaminant linkages. Based on the findings of the intrusive investigation it was considered that, following redevelopment, a Low risk of harm to human health receptors would remain as a result of contamination present within soils at the site. The risk to controlled waters resulting from contamination at the site following redevelopment was also considered Low.

	Based on the findings of the CSM/Risk Assessment the following measures are recommended as part of proposed redevelopment of the site. • It is recommended that during any groundworks/ remedial works in impacted materials, appropriately licenced contractors should be appointed, PPE/RPE should be worn as necessary by groundworkers, and a safe system of work is established prior to commencement. • The risk levels identified are partially contingent on the presence of low-permeability hardstanding in the area around WS2. Should development proposals change, resulting in a change of substrate in this area, it may be necessary to amend the risk assessment and/or undertake remedial works. • It is also recommended given the findings of the investigation that the site construction/earthworks contractor remain vigilant regarding the presence of unexpected contamination issues which may be discovered during the programme. • Re-use and/or disposal of site won materials/arisings should be undertaken in accordance with current waste management guidance/regulations. • Based on the presence of organic contaminants within the Made Ground, it may be necessary to use protected pipework for potable water supplies to the development.
Geotechnical Testing	A range of in-situ, laboratory and chemical testing for geotechnical purposes have been undertaken as part of the ground investigation. The results of these tests have been presented in this report and used to facilitate preliminary geotechnical design. Made Ground will not be suitable as a foundation stratum due to its inherent variability and risk of intolerable differential settlement. The natural Oxford Clay Formation Deposits exhibited consistently low SPT values at 1.0m and 2.0m bgl, however SPT values recovered by 3.0m bgl, recording a mean average SPT of 23.5. The Oxford Clay Formation Deposits could be suitable as a founding stratum for the proposed development using strip or trench fill foundations, depending on proposed loadings. Estimates of maximum allowable bearing pressures have been provided. In accordance with NHBC Standards Chapter 4.2 a minimum foundation depth of 1.0m (where outside the zone of influence of trees) will be required for strip and trench fill foundations extending through any Made Ground into the clays of the Weathered Oxford Clay Formation Deposits. Based on the near surface ground conditions encountered, and the findings of in-situ TRL DCP Probing it is recommended for preliminary design purposes a CBR value of 5% is adopted where formation level is within the existing compacted Made Ground, and 4% where formation level is within the natural Oxford Clay Formation Deposits. Groundwater may be encountered within shallow excavations at the site, however based on information obtained during the investigation, such water is likely to be a result of pooling/ponding within excavations, which are likely to act as a sump, potentially requiring dewatering.

This Executive Summary forms part of Grange GeoConsulting Ltd report number R22013/001 (Issue 1) and should not be used as a separate document.

1.0 INTRODUCTION

1.1 Terms of Reference

Grange GeoConsulting Limited was commissioned by Dragon Structural Ltd. to undertake a ground investigation in support of the proposed development of a site located toward the eastern periphery of Sawtry, Huntingdon, approximately 1km east of the Village centre, and 13km north of Huntingdon. The postcode for the site is PE28 5XN, and the approximate National Grid Reference is 517792, 283455. A Site Location Plan (Drawing R22013-DWG1) is presented in Appendix A

The site is rectangular in shape, aligned north to south, and occupies an area of approximately 0.52 hectares (5,200m^2).

At the time of the investigation, the centre of the site was occupied by the clubhouse of Sawtry Colts Football and Cricket Club, a single storey building of brick construction, with a pitched tile roof. The southern and western sections comprised vehicle parking and manoeuvring areas. These areas were not surfaced, and exhibited a compacted gravel substrate.

The area immediately east of the building consisted of a paved terrace/patio, enabling access between the clubhouse and a series of sports pitches located off site to the east. North of the clubhouse was an equipment compound including a temporary storage structure, which appeared to house grounds maintenance machinery, equipment, and supplies.

The northern section of the site was predominantly occupied by open, managed grassland. At the time of the investigation a small area situated toward the centre-north of this site was delineated using heras fencing. Anecdotal evidence obtained from the groundskeeper during the works suggests that the fencing was erected to prevent vehicle traffic over a septic tank located in this area.

A large stockpile of green waste (tree cuttings/branches, grass clippings) was noted toward the northern periphery of the site. A series of mature and semi mature trees were recorded along the western site boundary.

Vehicular access onto the site was from Straight Drove, located immediately south of the site.

The areas surrounding the site to the north and south-east were agricultural in character. A channelised watercourse (a river or drainage channel) delineated the western site boundary. Beyond the watercourse, at a distance of approximately 50m, were two large industrial buildings, with associated vehicle parking areas, service yards and external above ground tanks (contents unknown). These buildings were understood to be occupied by galvanising and metalworking businesses, respectively.

Current proposals for redevelopment of the site are understood to involve the construction of extensions to the existing clubhouse along the northern and southern elevations, with associated internal refit and refurbishment. In addition, a small area of block paving is to be laid immediately north-east of the clubhouse, and a cycle storage structure will be constructed to the south. The existing vehicle parking area is to be extended, formalised, and resurfaced although the substrate will remain stone rather than asphalt. A grass overspill car-park is

proposed across the northern section of the site. Localised ornamental and peripheral landscaping is to be allocated throughout the site following redevelopment.

A copy of the proposed site layout is included in Appendix A.

This report summarises the findings of a Phase 2 Ground Investigation that was undertaken at the site in March 2022, by Grange GeoConsulting Ltd.

Authorisation to proceed with this report was given by Dan Wright of Dragon Structural Ltd. in March 2022.

1.2 Objectives

The overall objective of the work undertaken was to carry out a ground investigation and assessment of the site:

- to assess the environmental quality of the underlying soils and groundwater (if encountered) and their potential to adversely impact on site end users and the wider environment;
- to provide geotechnical information to enable preliminary foundation design;
- to provide information regarding the foundations of the existing clubhouse building;
- to provide near surface ground density (CBR) information to enable the construction of external hardstanding areas;
- to assess the thickness and sub-base characteristics of the internal floorslab within the existing building.

1.3 Scope of Works

The scope of works, as outlined in the Grange GeoConsulting Ltd proposals submitted to Dragon Structural Ltd. on the 2nd February 2022 are summarised below.

- Dynamic (window) sampling in 4No. locations to depths of up to 4m bgl (or refusal) to enable the inspection of soils encountered, and the collection of soil samples;
- In-situ geotechnical testing (SPTs) to be undertaken to assess the density of the underlying ground to support geotechnical design;
- The hand excavation of 2No. trial pits against the northern and southern elevations of the clubhouse building in order to examine existing foundation construction and to establish (where possible) the founding stratum in each location;
- Concrete coring in 2No. locations within the footprint of the existing structure in order to examine the construction characteristics of the floor slab;
- Hand-held TRL Dynamic Cone Penetrometer tests undertaken in 4No. external and 2No. internal locations (following removal of slab core) in order to assess the relative density of near surface materials, and to provide an estimated CBR value allowing the design of external hardstanding;

- A falling head test undertaken within one of the window sample boreholes to provide an indication of permeability characteristics of the soils underlying the site;
- Laboratory chemical (contamination) and geotechnical analysis of soils; and
- Collation of the findings within an interpretative report.

1.4 Provided Information

The following has been provided to Grange GeoConsulting Ltd by the Client, Dragon Structural Ltd for use in the preparation of this report:

- An Existing Site Plan produced by HSSP Architects Ltd. (Drawing Ref. 8219 03 01 Rev. A) dated 4th May 2021.
- A proposed Site Plan produced by HSSP Architects Ltd. (Drawing Ref. 8219 03 03 Rev. A) dated 4th May 2021.

1.5 Limitations

This report is based upon information obtained from third party sources, together with observations and data obtained during the recent ground investigation. Any third-party data provided has been accepted at face value and has not been independently verified. Grange GeoConsulting Ltd can therefore give no warranty, representation, or assurance as to the accuracy or completeness of such information.

The spacing of excavations, and the sampling and analysis undertaken is considered to have provided a reasonable level of certainty concerning the ground conditions. However, it is important to recognise that contamination can be both widespread and relatively localised, depending upon its source and nature. No investigation, however comprehensive, can be expected to determine the nature and extent of all contamination that could be present, and there will always be an element of uncertainty. The potential for currently undetected contamination to be present must therefore be considered not only in the risk assessment presented within this report, but also in consideration of future development activities, i.e. health and safety planning and risk management.

This report has been prepared for the sole internal use and reliance of the Client, Dragon Structural Ltd. and shall not be relied upon by other parties without the express written authority of Grange GeoConsulting Ltd. If an unauthorised third party comes into possession of this report, they then rely on it at their own risk.

2.0 GROUND INVESTIGATION

2.1 Investigation Rationale

The ground investigation rationale, summarised in Table 2.1 is based on the requirements of the Client, outlined in the information provided to Grange GeoConsulting Limited.

Table 2.1: Investigation Rationale

Exploratory Holes	Purpose
Window sample boreholes (WS1 to WS4 inclusive) excavated to 4.0m below ground level (bgl).	• Enable logging of the soils encountered and assess ground conditions at the site. • Carry out in-situ penetration testing (SPTs) to assess the density of the ground within the window sample boreholes • Allow the collection of soil samples for chemical (contamination) and geotechnical testing. • WS1 and WS2 were excavated within the proposed footprint of the southern extension. The excavations were spread across the footprint in order to examine the lateral variability of ground conditions. • WS3 was positioned toward the south of the site within an existing /proposed vehicle parking area. • WS4 was placed within the proposed footprint of the northern extension.
Hand Excavated Trial Pits (HP1 and HP2) progressed to between 1.2m and 1.31m bgl.	• Enable logging of the soils encountered. • Examine the structural characteristics of the existing clubhouse foundations, and where possible to identify and describe the founding stratum.
Hand-held TRL DCP Probing (Dynamic Cone Penetrometer Testing) undertaken to depths of up to 1.0m bgl. (CBR1 to CBR4 inclusive Core 1 CBR, Core 2 CBR)	• Enable the examination of near surface ground density and to allow the calculation of CBRs to support the design of proposed external hardstanding.
Concrete Coring (Core 1, Core 2).	• Examine the construction characteristics of the existing internal clubhouse floor slab. • Where possible to examine and describe the underlying sub-base. • Enable TRL DCP probing through the base of the extracted cores.

2.2 Site Works

The fieldwork phase of the ground investigation was undertaken on the 29th and 30th March 2022. A selection of photographs taken during the investigation are presented in Appendix B.

The approximate positions of the excavations were surveyed using a tape measure, with distances measured from landmarks present on site. The locations are shown in the Site Investigation Plan (Drawing R22013-DWG2) provided in Appendix A. The works undertaken are summarised in Table 2.2. The exploratory hole logs, including details of the ground conditions encountered, water strikes, any visual or olfactory evidence of contamination, and in-situ testing are presented in Appendix C.

Table 2.2: Summary of Site Works

Exploratory Holes	Depth (m bgl)	In-situ testing	Observations
WS1	4.0m bgl	SPTs undertaken at 1m intervals throughout the excavation. Low SPTs at 1m and 2m bgl, Moderate SPT at 3m and Moderate to High SPT at 4m bgl. No SPT refusals (N>50) noted.	No groundwater encountered. Made Ground containing occasional clinker and slag was encountered between 0.0m and 0.3m bgl. Excavation was backfilled with arisings.
WS2	4.0m bgl	SPTs undertaken at 1m intervals throughout the excavation. Low SPTs at 1m and 2m bgl, Moderate SPT at 3m. High SPT at 4m bgl. No SPT refusals (N>50) noted.	No groundwater encountered. Made Ground containing occasional clinker was encountered between 0.0m and 0.4m bgl. Excavation was backfilled with arisings.
WS3	4.0m bgl	SPTs undertaken at 1m intervals throughout the excavation. Low SPTs at 1m and 2m bgl, Moderate SPT at 3m. High SPT at 4m bgl. No SPT refusals (N>50) noted.	No groundwater encountered. Made Ground containing occasional clinker was encountered between 0.0m and 0.35m bgl. Excavation was backfilled with arisings.
WS4	4.0m bgl	SPTs undertaken at 1m intervals throughout the excavation. Low SPTs at 1m and 2m bgl, Moderate SPT at 3m. High SPT at 4m bgl. No SPT refusals (N>50) noted.	No groundwater encountered. No visual or olfactory evidence of contamination. Excavation was backfilled with arisings.
HP1	1.31m bgl	None	Groundwater encountered at 0.8m bgl. Trial Pit was stable. No visual or olfactory evidence of contamination. Excavation was backfilled with arisings.
HP2	1.2m bgl	None	Groundwater encountered at 0.8m bgl. Trial Pit was stable. Plastic debris encountered, however no significant visual or olfactory evidence of contamination was noted. Excavation was backfilled with arisings.
Core 1	0.152m bgl	TRL DCP testing undertaken through base	Reinstated using excavated core and cement.
Core 2	0.182m bgl	TRL DCP testing undertaken through base	Reinstated using excavated core and cement.
CBR1	ca. 0.9m	TRL DCP testing undertaken	None
CBR2	ca. 0.9m	TRL DCP testing undertaken	None
CBR3	ca. 0.9m	TRL DCP testing undertaken	None
CBR4	ca. 0.9m	TRL DCP testing undertaken	None

2.3 Ground Conditions

Geological mapping published by the British Geological Survey (BGS) for the area indicates the site to be underlain by consolidated strata from the Oxford Clay Formation, of Jurassic age (157 to 166 million years). These materials are detrital and shallow marine in origin, forming interbedded sequences of fine and coarse grained deposits, and are typically described as grey silicate mudstones, locally slightly silty, with subordinate beds of argillaceous limestone nodules. The thickness of this unit is estimated by the BGS to potentially be between 50m and 70m locally.

No faults are recorded locally by the BGS.

The ground conditions encountered are shown in full on the logs presented in Appendix C and summarised below in Table 2.3. The observed ground conditions were in general accordance with the published geological records. Made Ground was encountered during the investigation at thicknesses of between 0.3m and 1.1m.

Table 2.3: Strata Encountered

Stratum Description	Depth to Top (m bgl)	Depth to Base (m bgl)	Thickness (m)
Topsoil Firm, brown silty slightly gravelly Clay. Encountered at the surface in one location (WS4)	0.0m bgl (Ground Level)	0.6m bgl	0.6m
Made Ground Made Ground was recorded in each excavation (with the exception of WS4) as one of 4No. sub-types; • Dark brown sandy Gravel. • Red cobbly Sand and Gravel • Firm brown locally mottled grey slightly silty slightly gravelly Clay • Dark brown clayey Gravel	0.0m bgl (Ground Level)	0.3m to 1.1m bgl	0.3m to 1.1m
Weathered Oxford Clay Formation A sequence of predominantly cohesive strata encountered in each of the excavations, and recorded as: • soft becoming firm brown mottled yellowish brown, orange, grey and/or light grey locally slightly gravelly CLAY , overlying; • firm becoming very stiff dark brown/grey or dark grey CLAY.	0.3m to 1.1m bgl	1.2m to 4.0m bgl (base unproven)	0.3m to 3.5m (thickness unproven)

2.3.1 Topsoil

Topsoil was encountered at the surface in a single location (WS4), and recorded to a depth of 0.6m bgl. This material was described as firm, brown silty slightly gravelly Clay. The gravel component was rounded to subangular of siltstone and chert. The topsoil in this location was considered to potentially represent part of a naturally derived weathered sequence associated with the Oxford Clay Formation (see 2.3.3).

2.3.2 Made Ground

Made Ground was encountered at the surface in each of the excavations with the exception of WS4. The thickness of the Made Ground varied between 0.3m and 1.1m.

Four principal made ground sub-types were identified during the works. A summary of these types and their distribution is presented below.

- Dark brown sandy Gravel. The sand was fine to coarse. The gravel was described as fine to coarse, angular to subangular of granite, chert, brick, quartzite, occasional to frequent clinker and slag, and locally carbonaceous mudstone, limestone, and sandstone (HP2 only). This subtype represented the upper layer/substrate in the vehicle parking and manoeuvring areas, and was encountered in WS1 (0.0m to 0.3m bgl), WS2 (0.0m to 0.4m bgl), WS3 (0.0m to 0.35m bgl), and at the surface in the hand excavated trial pit excavated along the northern clubhouse building elevation (HP2 0.0m to 0.15m bgl).

- Red cobbly Sand and Gravel Sand is coarse. Gravel is fine to coarse. Gravel and cobbles comprised angular fragments of ex-situ house bricks. This was recorded immediately below the Made Ground subtype described above in vehicle parking areas (WS1 0.3m to 0.45m bgl, WS2 0.4m to 0.5m bgl, and WS3 0.35m to 0.5m bgl).

- Firm brown locally mottled grey slightly silty slightly gravelly Clay. The gravel was described as fine to coarse, angular to rounded of chert, flint, rare carbonaceous mudstone, and siltstone. This subtype, recorded at the base of the made ground in WS1 (0.45m to 1.1m bgl), and in HP2 (0.15m to 0.9m bgl), appeared to be a reworked natural material containing additional anthropogenic materials, including a dismantled uPVC window in HP2.

- Dark brown clayey Gravel. The gravel was coarse, angular of limestone and brick. This subtype was encountered at the surface in a single location (HP1), between 0.0m and 0.3m bgl.

Whilst variable across the site, the characteristics of the Made ground encountered appeared to be closely linked to existing land use, with distinct sequences associated with the existing vehicle parking areas (WS1, WS2, WS3), and areas adjacent the existing clubhouse (HP1 and HP2).

2.3.3 Weathered Oxford Clay Formation

A sequence of predominantly cohesive strata consistent with Weathered Oxford Clay Formation deposits was encountered below the Made Ground in each of the excavations.

This sequence typically consisted of an upper layer, generally described as soft becoming firm brown mottled yellowish brown, orange, grey and/or light grey locally slightly gravelly CLAY. Where present the gravel comprised fine to coarse, subangular to angular of chert, flint, and sandstone. Bedding was locally visible within this material (notably in WS1).

Underlying the subtype described above, encountered at depths of between 1.68m and 3.05m bgl was material described as firm becoming very stiff dark brown/grey or dark grey CLAY, containing frequent shell fragments. Where encountered, this stratum was recorded to the base of the excavation.

Encountered locally throughout the Oxford Clay Formation deposits were subhorizontal discontinuities with partings of white silt and fine shell fragments.

Whilst this sequence (with localised slight variations in colour, consistency, and gravel characteristics) was present across the investigation areas, notable anomalies were recorded in WS2, which contained a zone of very soft material between 2.0m and 2.3m bgl, and in WS3, where a layer of stiff clay was noted toward the top of the unit.

No consolidated material (rockhead) was encountered during the investigation.

2.3.4 Excavation Stability

No evidence of instability was noted during the advancement any of the excavations undertaken as part of the investigation.

2.4 Internal Floor Slab Construction

The existing internal clubhouse floorslab was cored using electric drilling apparatus in two (2No.) locations (Core 1 and Core 2). The cores were subsequently extracted for examination, and where possible a sample of the underlying substrate was obtained for logging. The substrate underlying the floor slab was subjected to in-situ testing using a hand-held TRL probe (See Section 2.7.2) prior to reinstatement. A summary of the construction characteristics of the slab in each location is provided in Table 2.4.

Table 2.4: Concrete Cores

Core Loc.	Total Thickness (mm)	No. of Layers	Layer 1		Layer 2		Observations
			Thickness (mm)	Aggregate	Thickness (mm)	Aggregate	
Core 1	152mm	2	51mm	0.2mm-1.5mm, ave. 1mm (rounded of indeterminable lithology)	101mm	1mm-15mm, ave. 8mm (subangular to rounded of quartz, limestone feldspar, flint, and dolerite).	Layer 1: Unreinforced, matrix supported. Layer 2: Reinforcement 1 Layer, 6mm dia., indeterminate spacing, cover depth 97mm. General: smooth base with membrane.
Core 2	182mm	2	63mm	0.5mm-2mm, ave. 1mm (rounded of indeterminable lithology)	119mm	1mm-25mm, ave. 5mm (subangular to rounded of quartz, limestone feldspar, flint, and dolerite).	Layer 1: Unreinforced, matrix supported, frequent 1-2mm vugs. Layer 2: Reinforcement 1 Layer, 6mm dia., indeterminate spacing (>115mm), cover

Core Loc.	Total Thickness (mm)	No. of Layers	Layer 1		Layer 2		Observations
			Thickness (mm)	Aggregate	Thickness (mm)	Aggregate	
							depth 152mm.Occ. 1-4mm vugs. General: smooth base with membrane.

The sub-base immediately underlying Core 1 was described as light brown gravelly Sand. The sand was coarse. The gravel was coarse, angular of limestone.

Below Core 2, the sub-base comprised light brown gravelly Sand. The sand was coarse. Gravel was fine, subrounded of indeterminate lithology.

2.5 Visual and Olfactory Evidence of Contamination

Made Ground containing occasional clinker and slag was encountered in three of the exploratory holes progressed during the investigation (WS1, WS2 and WS3). Each of these excavations were positioned within existing vehicle parking areas, with the visually impacted material representing the substrate in these areas.

No organic/hydrocarbon staining or odours was/were recorded during the investigation.

2.6 Groundwater Strikes

In one of the hand excavated pits (HP1) groundwater was encountered at a depth of 0.8m bgl.

No groundwater strikes were encountered in any of the remaining excavations undertaken during the site investigation.

The strike encountered in HP1 is therefore not considered to be representative of a wider groundwater regime, and is considered likely to be a result of localised perching and/or a damming effect associated with the presence of adjacent foundation structures.

2.7 In-situ Testing

2.7.1 Standard Penetration Tests

Standard Penetrations Tests (SPTs) were undertaken during the advancement of the window sample boreholes. The SPT (N values) results are presented in Table 2.5.

Table 2.5: SPT Results (N values)

Window Sample Boreholes	Depth SPT undertaken (m)	SPT (N values) recorded
WS1	1.0m bgl	6
	2.0m bgl	6
	3.0m bgl	22
	4.0m bgl	37

Window Sample Boreholes	Depth SPT undertaken (m)	SPT (N values) recorded
WS2	1.0m bgl	5
	2.0m bgl	8
	3.0m bgl	26
	4.0m bgl	40
WS3	1.0m bgl	5
	2.0m bgl	7
	3.0m bgl	24
	4.0m bgl	40
WS4	1.0m bgl	5
	2.0m bgl	8
	3.0m bgl	22
	4.0m bgl	31

Table 2.6 summarises the findings of the SPT testing undertaken, presented by depth (see section 2.3 of this report).

Table 2.6: SPT Results

Depth (m below ground level)	Minimum Recorded SPT 'N' Value	Maximum Recorded SPT 'N' Value	Mean Average SPT 'N' Value
1.0m	5	6	5.2
2.0m	6	8	7.2
3.0m	22	26	23.5
4.0m	31	40	37

2.7.2 Hand-Held TRL Probe Results

The near surface density of soils below the site were examined in four external locations (CBR 1 to CBR2 inclusive) and two internal positions undertaken through the base of concrete cores (Core 1 and Core 2) excavated in the existing floor slab. The probing was carried out using a hand-held TRL Dynamic Cone Penetrometer (DCP). The penetration characteristics of each soil layer encountered within ca. 1m of the surface (excluding hardstanding) were subsequently used to obtain indicative CBR values.

The results of the testing programme are summarised in Table 2.7, and the testing certificates included in Appendix D. The location of each test is presented on Drawing R22013-DWG2 included in Appendix A.

