

CONSULTING ENGINEERS

CIVIL • STRUCTURAL
GEOTECHNICAL • ENVIRONMENTAL

**PROPOSED RESIDENTIAL DEVELOPMENT
PEEL PARK AVENUE,
CLITHEROE
FOR
APPLETHWAITE HOMES**

OCTOBER 2017

GEO-ENVIRONMENTAL INVESTIGATION REPORT

17110/GEIR/REV A

ROBERT E FRY & ASSOCIATES LTD.
45, Bridgeman Terrace
Wigan, WN1 1TT

Telephone: 01942 826020
Fax: 01942 230816
Email: mail@refa.co.uk
Company Registration No. 2436911



DOCUMENT STATUS

Site Reference	Peel Park Avenue, Clitheroe
Title	Geo-Environmental Investigation Report
Client	Applethwaite Homes
Project No.	17110/GEIR
Report Version	Final Issue
Date Issued	22 nd August 2017
Issue Notes	Issued for comment and approval.
Report Version	Revision A
Date Issued	12 th October 2017
Issue Notes	Updated site layout plan included.
Report Version	
Date Issued	
Issue Notes	
Report Version	
Date Issued	
Issue Notes	
Report Version	
Date Issued	
Issue Notes	

TABLE OF CONTENTS

1.0 INTRODUCTION	6.0 CONTAMINATION ANALYSIS & ASSESSMENT CRITERIA
1.1 Instructions	6.1 Sampling
1.2 Object	6.2 Range
1.3 Scope	6.3 Laboratory
1.4 Development Proposals	6.4 Development Proposals
1.5 Services	6.5 Analysis Range
2.0 THE SITE	6.6 Results
2.1 Location	6.7 Approach
2.2 Boundaries	6.8 Site Classification
2.3 Access	6.9 Criteria
2.4 Topography	7.0 RESULTS OF ANALYSIS & QUALITATIVE RISK ASSESSMENT
2.5 Site Conditions	7.1 Model
2.6 Trees	7.2 Results Summary
2.7 Walkover Survey	7.3 Metals & Inorganics
3.0 DESK STUDY	7.4 Speciated PAH
3.1 Historical Industrial Sites	7.5 Sulphates
3.2 Environmental Permits, Incidents & Registers	7.6 Ground Gases
3.3 Landfill Sites	8.0 DISCUSSIONS
3.4 Current Land Uses	8.1 General
3.5 Hydrogeology & Hydrology	8.2 Metals & Inorganics
3.6 Flooding	8.3 PAH Suite
3.7 Environmentally Sensitive Areas	8.4 Revised Conceptual Site Model
3.8 Geology	8.5 Preliminary Remediation Proposals
3.9 Ground Workings	8.6 Foundations
3.10 Mining	8.7 Ground Floor Construction
3.11 Background Soil Chemistry	9.0 CONCLUSIONS & RECOMMENDATIONS
3.12 BGS Boreholes	9.1 Remediation
3.13 Site History	9.2 Foundations
3.14 Anticipated Ground Conditions	9.3 Ground Floor Construction
3.15 Preliminary Conceptual Model	9.4 SUDS
4.0 SITE WORKS	9.5 Further Works
4.1 Intrusive Works	10.0 NOTES
4.2 Locations	
4.3 Records	
4.4 Targeting	
5.0 GROUND CONDITIONS	
5.2 Natural Strata	
5.3 Bedrock	
5.4 Groundwater	
5.5 Excavations	
5.6 Contamination	
5.7 Sampling	
5.8 Index Testing	
5.9 Ground Gases	
5.10 SUDS	

LIST OF TABLES

	<i>Executive Summary</i>
<i>Table 1</i>	<i>Review of Historical Maps</i>
<i>Table 2</i>	<i>Anticipated Ground Conditions</i>
<i>Table 3</i>	<i>Potential Ground Related Issues</i>
<i>Table 4</i>	<i>Preliminary Conceptual Site Model</i>
<i>Table 5</i>	<i>Initial Ground Investigation Strategy</i>
<i>Table 6</i>	<i>Table of Chemical Testing</i>
<i>Table 7</i>	<i>Summary of Contamination Analysis: Metals & Inorganics</i>
<i>Table 8</i>	<i>Summary of Contamination Analysis: Organics: Organics: PAH USEPA 16 Suite</i>
<i>Table 9</i>	<i>Revised Conceptual Site Model</i>

LIST OF DRAWINGS

<i>17110/01</i>	<i>Walkover Survey Plan</i>
<i>17110/02</i>	<i>Exploratory Hole Location Plan</i>
<i>17-15-SK01</i>	<i>Proposed Sketch Site Layout Plan</i>

LIST OF APPENDICES

<i>Appendix A</i>	<i>Exploratory Hole Location Plan</i>
<i>Appendix B</i>	<i>Groundsure Enviro-Insight Report</i>
<i>Appendix C</i>	<i>Groundsure Geo-Insight Report</i>
<i>Appendix D</i>	<i>Ordnance Survey Maps</i>
<i>Appendix E</i>	<i>Walkover Survey Plan</i>
<i>Appendix F</i>	<i>Walkover Survey Photographs</i>
<i>Appendix G</i>	<i>Proposed Site Layout Plan</i>
<i>Appendix H</i>	<i>TP logs</i>
<i>Appendix I</i>	<i>TP Photographs</i>
<i>Appendix J</i>	<i>Exova Jones Laboratory Test Results</i>
<i>Appendix K</i>	<i>Professional Soils Laboratory Test Results</i>

