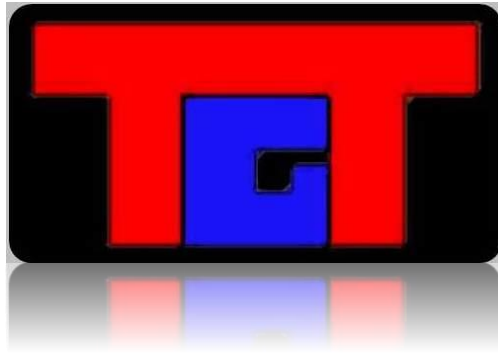




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Geo-Environmental Summary Report

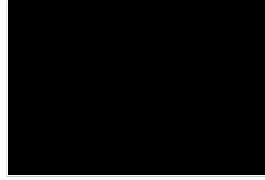
Client: Carter Construction (Derby)

Site: Land Adj. 32 Commonside, Church Gresley

Ref: TGT2876

Date: 23rd September 2019

Prepared By:



Graham Wing MCIHT
Engineering Technician

0.0	EXECUTIVE SUMMARY
1.0	INTRODUCTION & SCOPE OF WORKS
2.0	FIELDWORK & FINDINGS
3.0	LABORATORY TESTING
4.0	DISCUSSION
5.0	RECOMMENDATIONS & ADDITIONAL COMMENTS

APPENDICES

A Factual Report

0.0 Executive Summary

Item	Comments	Risk
Project Details	Trentside Geotechnical Testing & Site Investigations was commissioned by Mr Roger Carter of Carter Construction (Derby) Ltd to provide a summary report based on Ground Investigation (Ref: TGT2876) which included 2no 10m Boreholes with installations for groundwater monitoring and sampling for geotechnical and contamination testing purposes. Also 2 x Trial Pits for contamination testing purposes.	
Ground Conditions	The ground conditions encountered was hard standing generally turf over topsoil to a maximum depth of 0.10m below ground level (bgl). This was found to be underlain by apparent MADE GROUND consisting of slightly gravelly silty clayey sand to a maximum 1.6m in BH2 bgl before encountering apparent natural, soft, CLAY to a maximum encountered depth of 6.9m in BH2. Finally, a dense grey mudstone was encountered for the full depth of excavation of 10m.	
Swelling / Shrinking	The majority of this site will be expected to possess medium to high volume change potential.	
Root Activity	Limited Root Activity was encountered to a maximum of 1.1m	
Groundwater	No Groundwater was encountered in either of the boreholes.	
Bearing Capacity	The in-situ SPT carried out within the strata's encountered between 1.0m - 6.0m generally gave results that would equate to an N Value of between 4 - 6. Allowing for variation in ground conditions and test method, using a conservative average N Value of 6 and using Terzaghi, K. & Peck, R.B. (1996) (2m footing) an allowable bearing pressure in the region of 30kN/m ² * Material tested between 6.0m – 10.0m in non cohesive layers generally gave results that would equate to an N Value of 35 - 50+ . Allowing for variation in ground conditions and test method, using a conservative average N Value of 35 and an allowable bearing pressure of around 360kN/m ² . *Due to the variable nature of MADE GROUND, the test values may not be representative of the site as a whole, we would not recommend placing foundations within this material	
Settlement	On excavations below 6.0m, settlements can be expected to be typically lower than 25mm.	
Buried Concrete, Contamination Testing Results, Gas Monitoring	The results of the chemical analyses indicate that the samples tested in would fall into both Class DS-1 and DS-2 of the Building Research Establishments (BRE) classification system Special Digest Part 1:2005 "Concrete in aggressive ground". We would recommend that a minimum of Class DS-2 conditions are adopted for any concrete mix design and that consideration is given to using "sulphate resisting cement" in concrete mix at this site in accordance with the NHBC "Traffic Light" system, we would consider that the current site would be classified as Amber 1 or Characteristic Situation 3 The site investigation identified no elevated concentrations of contaminants within the samples tested. Waste Acceptance Criteria shows the likely classification of soils for disposal would be "Inert"	
Collapse of Excavations	The materials encountered indicate good conditions for trench opening due to the cohesive nature of the sub strata.	
Foundation Recommendations	Depending on the intended loadings, due to the low bearing capacity at shallow depths piling to a minimum depth of 7m would be the preferred option.	
<i>This executive summary only provides a summary of the site data and its assessment. It does not provide a definitive engineering analysis and is for guidance only. It is recommended that the reader reviews the reporting in its entirety and any material referenced therein.</i>		