Table 2.7: TRL DCP Results

Test Reference (Associated BH Location)	Layer Depth* (Top) (mm bgl)	Layer Depth (Bottom) (mm bgl)	CBR Value (%)
CBR 1	0	313	57.3
	313	537	7.7
	537	887	17.8
CBR2	0	195	>100
	195	887	12.1
CBR3	0	117	81.8
	117	233	27.5
	233	883	4.4
CBR4	0	92	41.3
	92	197	27.8
	197	756	8.9
	756	886	15.9
Core 1	152	193	19
	193	239	>100
	239	338	21.1
	338	625	6
	625	895	9.3
Core 2	182	425	12.6
	425	530	4.6
	530	869	2.0

*excluding hardstanding layers

2.8 Foundation Trial Pits

Two trial pits were excavated on the 30th March 2022 against the northern and southern walls of the existing clubhouse. Each of the excavations were advanced using hand-techniques. The excavation locations were selected by Dragon Structural Ltd. and set out on site by Grange GeoConsulting Ltd. A plan of the excavation locations is included in Appendix A.

The soil profile and other significant features were recorded as each exploratory hole was progressed. The ground conditions encountered are discussed in Section 2.3. A copy of the trial pit log including descriptions of the strata encountered is included in Appendix C.

Excavations were progressed to the base of the exposed footing, and/or maximum depth achievable by hand excavation, and where necessary extended by a manual probe in order to determine foundation dimensions. Logs were produced showing the size, depth, and configuration of the exposed foundations. Relative measurements of foundation depths were taken from adjacent ground levels.

Sketch drawings and photographs showing the findings of the exercise are included in Appendix E. A summary is provided below by location.

2.8.1 HP1 (Southern Elevation)

The external brick wall in this location extended approximately 880mm below the adjacent ground level, terminating on a footing of concrete construction. The concrete foundation extended horizontally for a distance of 1580mm, and was proven to a depth of approximately 1310mm bgl. which was the maximum depth reached using a metal probe. The foundation base could not be determined through hand excavation, and subsequent probing through the base of the excavation, however based on the behaviour of the inserted probe it is considered possible that the foundations terminated at this depth. Due to foundation depth, the founding stratum could not be confirmed.

2.8.2 HP2 (Northern Elevation)

The external brick wall extended 800mm below ambient ground level, terminating at this depth on a concrete footing. The concrete foundation extended horizontally for a distance of 220mm, and was proven to a depth of approximately 1200mm bgl. The foundation base exceeded the maximum depth achievable through hand excavation, and was tentatively identified using a metal probe extended through the pit base. Due to the requirement for probing, the founding stratum could not be definitively confirmed.

3.0 CHEMICAL (CONTAMINATION ANALYSIS) LABORATORY TESTING

3.1 Sampling Strategy

The following soil samples were taken by Grange GeoConsulting Ltd on the 29th March 2022:

- 4 No. soil samples from the various Made Ground sub-types for chemical analysis;
- 1 No. soil sample taken from the Topsoil in WS4 for chemical analysis; and
- 2 No. soil sample taken from the Oxford Clay Formation deposits for waste acceptance criteria (WAC) analysis.

Samples were taken, stored, and transported in general accordance with the British Standard 10175: 2011 Code of Practice for Investigation of Potentially Contaminated sites, and transported by courier to I2 Analytical Services; a UKAS accredited laboratory.

3.2 Laboratory Analyses Undertaken

A broad suite of analysis was undertaken on the samples obtained, which included the following determinands:

Soils

Arsenic (As), Cadmium (Cd), Hexavalent and Total Chromium (Cr III and VI), Copper (Cu), Lead (Pb), Inorganic Mercury (Hg), Nickel (Ni), Selenium (Se), Vanadium (V), Zinc (Zn), Total Cyanide, pH, Organic Matter, Asbestos Screen, speciated and Total Poly-Aromatic Hydrocarbons (PAH), BTEX, Methyl Tert-butyl Ether (MTBE), Speciated Total Petroleum Hydrocarbons (TPH) analysed using CWG Methodology.

In addition to the tests described above, two samples taken from the Oxford Clay Formation Deposits were scheduled for full (inert) WAC analysis suite.

Prior to transportation to the analysis laboratory, each of the samples were screened using a Photo-Ionisation Detector (PID) (headspace method) to determine the presence of Volatile Organic Compounds (VOCs). In general, concentrations exceeding 50ppm are considered significantly elevated, requiring subsequent laboratory VOC analysis. One of the 8No. samples screened (WS2 between 0.0m and 0.4m bgl) proved a concentration of VOCs which was above instrument detection limits. The recorded VOC concentration in this sample was nominally elevated (0.5ppm). As a result, no laboratory VOC testing was scheduled during the investigation.

4.0 CONTAMINATION RISK ASSESSMENT CRITERIA

A risk-based approach is used for the assessment of contamination. This requires identification of a contaminant source, a receptor, and a realistic pathway via which the contaminant may reach the receptor. The key receptors considered in this assessment are human health (groundworkers, future site users) and controlled waters (groundwater).

The Risk Assessment is a two-stage process. The first stage is to perform a Generic Quantitative Risk Assessment (GQRA) - the soil test results have been compared against the relevant Generic Assessment Criteria (GAC). In the absence of a complete regulatory set of screening values, derived using the CLEA Framework, Grange GeoConsulting Limited GAC screening values have been utilised and are based on the following:

- Category 4 Screening Levels (C4SLs) published by DEFRA;
- The 2014 Land Quality Management (LQM) / Chartered Institute of Environmental Health (CIEH) Suitable for Use Levels for Human Health Risk Assessment (S4ULs); and
- Guidance values produced by the Environmental Industries Commission (EIC), the Association of Geotechnical and Geoenvironmental Specialists (AGS), and Contaminated Land: Application in Real Environments (CL:AIRE) in December 2009.

The second stage of the Risk Assessment process is Risk Evaluation, which comprises an authoritative review of the findings with other pertinent information in cases where GAC are exceeded, to consider if exceedance may be acceptable in the context of the site.

4.1 Scope

The purpose of this risk assessment is to determine the potential contamination risks at the site for future development. The aspects of risk from substances in the ground considered below are as follows:

- human health; and
- pollution of controlled Waters.

4.2 Human Health

This is a Tier 2 assessment, using GAC soil screening values, and involves generic human health risk assessment for the CLEA scenario: **Public Open Space (Park)**. This scenario has been adopted based on the nature of proposed redevelopment, and the general applicability of the associated exposure scenario (sporadic, short term recreational exposure). Following redevelopment, areas of ornamental and peripheral landscaping will remain, and the vehicle parking areas will remain unsealed (gravel substrate).

The chemical (contamination analysis) testing results have been screened against Grange GeoConsulting Ltd GAC screening values (provided in Appendix F) to carry out an assessment of potential risks associated with contamination at the site. Justification for the criteria adopted for this Risk Assessment is given in Appendix F. In the case where all the samples tested for a given substance were below the GAC, no further consideration is necessary for that substance.

Contaminant concentrations recorded during chemical analysis have been directly compared with GACs as a worst-case scenario.

The mean average Soil Organic Matter Content (SOM) has been calculated for each of the of the units sampled. GACs for organic contaminants have been based on a representative SOM, derived from the mean organic matter content recorded during laboratory analysis. Table 4.1 presents the average SOM content for each geological unit, and the subsequent adopted soil organic matter content for GAC comparison.

Table 4.1: Soil Organic Matter Content for GAC Comparison

Stratum	Mean average of recorded SOM values (%)	Adopted GAC SOM (%)
Made Ground	3.7%	2.5%
Topsoil	3.9%	2.5%

5.0 CONTAMINATION ANALYSIS TESTING RESULTS AND RISK ASSESSMENT

5.1 Soil Analysis Results

5.1.1 Inorganic Contaminants (including Metals and Metalloids)

None of the remaining metal/semi-metal or inorganic contaminants tested were considered to be significantly elevated, or recorded at concentrations which exceeded GACs for a Public Open Space (Park) end-use scenario in any of the samples tested. The concentrations recorded were sufficiently low to be below criteria for a residential with plant uptake scenario (reflecting the most stringent exposure characteristics).

5.1.2 Total Petroleum Hydrocarbons (TPHs)

Whilst traces of aliphatic and aromatic hydrocarbons within the C10-C35 range were identified in a sample taken from WS2 at a depth of 0.0m-0.40m bgl, none of the individual carbon bands analysed during the Ground Investigation exceeded the adopted Generic Assessment Criteria.

5.1.3 Polycyclic Aromatic Hydrocarbons (PAHs)

One sample, taken from Made Ground in WS2 (0.0m to 0.4m bgl) proved individual PAH species at concentrations exceeding relevant GACs for a Public Open Space(Park) end use scenario, taking into consideration the appropriate SOM content. These exceedances are presented in Table 5.1.

Table 5.1: PAH Exceedances

Borehole Location	Sample Depth (m bgl)	Stratum	Determinand	Recorded Concentration (mg/kg)	GAC (mg/kg)
WS2	0.0m to 0.40m	Made Ground	Benzo(b)fluoranthene	56	15
			Benzo(a)pyrene	49	12
			Dibenz(a,h)anthracene	7.1	1.4

5.1.4 Asbestos

The concentration of asbestos within each of the samples analysed during the site investigation was found to be below qualitative (microscopy) laboratory levels of detection (<0.001%).

5.1.5 BTEX and MTBE

None of the individual compounds collectively referred to as BTEX, or MTBE were recorded at concentrations of in excess of laboratory levels of detection within the sample tested.

5.2 Waste Acceptance Testing

Samples were taken from the Oxford Clay Formation Deposits for the purpose of Waste Acceptance Criteria (WAC) testing. The results are presented in Table 5.2 and the certificates included in Appendix G.

Table 5.2: Waste Acceptance Criteria Testing

Borehole Location	Stratum	Sample Depth	WAC Classification
WS2	Oxford Clay Formation	1.5m to 1.8m bgl	Non-Hazardous*
WS3	Oxford Clay Formation	0.80m to 1.0m bgl	Inert

*Stable non-reactive hazardous waste in a non-hazardous landfill

The chemical testing results indicated a mixture of inert and hazardous waste landfill acceptance, depending on location and depth.

The sample taken from the WS2 at 1.5m to 1.8m bgl proved a concentration of sulphate which exceeded Inert Waste Landfill acceptance criteria.

It is recommended that the off-site disposal of the materials is discussed with the waste haulage contractor and the landfill provider or soil treatment facility to ensure that materials are disposed of appropriately and in line with duty of care and standard good practice.

6.0 RISK ASSESSMENT

A Conceptual Site Model represents the possible relationships between potential contaminant sources, pathways, and receptors in line with the Statutory Guidance to Part 2a of the Environmental Protection Act 1990. Plausible contaminant sources, pathways, and receptors have been identified and assessed based on the findings of the Phase 2 Ground Investigation

6.1 Sources

Laboratory chemical analysis results have identified localised contamination in soils underlying the site.

One sample, taken from Made Ground in WS2 (0.0m to 0.4m bgl) proved individual PAH species (benzo(b)fluoranthene, benzo(a)pyrene, and dibenz(a,h)anthracene at concentrations exceeding relevant GACs for a Public Open Space(Park) end use scenario, taking into consideration the appropriate SOM content.

None of the remaining samples, including those taken from Made Ground across the site recorded any inorganic or organic determinands at concentrations which exceeded adopted GACs.

6.2 Receptors

Potential receptors identified with respect to the site include the following:

- Site end users (future site users/visitors, and neighbours)
- Groundworkers (construction, demolition, and future maintenance workers)
- Building materials (buried concrete and underground services)

Controlled waters: Groundwater (underlying Oxford Clay Formation (Unproductive)), Surface Waters (drainage channel located adjacent to the west).

The Environment Agency have classified the Oxford Clay Formation which underlies the site as an Unproductive unit. Unproductive strata are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow. The intrusive investigation has confirmed the presence of predominantly cohesive weathered Oxford Clay Formation Deposits below the site. Subsequent infiltration testing (See Section 9.5) indicates that these materials are likely to exhibit low permeability and groundwater storage potential. Based on this information, the sensitivity of the underlying aquifer unit is considered low.

The closest identified surface water receptor is the watercourse/drainage channel located immediately west of the site. Whilst located in close proximity to the site, the presence of low permeability deposits underlying the site is considered likely to significantly attenuate the migration of contaminants toward this receptor. In addition, with the exception of localised perched water strikes recorded within and adjacent the subsurface structures located toward the centre of the site, no coherent groundwater regime was encountered. On this basis the off-site watercourse appears to be largely hydraulically isolated from the site.

6.3 Pathways

Potential pathways identified for the site include the following:

- Direct human (dermal) contact
- Inhalation (dust)
- Inhalation (gases and vapours)
- Ingestion
- Direct contact with aggressive ground conditions
- Leaching and migration via underlying soils

Current redevelopment proposals for the site are understood to involve the construction of extensions to the existing clubhouse with associated internal refit and refurbishment. The existing vehicle parking area is to be extended, formalised, and resurfaced although the substrate will remain stone (gravel) rather than asphalt. A grass overspill car-park is proposed across the northern section of the site. Localised ornamental and peripheral landscaping is to be allocated throughout the site following redevelopment.

The proposed layout includes areas of landscaping and vehicle parking areas with an unsurfaced, potentially permeable substrate, which could locally enable infiltration, vertical and lateral migration of contaminants. The underlying substrate, however, is considered unlikely to be significantly transmissive based on the findings of the investigation.

The nature, and likely use of external areas across the site (parking and manoeuvring) is considered likely to restrict the creation of dermal contact, ingestion and inhalation pathways between contamination present, and future site users. It should be noted that the localised hotspot of contamination identified during the site investigation appears to be restricted to a section of the site situated within the southern proposed building extension, and will therefore be overlain by a hardstanding substrate (floorslab) following the redevelopment.

6.4 Conceptual Site Model and Risk Assessment

A Conceptual Site Model (Table 6.2) has been produced which presents a list of plausible contaminant linkages based on information obtained during the site investigation, and an evaluation of these linkages in accordance with the guidance provided in Environment Agency (2021) Land Contamination Risk Management. (LCRM).

6.4.1 Summary of Potential Contaminant Linkages

Table 6.2 lists the plausible contaminant linkages identified for the site. These are considered as potentially unacceptable risks in in accordance with the guidance provided in Environment Agency (2020) Land Contamination Risk Management. (LCRM). Linkages have been assessed in general accordance with guidance provided in the CIRIA Report C552

(Rudland *et al* 2001) but with the addition of a 'no linkage' category as detailed in Table 6.1.

It should be noted that whilst the risk assessment process undertaken in this report may identify potential risks to groundworkers (construction and future maintenance workers), consideration of occupational health and safety issues is predominantly beyond the scope of this report and needs to be considered separately in the Construction Phase Health and Safety Plan.

Table 6.1: Risk Assessment Process

	Consequence			
Probability	**Severe**	**Medium**	**Mild**	**Minor**
High Likelihood	Very high risk	High risk	Moderate risk	Low risk
Likely	High risk	Moderate risk	Low risk	Very low risk
Low Likelihood	Moderate risk	Low risk	Low risk	Very low risk
Unlikely	Low risk	Very low risk	Very low risk	Very low risk
No Linkage	No risk			

Table 6.2: Conceptual Site Model - Source Pathway Receptor Contaminant Linkages

Source(s)	Possible Pathway(s)	Receptor(s)	Probability	Consequence	Risk	Comments
On Site: Contaminated Made Ground Hotspot PAH contamination identified within the Made Ground around WS2.	Direct human contact (dermal) Inhalation (dust and vapours) Ingestion.	Site end users (future site users, visitors) Groundworkers Building materials/utilities	Low Likelihood	Medium	Low	A localised hotspot of PAH contamination has been identified within the Made ground around WS2. The contamination is present within near surface material in an area which following redevelopment will be overlain by hardstanding (extension footprint). Exposure with respect to human health receptors is likely to be limited to short term, recreational use. The use of external areas across the site (parking and manoeuvring) is considered likely to limit the likelihood that human health pathways may become established. In addition, geotechnical requirements for external areas are likely to result in a compact substrate, further limiting human health exposure pathways. Construction workers may come into direct contact with contamination present. It is assumed that good working practices including the use of appropriate PPE, regular hand washing and other hygiene techniques will be adopted which would reduce the likelihood of long-term exposure.

Source(s)	Possible Pathway(s)	Receptor(s)	Probability	Consequence	Risk	Comments
On Site: Contaminated Made Ground Hotspot PAH contamination identified within the Made Ground around WS2.	Infiltration, leaching and migration via groundwater and permeable soils	Controlled waters: Oxford Clay Formation (Unproductive), Watercourse/ drainage channel located adjacent to the West.	Low Likelihood	Medium	Low	A localised hotspot of PAH contamination has been identified within the Made ground around WS2. The proposed layout includes areas of landscaping and vehicle parking areas with an unsurfaced, potentially permeable substrate, which could locally enable infiltration, vertical and lateral migration of contaminants. The underlying Oxford Clay Formation Deposits, however, have been classified as Unproductive by the EA, and are considered unlikely to be significantly permeable, based on the findings of the investigation. Whilst the proposed layout includes areas of landscaping and vehicle parking areas with an unsurfaced, potentially permeable substrate, which could locally enable infiltration, the identified contamination hotspot is situated in an area which is to be overlain by hardstanding (proposed extension footprint), which will limit infiltration potential. The closest identified surface water receptor is the watercourse/drainage channel located immediately west of the site. Whilst located in close proximity to the site, the presence of low permeability Oxford Clay Deposits underlying the site is likely to significantly attenuate the migration of contaminants toward this receptor. With the exception of localised perched water strikes recorded within and adjacent the subsurface structures located toward the centre of the site, no coherent groundwater regime was encountered.

6.5 Residual Risks

The Conceptual Site Model has enabled the examination of possible sources, pathways and receptors which were identified during the intrusive ground investigation, and the evaluation of plausible contaminant linkages considered to represent a potential risk following redevelopment of the site.

Based on the magnitude of harm and the likelihood of a pollutant pathway being established, and the findings of the intrusive investigation it is considered that following redevelopment (in accordance with current proposals), a **Low** risk of harm to human health receptors will remain as a result of contamination present within soils at the site.

The risk to controlled waters resulting from contamination at the site following redevelopment is considered **Low**.

This level of risk is contingent on appropriate steps being followed during the demolition and construction phases. These steps are presented in Section 7.0.

7.0 FURTHER RECOMMENDATIONS

Based on the findings of the CSM/Risk Assessment the following measures are recommended as part of proposed redevelopment of the site:

- It is recommended that during any groundworks/ remedial works in impacted materials, appropriately licenced contractors should be appointed, PPE/RPE should be worn as necessary by groundworkers, and a safe system of work is established prior to commencement.

- The risk levels identified are partially contingent on the presence of low-permeability hardstanding in the area around WS2. Should development proposals change, resulting in a change of substrate in this area, it may be necessary to amend the risk assessment and/or undertake remedial works.

- It is also recommended given the findings of the investigation that the site construction/earthworks contractor remain vigilant regarding the presence of unexpected contamination issues which may be discovered during the programme. Should any such unexpected contamination be identified, a suitably qualified environmental consultant should be contacted in order to appropriately assess the issue.
- Re-use and/or disposal of site won materials/arisings should be undertaken in accordance with current waste management guidance/regulations.
- Based on the presence of organic contaminants within the Made Ground, it may be necessary to use protected pipework for potable water supplies to the development, particularly where pipework is proposed in the areas around WS2. The local water supplier should be contacted for further details. The results provided as part of this report may be sufficient to confirm this requirement, however it may be necessary to undertake supplemental testing depending on the requirements of the utility provider.

Assuming these recommendations are implemented, it is anticipated that the risk to controlled water and human health receptors may be reduced to **Low**.

Further to the WAC testing described in Section 5.2, arisings generated from the Oxford Clay Formation are considered likely to be classified as either ‘Inert’, or ‘Non-Hazardous’ (stable non-reactive hazardous waste in a non-hazardous landfill) for purposes of disposal, depending on location (due to the presence of elevated sulphate concentrations), and subject to further testing.

It may be possible to retain excavated arisings at the site, depending on the material type, and providing these activities are undertaken in accordance with the CL:aire Definition of Waste Code of Practice (DoWCoP) or equivalent, and current Waste Management Regulations.

8.0 GEOTECHINCAL LABORATORY TESTING

8.1 Sampling Strategy

The following soil samples were taken by Grange GeoConsulting Ltd on 5th November 2021 for the purpose of geotechnical testing (excluding samples scheduled for pH testing as part of the chemical analysis programme).

- 1 No. samples from the Made Ground/Reworked.
- 8 No. samples from the Oxford Clay Formation Deposits.

Samples were taken, stored, and transported in general accordance with the British Standard 10175: 2011 Code of Practice for Investigation of Potentially Contaminated sites, and transported by courier to I2 Analytical Services; a UKAS accredited laboratory.

8.2 Laboratory Analyses Undertaken

Laboratory analysis has been undertaken to assess the density of the underlying ground, and to inform foundation design for the proposed development. The following analyses were undertaken:

- Natural moisture content testing;
- pH testing (as part of chemical suite);
- 6 No. Atterberg limit/Plasticity Index Tests;
- 3 No. Chemical tests for aggressive ground indicators (including water soluble sulphate)

9.0 GEOTECHNICAL TESTING RESULTS

The results of the geotechnical testing programme are summarised in the following section of the report, enabling preliminary geotechnical/foundation design for the proposed development.

9.1 pH

Table 9.1 shows the ranges of pH which were recorded in samples taken from the various units identified on site. Copies of the analysis certificates are included in Appendix G.

Table 9.1: pH test results

Stratum	Min. pH Value Recorded	Max. pH Value Recorded
Made Ground	7.9	10.6
Topsoil	8.0	8.0
Oxford Clay Formation	7.6	8.4

9.2 Natural Moisture Content

The natural moisture content of the geotechnical samples taken are presented by geological unit in Table 9.2. The analysis certificates are presented in Appendix H.

Table 9.2: Moisture content test results

Stratum	No. of Tests	Min. Recorded Natural Moisture Content (%)	Max. Recorded Natural Moisture Content (%)
Made Ground/ Reworked	1	44	44
Oxford Clay Formation	5	25	38

9.3 Atterberg Testing/Plasticity Index

The volume change potential as described in NHBC Standards 2021 (Chapter 4.2) with respect to building near trees have been determined from the results of plasticity index tests on samples of cohesive soils taken during the investigation. The findings are summarised in Table 9.3.

Table 9.3: Volume Change Potential

Stratum	No. Tests	Modified Plasticity Index (%)	Plasticity Designation	Volume Change Potential
Made Ground/ Reworked	1	57%	Very High	High
Oxford Clay Formation	5	31% to 45%	High to Very High	Medium to High

9.4 Aggressive Ground

The results of the chemical analysis undertaken with respect to aggressive ground indicators are presented in Table 9.4.

Table 9.4: Aggressive Ground Testing.

Stratum	No. of Tests	Total Sulphate as SO4 (%)		Water Soluble Sulphate as SO4 (g/l)		Total Sulphur (%)	
		Min	Max	Min	Max	Min	Max
Oxford Clay Formation	3	0.021	1.65	0.025	2.2	0.008	0.674

In accordance with BRE (Special Digest 1), the Design Sulphate (DS) classification and the Aggressive Chemical Environment for Concrete (ACEC) classification have been calculated with respect to the Oxford Clay Formation Deposits as DS-4 AC-3s. This classification assumes static, and brownfield conditions.