EXECUTIVE SUMMARY

Site	<i>The site is roughly square in shape and extends to an area of approximately 1.93 hectares. It is located upon the southern side of Peel Park Avenue within the town of Clitheroe, Lancashire.</i>
NGR	<i>SD 74803 40989</i>
Site History	<i>The site has remained as agricultural land throughout its history. The site contains a Roman Road within the eastern end of the site with a 6m easement.</i>
Investigations	<i>The investigations have extended to:-</i> • Walkover survey • Desk study • Extensive intrusive investigations by trial pit techniques. • Geotechnical & chemical analyses of soil samples
Ground Conditions	<i>The investigation has identified topsoil over the whole site area extending to depths between 0 – 0.4m bgl. The underlying superficial deposits comprise of firm to stiff sandy gravelly clays which have been proven to a maximum depth of 2.5m bgl. Within positions TP05 – TP06 a very clayey gravelly fine to coarse sand has been identified at depths between 0.6 – 1.4m bgl. Bedrock comprising of weak fine grained limestone has been identified within position TP01 at depths between 1.7 – 1.9m bgl.</i>
Groundwater	<i>Groundwater ingress has been identified within all positions at depths between 0.8- 1.7m bgl which is considered to represent perched water within the superficial and bedrock deposits.</i>
Environmental	<i>This investigation has not identified the presence of any elevated concentrations of contaminants and the topsoil material is considered suitable for reuse within the site.</i>
Trees	<i>The walkover survey has identified trees within all the site boundaries and a full arboriculturist report should be conducted.</i>
Foundations	<i>Based upon the results of this ground investigation strip foundations may be formed within the natural strata. The natural clay stratum is considered to offer a safe bearing capacity in the order of 100kN/m² at a minimum depth of 1.0mbgl. The granular sand deposits within positions TP05 – TP06 are considered to offer a reduced safe bearing capacity of 75kN/m² at a minimum depth of 0.6m bgl. The natural clay stratum is considered to have a low volume change potential in accordance with NHBC chapter 4.2. The bedrock within locality of TP01 is considered to offer a safe bearing capacity in the order of 300kN/m² at a minimum depth of 1.7m bgl. If foundations extend to bedrock then all foundations should extend to bedrock to avoid differential settlement.</i>
Slabs	<i>It is recommended that suspended ground floor construction be adopted for all properties located within this site. These floors may be of a pre cast concrete beam and block arrangement or of a suitably designed cast insitu reinforced concrete. In those areas where tree root effects are important it is recommended that a pre cast concrete beam and block type floor is utilised to allow for the provision of a suitable air void below the ground floor construction.</i>
SUDS	<i>It is considered that the site is not capable of adopting a soakaways system of surface water disposal and will need to connect to existing drainage sewers.</i>
Remediation	<i>There is no requirement for remedial works and the topsoil found on site is suitable for reuse.</i>

This brief summary should not be assumed to represent a complete account of all the potential geo-environmental issues that may exist at the site. As such it is strongly recommended that the report be read in its entirety.

GEO-ENVIRONMENTAL INVESTIGATION WORKS

PEEL PARK AVENUE, CLITHEROE

1.0 INTRODUCTION

1.1 Instructions

1.1.1 We are instructed by Applethwaite Homes, Sceptre House, Sceptre Way, Bamber Bridge, Preston, PR5 6AW to undertake a program of ground investigation works at a site located south east of Peel Park Avenue, Clitheroe which they intend to re-develop in a residential manner.

1.2 Object

1.2.1 The object of these investigations are as follows:

- To determine the engineering properties of the soils present within the site to form a basis upon which foundation and general infrastructure recommendations and design may be based;
- To enable sufficient information regarding ground conditions to be obtained from which risks to end users and the environment can be assessed;
- To utilise the information obtained from the investigations to provide recommendations for remediation measures where required.

1.3 Scope

1.3.1 The investigations considered within this report have comprised of the following elements:

- An initial environmental and engineering desk study based upon existing reports, services location information, geological, hydrogeology and hydrological information, a commercially available database and old Ordnance Survey maps;
- An initial walkover survey of the site has been undertaken prior to any intrusive investigations being commenced to determine the presence of any visible hazards or features which may affect the design of the ground investigation works;
- Undertake ground investigation works by trial pit excavations;
- Determine the presence, nature and extent of any soil and groundwater contamination at the site;
- Determination of the engineering properties of the soils present within the site to form a basis upon which recommendations for foundations and infrastructure construction may be based;
- Identify the potential requirements for any remedial action, where required.

1.4 Development Proposals

1.4.1 We understand that it is our client's intention that the site will be developed in a residential manner and an initial development proposal has been provided. A copy of the proposed site layout sketch is appended to this report for reference. It is however acknowledged that amendments may be made to these proposals as a result of planning consultations and commercial considerations. It is however anticipated that the development will be carried out generally in accordance with the principles of the current layout.

- 1.4.2 At the present time the proposed site layout sketch shows the site be developed by the construction of thirty four (34 No.) residential properties in detached, semi-detached and mews configurations. All residential properties within the site are to be provided with appropriate private garden areas and associated soft landscaping and associated road access. The site layout sketch (reference 17-15/SK01) is appended to this report for reference.