1.0 Introduction

1.1 Background

Trentside Geotechnical Testing & Site Investigations was commissioned by Mr Roger Carter of Carter Construction (Derby) Ltd to provide a summary report based on Ground Investigation (Ref: TGT2876) which included 2no 10m Boreholes with installations for groundwater monitoring and sampling for geotechnical and contamination testing purposes. Also 2 x Trial Pits for contamination testing purposes

1.2 Purpose of this Report

The Purpose of the investigation was to best determine current ground conditions to assist with the design of potential new structures and provide clear and pragmatic advice regarding the nature and site specific hazards which may be present at the Site.

1.3 Report Contents

This report is divided into two sections, as described below

Section	Content	Purpose
2.0 – 5.0 - SUMMARY REPORT	A summary of the important findings based on the information gathered from site attendance.	To present a clear and concise overview of the current Site conditions, including recommendations of how to manage any issues which may be present pertaining to future use
Appendix A FACTUAL REPORT	A collection of data which Section is based upon	To provide detailed information in support of the Section 2.0 – 5.0 and for client analysis and discussion

1.4 Report Limitations

It is noted that the findings presented in this report are largely based on information obtained from our own site works. Whilst we assume that all information is representative of the site and of present conditions we can offer no guarantee as to its validity in any areas other than the ones sampled or have any details regarding the short term or long term history of the Site.

This report excludes consideration of potential hazards arising from any activities at the Site other than normal use and occupancy for the intended land uses. Hazards associated with any other activities have not been assessed and must be subject to a specific risk assessment by the parties responsible for those activities.

2.0 Fieldwork and Findings

- 2.1 All fieldwork was generally executed in accordance with the recommendations given in British Standard BS 5930:1999+A2:2010, "Code of Practice for Site Investigations". Contamination sampling was undertaken in accordance with BS 10175: 2011, "Code of Practice for the Investigation of Potentially Contaminated Sites".
- 2.2 The sampling locations are provided on the appended Fieldwork Location Plan contained within the factual report.
- 2.3 Disturbed samples were taken within the made ground for contamination purposes then at 1.0m intervals after. Samples were bagged, labelled and returned to our geotechnical laboratory. Samples for contamination purposes taken from near surface were stored in their suitable sealed containers and were transported to and if requested, subsequently tested by a specialist contamination facility with analysis from a laboratory holding UKAS and MCERTS accreditations

3.0 Laboratory Analysis

3.1 Aggressive Ground

- 3.1.1 The pH and sulphate content has been determined for samples recovered from 12 samples at various locations and depths throughout the site. The pH values were found to range between 7.2 & 7.8 with the sulphate contents, on a 2:1 water:soil extract was found to range between 0.26 & 0.95 g/l SO₄.
- 3.1.2 The results of the chemical analyses indicate that the samples tested in would fall into both Class DS-1 and DS-2 of the Building Research Establishments (BRE) classification system Special Digest Part 1:2005 "Concrete in aggressive ground". We would recommend that a minimum of Class DS-2 conditions are adopted for any concrete mix design and that consideration is given to using "sulphate resisting cement" in concrete mix at this site
- 3.1.3 Full details of the results are given on the appended results sheets

3.2 Radon

- 3.2.1 According to the UK Radon Website (www.ukradon.org). The site is not located within a Radon affected area, as less than 1% of properties are above the Action Level. Using this information, we would suggest that no special radon prevention measures be required on this site.