9.5 Infiltration Tests

A falling head test was conducted in WS1 on completion of the excavation to assess on a preliminary basis the permeability of the various strata encountered. The borehole dimensions are provided in Table 9.5 below.

Table 9.5. Borehole dimensions for rising head tests

Exploratory Hole	Radius (m)	Response Zone (m bgl)
WS1	0.067	0.0m to 4.0m bgl

Water was introduced into the borehole at an approximate rate of 10ltr per minute. The falling head permeability test was carried out by measuring the depth to water level from a datum (ground level adjacent the borehole) at regular intervals over a test period of approximately 20.5 hrs.

The test results are provided below on Table 9.6.

Table 9.6. Falling Head Test Results

Location	Water Level at Start of Test	Stabilised Water Level on completion of Test (1,238 mins)	Soil Infiltration Rate (m/s)
BH1	0.43m bgl	0.47m bgl	N/A

Infiltration was insufficient to enable calculation of permeability/infiltration rate. Based on the findings, it is considered unlikely that the use of soakaway drainage will be feasible at the site.

The falling had test results and calculation sheets are included in Appendix I.

10.0 GEOTECHNICAL INTERPRETATION AND RECOMMENDATIONS

10.1 Foundations

Current proposals for redevelopment of the site are understood to involve the construction of extensions to the existing clubhouse along the northern and southern elevations, with associated internal refit and refurbishment. The existing vehicle parking area is to be extended, formalised, and resurfaced although the substrate will remain stone rather than asphalt. At the time of the investigation proposed building loads had not been provided.

The allowable bearing pressure / design bearing pressure for foundations takes into consideration an acceptable load to take into account the risk of shear failure of the ground (ultimate limit state) and also acceptable limits of settlement (serviceability limit state).

The exploratory holes encountered Made Ground or Topsoil to a depth of between 0.3m and 1.1m bgl, overlying weathered strata from the Oxford Clay Formation to a maximum recorded depth of 4.0m.

Made Ground will not be suitable as a foundation stratum due to its inherent variability and risk of intolerable differential settlement. The natural Oxford Clay Formation Deposits exhibited consistently low SPT values at 1.0m and 2.0m bgl, however SPT values recovered by 3.0m bgl, recording a mean average SPT of 23.5.

The Oxford Clay Formation Deposits could be suitable as a founding stratum for the proposed development using strip or trench fill foundations, depending on required loadings. Care should be taken when selecting foundation depths in order to ensure that adjacent foundations are placed in materials of similar bearing and consolidation characteristics, thus avoiding any potential differential settlement. In addition, where extensions are proposed, foundation design should be sympathetic with the construction characteristics of the existing structure.

10.1.1 Shallow and Trenchfill Foundations

In accordance with NHBC Standards Chapter 4.2 a minimum foundation depth of 1.0m will be required for strip and trench fill foundations extending through any Made Ground into the natural Oxford Clay Formation Deposits (where outside the zone of influence of trees).

We would recommend that where strip and trench fill foundations are required within the very soft to soft clays consistently encountered at 1m and 2m bgl, an allowable bearing capacity of 60kPa may be possible. The stiffer clays encountered at a depth of 3m bgl could provide an allowable bearing capacity of 200 kPa, which includes a factor of safety of 3.0 against general shear failure and will limit total foundation settlement to less than 25mm for foundation widths up to 1m.

Should the anticipated structural loadings exceed the allowable bearing pressures given above, or should the tolerance of the structure to settlement be low, alternative foundation options such as ground improvement and piles should be considered.

Deepening of foundations in accordance with NHBC Standards will be required where foundations are within the zone of influence of existing or proposed trees and proposed shrub

planting. Where foundations are within the influence of trees and are deeper than 1.5m bgl, a suitable compressible material or void former will be required.

Where foundations require deepening to greater than 2.5m below ground level, they must be designed by an engineer, as specified in NHBC Technical Requirement R5.

Foundations which span founding materials of different stiffness should have mesh reinforcement placed top and bottom of the foundation.

The depth of foundations should be designed, and the formations inspected by a geotechnical engineer. Any sub-formation materials deemed as unsuitable such as soft or loose zones should be excavated and replaced with well compacted suitable granular fill or lean mix concrete.

Foundation excavations should be protected from water and inclement weather including frost and any water should be removed by pumping from a sump in the base of the excavation.

10.2 Ground Floor Slabs

As clay soils of high volume change potential are present at the site, it is recommended that suspended floor slabs should be adopted, in accordance with NHBC Standards.

Floor slabs should be constructed as suspended where Made Ground is greater than 600mm thickness, or foundations are located within the zone of influence of a (new planted) tree.

Ground floor slabs may be constructed as ground bearing providing foundations are not within the zone of influence of a tree, or where the floor slabs overlie natural materials. Where the Made Ground is predominantly granular in nature and less than 1.2m thick, ground bearing slabs may be suitable provided the Made Ground is compacted with a heavy vibrating roller and any soft spots removed and replace by granular fill.

10.3 External Pavement Design

Based on the near surface ground conditions encountered, and the findings of in-situ TRL DCP Probing (See Section 2.7.2) it is recommended for preliminary design purposes a CBR value of 5% is adopted where formation level is within the existing compacted Made Ground, and 4% where formation level is within the natural Oxford Clay Formation Deposits (rounded down from 4.4%- worst case CBR from TRL probing).

All formation excavations should be examined by a suitably experienced engineer or inspector to check for soft or unsuitable material, which should be removed and replaced with compacted granular fill. Also, to ensure good compaction and remove unevenness, the formation should be compacted with equipment suitable for use in the ground conditions encountered. Careful inspection of this work will also help identify any soft spots at or just below formation level.

10.4 Groundwater

Groundwater may be encountered within shallow excavations at the site, however based on information obtained during the investigation, such water is likely to be a result of

pooling/ponding within excavations, which are likely to act as a sump, potentially requiring dewatering.

10.5 Buried Concrete

Based on guidelines provided in BRE Special Digest 1, the Oxford Clay Formation Deposits at the site may be classified as Design Sulfate Class DS-4 and ACEC Class AC-3s.

This equates to a Designated Concrete Class DC-3 for a 50year design life (see BS 8500-1 for details).

11.0 CONCLUSIONS AND RECOMMENDATIONS

11.1 Ground Conditions and Groundwater

An intrusive ground investigation was undertaken at the site in two phases on 29th and 30th March 2022 involving the excavation of four (4No.) Window Sample boreholes to depths of 4.0m bgl, two (2No.) hand excavated Trial Pits progressed adjacent the existing building to depths of 1.2m and 1.31 bgl respectively, and internal concrete coring in two (2No.) locations.

In addition, Dynamic Cone Penetrometer (DCP) testing using a TRL Probe was carried out in three (6No.) locations to determine near surface ground density, and preliminary infiltration (falling head) testing was carried out within one of the excavated boreholes.

Topsoil was encountered at the surface in a single location (WS4), and recorded to a depth of 0.6m bgl. This material was described as firm, brown silty slightly gravelly Clay.

Made Ground was encountered at the surface in each of the excavations with the exception of WS4. The thickness of the Made Ground varied between 0.3m and 1.1m. Four principal made ground sub-types were identified during the works:

- Dark brown sandy Gravel. The sand was fine to coarse. The gravel was described as fine to coarse, angular to subangular of granite, chert, brick, quartzite, occasional to frequent clinker and slag, and locally carbonaceous mudstone, limestone, and sandstone (HP2 only).

- Red cobbly Sand and Gravel Sand is coarse. Gravel is fine to coarse. Gravel and cobbles comprised angular fragments of ex-situ house bricks.

- Firm brown locally mottled grey slightly silty slightly gravelly Clay. The gravel was described as fine to coarse, angular to rounded of chert, flint, rare carbonaceous mudstone, and siltstone.

- Dark brown clayey Gravel. The gravel was coarse, angular of limestone and brick.

A sequence of predominantly cohesive strata consistent with Weathered Oxford Clay Formation deposits was encountered below the Made Ground in each of the excavations.

This sequence typically consisted of an upper layer, generally described as soft becoming firm brown mottled yellowish brown, orange, grey and/or light grey locally slightly gravelly CLAY. Underlying this stratum, encountered at depths of between 1.68m and 3.05m bgl was material described as firm becoming very stiff dark brown/grey or dark grey CLAY, containing frequent shell fragments. Where encountered, this stratum was recorded to the base of the excavation.

In one of the hand excavated pits (HP1) groundwater was encountered at a depth of 0.8m bgl. No groundwater strikes were encountered in any of the remaining excavations undertaken during the site investigation. The strike encountered in HP1 is considered likely to be a result of localised perching and/or a damming effect associated with the presence of adjacent foundation structures.

The foundations of the existing building were found to comprise concrete and brick footings extending to a proven depth of at least 1310mm (1.31m), and 1200mm (1.20m) bgl in HP1 and HP2, respectively.

11.2 Soil Contamination

Laboratory chemical analysis results have identified localised contamination in soils underlying the site.

One sample, taken from Made Ground in WS2 (0.0m to 0.4m bgl) proved individual PAH species (benzo(b)fluoranthene, benzo(a)pyrene, and dibenz(a,h)anthracene at concentrations exceeding relevant GACs for a Public Open Space(Park) end use scenario, taking into consideration the appropriate SOM content.

None of the remaining samples, including those taken from Made Ground across the site recorded any inorganic or organic determinands at concentrations which exceeded adopted GACs.

11.3 Further Recommendations

Based on the findings of the CSM/Risk Assessment the following measures are recommended as part of proposed redevelopment of the site. If adopted, it is considered that risk to the proposed development from contamination at the site will be 'Low':

- It is recommended that during any groundworks/ remedial works in impacted materials, appropriately licenced contractors should be appointed, PPE/RPE should be worn as necessary by groundworkers, and a safe system of work is established prior to commencement.

- The risk levels identified are partially contingent on the presence of low-permeability hardstanding in the area around WS2. Should development proposals change, resulting in a change of substrate in this area, it may be necessary to amend the risk assessment and/or undertake remedial works.

- It is also recommended given the findings of the investigation that the site construction/earthworks contractor remain vigilant regarding the presence of unexpected contamination issues which may be discovered during the programme.
- Re-use and/or disposal of site won materials/arisings should be undertaken in accordance with current waste management guidance/regulations.
- Based on the presence of organic contaminants within the Made Ground, it may be necessary to use protected pipework for potable water supplies to the development, particularly where pipework is proposed in the areas around WS2. The local water supplier should be contacted for further details.

Further to the WAC testing described in Section 5.2, arisings generated from the Oxford Clay Formation are considered likely to be classified as either 'Inert', or 'Non-Hazardous' (stable non-reactive hazardous waste in a non-hazardous landfill) for purposes of disposal, depending on location (due to the presence of elevated sulphate concentrations), and subject to further testing.

It may be possible to retain excavated arisings at the site, depending on the material type, and providing these activities are undertaken in accordance with the CL:aire Definition of Waste Code of Practice (DoWCoP) or equivalent, and current Waste Management Regulations.

12.0 REFERENCES

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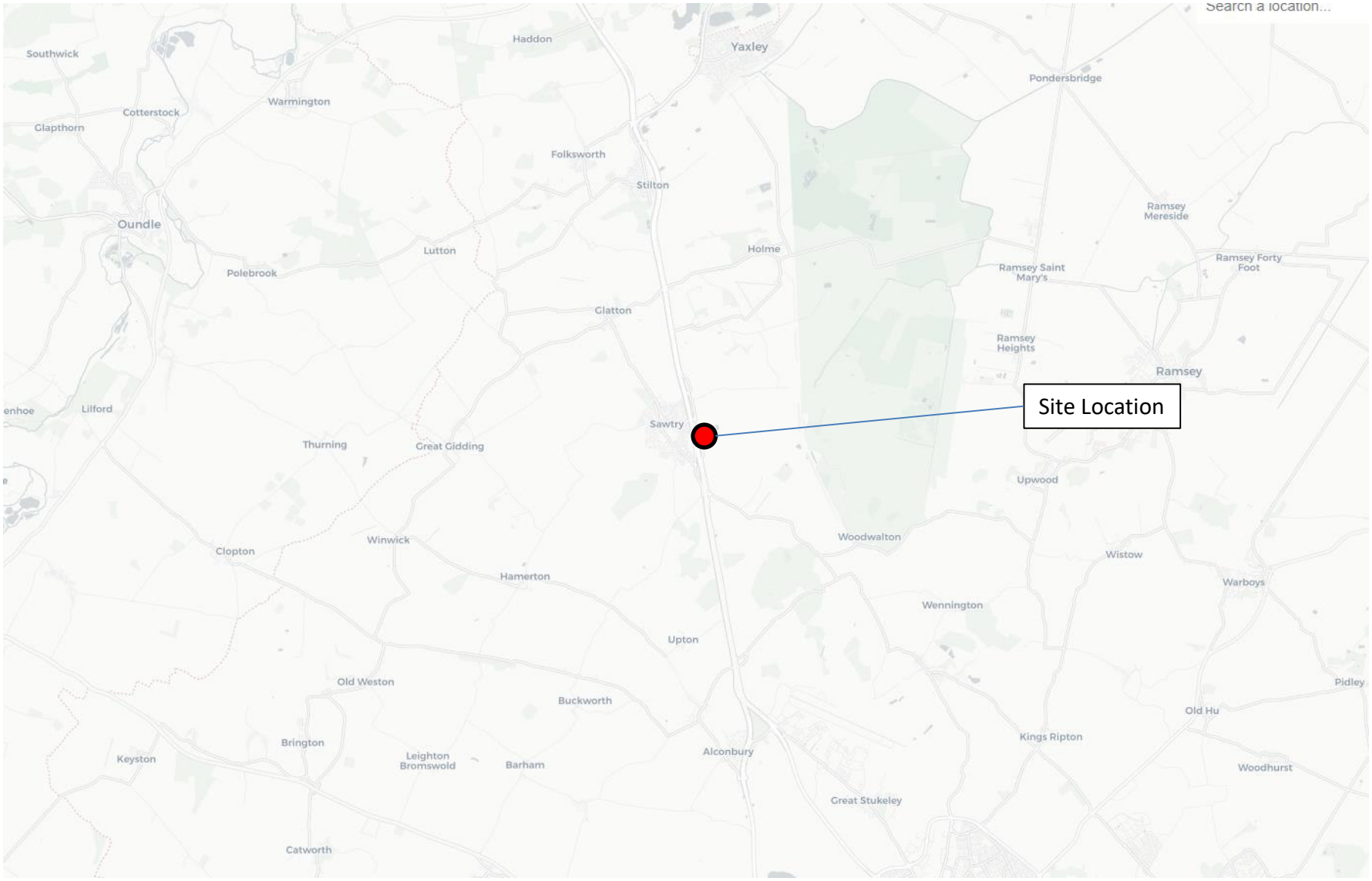
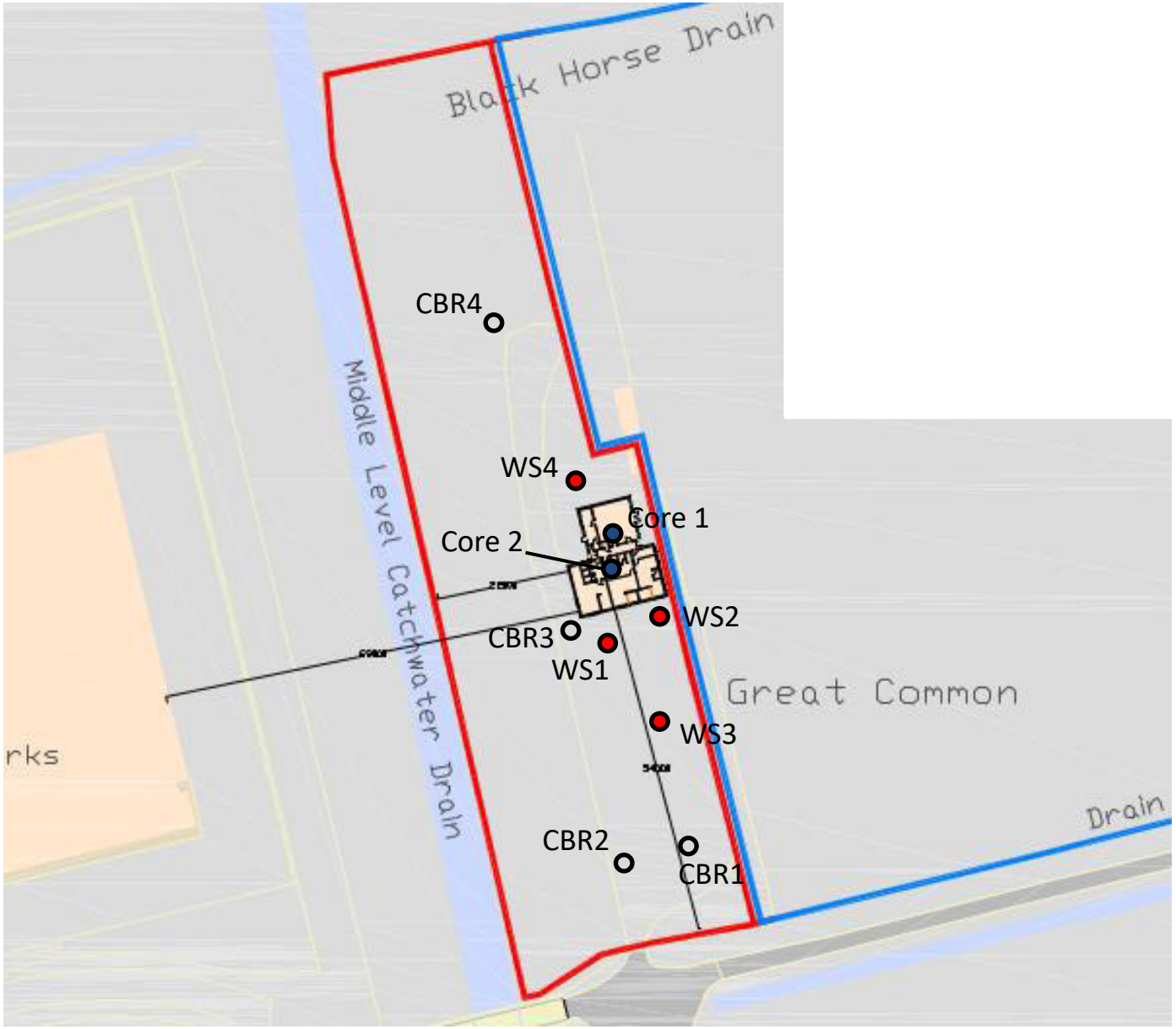
Appendix A

DRAWINGS



Grange Geo	**Site Location Plan** Sawtry, Huntingdon	**Client**- Dragon Structural Ltd. **Date**- May 2022	North	R22013-DWG1



Grange Geo	**Exploratory Hole Loc. Plan** Sawtry, Huntingdon	**Client**- Dragon Structural Ltd. **Date**- May 2022	North	R22013-DWG2

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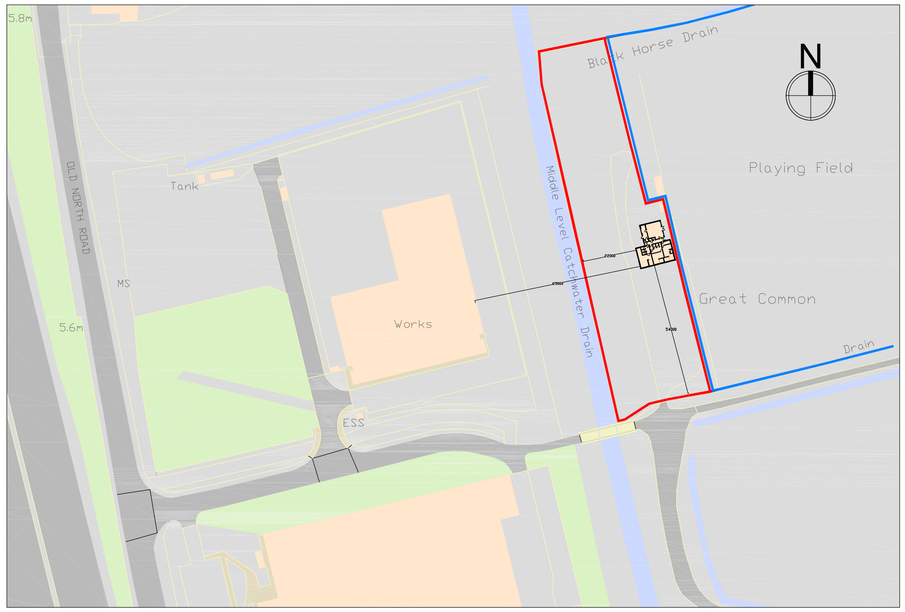
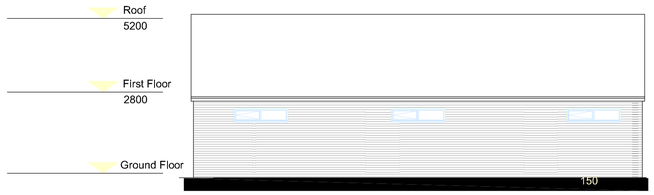
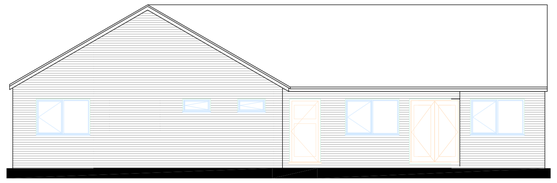
This drawing is to be read in conjunction with clients specific/university/employers requirements and structural engineers design.



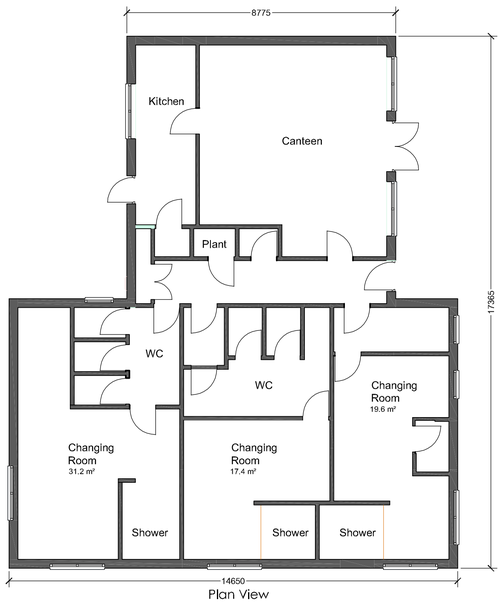
Site Plan Scale 1:1250



South elevation

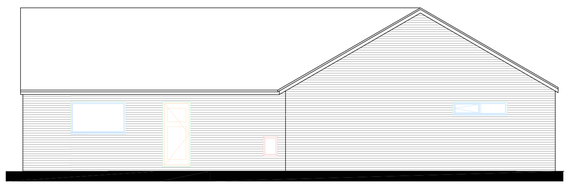


East elevation



Plan View

North elevation



West elevation

REV A Blue line added, red line clarified
Dimensions added to GF Plan 04 05 2021

PLANNING

Rev.	Date.	Drawn.