1.5 Services

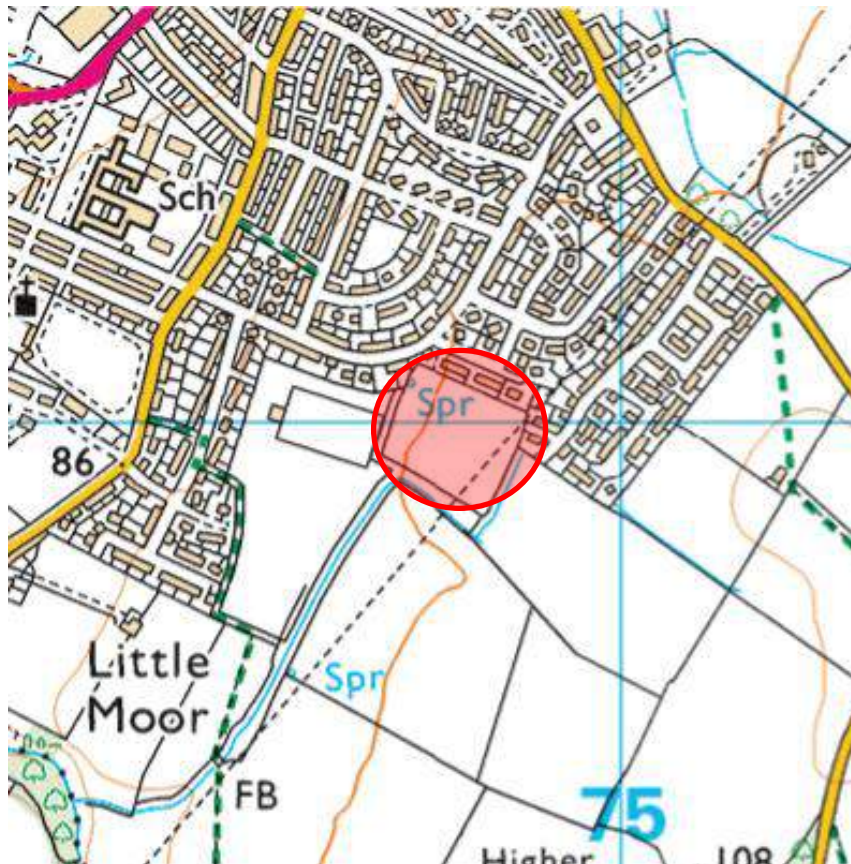
- 1.5.1 As part of our desk studies the client has provided us with drawings information for the site and has identified the presence of overhead power cables located centrally within the site trending in an east to west direction. All remaining service drawings have indicated public services are located outside the site boundary mainly located within the road area of Peel Park Avenue.
- 1.5.2 Each trial pit position has been preceded by a survey utilising a cable avoidance tool (CAT).

2.0 THE SITE

2.1 Location

- 2.1.1 The site is roughly square in shape and extends to an area of approximately 1.93 hectares. The site is located south east of Peel Park Avenue, Clitheroe approximately 1.2km south east of Clitheroe town centre. It is situated at approximate National Grid Reference SD 74803 40989. The site location is shown in figure 1 below.

Figure 1 Site Location



2.2 Boundaries

2.2.1 *The eastern, southern and western boundaries are formed by hedgerows leading on to further agricultural land and land associated with St Thomas's Grammar School. The northern boundary is formed by a hedgerow leading on to residential properties along Claremont Drive.*

2.3 Access

2.3.1 *The site is currently accessed from Peel Park Avenue, adjacent to property number 32. The access to the development will be constructed in agreement with the requirements of the Local Authority.*

2.4 Topography

2.4.1 *The general topography of the site slopes towards the north west at approximate gradient of 1:10. No significant topographical features have been identified within this site.*

2.5 Site Conditions

2.5.1 *At the time of the site walkover and ground investigation the site comprised of agricultural land and the presence of overhead power cables present within the central area of the site trending in an east to west direction.*

2.6 Trees

2.6.1 *No trees are located within the site itself, however a number of trees and shrubs have been identified in all the site boundaries and therefore there will be a requirement for a detailed arboriculturist report prior to any further work being undertaken to determine the influence of tree roots.*

2.7 Walkover Survey

2.7.1 *Prior to commencing the ground investigation works, we have undertaken an initial walkover survey of the site to identify any areas which may impact upon the proposed site redevelopment works. These features are identified upon the appended walkover survey plan which is appended to this report for reference.*

2.7.2 *The site walkover was conducted on the 19th July 2017 and at the time of the survey the weather conditions were overcast but dry. The survey has confirmed that the site comprises of agricultural land.*

2.7.3 *The walkover survey has confirmed that the site generally slopes towards the north west at an approximate gradient of 1:10, there are no other significant topographical features. Overhead electricity line has been identified within the central area of the site. Where natural gaps were present within the hedgerow fences have been utilised to deny access.*

2.7.4 *The walkover survey plan has been appended to this report for reference, drawing number 17110/01.*

3.0 DESK STUDY

3.0.1 As part of our environmental desk studies we have commissioned an Enviro-Insight report by Groundsure which gives details of all recorded environmental features relating to the site and its immediately surrounding area. We have also obtained copies of all available old Ordnance Survey maps for the area and these give some historical guidance regarding the former usage of the site area and its immediate vicinity. A Geo-Insight report has also been commissioned which assesses the geological structures within the general area of the site. It should be noted that the area of desk study extends to a greater area than the proposed development site.

3.1 Historical Industrial Sites

3.1.1 The Enviro-Insight report has identified seven (7 No.) records of potentially contaminative past land uses within 500m of the search boundary. All land uses are noted to be within excess of 425m from the site boundary and therefore are not considered to pose a potential source of contamination to this site.

3.1.2 The environmental report has identified one (1 No.) records of unspecified tanks located 166m to the east which is considered too remote to pose a potential source of contamination to this development.