4.0 Discussion

4.1 Geotechnical Aspects

- 4.1.1 The ground investigation revealed the anticipated geology with the subsoil consisting of underlying bedrock geology **Pennine Middle Coal Measures Formation**
- 4.1.2 The in-situ SPT carried out within the strata's encountered between 1.0m - 6.0m generally gave results that would equate to an N Value of between 4 - 6. Allowing for variation in ground conditions and test method, using a conservative average N Value of 6 and using Terzaghi, K. & Peck, R.B. (1996) (2m footing) an allowable bearing pressure in the region of 30kN/m² *
- Material tested between 6.0m – 10.0m in non cohesive layers generally gave results that would equate to an N Value of 35 - 50+ . Allowing for variation in ground conditions and test method, using a conservative average N Value of 35 and an allowable bearing pressure of around 360kN/m² .
- *Due to the variable nature of MADE GROUND, the test values may not be representative of the site as a whole, we would not recommend placing foundations within this material
- 4.1.5 Limited Root Activity was encountered to a maximum of 1.1m. Roots appeared live in appearance up to 3mm in diameter.

4.1.6 Groundwater activity was not recorded in either Boreholes.

4.2 Chemical Testing

4.2.1 3 representative samples of the Upper ground encountered across the site were selected and tested for a range of commonly occurring contaminants and indicators of contamination including those given by the Contaminated Land Exposure Assessment (CLEA).

4.2.2 The regime for contaminated land was set out in Part IIA of the Environmental Protection Act (EPA) 1990, as inserted by S.57 of The Environment Act 1995 and came into effect in England on 1st April 2000 as The Contaminated Land (England) Regulations 2000 (SI 2000/227). These regulations were subsequently updated with the provision of The Contaminated Land (England) Regulations 2006 (SI 2006/1380), which consolidated the previous regulations and amendments and added in provisions regarding radioactive contaminated land. These regulations came into force on 4th August 2006. This modified the wording for “Contaminated Land” under Part IIA of the EPA. Section 78A (2) defines contaminated land as “land which appears to be in such a condition, by reason of substances in, on or under the land, that:

- significant harm is being caused, or there is a significant possibility of significant harm being caused (SPOSH);

4.2.3 An initial Generic Quantitative Risk Assessment (GQRA) for human health has been undertaken by comparison of the soil analytical results with published guidance criteria. These can be classified as Generic Assessment Criteria (GAC) and are widely referred to by consultants, Regulatory Authorities and other professionals within the industry and include the following:

- Current published Soil Guideline Values (SGVs) published by the Environmental Agency (EA)
- Land Quality Management (LQM) have published a series of GACs via the CLEA v1.04 software which are applicable to the UK for common determinants. The GAC's can be applied to a wide range of land contamination problems, which can be used as initial screening criteria in order to assess potentially contaminated land.
- ATRISK Soil SSV's (Soil Screening Values) at 1% SOM for a sand soil derived by Atkins in line with the Environment Agency 2009 guidance (SR2, SR3, SR4, SR7) using the CLEA v1.04 and CLEA v1.06 software; and WSV's (Water Screening Values) for Human Health using the RBCA v2.5 software. The modelling inputs were made compliant with the SR3 residential conceptual site model and follow the guidance provided within SR3 where possible.
- Contaminated Land: Applications in Real Environments (CL:AIRE) 'The Soil Generic Assessment Criteria for Human Health Risk Assessment' GAC's via the CLEA v1.06 software (updated version of the v1.04 update after the release of LQM GAC's).
- Defra C4SL's: Development of Category 4 Screening Levels for assessment of land affected by contamination.

It should be noted that the above guidance criteria are generally restricted with depth i.e. the values quoted with reference to human health are generally only applicable in the top 1.00 m of soil and do not (dependent on the conceptual site model and conditions identified on site) necessarily identify significant harm. Further detailed quantitative risk assessment (DQRA) may be required.