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Project.
Club House and Changing rooms
Green Field Sports Field
Sawtry
Huntingdon PE28 5XP

Title.
Existing Plans and Elevations

Scale.	Drawn.	Checked.	Date.
1 100	PJB	-	11 02 2021

Drawing No.	Revision.
8219 03 01	A

HSSP A1

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This drawing is to be read in conjunction with clients specification/employers requirements and structural engineers design.

Site Location Plan
Scale 1:1250
[Site Area: 0.52HA]

Grass over-spill Car park

Grass over-spill Car park

Planter

Planter

Storage

Stone laid Car Park

Outside Eating Area Block Paving

playing fields

Covered Area

22000

Planter

Planter

Cycles

Planter

Stone laid Car Park

43510

Planter

Planter

Site Entrance

REV A Blue line added, red line clarified
Site Area 0.52HA. Date 04 05 2021

Revision Notes.

Drawing Status.
PLANNING

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Project.
Club House and Changing Rooms
Green Fields Sports Fields
Sawtry
Huntingdon PE28 5XP

Title.
Site Plan

Scale.	Drawn.	Checked.	Date.
1:200@A1	PJB	-	NC

Drawing No. 8219 03 03
Revision. A

HSSP A1

Appendix B

GROUND INVESTIGATION PHOTOGRAPHS

WS1

WS3

WS2

WS4

Grange Geo	**Photo Record** Sawtry, Huntingdon	**Client:** Dragon Structural Ltd.	**Date-** May 2022	Appendix B

Appendix C

EXPLORATORY HOLE LOGS

Borehole Log

BH No: **WS1**

Client: Dragon Structural Ltd.
Project: Sawtry, Huntingdon

Sheet: 1 of 1
Method: Window Sample Borehole

Sample Depth (m)	Sample Type	Testing result	Description	Depth mBGL	Legend
0.0-0.3	ES		Dark brown sandy Gravel. Sand is fine to coarse. Gravel is fine to coarse, angular of granite, chert, brick, quartzite and occasional clinker and slag. [Made Ground]		
			Red cobbly Sand and Gravel. Sand is coarse. Gravel is fine to coarse. Gravel and cobbles are angular of ex-situ house brick fragments. [Made Ground]	0.30	
0.4-0.6	D		Firm brown slightly silty slightly gravelly CLAY. Gravel is fine to medium, angular to rounded of chert, rare carbonaceous mudstone and siltstone. [Possible Rework]	0.45	
0.8-1.0	ES				
1.0	SPT	1,2,2,1 = 6		1.0	
1.1-1.3	D		Soft brown mottled yellowish brown CLAY [Oxford Clay Formation]	1.1	
			Firm brown mottled orange and light grey CLAY. [Oxford Clay Formation]	1.4	
			Pockets of silt below 1.5m bgl.		
			Firm brown thinly laminated CLAY interbedded with subordinate white SILT [Oxford Clay Formation]	1.7	
			Bedding marks visible.		
2.0	SPT	1,1,2,2 = 6	Firm dark brown/grey CLAY. Frequent shell fragments. [Oxford Clay Formation]	2.0	
2.2-2.5	D				
3.0	SPT	4,5,6,7 = 22	Very stiff from 3.1m bgl.	3.0	
3.0-4.0	B				
4.0	SPT	7,9,10,11 = 37	Borehole Ended 4.0m bgl.	4.0	
				5.0	

General Comments:

1. Excavation terminated at 4.0m. SPTs undertaken to 4.45m bgl.
2. No groundwater encountered.
3. No installation. Backfilled with arisings.

Scale: NTS
Date: 29/03/22
Logged by:SW
Checked: SW
Job No: R22013

Borehole Log

BH No: **WS2**

Client: Dragon Structural Ltd.
Project: Sawtry, Huntingdon

Sheet: 1 of 1
Method: Window Sample Borehole

Sample Depth (m)	Sample Type	Testing result	Description	Depth mBGL	Legend
0.0-0.4	ES		Dark brown sandy Gravel. Sand is fine to coarse. Gravel is fine to coarse, angular of granite, chert, brick, quartzite and frequent clinker and carbonaceous mudstone. [Made Ground]		
			Red cobbly Sand and Gravel. Sand is coarse. Gravel is fine to coarse. Gravel and cobbles are angular of ex-situ house brick fragments. [Made Ground]	0.4	
0.5-0.8	D		Soft yellowish brown slightly gravelly CLAY. Gravel is rare, fine to medium, subangular of chert. [Oxford Clay Formation]	0.5	
1.0	SPT	1,1,2,1 = 5	Mottled grey from 1.0m bgl.	1.0	
1.3-1.5	D				
1.5-1.8	ES				
			Discontinuity with white silt parting at 1.8m bgl.		
2.0	SPT	2,2,2,2 = 8	Very soft between 2.0m and 2.3m bgl	2.0	
2.0-2.3	D				
			Firm dark brown/grey CLAY. Frequent fine shell fragments [Oxford Clay Formation]	2.3	
3.0	SPT	6,6,7,7 = 26	Very stiff from 3.0m bgl	3.0	
4.5-4.8	D				
4.0	SPT	8,10,11,11 = 40	Borehole ended 4.0m bgl	4.0	
				5.0	

General Comments:

1. Excavation terminated at 4.0m. SPTs undertaken to 4.45m bgl.
2. No groundwater encountered.
3. No installation. Backfilled with arisings.

Scale: NTS
Date: 29/03/22
Logged by:SW
Checked: SW
Job No: R22013

Grange Geo Consulting Ltd

Borehole Log

BH No: **WS3**

Client: Dragon Structural Ltd.
Project: Sawtry, Huntingdon

Sheet: 1 of 1
Method: Window Sample Borehole

Sample Depth (m)	Sample Type	Testing result	Description	Depth mBGL	Legend
0.0-0.35	ES		Dark brown sandy Gravel. Sand is fine to coarse. Gravel is fine to coarse, angular of granite, chert, brick, quartzite and occasional clinker and slag. [Made Ground]		
			Red cobbly Sand and Gravel. Sand is coarse. Gravel is fine to coarse. Gravel and cobbles are angular of ex-situ house brick fragments. [Made Ground]	0.35	
0.5-0.8	D		Stiff yellowish brown slightly silty slightly gravelly slightly cobbly CLAY. Gravel is fine to coarse. Gravel and cobbles are angular of flint and chert. [Oxford Clay Formation]	0.5	
0.8-1.0	ES				
1.0	SPT	1,1,2,1 = 5	Soft to firm brown mottled grey CLAY. [Oxford Clay Formation]	1.0	
1.5-1.8	D		Discontinuities with partings of white silt and fine shell fragments at 1.6m and 1.95m bgl.		
2.0	SPT	2,1,2,2 = 7		2.0	
2.0-3.0	B		Soft to firm brown mottled orange CLAY. [Oxford Clay Formation] Occasional pockets of white silt and fine shell fragments.	2.1	
3.0	SPT	5,5,7,7 = 24		3.0	
3.5-3.8	D		Very stiff dark brown/grey CLAY. Rare shell fragments [Oxford Clay Formation]	3.05	
4.0	SPT	8,9,11,12 = 40	Borehole ended 4.0m bgl.	4.0	
				5.0	

General Comments:

1. Excavation terminated at 4.0m. SPTs undertaken to 4.45m bgl.
2. No groundwater encountered.
3. No installation. Backfilled with arisings.

Scale: NTS
Date: 29/03/22
Logged by:SW
Checked: SW
Job No: R22013

Borehole Log

BH No: **WS4**

Client: Dragon Structural Ltd.
Project: Sawtry, Huntingdon

Sheet: 1 of 1
Method: Window Sample Borehole

Sample Depth (m)	Type	Testing result	Description	Depth mBGL	Legend
			Grass over firm brown silty slightly gravelly Clay. Gravel is rare, rounded to subangular of siltstone and chert. [Topsoil]		
0.0-0.6	ES				
0.0-0.6	D				
			Soft to firm yellowish brown silty slightly gravelly CLAY. Gravel is rare rounded to subangular of sandstone. [Oxford Clay Formation]	0.6	
0.8-1.0	D				
1.0	SPT	1,1,1,2 = 5		1.0	
			Soft to firm brown mottled grey CLAY. Rare shell fragments. [Oxford Clay Formation]	1.1	
1.4-1.6	D				
			Very soft orange SILT [Oxford Clay Formation]	1.65, 1.68	
			Firm dark brown /dark grey CLAY. [Oxford Clay Formation]		
1.8-2.0	ES				
2.0	SPT	2,2,2,2 = 8		2.0	
			Rare organic fragments/carbonaceous mudstone between 2.4m bgl and 2.8m.		
2.5-2.8	D				
3.0	SPT	5,5,6,6 = 22	Very stiff from 3.0m bgl.	3.0	
4.0	SPT	6,7,8,10 = 31	Borehole ended 4.0m bgl.	4.0	
				5.0	

General Comments:

1. Excavation terminated at 4.0m. SPTs undertaken to 4.45m bgl.
2. No groundwater encountered.
3. No installation. Backfilled with arisings.

Scale: NTS
Date: 29/03/22
Logged by:SW
Checked: SW
Job No: R22013

Grange Geo Consulting Ltd

Trial Pit Log

BH No: **HP1**

Client: Dragon Structural Ltd.
Project: Sawtry, Huntingdon

Sheet: 1 of 1
Method: Window Sample Borehole

Sample Depth (m)	Sample Type	Testing result	Description	Depth mBGL	Legend
			Dark brown clayey Gravel. Gravel is coarse, angular of limestone and brick. [Made Ground]		
			Firm brown mottled grey silty CLAY. [Oxford Clay Formation]	0.3	
				0.5	
				1.0	
				1.31	
				1.5	
				2.0	
				5.0	

General Comments:

1. Excavation terminated at 4.0m. SPTs undertaken to 4.45m bgl.
2. Groundwater encountered at 0.8m bgl.
3. Backfilled with arisings.

Scale: NTS
Date: 29/03/22
Logged by:SW
Checked: SW
Job No: R22013

Grange Geo Consulting Ltd

Trial Pit Log

BH No: **HP2**

Client: Dragon Structural Ltd.
Project: Sawtry, Huntingdon

Sheet: 1 of 1
Method: Window Sample Borehole

Sample Depth (m)	Sample Type	Testing result	Description	Depth mBGL	Legend
			Dark brown sandy Gravel. Sand is fine to coarse. Gravel is fine to coarse, angular to subangular of limestone, brick, sandstone and mudstone. [Made Ground] Frequent plastic fragments.		
			Firm brown mottled grey slightly gravelly Clay. Gravel is fine to coarse, angular of flint and chert. [Made Ground] Occasional timber and root fragments. Fragments of a dismantled UPVC Window frame and glass between 0.58m and 0.8m bgl.	0.15 0.5	
			Firm brown mottled grey slightly gravelly Clay. Gravel is fine to coarse, angular of flint and chert. [Oxford Clay Formation]	0.9 1.0	
			Borehole ended 1.2m	1.2 1.5 2.0 5.0	

General Comments:

1. Excavation terminated at 1.2m.
2. No groundwater encountered.
3. Backfilled with arisings.

Scale: NTS
Date: 29/03/22
Logged by:SW
Checked: SW
Job No: R22013

Grange Geo Consulting Ltd

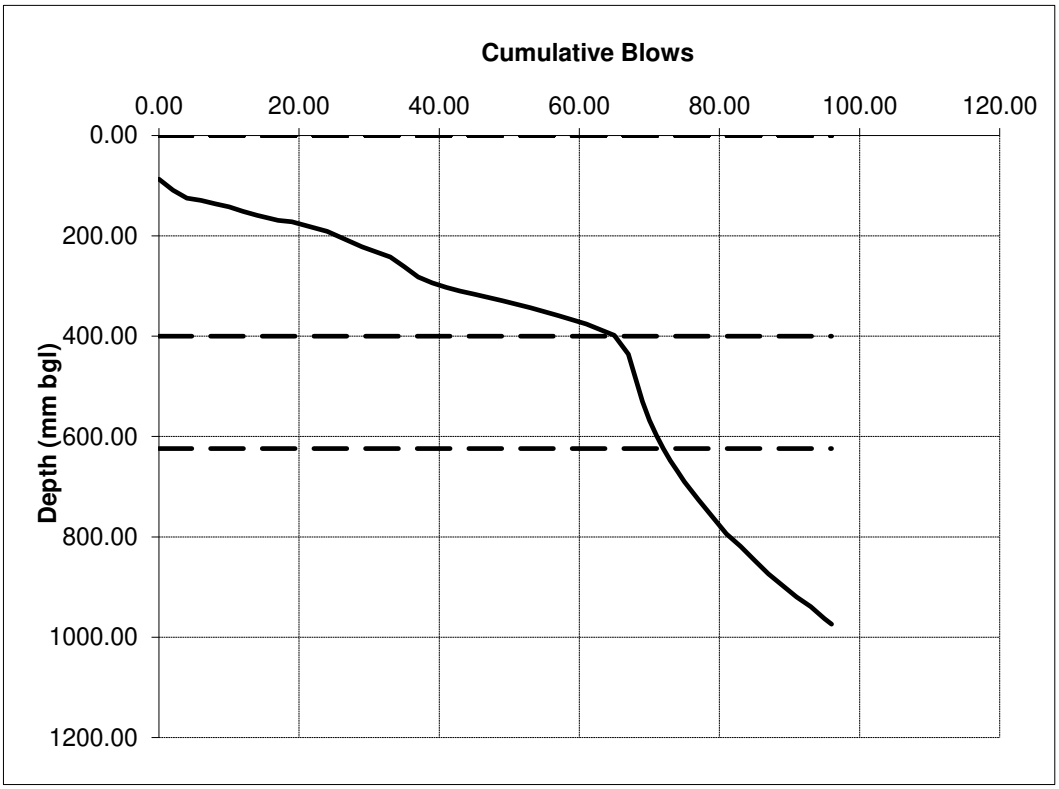
Appendix D

IN-SITU TESTING RESULTS (TRL PROBING)

Dynamic Cone Penetrometer

PROJECT NUMBER	**R22013**
PROJECT TITLE	**Sawtry**
TEST REFERENCE	**CBR1**
DATE	29-Mar-22
MATERIAL/ STRATA TYPE	MG/Clay
START DEPTH (mm bgl)	87
WEATHER/ GROUND CONDITION	Intermittant Drizzle

Layer	Blows	Cumulative Blows	Layer Thickness (mm)	Total Depth (mm bgl)	CBR (%)
1	65	65	313	400	**57.3**
2	7	72	224	624	**7.7**
3	24	96	350	974	**17.8**

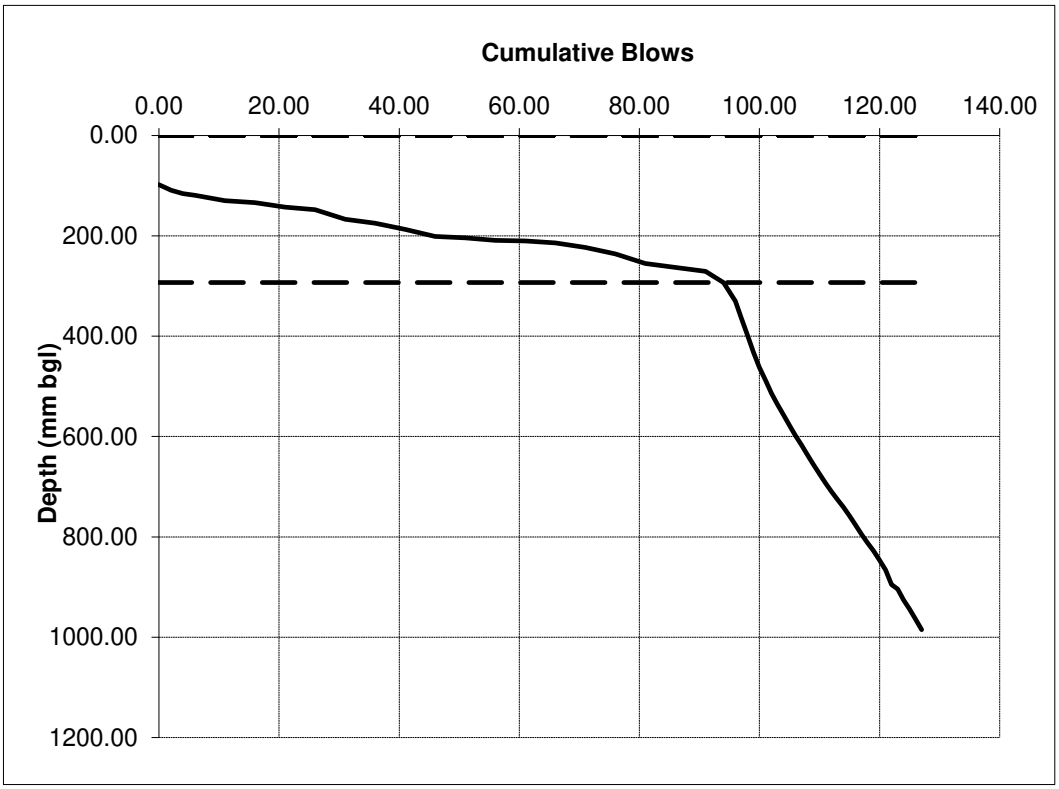


CBR Interpretation based on the TRL Equation: Log10(CBR) = 2.480 - [1.057 x Log 10(DCP Strength)]

Dynamic Cone Penetrometer

PROJECT NUMBER	**R22013**
PROJECT TITLE	**Sawtry**
TEST REFERENCE	**CBR2**
DATE	29-Mar-22
MATERIAL/ STRATA TYPE	MG/Clay
START DEPTH (mm bgl)	98
WEATHER/ GROUND CONDITION	Dry

Layer	Blows	Cumulative Blows	Layer Thickness (mm)	Total Depth (mm bgl)	CBR (%)
1	94	94	195	293	**>100**
2	33	127	692	985	**12.1**

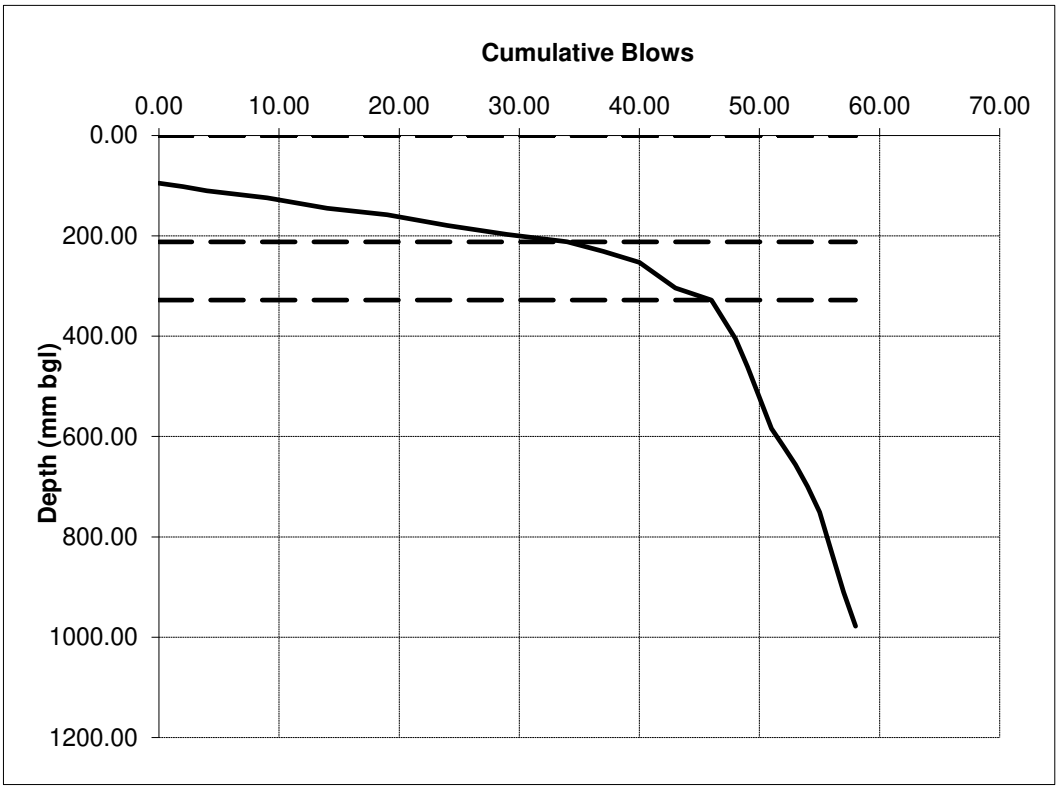


CBR Interpretation based on the TRL Equation: Log10(CBR) = 2.480 - [1.057 x Log 10(DCP Strength)]

Dynamic Cone Penetrometer

PROJECT NUMBER	**R22013**
PROJECT TITLE	**Sawtry**
TEST REFERENCE	**CBR3**
DATE	29-Mar-22
MATERIAL/ STRATA TYPE	MG/Clay
START DEPTH (mm bgl)	95
WEATHER/ GROUND CONDITION	Dry

Layer	Blows	Cumulative Blows	Layer Thickness (mm)	Total Depth (mm bgl)	CBR (%)
1	34	34	117	212	**81.8**
2	12	46	116	328	**27.5**
3	12	58	650	978	**4.4**

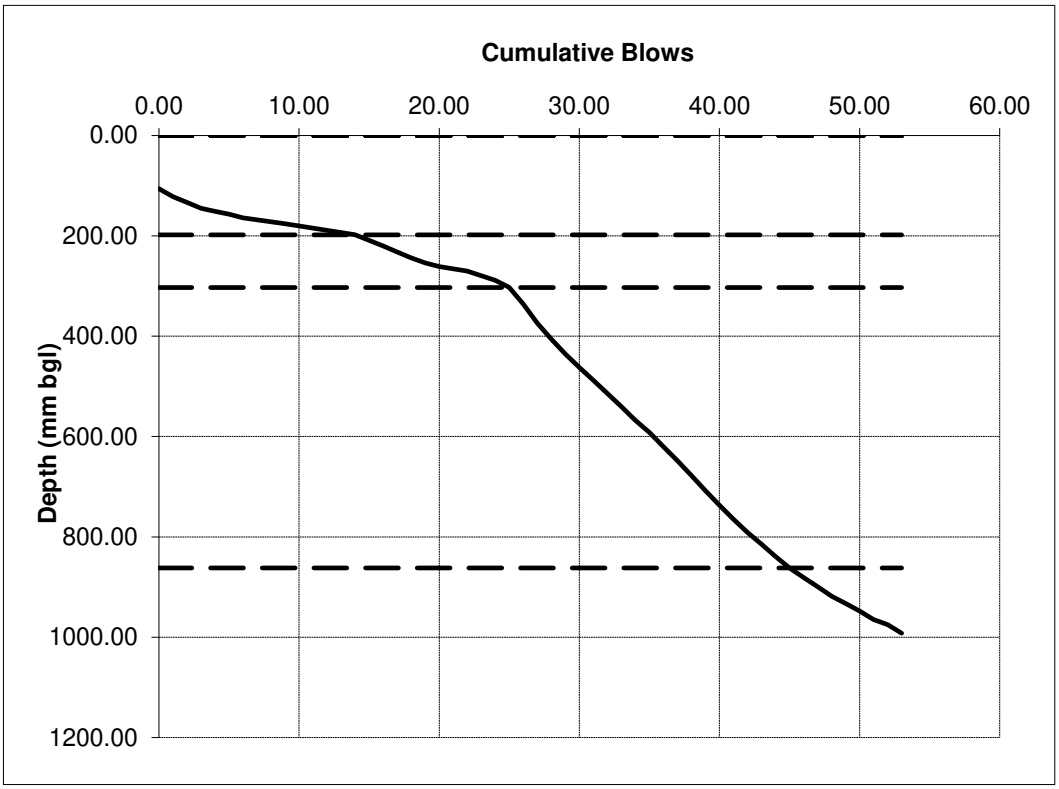


CBR Interpretation based on the TRL Equation: Log10(CBR) = 2.480 - [1.057 x Log 10(DCP Strength)]