3.1.3 The Enviro-Insight report has identified thirty four (34 No.) records of historical energy features within 500m of the search boundary. These all relate to electricity substations which are located in excess of 14m from the site boundary and therefore are not considered to pose a potential source of PCB contamination to this development.

3.1.4 The environmental report has identified six (6 No.) records of potentially infilled land however these are all located in excess of 420m from the site boundary and are not considered to pose potential offsite sources of explosive or toxic gases to this development.

3.2 Environmental Permits, Incidents & Registers

3.2.1 The environmental report has identified one (1 No.) records of part A (2) and Part B activities located 451m to the west which relates to the process of respraying old vehicles. It is noted that the permit type was Part B however this has now been revoked and no enforcements have been notified.

3.2.2 The environmental report has identified one (1 No.) records of licensed discharge consents located 340m to the north east which related to the discharge of treated affluent into Shore Brook. Due to its remote locality this discharge is not considered to pose a potential source of contamination to the proposed development.

3.2.3 The Enviro-Insight report has identified five (5 No.) records of National Incidence Recording System (NIRS) list 2 records within 500m of the study site. All records are located in excess of 30m from the site boundary and are noted category four (no impact) to category three (minor impact to water, land and air). Therefore these incidences are not considered to pose a potential source of contamination to the development site.

3.3 Landfill Sites

- 3.3.1 *The environmental report has not identified any landfill or waste sites within 440m of the site boundary however records do exist beyond this distance but are not considered to pose potential offsite sources of migrating explosive or toxic gases.*

3.4 Current Land Uses

- 3.4.1 *The Enviro-Insight report has identified five (5 No.) records of potentially contaminative industrial sites within 250m of the study site boundary. The first record is located 24m to the west which relates to electricity substation. This is not considered to cause a potential source of PCB contamination to this site. All remaining records are located in excess of 65m from the site boundary and are not considered to pose a potential off site sources of contamination.*
- 3.4.2 *The Enviro-Insight report has not identified any petrol or fuel sites located within 500m of the study site boundary.*
- 3.4.3 *The environmental report has not identified any National Grid underground electrical cables or high pressure gas mains within 500m of the study site.*

3.5 Hydrogeology & Hydrology

- 3.5.1 *The superficial deposits within the vicinity of the site are designated as Secondary (undifferentiated). This designation is assigned when it is not possible to attribute either category A or B to a soil type. In general these layers have previously been designated as both minor and none aquifer in different locations due to the variable characteristics of the soil type.*
- 3.5.2 *The site is located above Secondary (A) aquifer rocks which comprise of permeable layers capable of supporting water supplies at a local rather than strategic scale in some cases form an important source of base flow to rivers. These are generally aquifers formally classified as minor aquifers. The development of this site is not considered to pose a hazard to the underlying aquifers.*
- 3.5.3 *The environmental report has not identified any groundwater, surface water or potable water abstraction licences within 650m of the site boundary and therefore this development does not pose a hazard to any abstraction licences. Although records do exist beyond this distance.*
- 3.5.4 *The environmental report provides Environment Agency information on groundwater vulnerability and the soil leaching potential. Information is provided for the site which is classified as minor aquifers with a low leaching potential. The soil vulnerability is categorised as L.*
- 3.5.5 *A river network has been identified immediately adjacent to the south east boundary, however the development of the site is not considered to pose a potential hazard to this river network. However appropriate measures should be adopted to ensure the protection of this river network.*

3.6 Flooding

- 3.6.1 *The environmental report has identified that the site does not lie within an Environment Agency Zone 2 or Zone 3 flood plain and the risk of flooding from rivers and the sea (RoFRas) is considered to be very low.*

3.6.2 The environmental report has indicated that the site is within 50m of a British Geological Survey groundwater flooding susceptibility area that relates to both clear water and superficial deposits flooding with potential below surface. Where the potential for ground water flooding of properties situated below ground water level is indicated this means that given the geological conditions there may be ground water flooding hazard to basements and other below surface infrastructure. Unless other relevant information e.g. records of previous flooding suggest ground water flooding has occurred before in this area then no further action in relation to ground water flooding hazard should be taken. If there are records of previous instances of ground water flooding then it is recommended that other information e.g. rain fall history, property type and land drainage in formation in addition to previous records of flooding be investigated in order to establish relative but not absolute risk of ground water flooding. High confidence rating is applied to this flooding susceptibility.

3.7 Environmentally Sensitive Areas

3.7.1 The Enviro-Insight report has not identified any records of environmentally sensitive areas within 1300m of the site boundary. However, records do exist beyond this distance.

3.8 Geology

3.8.1 The Geo-Insight report has indicated the presence of superficial deposits comprising of Devensian age glacial till deposits and is considered to comprise of unlithified clay, sand and gravel deposits. These glacial deposits are considered to have a low to high permeability with a mixed flow type.

3.8.2 The solid geology below the site comprises of the Clitheroe Limestone formation which is viséan in age and is considered to comprise mainly of limestone alternating with mudstones. The bedrock below the site is considered to have a low permeability with a fracture flow type.

3.8.3 No records of geological faults have been identified within the site or in close proximity to the site and therefore geological faulting is not considered to pose a potential source of minor ground movements within the proposed development.

3.8.4 The site is located within an area where 1-3% of properties are above the action level for radon gas. Therefore, according to publication BR211 by the Building Research Establishment no radon protective measures are necessary.

3.9 Ground Workings

3.9.1 The geological report has not identified any records of historical ground working features or current ground workings within 250m of the study site boundary.