- 4.2.4 Neither CLEA or ATRISK currently publish values for Hexavalent Chromium. Therefore, both Total Chromium and Hexavalent Chromium values have been compared against the Land Quality Management/Chartered Institute of Environmental Health (LQM/CIEH) Generic Assessment Criteria published in 2009 and based on CLEA v1.04 with Total Chromium values based on Chromium III.
- 4.2.5 The Generic Assessment Criteria (GAC) used for the screening of the soils and their sources are outlined in the table in Appendix A.

The GAC used are a combination of:

- Category 4 Screening Levels (residential with home grown produce)
- LQM Suitable for Use Levels (Residential - With Plant Uptake – 2.5% Organic Matter)

The choice of which GAC source to use for each contaminant was based on the GAC that was most conservative.

A Total Organic Carbon (TOC) concentration of 3.13% was observed within the soil samples analysed giving a Fraction of Organic Carbon (FOC) of 0.0313%. Therefore based on the relationships below a soil organic matter content of 6% was assumed.

The statistical analysis was carried out in accordance with the methodology laid out in the document “Guidance on comparing soil contamination data with critical concentration” published by the Chartered Institute of Environmental Health & CLAIRE.

It was recognized that the number of samples is insufficient to allow for proper meaningful statistical analysis; however it was considered useful, adequate and reasonable practicable for this development to use the approach as part of the risk assessment.

The “Planning” scenario was used to undertake the statistical tests. Under this scenario, the Alternative Hypothesis is that “the true mean is lower than the critical concentration” and the Null hypothesis is that “the true mean is equal to or greater than the critical concentration”. The critical concentration was taken as the relevant GAC for each contaminant.

For the purpose of the statistical tests, sample results where the contaminant concentrations were below the limit of detection (LOD) were set to zero. This was considered to be a conservative approach (i.e. protective of human health). Statistical tests were only carried out on datasets where at least one of the samples returned a contaminant concentration above the limit of detection.

The Shapiro-Wilk normality test was used to assess whether datasets were normally or non-normally distributed.

- 4.2.6 No contaminants from the investigation were found to exceed their relevant GAC.

4.3 Updated Conceptual Site Model

4.3.1 Following the results of the site investigation, above assessment and gas monitoring results presented in the appendix and commented on in paragraph 4.5 an updated CSM has been produced below: Updated Conceptual Site Model.

Receptor	Potential Sources	Pathways	Risk	Action / Mitigation
Human Health				
Existing site workers	Contaminated soils and groundwater.	Direct contact / ingestion, inhalation.	Low	Soil & Chemical Testing indicated that there were no undue levels of contamination
	Ground gas / vapours.	Inhalation.	Low	Gas monitoring indicated there were no undue levels of groundborne gasses on site
Future site users including construction and ground workers	Contaminated soils and groundwater.	Direct contact / ingestion, inhalation.	Low	Soil & Chemical Testing indicated that there were no undue levels of contamination
	Ground gas / vapours.	Inhalation.	Low	Gas monitoring indicated there were no undue levels of groundborne gasses on site
Adjacent properties users	Contaminated groundwater and vapour.	Migration through Aquifer, direct contact, inhalation, ingestion.	Low	Soil/Water & Chemical Testing indicated that there were no undue levels of contamination
Property (Buildings)				
Adjacent structures	Contaminated soils and groundwater	Migration through groundwater.	Low	Soil/Water & Chemical Testing indicated that there were no undue levels of contamination
	Ground gas / vapours.	Migration through near surface soils.	Low	Gas monitoring indicated there were no undue levels of groundborne gasses on site
Property (Crops and Pets)				
Crops and Pets	Contaminated soils and groundwater. Ground gas / vapours	Migration through Aquifer strata, direct contact, inhalation, ingestion.	Low	Soil/Water & Chemical Testing indicated that there were no undue levels of contamination

Water Bodies				
Lakes/ Reservoir, Culverted Sources and Drains	Contaminated soils and groundwater.	Surface water run-off, lateral migration of contamination.	Low	Soil/Water & Chemical Testing indicated that there were no undue levels of contamination
Secondary A Aquifer / Principal Aquifer	Contaminated soils and groundwater	Downward migration through the soils.	Low	Soil/Water & Chemical Testing indicated that there were no undue levels of contamination.