Dynamic Cone Penetrometer

PROJECT NUMBER	**R22013**
PROJECT TITLE	**Sawtry**
TEST REFERENCE	**CBR4**
DATE	29-Mar-22
MATERIAL/ STRATA TYPE	MG/Clay
START DEPTH (mm bgl)	106
WEATHER/ GROUND CONDITION	Dry

Layer	Blows	Cumulative Blows	Layer Thickness (mm)	Total Depth (mm bgl)	CBR (%)
1	14	14	92	198	**41.3**
2	11	25	105	303	**27.8**
3	20	45	559	862	**8.9**
4	8	53	130	992	**15.9**

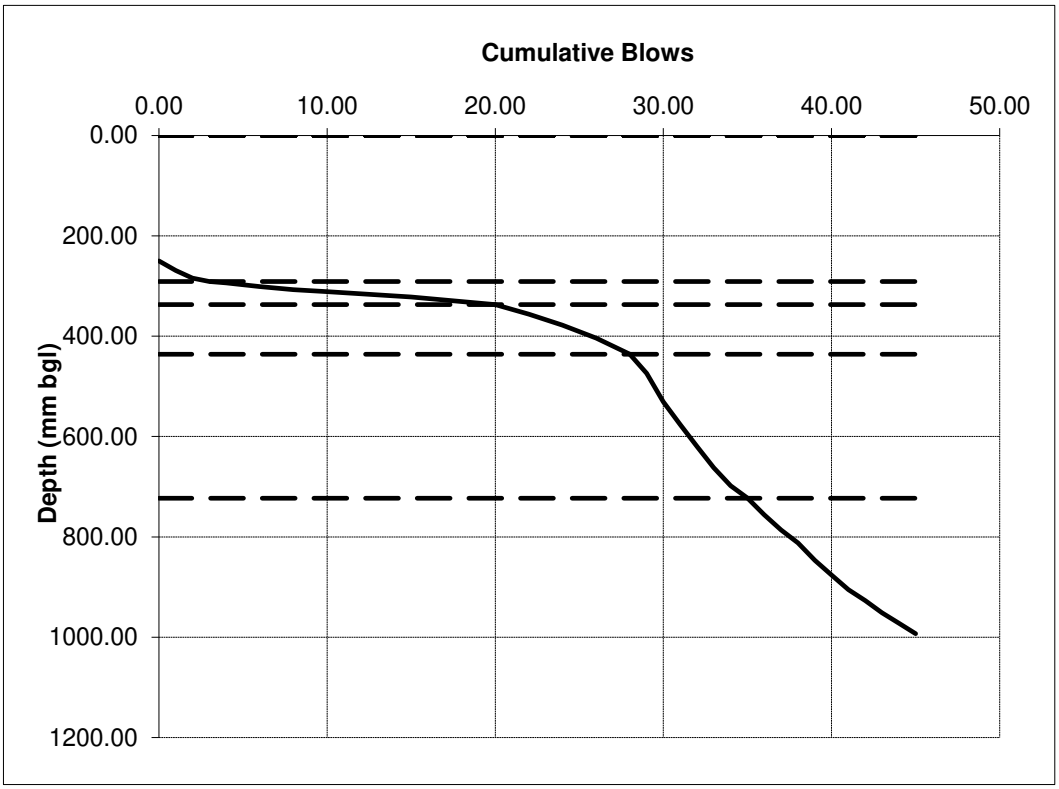


CBR Interpretation based on the TRL Equation: Log10(CBR) = 2.480 - [1.057 x Log 10(DCP Strength)]

Dynamic Cone Penetrometer

PROJECT NUMBER	**R22013**
PROJECT TITLE	**Sawtry**
TEST REFERENCE	**Core 1**
DATE	30-Mar-22
MATERIAL/ STRATA TYPE	MG/Clay
START DEPTH (mm bgl)	250
WEATHER/ GROUND CONDITION	Dry

Layer	Blows	Cumulative Blows	Layer Thickness (mm)	Total Depth (mm bgl)	CBR (%)
1	3	3	41	291	**19.0**
2	17	20	46	337	**>100**
3	8	28	99	436	**21.1**
4	7	35	287	723	**6.0**
5	10	45	270	993	**9.3**

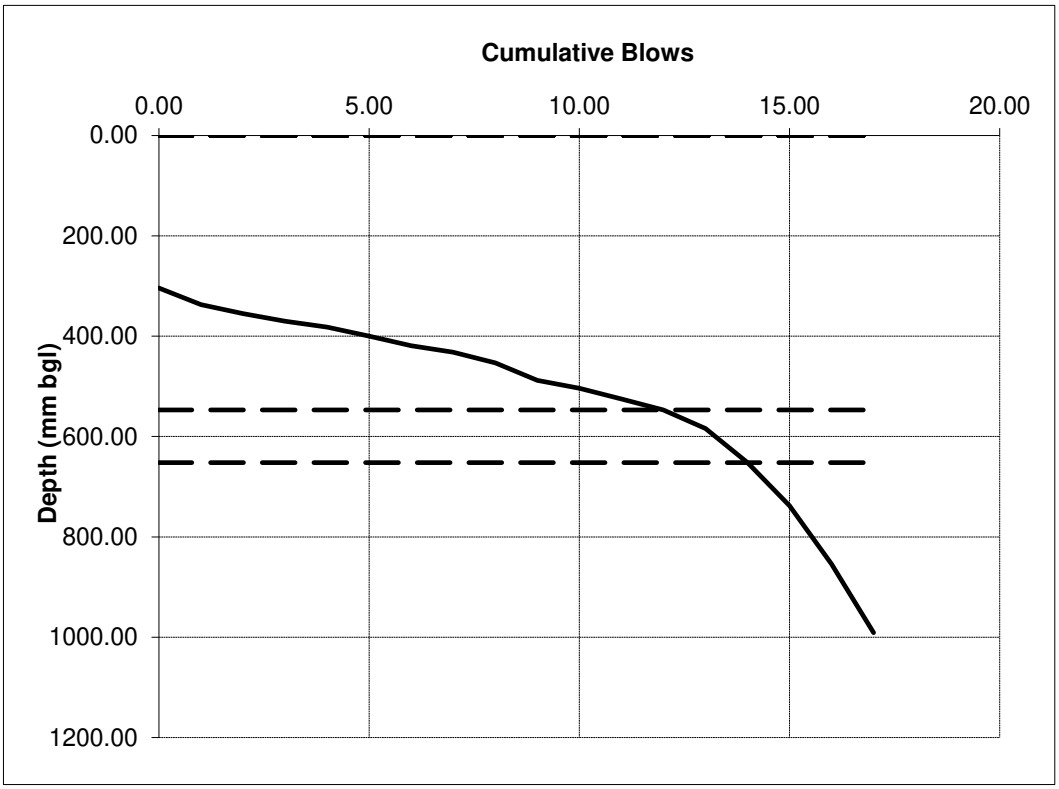


CBR Interpretation based on the TRL Equation: Log10(CBR) = 2.480 - [1.057 x Log 10(DCP Strength)]

Dynamic Cone Penetrometer

PROJECT NUMBER	**R22013**
PROJECT TITLE	**Sawtry**
TEST REFERENCE	**Core 2**
DATE	30-Mar-22
MATERIAL/ STRATA TYPE	MG/Clay
START DEPTH (mm bgl)	304
WEATHER/ GROUND CONDITION	Dry

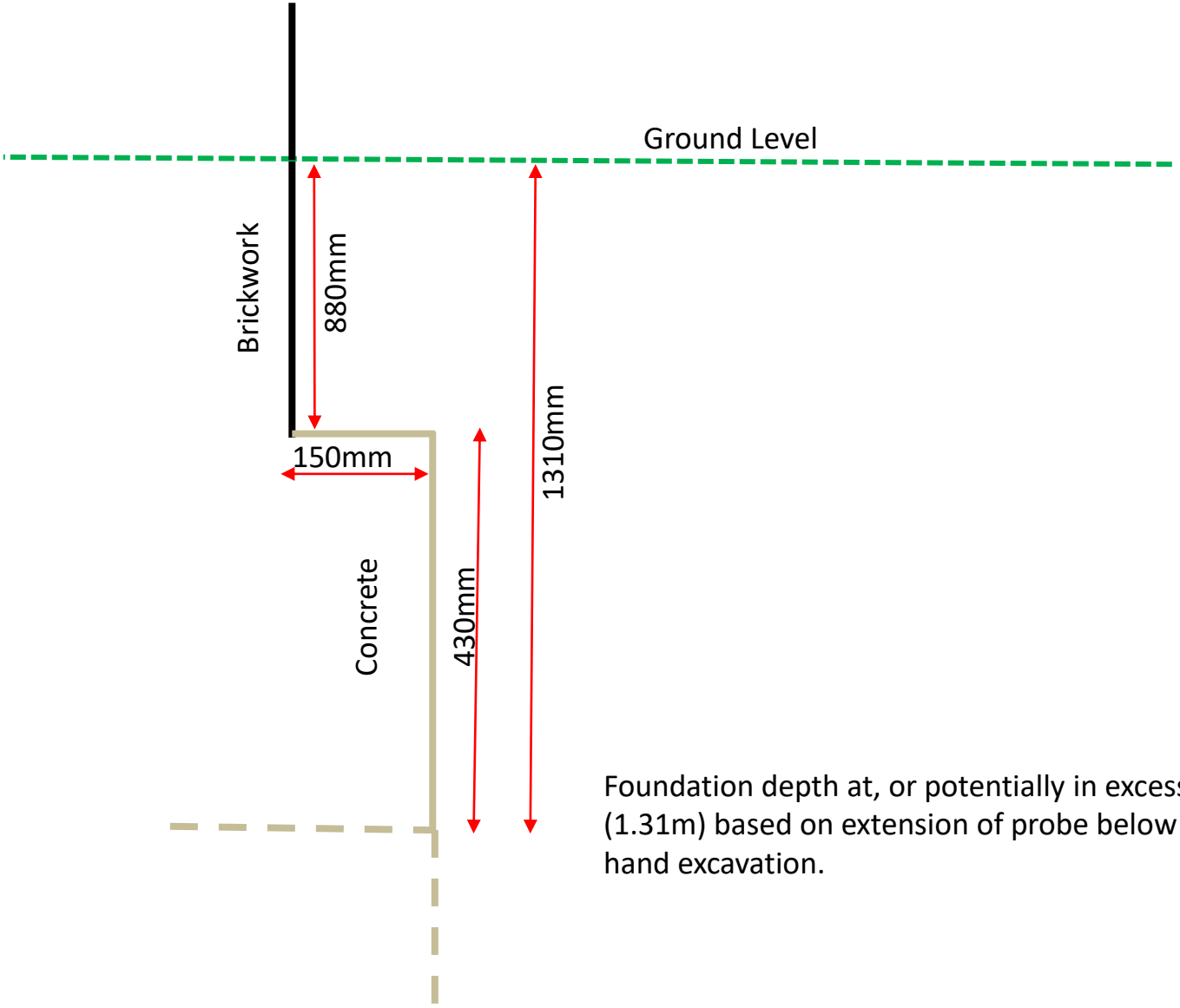
Layer	Blows	Cumulative Blows	Layer Thickness (mm)	Total Depth (mm bgl)	CBR (%)
1	12	12	243	547	**12.6**
2	2	14	105	652	**4.6**
3	3	17	339	991	**2.0**



CBR Interpretation based on the TRL Equation: Log10(CBR) = 2.480 - [1.057 x Log 10(DCP Strength)]

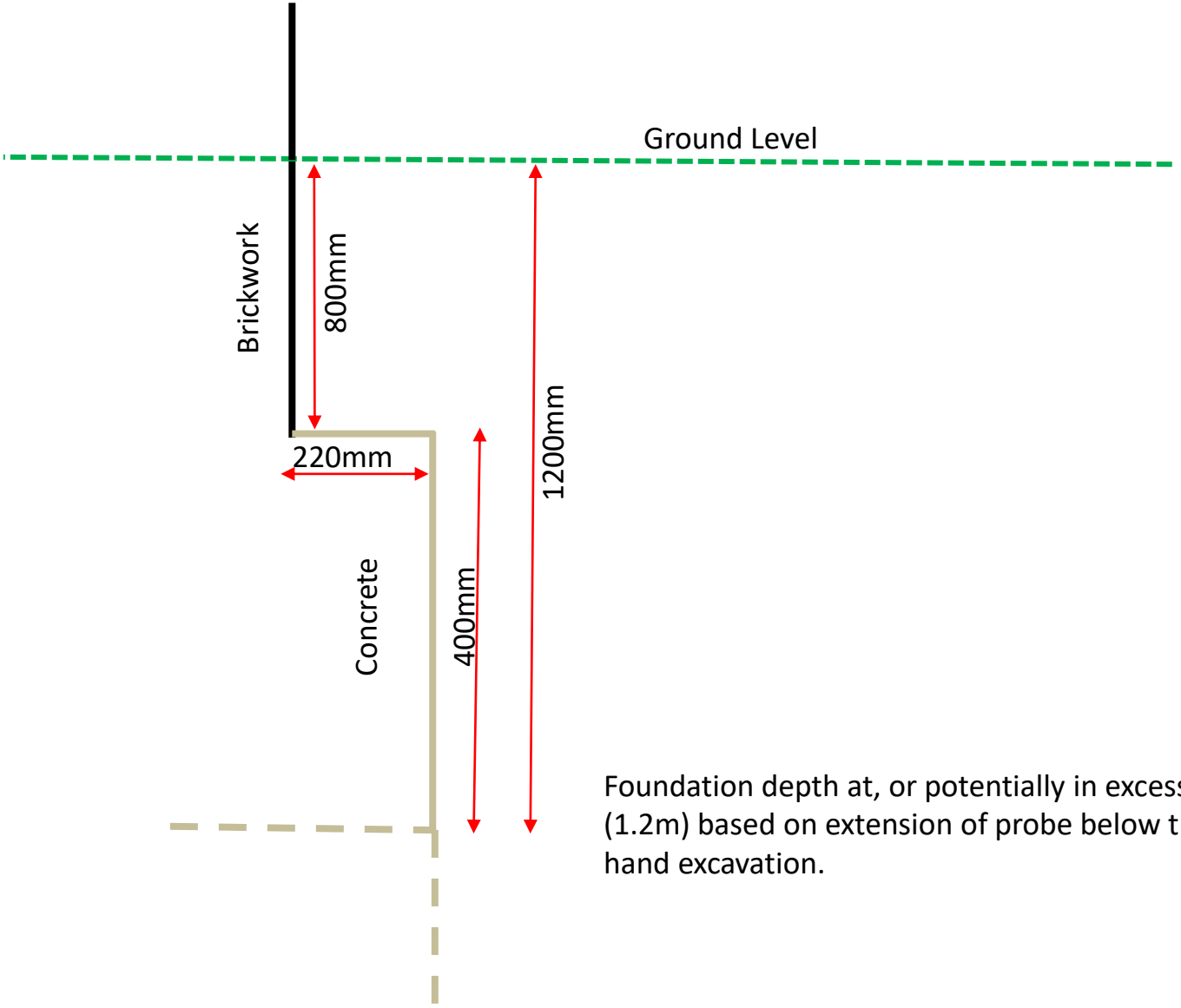
Appendix E

FOUNDATION SKETCH PLANS AND PHOTOGRAPHS



Foundation depth at, or potentially in excess of 1310mm (1.31m) based on extension of probe below the base of hand excavation.

Grange Geo	**Sawtry, Huntingdon** HP1 Foundation Sketch Plan	**Client-** Dragon Structural Ltd. **Date-** May 2022		**Job No.** R22013



Foundation depth at, or potentially in excess of 1200mm (1.2m) based on extension of probe below the base of hand excavation.

Grange Geo	**Sawtry, Huntingdon** HP2 Foundation Sketch Plan	**Client-** Dragon Structural Ltd. **Date-** May 2022		**Job No.** R22013

HP1

HP2

Grange Geo	**Foundation Photo Record** Sawtry Huntingdon	**Client:** Dragon Structural Ltd.	**Date-** May 2022	Appendix E

Appendix F

GRANGE GEOCONSULTING LTD METHODOLOGY

RISK ASSESSMENT RATIONALE

The work presented in this report has been carried out in general accordance with recognised best practice as detailed in guidance documents such as in BS5930:1999 and BS10175:2001. Important aspects of the risk assessment process are transparency and justification. The rationale behind the risk assessments presented is given in this appendix.

A preliminary risk assessment is made of both geotechnical and geo-environmental hazards identified at the desk study stage and confirmed (or amended) at the ground investigation stage. This is based on a simple matrix of probability of occurrence versus the consequence, as explained below. In the case of geo-environmental hazards, the risk assessment process proceeds to the next level, the generic risk assessment, in which actual contaminant concentrations are considered.

Preliminary Risk Assessment (Geotechnical Risk Register)

The preliminary geotechnical risk register is compiled in accordance with the Highways Agency Design Manual for Roads and Bridges HD/02. This requires an estimation of the *probability* of an event happening multiplied by the *impact* or consequences of that event. Five levels of probability and impact are given scores, and these are multiplied to give a risk rating and a qualitative risk level is assigned as in Table A based on the terminology of Clayton (2001).

Table A: Geotechnical Risk Rating

Assessment of Geotechnical Risks (Risk Register)				
Probability (P)	**Impact (I)**	**Impact in terms of cost or time (% of construction cost or time)**	**Risk Rating (R = P x I)**	**Risk Level**
Very likely (5)	Very High (5)	>25%	17 to 25	Intolerable
Likely (4)	High (4)	10 to 25%	13 to 16	Intolerable
Probable (3)	Medium (3)	4 to 10%	9 to 12	Substantial
Unlikely (2)	Low (2)	1 to 4%	5 to 8	Tolerable
Negligible (1)	Very Low (1)	<1%	1 to 4	Trivial

Preliminary Risk Assessment (Geoenvironmental Consequences and Probability)

The Preliminary Risk Assessment includes a geo-environmental Hazard Identification, which seeks to list all the suspected contaminant **sources**, the **receptors** that might be harmed by those sources and the **pathways** via which the sources might reach the receptors to cause the harm. The source-pathway-receptor concept is known as a pollution linkage, and only when a linkage is complete is there any possibility of risk of harm arising.

The Hazard Identification evaluates all the **possible** pollution linkages in tabular form. Professional judgement is then used to evaluate which of these pollution linkages may be considered as **plausible**. Plausible pollution linkages are unacceptable risks in terms of the current contaminated land regime legal framework and require either remediation or further assessment. These are normally addressed via intrusive ground investigation and the chemical analysis of soil and water samples.

Where no plausible linkage identified, the linkage is classed as ‘no linkage’ in the summary table and no further action is required. If a linkage is plausible, a comparison is made of consequence against probability in general accordance with the guidance given in CIRIA Report C552 (Rudland *et al* 2001). Classification of consequences and probability are given in CIRIA C552 Tables 6.3 and 6.4, respectively, but there are

several inconsistencies in the original Table 6.3, in particular relating to 'significant harm or significant possibility of significant harm' (SH/SPOSH). Consequently, the table has been updated by Grange Geo in line with current practice and is given in Table B. Also added are scores from 1 to 4 for each category.

The basis of the classification is that 'severe' and 'major' are likely to result in SH/SPOSH as defined by the EPA 1990, Part 2A, with 'severe' resulting in acute harm. 'Moderate' lies below the level of SH/SPOSH but above the level of 'no harm' as implied by the relevant Generic assessment criterion (GAC, see below). Minor lies below the 'no harm' level.

Table B: Classification of Consequences of Geoenvironmental Risks

Classification of Consequences for Geoenvironmental Risks		
Classification	**Definition**	**Examples**
Severe (4 points)	Concentration of contaminants is likely to (or is known from previous data to) exceed that indicative of unacceptable intake or contact. I.e. >>SH/SPOSH, concentrations are high enough to cause acute (short-term) effects.	Human health: short-term (acute) effects likely to result in significant harm. E.g. high conc. of cyanide at the surface of an informal recreational area. Planting: complete and rapid die-back of landscaped areas. Controlled waters: short-term pollution, e.g. major spillage into controlled water. Buildings etc.: catastrophic damage, e.g. explosion causing collapse. Ecosystems: short-term risk to an ecosystem or organism forming part of that ecosystem in a designated protected area, e.g. by contamination spillage. Site workers: risk assessment required to determine PPE, and this may involve USEPA Level A, B or C protection.
Major (3 points)	Concentration of contaminants is likely to (or is known from previous data to) exceed that indicative of unacceptable intake or contact. I.e. >SH/SPOSH.	Human health: long-term (chronic) effects likely to result in significant harm. E.g. high conc. of contaminants close to the surface of a development site. Planting: stressed or dead plants in landscaped areas. Controlled waters: pollution of sensitive water resources, e.g. leaching into major or minor aquifers or rivers. Buildings etc.: damage renders unsafe to occupy. Ecosystems: death of species in an ecosystem in a designated protected area, e.g. by contamination spillage. Site workers: risk assessment required to determine PPE, and this may involve USEPA Level B, C or D protection.

Classification of Consequences for Geoenvironmental Risks		
Classification	**Definition**	**Examples**
Moderate (2 points)	Concentration of contaminants is likely to (or is known from previous data to) exceed that indicative of no harm but not unacceptable intake or contact. I.e. >SVG/GAC but <SH/SPOSH.	Human health: harm but probably not significant harm unless particularly sensitive individual within the receptor group. May be aesthetic/olfactory impacts. Planting: damage to plants in landscaped areas, e.g. stunted growth, discoloration. Controlled waters: pollution of non-sensitive water bodies e.g. leaching into non-classified groundwater or minor ditches. Buildings etc.: damage to sensitive buildings etc. Ecosystems: minor change in an ecosystem in a designated protected area, but not significant harm. Site workers: risk assessment required to determine PPE, and this may involve USEPA Level C or D protection.
Minor (1 point)	Concentration of contaminants is likely to (or is known from previous data to) be less than that indicative of no harm. I.e. <SGV/GAC.	No measurable effects, but simple PPE required (USEPA Level D protection, i.e. overalls, boots, goggles, hard hat).

CIRIA Table 6.4 is reproduced as Table C below, but also with the addition of scores from 1 to 4. This provides an estimate of the probability that the event described by the pollution linkage will occur. For example, the likelihood that pollution of groundwater will occur by leaching of metals into the aquifer.

Table C: Classification of Probability of Geoenvironmental Risks

Classification of Probability of Geoenvironmental Risks	
Classification	**Definition**
High (4 points)	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.
Medium (3 points)	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 in not inevitable, but possible in the short term and likely over the long term.
Low (2 points)	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is no means certain that even over a longer period such event could take place and is less likely in the shorter term.
Unlikely (1 point)	There is a pollution linkage, but circumstances are such that it is improbable that an event would occur even in the very long term.