3.10 Mining

3.10.1 The geological report has confirmed that the site is not located within an area known for coal mining however the geological report has identified that localised small scale underground mining may have occurred in relation to vein minerals. The potential for difficult ground conditions are unlikely or localised at a level where they need not to be considered. Therefore the site is considered not to be at risk of minor ground movement's associated with the collapse of shallow mine workings.

3.11 Background Soil Chemistry

3.11.1 The Geo-Insight report includes an estimated geometric mean soil concentration of various elements. Assessment of this information suggests that all determinands listed are at concentrations below the current tier 1 assessment criteria in relation to human health. Therefore the underlying natural strata arte not considered to contain naturally occurring contaminants.

3.12 Site History

3.12.1 Table 1 – Review of Historical Maps

Date	Site	Adjacent Land
1848	The site comprises of open fields with a field boundary located centrally within the site. A roman road is shown to enter the site in the north east corner and continues towards the south boundary where it continues outside the site.	Majority of the surrounding land comprises of further agricultural fields.
1912	The site is now shown to be one piece of agricultural land.	An access road is shown adjacent to the northern corner of the site which trends in a northerly direction towards residential property called Goose Buds. Residential development has taken place in excess of 250m to the west.
1932	No significant changes.	A spring is shown to be adjacent to the northern corner of the site and allotment gardens are now shown to be present 190m to the west.
1964	No significant changes.	Significant residential development has taken place to the north west and north east along Peel Park Avenue and Claremont Avenue. The track from Goose Buds no longer extends down towards the development site.
1986	No significant changes.	Further residential development has taken place to the north and a playing field is located immediately adjacent to the western boundary of the site.
1993 - 1995	No significant changes.	No significant changes.
2010 - 2014	No significant changes.	No significant changes.

3.12.2 Careful appraisal of the historical maps has identified that the site has remained in agricultural usage throughout its whole history and has contained roman road within the eastern area of the site. A review of the surrounding land has identified significant residential development to the north along Clitheroe Avenue and Peel Park Avenue. Historical mapping has not illustrated the presence of overhead electricity lines within the central area of the site which we have identified during the site walkover which may indicate that they are relatively modern in age. A review of the historical OS maps has not identified any significant features that may pose a potential source of contamination to the site.

3.13 Anticipated Ground Conditions

3.13.1 Based upon the information obtained during the initial desk study phase, the anticipated ground conditions are expected to comprise of strata as detailed in table 2 below.

Table 2 – Anticipated Ground Conditions

Ground Material	Anticipated Condition
<i>Topsoil</i>	<i>Topsoil is likely to be present over the whole site area.</i>
<i>Glacial Till Deposits</i>	<i>It is anticipated that these deposits will consist mainly of clays with minor sand and gravel units.</i>
<i>Bedrock</i>	<i>Comprises of the Clitheroe Limestone formation consisting of alternating mudstones and siltstones.</i>
<i>Groundwater</i>	<i>Expected to lie at depth within bedrock, although there may be localised areas of perched water within the superficial deposits.</i>

3.13.2 Based upon the data available within the desk study and tables 1 and 2 above, potential ground related issues associated with the proposed redevelopment of this site are likely to include the elements noted in table 3 below.

Table 3 – Potential Ground Related Issues

3.14

Type of Issue	Site Specific issue	Remarks (refer to walk over survey plan)
<i>Potential on Site Contamination Sources</i>	1. <i>Naturally occurring contamination in the natural soil.</i>	1. <i>Generally over the site area.</i>
<i>Potential off Site Contamination Sources</i>	1. <i>None identified.</i>	1. <i>None identified.</i>
<i>Potential Geotechnical Hazards</i>	1. <i>Soft/loose ground.</i>	1. <i>Potential soft clay deposits</i>

Preliminary Conceptual Model

3.14.1 The information presented within this Desk Study section of this report has been used to compile a preliminary conceptual model for the site. The identified potential contaminant and receptors have been considered along with any possible pathways that may link them. The resulting pollution linkages are considered in table 4 below. The risk classification has been estimated in accordance with the terms and definitions based upon CIRIA C552 Contaminated Land Risk Assessment, A Guide to Good Practice.

Table 4 – Preliminary Conceptual Site Model

Potential Source	Potential Receptor	Possible Pathway	Probability	Consequence	Risk	Mitigation / Investigation
Contaminated soils	Future site users	Direct contact of soils Inhalation or ingestion of soil / dust	Lw	Md	Moderate/Low	Soil sampling during intrusive investigations. Laboratory analysis of samples.
	Surface water in the vicinity of the site	Leaching of contaminants through drainage system	Lw	Mi	Low	
	Ground water in aquifer	Leaching of contaminants to ground water	UI	Md	Low	
	Future site users	Vapour migration from soils	UI	Md	Low	
	Proposed buildings and services	Direct contact with contaminated soils	UI	Md	Low	
	Plants in gardens and soft landscaping	Direct contact	UI	Md	Low	
Contaminated ground water	Site personnel during construction	Water entering excavations	Lw	Mi	Low	Sampling of ground water (where encountered)
	Future site Users	Retained surface water	Lw	Mi	Low	
Toxic and explosive gases	Proposed buildings and occupiers	Ground gas migration into buildings	Lw	Md	Moderate / Low	Program of ground gas monitoring (where required)
Radon gases	Proposed buildings and occupiers	Ground gas migration into buildings	UI	Md	Low	No Radon ground gas precautions required.
Key: Consequence: Sv = Severe, Md = Medium, Mi = Mild, Mr = Minor Probability: Hi = High, Li = Likely, Lw = Low Likelihood, UI = Unlikely						

4.0 SITE WORKS

4.1 Intrusive Works

4.1.1 The ground conditions present within this site have been investigated utilising a series of twelve (12 No.) trial pits which have been supervised by a REFA engineer utilising backhoe style excavator. Representative samples of strata encountered during these excavation works have been retained for laboratory analysis and testing where considered to be appropriate.