4.4 Waste Classification Tests

- 4.4.1 A single sample collected from BH1 was selected and tested for Waste Acceptance Criteria (WAC) in accordance with BS EN 12457 Part 3
- 4.4.2 The samples selected from BH1 at a depth of 0.75m below existing ground level indicated that according to Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg the MADE GROUND would be classed as Inert Waste.
- 4.4.3 Full details of the results are given on the appended results sheets
- 4.4.4 It should be noted that Trentside Geotechnical Testing are not a licensed landfill operator and we therefore strongly recommend that the WAC data should be presented to potential Waste Management Companies in order for them to confirm the waste classification of surplus soils to be removed from this site and to determine its acceptability at appropriate landfill sites for disposal/treatment

4.5 Ground Gas Monitoring

1no 10m Borehole (BH1) and installation for Gas Monitoring (9m Plain 50mm dia. HDPE pipe and 1m slotted 50mm dia. HDPE pipe). 6 subsequent visits to monitor ground gas concentrations were carried out, the maximum methane concentration recorded was 0.7%v/v. The maximum carbon dioxide concentration was recorded at 0.5%v/v. The associated flow rates reached a maximum of 0.2l/hr. Oxygen levels ranged between 19.0 – 19.2%v/v.

CIRIA Publication C665 “Assessing Risks posed by Hazardous Ground gases to Buildings (Revised 2007) includes the NHBC “Traffic Light” system

Given the flow rates and associated Gas Screening Values (GSVs), presented within the appended Gas Results Sheet, and in accordance with the NHBC “Traffic Light” system, we would consider that the current site would be classified as Green or Characteristic Situation 1. Therefore this would indicate that Lowest ground gas protection measures are required and it is suggested that installing a membrane merely as a precautionary measure. Gas protection measures are to be installed as prescribed in BRE 414.

4.0 Discussion

4.6 Shallow Foundations

- 4.6.1 Any conventional shallow strip or pad foundations should be set below any MADE GROUND and within the definitive medium dense underlying natural material, generally found at 6.0m. It is assumed that this depth is deemed too deep for the consideration of shallow foundations.
- 4.6.2 Acceptable settlement is often taken to lie within the range of 10-25mm, but is structure-dependent. Anticipated settlement can be calculated using elastic methods and will vary according to foundation shape and soil stiffness.
- 4.6.3 In this case the natural material appears to have 'poor' load bearing characteristics, with the results of the in-situ testing, in conjunction with research undertaken by Skempton, indicating a maximum safe (design) bearing pressure of approximately 20kN/m² at depths up to 6.0m.

4.7 Piled Foundations

- 4.7.1 If due to the magnitude of the anticipated loads, the presence of groundwater, or for any other economic reason that shallow foundations are not deemed as an alternative, the installation of a combination of secant/contiguous piles around the perimeter of the site in order to construct the development could be undertaken. It is assumed that the pile heads would be restrained in the permanent condition by a pile cap that will be formed of reinforced concrete and the pile walls will have a concrete inner liner wall.
- 4.7.2 Piles at this site would need to be bored or driven through any MADE GROUND and granular stratum to support the foundation loads mainly in adhesion within the deep underlying natural MUDSTONE stratum encountered at its stiffening point generally at 7m.
- 4.7.3 It is beyond our brief to provide a full and detailed pile design and the advice of a specialist piling contractor should be sought in this respect. All pile design is of course the responsibility of the selected piling contractor, and thus the soil parameters/assumptions listed below are given for guidance purposes only. These soil parameters/assumptions relate to "static design" for vertically loaded single and contiguous bored/cfa piles:

Made Ground

Bulk unit weight, γ_b :	17kN/m ³
Effective angle of internal friction, ϕ' :	Zero
Undrained shear strength, S_u/C_u :	Zero

Granular Material

Bulk unit weight, γ_b :	19kN/m ³
Effective angle of internal friction, ϕ' :	38° - Based on CPT results and research by Peck, Hanson & Thorburn
Effective angle of wall friction, δ' :	Piling contractor's advice, but typically 0.70 to 0.80
Undrained shear strength, S_u/C_u :	Zero
Bearing Capacity Factor, N_c :	Relates to pile and size – normal to utilise research by Berezantsev

Clay

Bulk unit weight, γ_b :	20kN/m ³
Undrained shear strength, S_u/C_u :	Varying between approximately 185-285kN/m ² (interpreted from SPT results and Stroud (1989))
Adhesion Factor, α :	Piling contractor's advice, but within the range 0.45 to 0.60
Effective angle of internal friction, ϕ' :	15-20°
Bearing Capacity Factor, N_c :	9

5.0 Additional Comments

- 5.1 As always, the above recommendations are based on a selected number of representative samples and further testing may be required if any other contamination is suspected or encountered during future ground works.
- 5.2 It should be noted that should ground conditions differing significantly from those described in our report be encountered during foundation excavation, then the author should be contacted immediately and that the details of this report discussed above may need to be altered accordingly.

We trust that you will find the enclosed information of value but should you have any queries please do not hesitate to contact the writer at the above noted address.

- a) This report has been prepared for the purpose of providing advice to the client pursuant to its appointment of Trentside Geotechnical as a summarizer.
- b) Save for the client no duty is undertaken or warranty or representation made to any party in respect of the opinions, advice, recommendations or conclusions herein set out.
- c) All work carried out in preparing this report has used, and is based upon, our professional knowledge and understanding of the current relevant English and European Community standards, approved codes of practice, technology and legislation.
- d) Changes in the above may cause the opinion, advice, recommendations or conclusions set out in this report to become inappropriate or incorrect. However, in giving its opinions, advice, recommendations and conclusions, TGT has considered pending changes to environmental legislation and regulations of which it is currently aware. Following delivery of this report, we will have no obligation to advise the client of any such changes, or of their repercussions.
- e) TGT acknowledges that it is being retained, in part, because of its knowledge and experience with respect to environmental matters. TGT will consider and analyse all information provided to it in the context of our knowledge and experience and all other relevant information known to us. To the extent that the information provided to us is not inconsistent or incompatible therewith, TGT shall be entitled to rely upon and assume, without independent verification, the accuracy and completeness of such information.
- f) The content of this report represents the professional opinion of experienced environmental consultants. TGT does not provide specialist legal advice and the advice of lawyers may be required.
- g) In the Summary and Recommendations sections of this report, TGT has set out our key findings and provided a summary and overview of our advice, opinions and recommendations. However, other parts of this report will often indicate the limitations of the information obtained by TGT and therefore any advice, opinions or recommendations set out in the Executive Summary, Summary and Recommendations sections ought not to be relied upon unless they are considered in the context of the whole report.
- h) The assessments made in this report are based on the ground conditions as revealed by walkover survey and/or intrusive investigations, together with the results of any field or laboratory testing or chemical analysis undertaken and other relevant data, which may have been obtained including previous site investigations. In any event, ground contamination often exists as small discrete areas of contamination (hot spots) and there can be no certainty that any or all such areas have been located and/or sampled.
- i) There may be special conditions appertaining to the site, which have not been taken into account in the report. The assessment may be subject to amendment in light of additional information becoming available.
- j) Where any data supplied by the client or from other sources, including that from previous site investigations, have been used it has been assumed that the information is correct. No responsibility can be accepted by TGT for inaccuracies within the data supplied by other parties.
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- l) Comments on groundwater conditions are based on observations made at the time of the investigation unless otherwise stated. Groundwater conditions may vary due to seasonal or other effects.
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