The perceived level of risk for each pathway is then derived from the probability versus consequences matrix, modified after CIRIA C552 Table 6.5, given in Table D. The scores are summed accordingly and the result assigned a risk level by dividing the range between the minimum score of 1 and the maximum score of 16 equally into 5 categories i.e. 1 to <4 is very low risk, 4 to <7 is low risk, 7 to <10 is moderate risk, 10 to <13 is high risk and 13 to 16 is very high risk.

Table D: Qualitative Risk Level from Consequence and Probability

		Consequence			
	product	**Severe (4)**	**Major (3)**	**Moderate (2)**	**Minor (1)**
Probability	**High (4)**	16 = Very high risk	12 = High risk	8 = Moderate risk	4 = Low risk
	Medium (3)	12 = High risk	9 = Moderate risk	6 = Low risk	3 = Very low risk
	Low (2)	8 = Moderate risk	6 = Low risk	4 = Low risk	2 = Very low risk
	Unlikely (1)	4 = Low risk	3 = Very low risk	2 = Very low risk	1 = Very low risk

This approach assumes an equivalence between probability and consequences and ignores the difficulty that can arise where to probability of occurrence appears to be almost negligible, but the consequences are very severe. In such conditions, there is a degree of subjectivity in assessing the level of risk and it could be low, moderate or high. Such risks may require specialist consideration beyond the scope of this standard report.

A description of the classified risks and the likely action required can be determined from Table E.

Table E: Description of the Classified Risks and Likely Action Required

Description of Classified Risks and Likely Action Required	
Very High Risk	A significant pollution linkage, including actual evidence of significant harm or significant possibility and significant harm, is clearly identifiable at the site (e.g. from visual or documentary evidence) under current conditions, with potential for legal and/or financial consequences for the site owner or other Responsible Person. Remediation advisable based on acute impacts being likely. Immediate action should be considered.
High Risk	A pollution linkage is identifiable at the site under current and future use conditions. Although likely, there is no obvious actual evidence of significant harm or significant possibility and significant harm under current conditions. Extent of risk is therefore subject to confirmation by investigation and risk assessment and most likely to be deemed significant. Remediation required for redevelopment and may also be required under Part 2A for existing receptors.
Moderate Risk	A pollution linkage is identifiable at the site under current and future use conditions. However, it is not likely to be a significant linkage under current conditions. Actual extent of risk subject to confirmation by additional investigation and risk assessment and most likely to lie between no possibility of harm (under current conditions) and significant possibility of significant harm (under conditions created by new use). Remediation may be required for redevelopment.
Low risk	Potential pathways and receptors exist but history of contaminative use or site conditions indicates that contamination is likely to be of limited extent and below the level of no possibility of harm. Precautionary investigations and risk assessment advisable on change of use.
Very Low Risk	No pollution linkage likely to exist under current or future conditions. Site not capable of being determined under Part 2A (in accordance with PPS23) where the Local Authority inspects the site. No further action recommended.

Contaminant Analysis of Samples

CLR 8 (Environment Agency 2002b), the DoE Industry Profile documents and ISO10381-5 provide good summaries of priority pollutants for UK sites. Additionally, the Environment Agency has produced a list of priority pollutants for ecological risk assessment in a consultation document (Environment Agency 2003a). These documents have been used, with the findings of the Phase 1 investigation, to scope the analyses of chemicals of potential concern.

Grange Geo considers there to be a minimum requirement for soil chemical analysis, even for Greenfield sites, to satisfy the 'suitable for use' criterion of the planning regime. The GACs adopted by Grange Geo for the Site are given in the following table.

There is no safe acceptable level for asbestos in soils, detect or non-detect is recorded with asbestos quantification undertaken on samples found to contain asbestos.

Table F presents the Generic Assessment Criteria (GAC) for the residential without plant uptake (excluding the consumption of home-grown produce)**.**

Table F: GAC for Public Open Space (Park)

Based on a 2.5% Soil Organic Matter Content.

Based on SGVs, C4SL and S4UL values.

All GACs are expressed as mg/kg unless otherwise stated.

Heavy Metals	
Arsenic	170
Beryllium	63
Boron	46000
Cadmium	532
Chromium (III)	33000
Chromium (VI)	220
Copper	44000
Lead	1300
Mercury (elemental)	
Mercury (inorganic)	240
Nickel	3400
Selenium	1800
Vanadium	5000
Zinc	170000
BTEX	
Benzene	100
Toluene	95000
Ethyl Benzene	22000
m Xylene	24000
p Xylene	23000
o Xylenes	24000

Speciated PAHs	
Naphthalene	1900
Acenaphthylene	30000
Acenaphthene	30000
Fluorene	20000
Phenanthrene	6200
Anthracene	150000
Fluoranthene	6300
Pyrene	15000
Benzo[a]anthracene	56
Chrysene	110
Benzo[b]fluoranthene	15
Benzo[k]fluoranthene	410
Benzo[a]pyrene	12
Indeno[123-cd]pyrene	170
Dibenzo[ah]anthracene	1.3
Benzo[ghi]perylene	1500
Asbestos	
Asbestos	None-detected
Speciated TPH	
Aliphatic C5 - C6	130000
Aliphatic C6 - C8	220000
Aliphatic C8 - C10	18000
Aliphatic C10 - C12	23000
Aliphatic C12 - C16	25000
Aliphatic C16 – C35	480000
Aliphatic C35 – C44	480000
Aromatic C5 - C7	84000
Aromatic C7 - 8	95000
Aromatic C8 - C10	8500
Aromatic C10 - 12	9700
Aromatic C12 - C16	10000
Aromatic C16 - C21	7700
Aromatic C21 - C35	7800
Aromatic C35 – C44	7800

Appendix G

CONTAMINATION TESTING RESULTS

Steve Woodall
Grange Geo Consulting Ltd
43 Winchilsea Avenue
Newark
Notts
NG24 4AD

e: steve@grangegeo.co.uk

i2 Analytical Ltd.
7 Woodshots Meadow,
Croxley Green
Business Park,
Watford,
Herts,
WD18 8YS

t: 01923 225404
f: 01923 237404
e: reception@i2analytical.com

Analytical Report Number : 22-49466

Project / Site name:	Sawtry	**Samples received on:**	01/04/2022
Your job number:	R22013	**Samples instructed on/ Analysis started on:**	01/04/2022
Your order number:		**Analysis completed by:**	12/04/2022
Report Issue Number:	1	**Report issued on:**	12/04/2022
Samples Analysed:	5 soil samples		

Signed:

Joanna Wawrzeczko
Reporting Specialist
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

Excel copies of reports are only valid when accompanied by this PDF certificate.

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: 22-49466
Project / Site name: Sawtry

Lab Sample Number				2225443	2225444	2225445	2225446	2225447
Sample Reference				WS1	WS1	WS2	WS3	WS4
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.00-0.30	0.80-1.00	0.00-0.40	0.00-0.35	0.00-0.60
Date Sampled				29/03/2022	29/03/2022	29/03/2022	29/03/2022	29/03/2022
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	72	< 0.1	58	64	< 0.1
Moisture Content	%	0.01	NONE	4	18	3	3.8	21
Total mass of sample received	kg	0.001	NONE	1.1	1.1	1	1	1
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Not-detected	Not-detected
Asbestos Analyst ID	N/A	N/A	N/A	MLO	MLO	MLO	MLO	MLO
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	9	7.9	10.6	10.1	8
Total Cyanide	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Organic Matter (automated)	%	0.1	MCERTS	2.3	1.8	8.1	2.7	3.9
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	1.1	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.96	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	8.4	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	5.4	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	0.86	0.37	48	0.43	< 0.05
Anthracene	mg/kg	0.05	MCERTS	0.34	< 0.05	17	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	1.8	0.74	85	0.68	0.24
Pyrene	mg/kg	0.05	MCERTS	1.6	0.72	80	0.64	0.22
Benzo(a)anthracene	mg/kg	0.05	MCERTS	1.2	0.42	51	0.4	< 0.05
Chrysene	mg/kg	0.05	MCERTS	1.1	0.39	43	0.45	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	1.3	0.38	56	0.56	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	0.6	0.17	18	0.29	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	1.2	0.35	49	0.45	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	0.69	0.21	26	0.22	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	7.1	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	0.73	0.25	29	0.28	< 0.05
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	11.4	4	525	4.4	< 0.80
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	20	14	12	26	16
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	0.5
Chromium (hexavalent)	mg/kg	4	NONE	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	31	35	37	30	47
Copper (aqua regia extractable)	mg/kg	1	MCERTS	70	16	33	68	26
Lead (aqua regia extractable)	mg/kg	1	MCERTS	44	15	24	42	32
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	23	19	11	22	34
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	75	43	120	110	55
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	96	70	59	110	120
Monoaromatics & Oxygenates								
Benzene	µg/kg	1	MCERTS	< 1.0	-	< 1.0	< 1.0	-
Toluene	µg/kg	1	MCERTS	< 1.0	-	< 1.0	< 1.0	-
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	-	< 1.0	< 1.0	-
p & m-xylene	µg/kg	1	MCERTS	< 1.0	-	< 1.0	< 1.0	-
o-xylene	µg/kg	1	MCERTS	< 1.0	-	< 1.0	< 1.0	-
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	-	< 1.0	< 1.0	-

Analytical Report Number: 22-49466
Project / Site name: Sawtry

Lab Sample Number				2225443	2225444	2225445	2225446	2225447
Sample Reference				WS1	WS1	WS2	WS3	WS4
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.00-0.30	0.80-1.00	0.00-0.40	0.00-0.35	0.00-0.60
Date Sampled				29/03/2022	29/03/2022	29/03/2022	29/03/2022	29/03/2022
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >EC5 - EC6 $_{HS\_1D\_AL}$	mg/kg	0.001	MCERTS	< 0.001	-	< 0.001	< 0.001	-
TPH-CWG - Aliphatic >EC6 - EC8 $_{HS\_1D\_AL}$	mg/kg	0.001	MCERTS	< 0.001	-	< 0.001	< 0.001	-
TPH-CWG - Aliphatic >EC8 - EC10 $_{HS\_1D\_AL}$	mg/kg	0.001	MCERTS	< 0.001	-	< 0.001	< 0.001	-
TPH-CWG - Aliphatic >EC10 - EC12 $_{EH\_CU\_1D\_AL}$	mg/kg	1	MCERTS	< 1.0	-	2.5	< 1.0	-
TPH-CWG - Aliphatic >EC12 - EC16 $_{EH\_CU\_1D\_AL}$	mg/kg	2	MCERTS	< 2.0	-	8.6	< 2.0	-
TPH-CWG - Aliphatic >EC16 - EC21 $_{EH\_CU\_1D\_AL}$	mg/kg	8	MCERTS	< 8.0	-	16	< 8.0	-
TPH-CWG - Aliphatic >EC21 - EC35 $_{EH\_CU\_1D\_AL}$	mg/kg	8	MCERTS	< 8.0	-	81	< 8.0	-
TPH-CWG - Aliphatic (EC5 - EC35) $_{EH\_CU+HS\_1D\_AL}$	mg/kg	10	MCERTS	< 10	-	110	< 10	-
TPH-CWG - Aromatic >EC5 - EC7 $_{HS\_1D\_AR}$	mg/kg	0.001	MCERTS	< 0.001	-	< 0.001	< 0.001	-
TPH-CWG - Aromatic >EC7 - EC8 $_{HS\_1D\_AR}$	mg/kg	0.001	MCERTS	< 0.001	-	< 0.001	< 0.001	-
TPH-CWG - Aromatic >EC8 - EC10 $_{HS\_1D\_AR}$	mg/kg	0.001	MCERTS	< 0.001	-	< 0.001	< 0.001	-
TPH-CWG - Aromatic >EC10 - EC12 $_{EH\_CU\_1D\_AR}$	mg/kg	1	MCERTS	< 1.0	-	4.3	< 1.0	-
TPH-CWG - Aromatic >EC12 - EC16 $_{EH\_CU\_1D\_AR}$	mg/kg	2	MCERTS	< 2.0	-	31	< 2.0	-
TPH-CWG - Aromatic >EC16 - EC21 $_{EH\_CU\_1D\_AR}$	mg/kg	10	MCERTS	< 10	-	220	< 10	-
TPH-CWG - Aromatic >EC21 - EC35 $_{EH\_CU\_1D\_AR}$	mg/kg	10	MCERTS	13	-	710	< 10	-
TPH-CWG - Aromatic (EC5 - EC35) $_{EH\_CU+HS\_1D\_AR}$	mg/kg	10	MCERTS	19	-	960	< 10	-

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

Analytical Report Number : 22-49466
Project / Site name: Sawtry

* 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 *
2225443	WS1	None Supplied	0.00-0.30	Brown loam and sand with stones and concrete.
2225444	WS1	None Supplied	0.80-1.00	Brown clay with gravel.
2225445	WS2	None Supplied	0.00-0.40	Brown loam and sand with rubble and vegetation.
2225446	WS3	None Supplied	0.00-0.35	Brown loam and sand with stones and concrete.
2225447	WS4	None Supplied	0.00-0.60	Brown clay with gravel and vegetation.

Analytical Report Number : 22-49466
Project / Site name: Sawtry

Water matrix abbreviations:
Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
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
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In house method.	L019-UK/PL	W	NONE
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
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method with silica gel split/clean up.	L088/76-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
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	NONE

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.
Unless otherwise indicated, site information, order number, project number, sampling date, time, sample reference and depth are provided by the client. The instructed on date indicates the date on which this information was provided to the laboratory.

Information in Support of Analytical Results

List of HWOL Acronyms and Operators

Acronym	Descriptions
HS	Headspace Analysis
MS	Mass spectrometry
FID	Flame Ionisation Detector
GC	Gas Chromatography
EH	Extractable Hydrocarbons (i.e. everything extracted by the solvent(s))
CU	Clean-up - e.g. by Florisil®, silica gel
1D	GC - Single coil/column gas chromatography
2D	GC-GC - Double coil/column gas chromatography
Total	Aliphatics & Aromatics
AL	Aliphatics

Analytical Report Number : 22-49466
Project / Site name: Sawtry

Water matrix abbreviations:
Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
AR	Aromatics				
#1	EH_2D_Total but with humics mathematically subtracted				
#2	EH_2D_Total but with fatty acids mathematically subtracted				
_	Operator - understore to separate acronyms (exception for +)				
+	Operator to indicate cumulative e.g. EH+HS_Total or EH_CU+HS_Total				

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Analytical Report Number : 22-49467

Replaces Analytical Report Number: 22-49467, issue no. 1
Report format change.

Project / Site name:	Sawtry	**Samples received on:**	01/04/2022
Your job number:	R22013	**Samples instructed on/ Analysis started on:**	01/04/2022
Your order number:		**Analysis completed by:**	12/04/2022
Report Issue Number:	2	**Report issued on:**	13/04/2022
Samples Analysed:	2 10:1 WAC samples		

Izabela Wójcik
Signed:

Izabela Wójcik
Reporting Specialist
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

Excel copies of reports are only valid when accompanied by this PDF certificate.

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.

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Waste Acceptance Criteria Analytical Results

Report No:	22-49467						
					Client: GRANGEGC		
Location	Sawtry						
Lab Reference (Sample Number)	2225448 / 2225449				Landfill Waste Acceptance Criteria Limits		
Sampling Date	29/03/2022						
Sample ID	WS2				Inert Waste Landfill	Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill	Hazardous Waste Landfill
Depth (m)	1.50-1.80						
Solid Waste Analysis							
TOC (%)**	1.2				3%	5%	6%
Loss on Ignition (%) **	-				--	--	10%
BTEX (µg/kg) **	< 10				6000	--	--
Sum of PCBs (mg/kg) **	< 0.007				1	--	--
Mineral Oil (mg/kg) EH_1D_CU_AL	< 10				500	--	--
Total PAH (WAC-17) (mg/kg)	< 0.85				100	--	--
pH (units)**	-				--	>6	--
Acid Neutralisation Capacity (mmol / kg)	-				--	To be evaluated	To be evaluated
Eluate Analysis	10:1			10:1	Limit values for compliance leaching test		
(BS EN 12457 - 2 preparation utilising end over end leaching procedure)	mg/l			mg/kg	using BS EN 12457-2 at L/S 10 l/kg (mg/kg)		
Arsenic *	< 0.0010			< 0.0100	0.5	2	25
Barium *	0.0231			0.175	20	100	300
Cadmium *	< 0.0001			< 0.0008	0.04	1	5
Chromium *	0.0015			0.011	0.5	10	70
Copper *	0.011			0.081	2	50	100
Mercury *	< 0.0005			< 0.0050	0.01	0.2	2
Molybdenum *	0.0047			0.0358	0.5	10	30
Nickel *	0.0048			0.037	0.4	10	40
Lead *	0.0034			0.026	0.5	10	50
Antimony *	< 0.0017			< 0.017	0.06	0.7	5
Selenium *	< 0.0040			< 0.040	0.1	0.5	7
Zinc *	0.0062			0.047	4	50	200
Chloride *	2.3			18	800	15000	25000
Fluoride	0.63			4.8	10	150	500
Sulphate *	260			2000	1000	20000	50000
TDS*	280			2100	4000	60000	100000
Phenol Index (Monohydric Phenols) *	< 0.010			< 0.10	1	-	-
DOC	5.18			39.2	500	800	1000
Leach Test Information							
Stone Content (%)	< 0.1						
Sample Mass (kg)	1.0						
Dry Matter (%)	79						
Moisture (%)	21						

Results are expressed on a dry weight basis, after correction for moisture content where applicable.
*= UKAS accredited (liquid eluate analysis only)
Stated limits are for guidance only and i2 cannot be held responsible for any discrepancies with current legislation
** = MCERTS accredited

Landfill WAC analysis (specifically leaching test results) must not be used for hazardous waste classification purposes as defined by the Waste (England and Wales) Regulations 2011 (as amended) and EA Guidance WM3.
This analysis is only applicable for landfill acceptance criteria (The Environmental Permitting (England and Wales) Regulations) and does not give any indication as to whether a waste may be hazardous or non-hazardous.

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Waste Acceptance Criteria Analytical Results

Report No:	22-49467						
					Client: GRANGEGC		
Location	Sawtry						
Lab Reference (Sample Number)	2225450 / 2225451				Landfill Waste Acceptance Criteria Limits		
Sampling Date	29/03/2022						
Sample ID	WS3				Inert Waste Landfill	Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill	Hazardous Waste Landfill
Depth (m)	0.80-1.00						
Solid Waste Analysis							
TOC (%)**	0.3				3%	5%	6%
Loss on Ignition (%) **	-				--	--	10%
BTEX (µg/kg) **	< 10				6000	--	--
Sum of PCBs (mg/kg) **	< 0.007				1	--	--
Mineral Oil (mg/kg) EH_1D_CU_AL	< 10				500	--	--
Total PAH (WAC-17) (mg/kg)	< 0.85				100	--	--
pH (units)**	-				--	>6	--
Acid Neutralisation Capacity (mmol / kg)	-				--	To be evaluated	To be evaluated
Eluate Analysis	10:1			10:1	Limit values for compliance leaching test		
(BS EN 12457 - 2 preparation utilising end over end leaching procedure)	mg/l			mg/kg	using BS EN 12457-2 at L/S 10 l/kg (mg/kg)		
Arsenic *	< 0.0010			< 0.0100	0.5	2	25
Barium *	0.0120			0.106	20	100	300
Cadmium *	< 0.0001			< 0.0008	0.04	1	5
Chromium *	0.0024			0.022	0.5	10	70
Copper *	0.0089			0.078	2	50	100
Mercury *	< 0.0005			< 0.0050	0.01	0.2	2
Molybdenum *	0.0021			0.0182	0.5	10	30
Nickel *	0.0039			0.035	0.4	10	40
Lead *	0.0031			0.027	0.5	10	50
Antimony *	< 0.0017			< 0.017	0.06	0.7	5
Selenium *	< 0.0040			< 0.040	0.1	0.5	7
Zinc *	0.0074			0.065	4	50	200
Chloride *	2.0			17	800	15000	25000
Fluoride	0.71			6.3	10	150	500
Sulphate *	37			320	1000	20000	50000
TDS*	83			730	4000	60000	100000
Phenol Index (Monohydric Phenols) *	< 0.010			< 0.10	1	-	-
DOC	7.78			68.6	500	800	1000
Leach Test Information							
Stone Content (%)	< 0.1						
Sample Mass (kg)	1.0						
Dry Matter (%)	89						
Moisture (%)	11						

Results are expressed on a dry weight basis, after correction for moisture content where applicable.
*= UKAS accredited (liquid eluate analysis only)
Stated limits are for guidance only and i2 cannot be held responsible for any discrepencies with current legislation
** = MCERTS accredited

Landfill WAC analysis (specifically leaching test results) must not be used for hazardous waste classification purposes as defined by the Waste (England and Wales) Regulations 2011 (as amended) and EA Guidance WM3.
This analysis is only applicable for landfill acceptance criteria (The Environmental Permitting (England and Wales) Regulations) and does not give any indication as to whether a waste may be hazardous or non-hazardous.

Analytical Report Number : 22-49467
Project / Site name: Sawtry

* 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 *
2225448	WS2	None Supplied	1.50-1.80	Brown clay with gravel.
2225450	WS3	None Supplied	0.80-1.00	Brown clay and sand with gravel and vegetation.

Analytical Report Number : 22-49467
Project / Site name: Sawtry

Water matrix abbreviations:
Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
BS EN 12457-2 (10:1) Leachate Prep	10:1 (as recieved, moisture adjusted) end over end extraction with water for 24 hours. Eluate filtered prior to analysis.	In-house method based on BSEN12457-2.	L043-PL	W	NONE
Mineral Oil (Soil) C10 - C40	Determination of mineral oil fraction extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method with silica gel split/clean up.	L076-PL	D	NONE
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In house method.	L019-UK/PL	W	NONE
Speciated WAC-17 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. MCERTS accredited except Coronene.	L064-PL	D	MCERTS
PCB's By GC-MS in soil	Determination of PCB by extraction with acetone and hexane followed by GC-MS.	In-house method based on USEPA 8082	L027-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 organic carbon (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
BTEX in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
Total BTEX in soil (Poland)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073-PL	W	MCERTS
Metals in leachate by ICP-OES	Determination of metals in leachate by acidification followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil""	L039-PL	W	ISO 17025
Chloride 10:1 WAC	Determination of Chloride colorimetrically by discrete analyser.	In house based on MEWAM Method ISBN 0117516260.	L082-PL	W	ISO 17025
Fluoride 10:1 WAC	Determination of fluoride in leachate by 1:1ratio with a buffer solution followed by Ion Selective Electrode.	In-house method based on Use of Total Ionic Strength Adjustment Buffer for Electrode Determination"	L033B-PL	W	ISO 17025
Sulphate 10:1 WAC	Determination of sulphate in leachate by ICP-OES	In-house method based on MEWAM 1986 Methods for the Determination of Metals in Soil""	L039-PL	W	ISO 17025
Total dissolved solids 10:1 WAC	Determination of total dissolved solids in water by EC probe using a factor of 0.6.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L004-PL	W	ISO 17025
Monohydric phenols 10:1 WAC	Determination of phenols in leachate by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L080-PL	W	ISO 17025
Dissolved organic carbon 10:1 WAC	Determination of dissolved inorganic carbon in leachate by TOC/DOC NDIR Analyser.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L037-PL	W	NONE

Analytical Report Number : 22-49467
Project / Site name: Sawtry

Water matrix abbreviations:
Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status

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.

Unless otherwise indicated, site information, order number, project number, sampling date, time, sample reference and depth are provided by the client. The instructed on date indicates the date on which this information was provided to the laboratory.