4.2 Locations

4.2.1 The locations of the trial pits were chosen by ourselves in conjunction with the desk study information and where areas were accessible in an effort to identify the representative ground conditions and shallow geology present across the whole site area. A six metre easement was adopted within the approximate location of the Roman road.

4.2.2 The locations of each of the trial pits are indicated upon the appended exploratory hole plan 17110/02. These locations are shown in relation to site features present at the time of the investigations.

4.3 Records

4.3.1 During the investigations details of the strata types, water entries, ground conditions and levels have been maintained by the site engineer. This information has been collated into a series of trial pit logs which are appended to this report for reference. Also during these investigations representative samples of the strata encountered have been retained for laboratory testing as required.

4.4 Targeting

4.4.1 The trial pits were undertaken to identify the shallow superficial strata present over the whole site area, though it is acknowledged that ground conditions may vary between investigation locations.

4.4.2 The investigation locations have been spread over the whole area of the site in accordance with the recommendations laid down in BS10175: 2011 "Investigation of Potentially Contaminated Sites". The initial ground investigation strategy is detailed within table 5 below.

Table 5 - Initial Ground Investigation Strategy

Exploratory Hole No.	Target	Purpose
TP01 – TP12	Generally over the site	To determine the general nature of underlying soils and geology including: 1. Nature, distribution and thickness of made ground. 2. Nature, degree and extent of potential contamination. 3. Content of unacceptable material e.g. peat and biodegradable matter etc. 4. Suitability of the ground for the founding of structures. 5. Engineering properties of the ground.

5.0 GROUND CONDITIONS

5.1 Made Ground

5.1.1 Topsoil deposits were identified over the whole site and have been proven to a maximum depth of 0.4m bgl. No visual or olfactory signs of contamination have been identified within the topsoil material however samples of the topsoil have been collected to determine suitability for reuse within the proposed development.

5.2 Natural Strata

5.2.1 These investigations have identified the presence of shallow Glacial Till deposits underlying the topsoil strata comprising mainly of firm to stiff sandy clay at depths between 0.2 – 1.1m bgl. The hand shear vane tests conducted within the strata recorded hand shear vane values between 55 – 113 kN/m². This is considered to offer a safe bearing capacity in excess of some 100kN/m².

5.2.2 Underlying the upper clay unit a firm to stiff gravely clay with medium to high boulder content and mudstone has been identified at depths varying between 0.2 – 2.5m bgl.

Due to the high percentage of gravels, cobbles and boulders within this unit it has not been possible to carry out hand shear vane testing within this unit however visual inspection of this unit has confirmed that it is considered suitable of offering a safe bearing capacity in the order of 100kN/m².

- 5.2.3 *Within position TP05 and TP06 a dark brown very clay gravely fine to coarse sand has been identified at depths found between 0.6 – 1.4m bgl. The assessment of the granular strata indicates that it is capable of offering a reduced safe bearing capacity of 75kN/m² at a minimum depth of 0.6m bgl.*

5.3 Bedrock

- 5.3.1 *Within position TP01 where the bedrock has been identified at depths between 1.7 – 1.9m comprising of dark grey limestone recovered as medium to coarse cobbles and boulders. The weathered bedrock is considered to offer a safe bearing capacity in excess of 300kN/m².*

5.4 Groundwater

- 5.4.1 *Groundwater ingress was identified in all the investigation locations at depths varying between 0.8 – 1.7m bgl. These ground water strikes are considered to represent perched water within the superficial deposit and bedrock.*
- 5.4.2 *The natural strata within this site comprises of cohesive impermeable clays and it is considered that during periods of inclement weather perched water may become present within excavations with the cohesive materials. If localised temporary flooding does occur then standing water may be removed by simple sump pumping operations.*

5.5 Excavations

- 5.5.1 *The natural strata across the site comprises mainly of firm to stiff cohesive clay deposits and during the investigation works no instability of the trial pits were noted therefore the natural clay strata within this site is considered capable of remaining open for significant periods of time. Within locations TP5 and TP6, although no collapses were noted within the granular sand strata, it is considered that this sand strata may not be capable of remaining open for significant periods of time.*
- 5.5.2 *It is essential that personnel should not be allowed to approach or enter any excavation made upon this site unless appropriate precautions have been adopted to ensure that hazardous side instability has been prevented. This is particularly important in relation to foundation and drainage construction where personnel may be specifically required to enter deeper excavations for essential construction purposes. Reference should be made to H.S.E. publication HSG 150 for guidance.*

5.6 Contamination

- 5.6.1 *The intrusive investigations have identified topsoil deposits overlying natural clay deposits, no signs of visual or olfactory evidence have been identified within the topsoil or natural strata. The topsoil material on site represents material capable of reuse within the garden landscaped areas of the proposed developments and therefore samples have been obtained of the topsoil material to determine its suitability for reuse within the proposed residential development.*

5.7 Sampling

5.7.1 *Based upon the initial site appraisal in conjunction with the findings of the intrusive investigations a series of representative samples of the strata encountered have been retained for laboratory analyses. These analyses have been intended to determine the potential presence of any contamination which may represent a hazard to site operatives or end users of the site. This section of the work is considered in more detail in section 7 of this report.*