Information in Support of Analytical Results

List of HWOL Acronyms and Operators

Acronym	Descriptions
HS	Headspace Analysis
MS	Mass spectrometry
FID	Flame Ionisation Detector
GC	Gas Chromatography
EH	Extractable Hydrocarbons (i.e. everything extracted by the solvent(s))
CU	Clean-up - e.g. by Florisil®, silica gel
1D	GC - Single coil/column gas chromatography
2D	GC-GC - Double coil/column gas chromatography
Total	Aliphatics & Aromatics
AL	Aliphatics
AR	Aromatics
#1	EH_2D_Total but with humics mathematically subtracted
#2	EH_2D_Total but with fatty acids mathematically subtracted
_	Operator - understore to separate acronyms (exception for +)
+	Operator to indicate cumulative e.g. EH+HS_Total or EH_CU+HS_Total

Appendix H

GEOTECHNICAL TESTING RESULTS

TEST CERTIFICATE

DETERMINATION OF LIQUID AND PLASTIC LIMITS

Tested in Accordance with:BS 1377-2:1990:Clause 4.4 and 5

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

4041

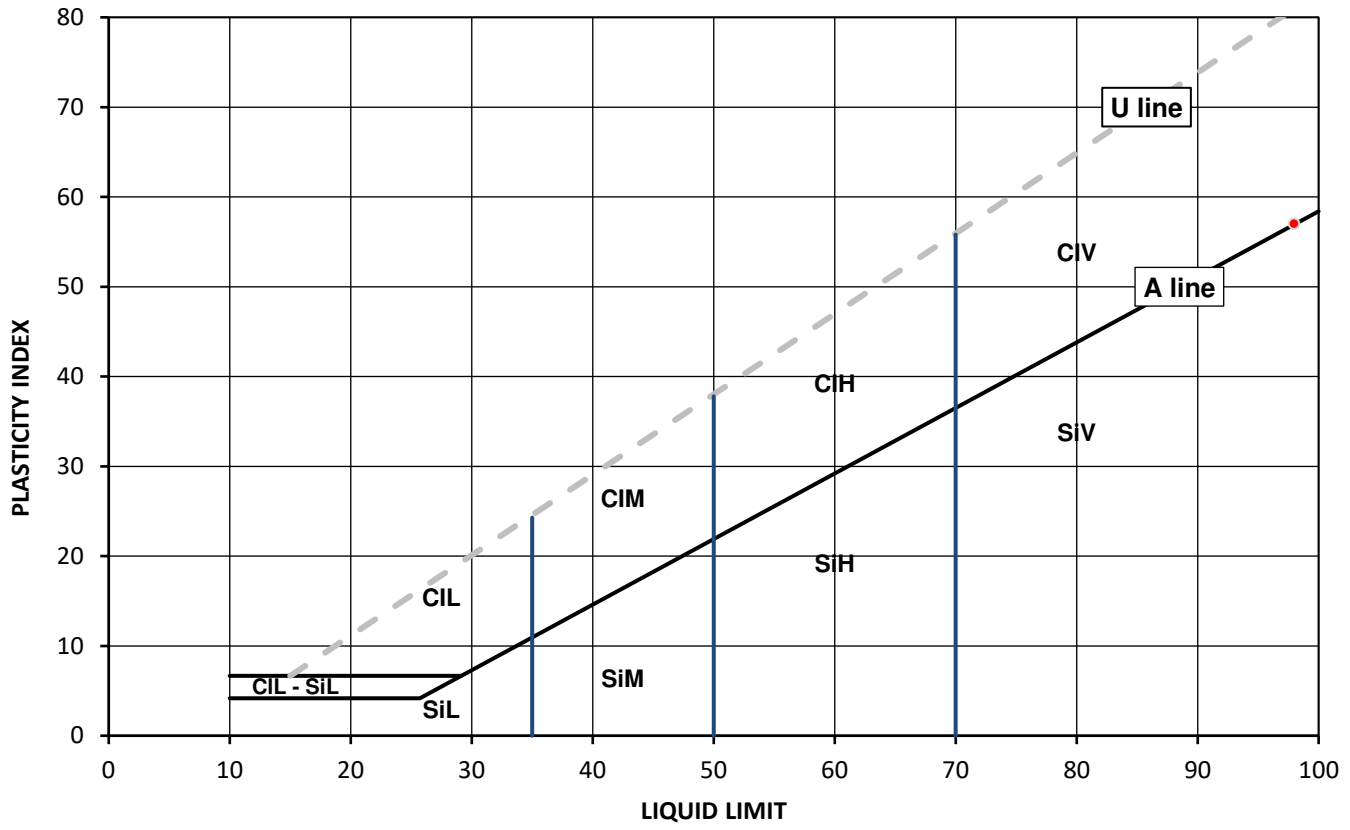
Client:	Grange Geo Consulting Ltd	Client Reference:	R22013
Client Address:	43 Winchilsea Avenue, Newark, Notts, NG24 4AD	Job Number:	22-49442
		Date Sampled:	Not Given
		Date Received:	01/04/2022
Contact:	Steve Woodall	Date Tested:	15/04/2022
Site Address:	Sawtry	Sampled By:	Client

Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

Test Results:

Laboratory Reference:	2225372	Depth Top [m]:	0.40
Hole No.:	WS1	Depth Base [m]:	0.60
Sample Reference:	Not Given	Sample Type:	D
Sample Description:	Brown slightly organic CLAY		
Sample Preparation:	Tested in natural condition		

As Received Water Content [W] %	Liquid Limit [WL] %	Plastic Limit [Wp] %	Plasticity Index [Ip] %	% Passing 425µm BS Test Sieve
44	98	41	57	100



Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

		Plasticity		Liquid Limit
Cl	Clay	L	Low	below 35
Si	Silt	M	Medium	35 to 50
		H	High	50 to 70
		V	Very high	exceeding 70
		O	Organic	append to classification for organic material (eg ClHO)

Note: Water Content by BS 1377-2: 1990: Clause 3.2

Remarks:

Signed:

Monika Siewior
Reporting Specialist
for and on behalf of i2 Analytical Ltd

Date Reported: 21/04/2022

GF 232.12

TEST CERTIFICATE

DETERMINATION OF LIQUID AND PLASTIC LIMITS

Tested in Accordance with:BS 1377-2:1990:Clause 4.4 and 5

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

4041

Client:	Grange Geo Consulting Ltd	Client Reference:	R22013
Client Address:	43 Winchilsea Avenue, Newark, Notts, NG24 4AD	Job Number:	22-49442
		Date Sampled:	Not Given
		Date Received:	01/04/2022
Contact:	Steve Woodall	Date Tested:	15/04/2022
Site Address:	Sawtry	Sampled By:	Client

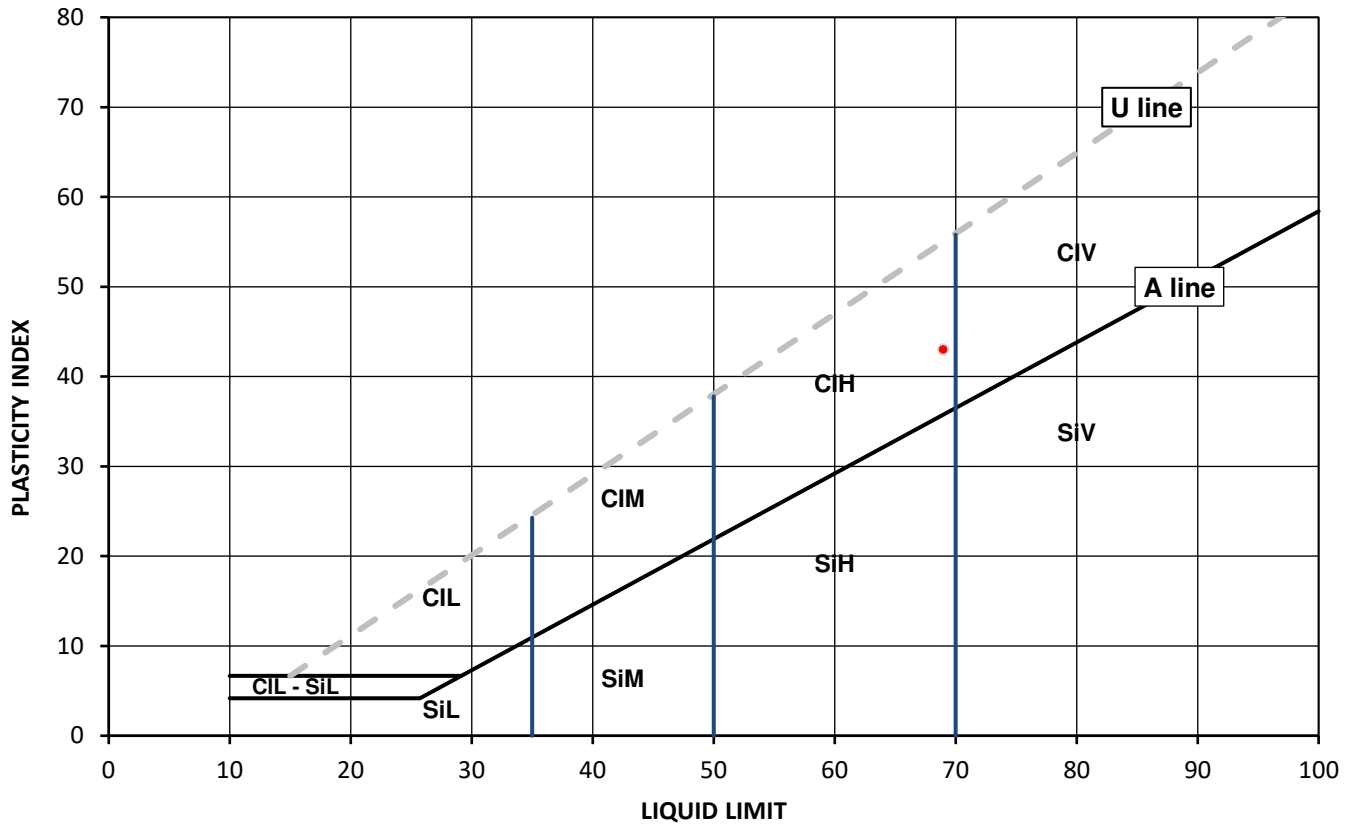
Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

Test Results:

Laboratory Reference:	2225373	Depth Top [m]:	1.10
Hole No.:	WS1	Depth Base [m]:	1.30
Sample Reference:	Not Given	Sample Type:	D
Sample Description:	Brownish grey CLAY		

Sample Preparation: Tested in natural condition

As Received Water Content [W] %	Liquid Limit [WL] %	Plastic Limit [Wp] %	Plasticity Index [Ip] %	% Passing 425µm BS Test Sieve
28	69	26	43	100



Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

		Plasticity		Liquid Limit
Cl	Clay	L	Low	below 35
Si	Silt	M	Medium	35 to 50
		H	High	50 to 70
		V	Very high	exceeding 70
		O	Organic	append to classification for organic material (eg ClHO)

Note: Water Content by BS 1377-2: 1990: Clause 3.2

Remarks:

Signed:

Monika Siewior
Reporting Specialist
for and on behalf of i2 Analytical Ltd

Date Reported: 21/04/2022

GF 232.12

TEST CERTIFICATE

DETERMINATION OF LIQUID AND PLASTIC LIMITS
Tested in Accordance with:BS 1377-2:1990:Clause 4.4 and 5

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

UKAS TESTING
4041

Environmental Science

Client:	Grange Geo Consulting Ltd	Client Reference:	R22013
Client Address:	43 Winchilsea Avenue, Newark, Notts, NG24 4AD	Job Number:	22-49442
		Date Sampled:	Not Given
		Date Received:	01/04/2022
Contact:	Steve Woodall	Date Tested:	11/04/2022
Site Address:	Sawtry	Sampled By:	Client

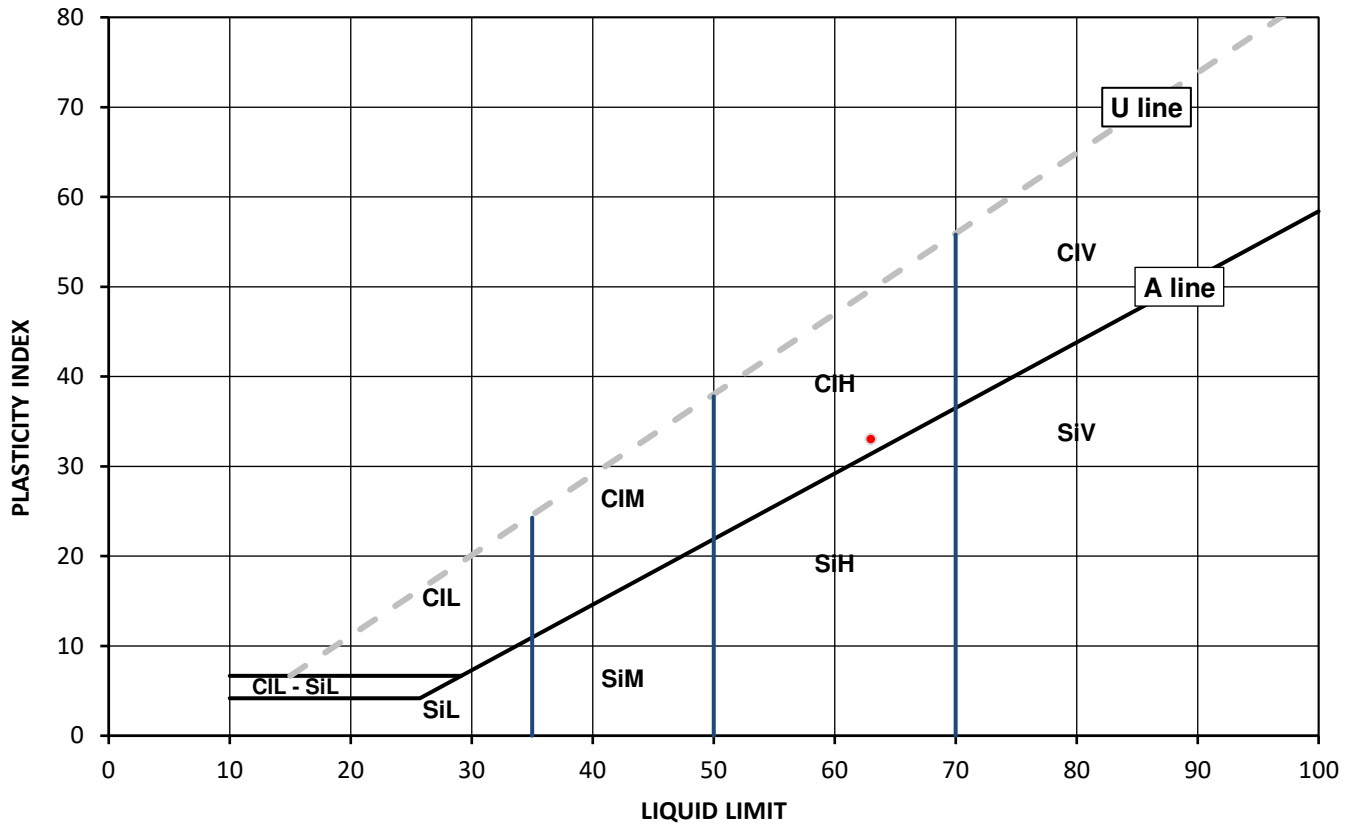
Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

Test Results:

Laboratory Reference:	2225374	Depth Top [m]:	3.00
Hole No.:	WS1	Depth Base [m]:	4.00
Sample Reference:	Not Given	Sample Type:	B
Sample Description:	Grey CLAY		

Sample Preparation: Tested in natural condition

As Received Water Content [W] %	Liquid Limit [WL] %	Plastic Limit [Wp] %	Plasticity Index [Ip] %	% Passing 425µm BS Test Sieve
25	63	30	33	100



Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

		Plasticity		Liquid Limit
Cl	Clay	L	Low	below 35
Si	Silt	M	Medium	35 to 50
		H	High	50 to 70
		V	Very high	exceeding 70
		O	Organic	append to classification for organic material (eg ClHO)

Note: Water Content by BS 1377-2: 1990: Clause 3.2

Remarks:

Signed:

Monika Siewior
Reporting Specialist
for and on behalf of i2 Analytical Ltd

Date Reported: 21/04/2022

GF 232.12

TEST CERTIFICATE

DETERMINATION OF LIQUID AND PLASTIC LIMITS

Tested in Accordance with:BS 1377-2:1990:Clause 4.4 and 5

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

UKAS TESTING 4041

Environmental Science

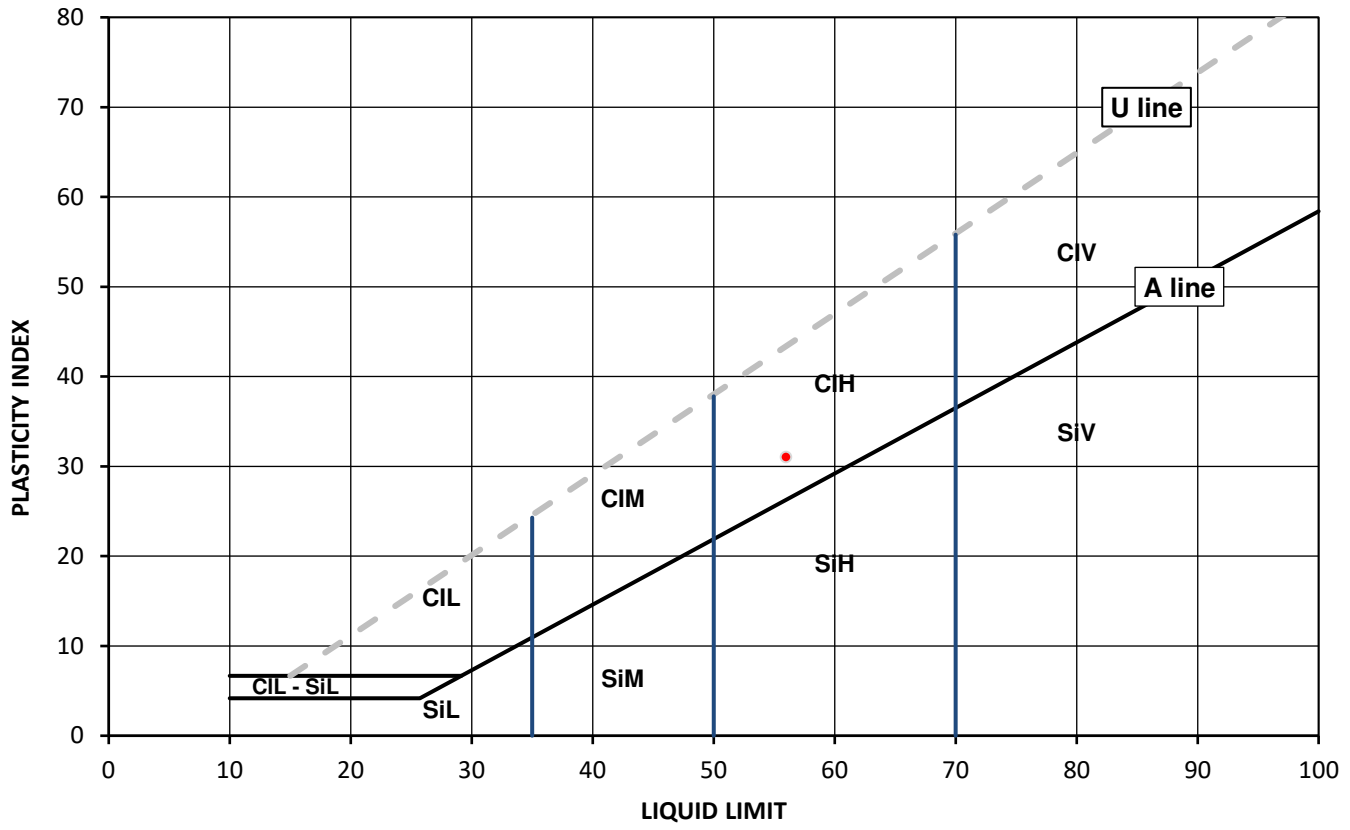
Client:	Grange Geo Consulting Ltd	Client Reference:	R22013
Client Address:	43 Winchilsea Avenue, Newark, Notts, NG24 4AD	Job Number:	22-49442
		Date Sampled:	Not Given
		Date Received:	01/04/2022
Contact:	Steve Woodall	Date Tested:	14/04/2022
Site Address:	Sawtry	Sampled By:	Client

Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

Test Results:

Laboratory Reference:	2225375	Depth Top [m]:	2.00
Hole No.:	WS2	Depth Base [m]:	2.30
Sample Reference:	Not Given	Sample Type:	D
Sample Description:	Brownish grey slightly sandy CLAY with fragments of shells		
Sample Preparation:	Tested in natural condition		

As Received Water Content [W] %	Liquid Limit [WL] %	Plastic Limit [Wp] %	Plasticity Index [Ip] %	% Passing 425µm BS Test Sieve
38	56	25	31	100



Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

		Plasticity		Liquid Limit
Cl	Clay	L	Low	below 35
Si	Silt	M	Medium	35 to 50
		H	High	50 to 70
		V	Very high	exceeding 70
		O	Organic	append to classification for organic material (eg ClHO)

Note: Water Content by BS 1377-2: 1990: Clause 3.2

Remarks:

Signed: Monika Siewior

Monika Siewior
Reporting Specialist
for and on behalf of i2 Analytical Ltd

Date Reported: 21/04/2022

GF 232.12

TEST CERTIFICATE

DETERMINATION OF LIQUID AND PLASTIC LIMITS
Tested in Accordance with:BS 1377-2:1990:Clause 4.4 and 5