5.8 Index Testing

5.8.1 *A total of ten (10 No.) samples of clay strata encountered during these investigations have been returned to a civil engineering laboratory to determine their index properties. Copies of the laboratory tests are appended to this report for reference. Consideration of these results confirms that generally the clay soils within the site have a plasticity index in the range of 10 - 18%. Within position TP6 at 1.0m a sample of the very clayey sand was obtained to determine its potential plasticity index however the results have indicated that this material is not plastic and therefore not susceptible to volume change dependant on moisture content. The remaining results have identified that the clay within the site have a low volume change potential as defined by the NHBC Handbook Chapter 4.2.*

5.9 Ground Gases

5.9.1 *The desk study information has not identified any landfill or licensed waste sites within 500m of the site area and this investigation has not identified any buried deep deposits of made ground or organic material that may have a potential for generating ground gases within the development itself. Therefore we consider there is no potential source of toxic or explosive gases within the site and the site may be classified as Characteristic Situation 1 as defined by CIRIA C665 and Green as defined by the NHBC Report No. 4.*

5.10 SUDS

5.10.1 *Assessment of the ground conditions present within this site in terms of sustainable urban drainage confirms that the majority of the site comprises of impermeable cohesive clay and considered that the site will not be capable of a soakaway system of surface water disposal and drainage will have to connect to existing sewers.*

6.0 CONTAMINATION ANALYSIS & ASSESSMENT CRITERIA

6.1 Sampling

6.1.1 *This investigation has identified topsoil deposits over the whole of the site. A total of nine (9 No.) samples of topsoil strata have been obtained during this investigation for chemical analysis. These samples are considered to be representative of the ground conditions within the site and form a basis for assessment of their potential for reuse within a residential environment.*

6.1.2 *All samples obtained from this site were considered to be subject to a program of PAH analyses. Accordingly all samples have been placed into a 500ml wide necked brown glass jar. All soil samples have been stored in cool boxes at temperatures of approximately 4° (+ or - 2°C) until delivery to the selected laboratory.*

All sample containers were marked with the site address, trial pit or borehole number, depth and date of sampling. All samples have been tested within the specified handling period to accord with the sampling protocol presented by Exova Laboratories.

6.2 Range

- 6.2.1 *Topsoil has been identified within the site and representative samples of this material have been retained for analysis to determine whether it is suitable for reuse and retention within the proposed development.*
- 6.2.2 *Natural strata has been identified within all the exploratory holes underlying the topsoil strata. This natural strata comprises of varying firm to stiff clays which do not contain any visual or olfactory evidence of contamination. Accordingly the natural strata present within this site is considered to be suitable for the retention within the residential environment.*

6.3 Laboratory

- 6.3.1 *All samples selected for chemical analyses have been returned to Exova Ltd., who are an MCERTS and UKAS accredited laboratory facility. Each sample has been subject to a range of chemical analyses to determine the concentrations of a wide range of common contaminants applicable to the former use of this site and the materials present. Details of the analysis program are shown in table 6 below. Confirmation of the UKAS and MCERTS accreditations for each test is indicated within the results which are appended to this report.*

6.4 Development Proposals

- 6.4.1 *We understand that the site is to be re-developed in a residential manner with associated rear garden areas, areas of hard standing and access roads. It is essential to ensure that the materials present within the sensitive site areas are suitable for retention within a residential environment.*

6.5 Analysis Range

- 6.5.1 *The preliminary conceptual model identifies that there is the potential for a pollutant pathway linkage to be present at the site and that further assessment is required. Table 6 below confirms the range of analyses undertaken upon the samples of topsoil obtained from this site.*

Table 6: Chemical Testing Schedule		
Analysis	Determinands	No. of Samples
Metals	Arsenic, Cadmium, Chromium (total), Copper, Lead, Mercury, Nickel, Selenium, Zinc	9
Organics	PAH – USEPA 16 suite, Phenol	9
Inorganics	Cyanide, Soluble sulphates, Sulphide, pH, TOC	9

6.6 Results

- 6.6.1 *Full details of the chemical analyses results are appended to this report for reference and should be read in conjunction with the comments and recommendations regarding risk assessments. Summaries of the test results are presented in conjunction with the current assessment criteria in Section 7 of this report.*

6.7 Approach

6.7.1 *The current UK approach to the consideration of contaminated land is based upon the principles of risk assessment. This in turn is founded upon the use of a source-pathway-target principle in order to establish the presence of a potential pollutant linkage. Our approach to the risk assessment is consistent with UK guidance and best practice. As advocated in the EA Policy Statement: Guidelines for Environmental Risk Assessment and Management a tiered approach has been adopted. This tiered approach is central to Part IIA of the Environmental Protection Act 1990 and the Town and Country Planning Act 1990.*

6.8 Site Classification

6.8.1 *A sketch of the proposed site layout has been made available to us and we can confirm that it is intended to be developed on a private residential basis utilising large areas of private gardens. Accordingly the site usage has been considered on the basis of an end land use of residential as defined by EA Science Report SC050021/SR3 2009 in relation to the most recent soil guideline values.*

6.9 Criteria

6.9.1 *The concentrations of contaminants within the ground have been compared to a range of generic soil guideline values that have been prepared by DEFRA and the Environment Agency. Where published, soil guideline values (SGV) have been utilised as intervention values for the purpose of an initial tier 1 assessment.*

6.9.2 *At the time of the preparation of this report soil guideline values were available only for a limited number of contaminants and the development of both the CLEA model and additional soil guideline values is on-going. Where published soil guideline values are available they have been utilised as intervention values for the purposes of an initial tier 1 assessment. A number of SGV's have recently been updated to reflect a modern approach to the protection of human health.*