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

UKAS TESTING
4041

Environmental Science

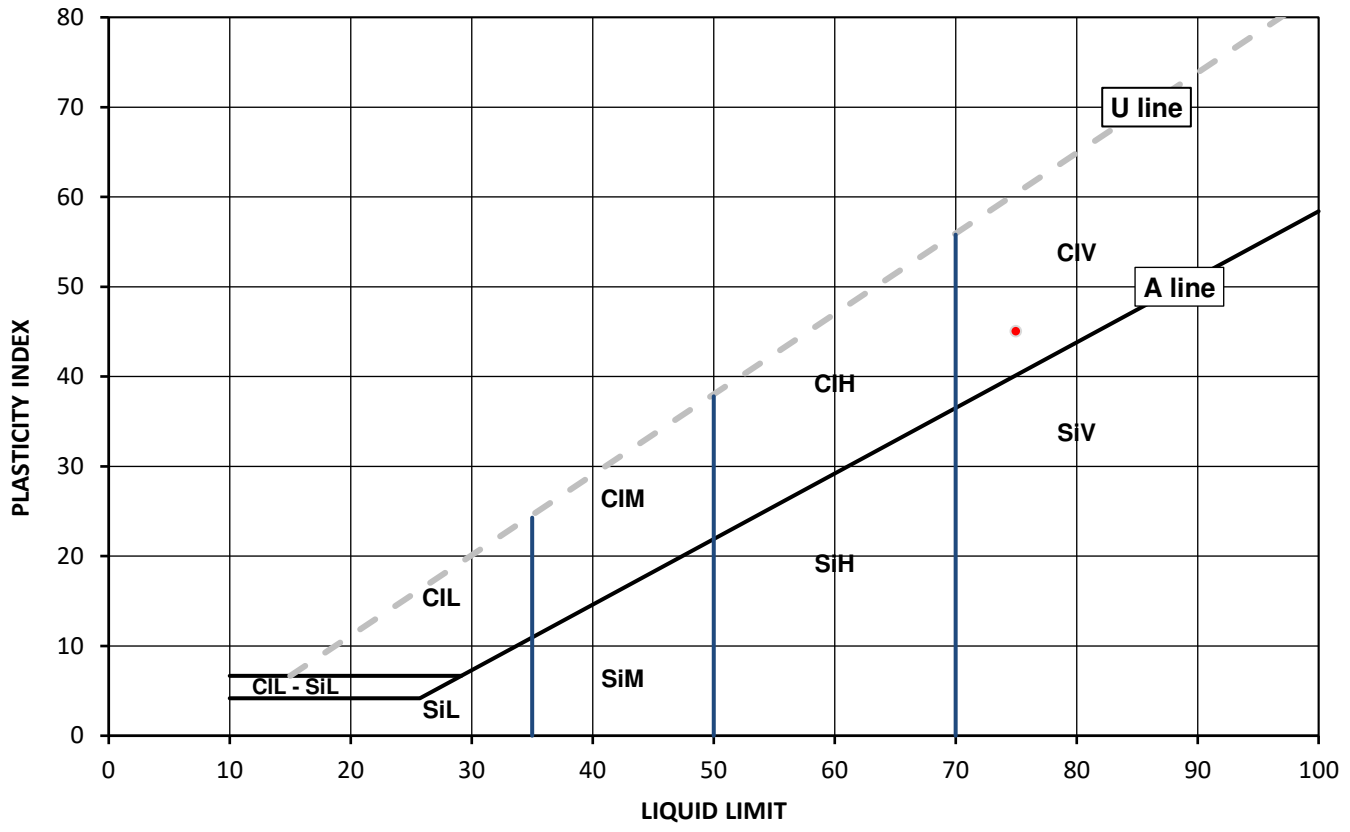
Client:	Grange Geo Consulting Ltd	Client Reference:	R22013
Client Address:	43 Winchilsea Avenue, Newark, Notts, NG24 4AD	Job Number:	22-49442
		Date Sampled:	Not Given
		Date Received:	01/04/2022
Contact:	Steve Woodall	Date Tested:	15/04/2022
Site Address:	Sawtry	Sampled By:	Client

Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

Test Results:

Laboratory Reference:	2225378	Depth Top [m]:	1.40
Hole No.:	WS4	Depth Base [m]:	1.60
Sample Reference:	Not Given	Sample Type:	D
Sample Description:	Brownish grey CLAY		
Sample Preparation:	Tested in natural condition		

As Received Water Content [W] %	Liquid Limit [WL] %	Plastic Limit [Wp] %	Plasticity Index [Ip] %	% Passing 425µm BS Test Sieve
33	75	30	45	100



Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

		Plasticity		Liquid Limit
Cl	Clay	L	Low	below 35
Si	Silt	M	Medium	35 to 50
		H	High	50 to 70
		V	Very high	exceeding 70
		O	Organic	append to classification for organic material (eg ClHO)

Note: Water Content by BS 1377-2: 1990: Clause 3.2

Remarks:

Signed: Monika Siewior

Monika Siewior
Reporting Specialist
for and on behalf of i2 Analytical Ltd

Date Reported: 21/04/2022

GF 232.12

TEST CERTIFICATE

DETERMINATION OF LIQUID AND PLASTIC LIMITS
Tested in Accordance with:BS 1377-2:1990:Clause 4.4 and 5

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

4041

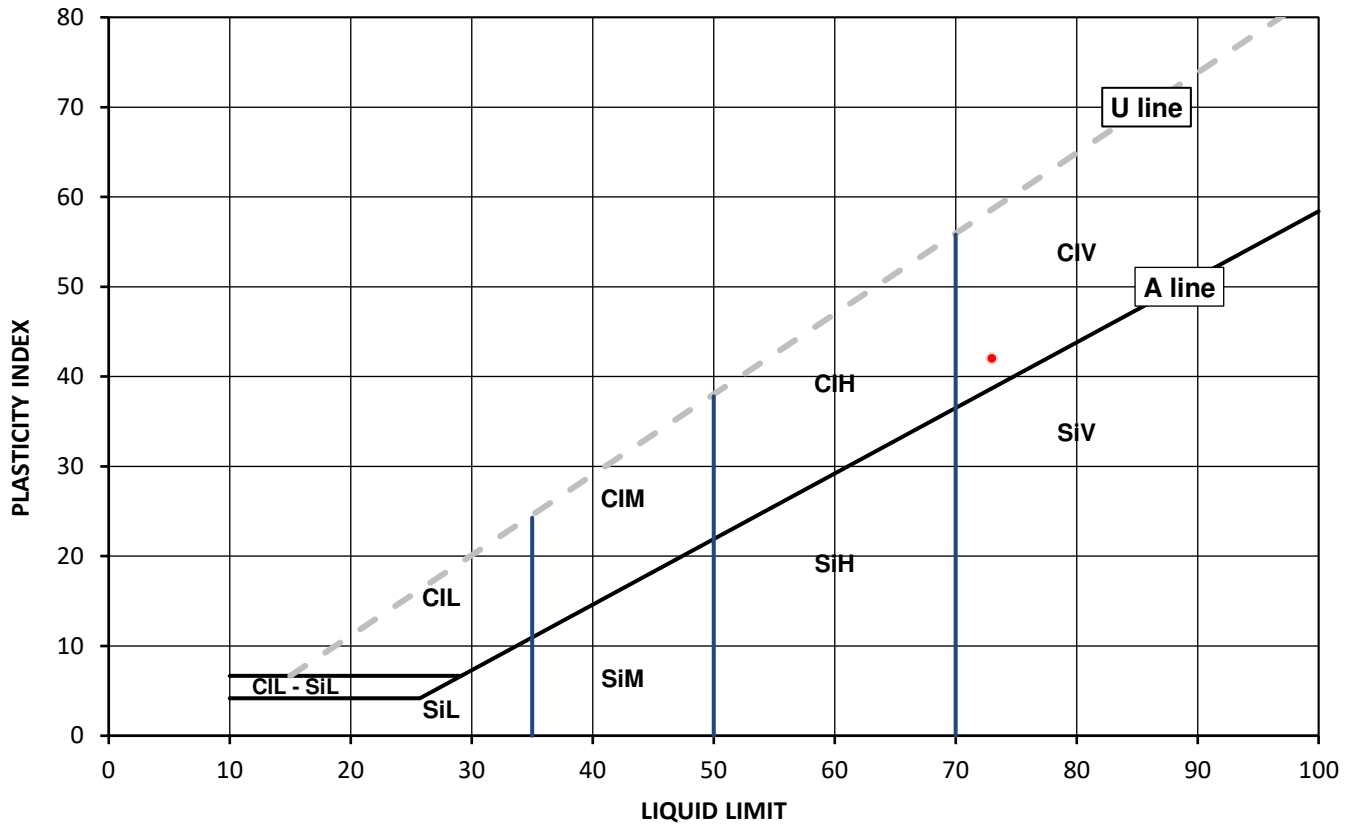
Client:	Grange Geo Consulting Ltd	Client Reference:	R22013
Client Address:	43 Winchilsea Avenue, Newark, Notts, NG24 4AD	Job Number:	22-49442
		Date Sampled:	Not Given
		Date Received:	01/04/2022
Contact:	Steve Woodall	Date Tested:	15/04/2022
Site Address:	Sawtry	Sampled By:	Client

Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

Test Results:

Laboratory Reference:	2225379	Depth Top [m]:	2.50
Hole No.:	WS4	Depth Base [m]:	2.80
Sample Reference:	Not Given	Sample Type:	D
Sample Description:	Brownish grey CLAY		
Sample Preparation:	Tested in natural condition		

As Received Water Content [W] %	Liquid Limit [WL] %	Plastic Limit [Wp] %	Plasticity Index [Ip] %	% Passing 425µm BS Test Sieve
36	73	31	42	100



Legend, based on BS EN ISO 14688 2:2018 Geotechnical investigation and testing – Identification and classification of soil

		Plasticity		Liquid Limit
Cl	Clay	L	Low	below 35
Si	Silt	M	Medium	35 to 50
		H	High	50 to 70
		V	Very high	exceeding 70
		O	Organic	append to classification for organic material (eg ClHO)

Note: Water Content by BS 1377-2: 1990: Clause 3.2

Remarks:

Signed:

Monika Siewior
Reporting Specialist
for and on behalf of i2 Analytical Ltd

Date Reported: 21/04/2022

GF 232.12

SUMMARY REPORT

SUMMARY OF CLASSIFICATION TEST RESULTS

Tested in Accordance with:

Water Content by BS 1377-2:1990: Clause 3.2; Atterberg by BS 1377-2: 1990: Clause 4.3 (4 Point Test), Clause 4.4 (1 Point Test) and 5; PD by BS 1377-2: 1990: Clause 8.2

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

4041

Client: Grange Geo Consulting Ltd

Client Address: 43 Winchilsea Avenue, Newark, Notts, NG24 4AD

Contact: Steve Woodall

Site Address: Sawtry

Client Reference: R22013
Job Number: 22-49442
Date Sampled: Not Given
Date Received: 01/04/2022
Date Tested: 11/04 - 15/04/2022
Sampled By: Client

Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

Test results

Laboratory Reference	Hole No.	Sample				Description	Remarks	Water Content BS 1377-2 [W]	Water Content BS EN ISO 17892-1 [W]	Atterberg				Density			Total Porosity#		
		Reference	Depth Top	Depth Base	Type					% Passing 425um	WL	Wp	Ip	bulk	dry	PD			
			m	m				%	%	%	%	%	%	Mg/m3	Mg/m3	Mg/m3	%		
2225372	WS1	Not Given	0.40	0.60	D	Brown slightly organic CLAY	Atterberg 1 Point	44		100	98	41	57						
2225373	WS1	Not Given	1.10	1.30	D	Brownish grey CLAY	Atterberg 1 Point	28		100	69	26	43						
2225374	WS1	Not Given	3.00	4.00	B	Grey CLAY	Atterberg 1 Point	25		100	63	30	33						
2225375	WS2	Not Given	2.00	2.30	D	Brownish grey slightly sandy CLAY with fragments of shells	Atterberg 1 Point	38		100	56	25	31						
2225378	WS4	Not Given	1.40	1.60	D	Brownish grey CLAY	Atterberg 1 Point	33		100	75	30	45						
2225379	WS4	Not Given	2.50	2.80	D	Brownish grey CLAY	Atterberg 1 Point	36		100	73	31	42						

Note: # Non accredited; NP - Non plastic

Comments:

Signed:

Monika Siewior
Reporting Specialist
for and on behalf of i2 Analytical Ltd

Date Reported: 21/04/2022

GF 234.14

SUMMARY REPORT

DETERMINATION OF WATER CONTENT

Tested in Accordance with: BS 1377-2: 1990: Clause 3.2

i2 Analytical Ltd
Unit 8 Harrowden Road
Brackmills Industrial Estate
Northampton NN4 7EB

4041

Client: Grange Geo Consulting Ltd

Client Address: 43 Winchilsea Avenue, Newark, Notts, NG24 4AD

Contact: Steve Woodall

Site Address: Sawtry

Client Reference: R22013
Job Number: 22-49442
Date Sampled: Not Given
Date Received: 01/04/2022
Date Tested: 11/04 - 15/04/2022
Sampled By: Client

Testing carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland

Test results

Laboratory Reference	Hole No.	Sample				Description	Remarks	WC	Sample preparation / Oven temperature at the time of testing			
		Reference	Depth Top m	Depth Base m	Type			%				
2225372	WS1	Not Given	0.40	0.60	D	Brown slightly organic CLAY		44	Sample was quartered, oven dried at 106.4 °C			
2225373	WS1	Not Given	1.10	1.30	D	Brownish grey CLAY		28	Sample was quartered, oven dried at 106.4 °C			
2225374	WS1	Not Given	3.00	4.00	B	Grey CLAY		25	Sample was quartered, oven dried at 106.2 °C			
2225375	WS2	Not Given	2.00	2.30	D	Brownish grey slightly sandy CLAY with fragments of shells		38	Sample was quartered, oven dried at 109 °C			
2225378	WS4	Not Given	1.40	1.60	D	Brownish grey CLAY		33	Sample was quartered, oven dried at 106.4 °C			
2225379	WS4	Not Given	2.50	2.80	D	Brownish grey CLAY		36	Sample was quartered, oven dried at 106.4 °C			

Comments:

Signed: Monika Siewior

Monika Siewior
Reporting Specialist
for and on behalf of i2 Analytical Ltd

Date Reported: 21/04/2022

GF 099.16

Steve Woodall
Grange Geo Consulting Ltd
43 Winchilsea Avenue
Newark
Notts
NG24 4AD

e: steve@grangegeo.co.uk

i2 Analytical Ltd.
7 Woodshots Meadow,
Croxley Green
Business Park,
Watford,
Herts,
WD18 8YS

t: 01923 225404
f: 01923 237404
e: reception@i2analytical.com

Analytical Report Number : 22-49437

Project / Site name:	Sawtry	**Samples received on:**	01/04/2022
Your job number:	R22013	**Samples instructed on/ Analysis started on:**	01/04/2022
Your order number:		**Analysis completed by:**	12/04/2022
Report Issue Number:	1	**Report issued on:**	12/04/2022
Samples Analysed:	3 soil samples		

Martyna Langer

Signed:

Martyna Langer
Junior Reporting Specialist
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: 22-49437
Project / Site name: Sawtry

Lab Sample Number				2225304	2225305	2225306
Sample Reference				WS1	WS2	WS4
Sample Number				None Supplied	None Supplied	None Supplied
Depth (m)				1.10-1.30	1.30-1.50	0.80-1.00
Date Sampled				Deviating	Deviating	Deviating
Time Taken				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
Moisture Content	%	0.01	NONE	19	21	16
Total mass of sample received	kg	0.001	NONE	0.5	1.5	1.5
General Inorganics						
pH - Automated	pH Units	N/A	MCERTS	8	7.6	8.4
Total Sulphate as SO4	%	0.005	MCERTS	0.119	1.65	0.021
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.08	2.2	0.025
Water Soluble Chloride (2:1) (leachate equivalent)	mg/l	0.5	MCERTS	9.4	10	2.1
Total Sulphur	%	0.005	MCERTS	0.046	0.674	0.008
Water Soluble Nitrate (2:1) as N (leachate equivalent)	mg/l	2	NONE	< 2.0	< 2.0	< 2.0
Heavy Metals / Metalloids						
Magnesium (water soluble)	mg/kg	5	NONE	7.1	210	6.7
Magnesium (leachate equivalent)	mg/l	2.5	NONE	3.6	110	3.4

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

Analytical Report Number : 22-49437
Project / Site name: Sawtry

* 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 *
2225304	WS1	None Supplied	1.10-1.30	Brown clay.
2225305	WS2	None Supplied	1.30-1.50	Brown clay with gravel.
2225306	WS4	None Supplied	0.80-1.00	Brown sandy clay with gravel and vegetation.

Analytical Report Number : 22-49437
Project / Site name: Sawtry

Water matrix abbreviations:
Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Waters (PrW) Final Sewage Effluent (FSE) Landfill Leachate (LL)

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
Magnesium, water soluble, in soil	Determination of water soluble magnesium by extraction with water followed by ICP-OES.	In-house method based on TRL 447	L038-PL	D	NONE
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In house method.	L019-UK/PL	W	NONE
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 Sulphate in soil as %	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES.	In house method.	L038-PL	D	MCERTS
Total Sulphur in soil as %	Determination of total sulphur in soil by extraction with aqua-regia, potassium bromide/bromate followed by ICP-OES.	In house method.	L038-PL	D	MCERTS
Water Soluble Nitrate (2:1) as N in soil	Determination of nitrate by reaction with sodium salicylate and colorimetry.	In-house method based on Examination of Water and Wastewatern & Polish Standard Method PN-82/C-04579.08, 2:1 extraction.	L078-PL	W	NONE
Chloride, water soluble, in soil	Determination of Chloride colorimetrically by discrete analyser.	In house method.	L082-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.

Unless otherwise indicated, site information, order number, project number, sampling date, time, sample reference and depth are provided by the client. The instructed on date indicates the date on which this information was provided to the laboratory.

Sample Deviation Report

Analytical Report Number : 22-49437
Project / Site name: Sawtry

This deviation report indicates the sample and test deviations that apply to the samples submitted for analysis.Please note that the associated result(s) may be unreliable and should be interpreted with care.

Sample ID	Other ID	Sample Type	Lab Sample Number	Sample Deviation	Test Name	Test Ref	Test Deviation
WS1	None Supplied	S	2225304	a	None Supplied	None Supplied	None Supplied
WS2	None Supplied	S	2225305	a	None Supplied	None Supplied	None Supplied
WS4	None Supplied	S	2225306	a	None Supplied	None Supplied	None Supplied

Key: **a** - No sampling date **b** - Incorrect container
c - Holding time **d** - Headspace **e** - Temperature

Appendix I

INFILTRATION (FALLING HEAD) TESTING RESULTS

INSITU TESTING - Falling Head Permeability Test

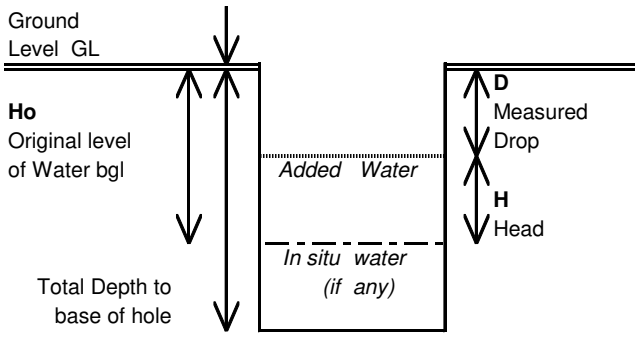
Project Name: Sawtry, Huntingdon

BH Hole No: WS1
Test No: 1

Project Ref: R22013

Date: 29/01/2022

TIME (minutes)	DROP Measured Ground Level to Test Water Level (m) D	HEAD Depth of water above original water level or base of hole m) H	LOSS RATIO HEAD / Original Water Level H / Ho
0.00	0.43	3.57	0.89
1.00	0.43	3.57	0.89
2.00	0.44	3.56	0.89
3.00	0.44	3.56	0.89
4.00	0.44	3.56	0.89
5.00	0.44	3.56	0.89
10.00	0.44	3.56	0.89
20.00	0.44	3.56	0.89
30.00	0.44	3.56	0.89
60.00	0.44	3.56	0.89
120.00	0.44	3.56	0.89
180.00	0.44	3.56	0.89
1238.00	0.47	3.53	0.88
Proof	*4.00*	*0.00*	*0.00*



Original level of water below ground level **Ho** 4.00 m

NB If hole is dry, enter depth to base value

Depth to base of hole 4.00 m

Depth to bottom of casing 0.00 m

Diameter of borehole at test section **(Ø)** 0.067 m

Ground level m

Extrapolated Time **(T)** mins
taken from graph

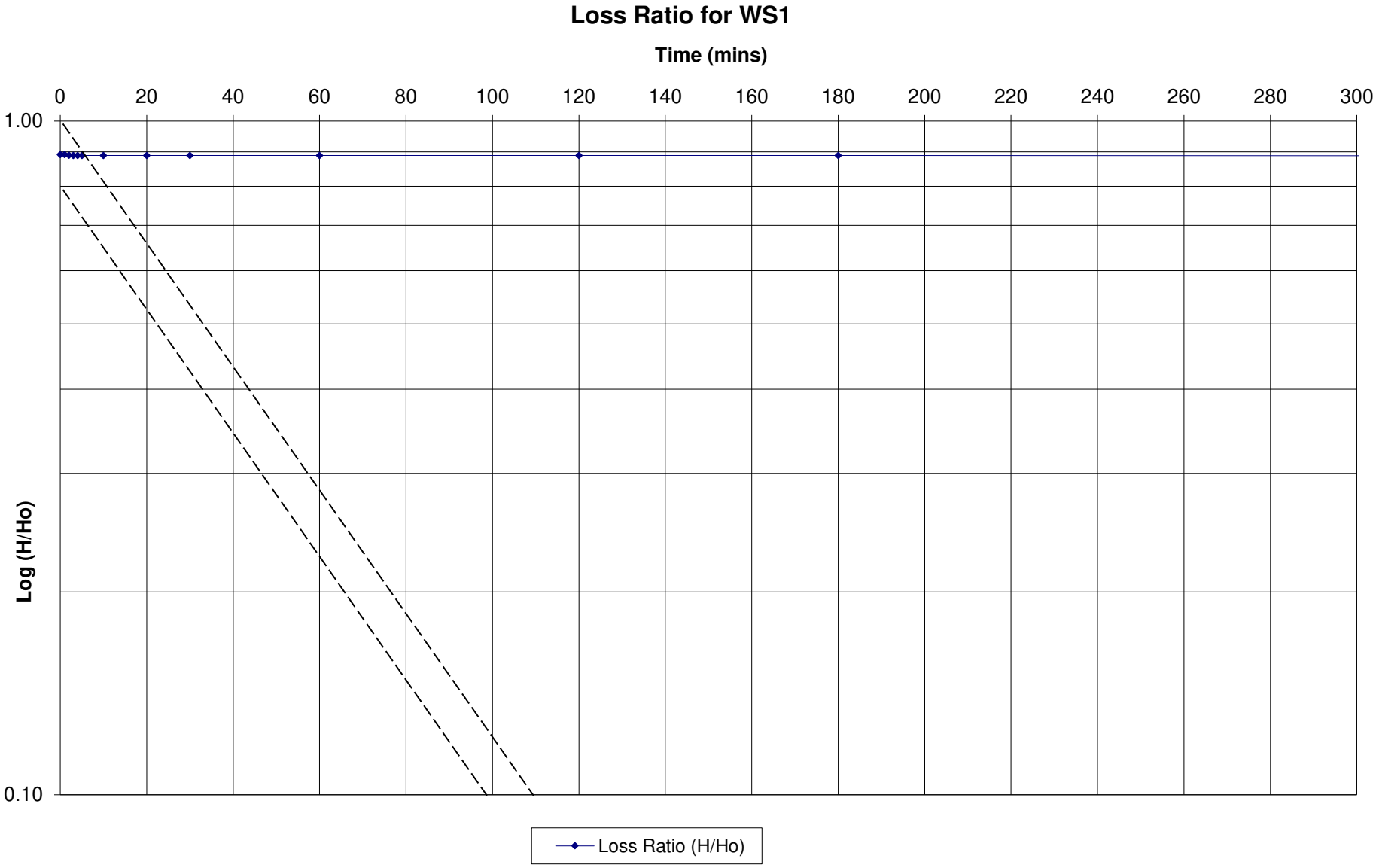
AIM: *For Head (H) to return to original level*

If DROP is slow: *Test must be continued until Head (H) measurement falls below 80% of the original level (Ho) (Test requirement is a one fifth drop from start level)*

Slow DROP measurement for this test is: m

Corresponding H/Ho result for this measurement is:

Permeability =	A / FT	meters per second
A =	0.003526	sq meters
F =	0.18425	meters
T =	0.00	seconds
Permeabilty =	**#DIV/0!**	


Loss Ratio for WS1
Time (mins)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
1.00
0.10
Log (H/Ho)
Loss Ratio (H/Ho)