6.9.3 *In March 2014 the Department for Environment Food & Rural Affairs published SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination Policy Companion Document. This document provides a series of Category 4 screening levels based upon differing land uses. Reference has been made to the values presented within this report in relation to the appropriate land usage.*

6.9.4 *Where soil guideline values were not published at the time of preparing this report, generic assessment criteria (GAC) published by Land Quality Management Ltd., in conjunction with the Chartered Institute Of Environmental Health have been adopted. The values published in the "LQM/CIEH S4UL's for Human Health Risk Assessment" Registration No. S4UL3265.*

6.9.5 *Reference has also been made to published soil screening values presented by Atkins Ltd., under their Atrisk Subscription Service. The SSVs have been adopted where SGVs or GACs are not available. The remaining contaminants have been considered based upon information that was the best available at the time of the study.*

7.0 RESULTS OF ANALYSIS & QUALITATIVE RISK ASSESSMENT

7.1 Model

7.1.1 *As discussed above, assessment of contaminated land is based upon a simple assessment of pollutant linkages referred to as the source-pathway-target model.*

This assessment considers the current or proposed usage of the site in terms of suitability for use. This implies the use of risk assessment in principle in order to evaluate the potential effects and concerns of contamination on a site-specific basis.

7.1.2 Initial assessment of the chemical analyses results has been undertaken to assess the concentrations of determinands in relation to tier 1 assessment criteria. The summary of these test results is detailed below.

7.2 Results Summary

7.2.1 The samples were obtained from the topsoil deposits across the whole of the site. Tables 7 - 8 have been prepared as a summary of the laboratory analyses depending upon the class of analyses undertaken and the strata type present. The test results have been compared to the adopted assessment criteria, relating to a proposed residential with home grown produce land usage.

7.3 Metals & Inorganics

7.3.1 Table 7 below indicates the range of contaminants that were included within the metals and inorganics analyses along with their respective assessment criteria. A review of the results has not identified any elevated concentrations of metals or inorganics within the topsoil.

Table 7: Summary of Contamination Analysis – Metals & Inorganics –Topsoil					
	No. of Samples	Range of Values (mg/kg)	Assessment Criteria (mg/kg)	No. of Samples Failing	Locations
Arsenic	9	12.3 – 19.3	37 ³	0	-
Cadmium	9	0.8 – 1.3	11.0 ³	0	-
Chromium (total)	9	50.6 – 65.9	910 ³	0	-
Copper	9	27.0 – 83.0	2400 ³	0	-
Lead	9	60.0 – 188.0	200 ⁴	0	-
Mercury	9	<0.1	40 ³	0	-
Nickel	9	34.2 – 50.9	180 ³	0	-
Selenium	9	<0.1 – 2.0	250 ³	0	-
Zinc	9	138.0 – 226.0	3700 ³	0	-
Total Cyanide	9	<0.5	34.2 ³	0	-
Phenol	9	<0.15 – 0.23	120 ³	0	-
pH	9	6.23 – 7.58	-	0	-
SOM%	9	5.21 – 13.02	-	0	-
SO ₄ (2:1)	9	<0.001 – 0.01	0.5 ⁵	0	-
¹ DEFRA : SP1010 : Category 4 Screening Levels ² Atkins Atrisk SSV residential without home grown produce (1% SOM) ³ LQM and CIEH S4UL's for Human Health Risk Assessment (Registration No. S4UL 3265) – residential with home grown produce (1% SOM) ⁴ BRE Special Digest 1:2005 DS-1.					
					N.D. – None detected.

7.4 Speciated PAH

7.4.1 The topsoil samples retained from the site investigation have been subject to a programme of analyses which have assessed the concentrations of the individual constituents of the polycyclic aromatic hydrocarbon series. A summary of these results is shown in table 8 below. The assessment criteria utilised are based upon the presence of 1% soil organic matter within the samples generally. Reference to the tests results does however show more variable soil organic matter content.

Table 8: Summary of Contamination Analysis: Organics : PAH USEPA 16 Suite - Topsoil					
	No. of Samples	Range of Values (mg/kg)	Assessment Criteria¹ (mg/kg)	No. of Samples Failing	Locations
Acenaphthene	9	<0.01 – 0.25	210	0	-
Acenaphthylene	9	<0.03 – 0.07	170	0	-
Anthracene	9	<0.04 – 0.32	2400	0	-
Benzo[a]anthracene	9	0.13 – 1.10	7.2	0	-
Benzo[a]pyrene	9	0.05 – 0.66	5.0 ²	0	-
Benzo[b]fluoranthene	9	0.09 – 0.98	2.6	0	-
Benzo[ghi]perylene	9	<0.04 – 0.45	320	0	-
Benzo[k]fluoranthene	9	0.03 – 0.38	77.0	0	-
Chrysene	9	0.09 – 1.19	15.0	0	-
Dibenz[ah]anthracene	9	<0.04 – 0.11	0.24	0	-
Fluoranthene	9	0.13 – 2.25	280	0	-
Fluorene	9	<0.04 – 0.16	170	0	-
Indeno[123-cd]pyrene	9	<0.04 – 0.44	27.0	0	-
Naphthalene	9	<0.01 – 0.21	2.3	0	-
Phenanthrene	9	0.08 – 1.51	95.0	0	-
Pyrene	9	0.12 – 1.82	620	0	-
¹ LQM & CIEH S4UL's for human health risk assessment (registration no. S4UL 3265) – Residential with home grown produce (1% SOM)					
² DEFRA : SP1010 : Category 4 Screening Levels					

7.4.2 Assessment of table 8 above has not identified any elevated concentrations of PAH compounds therefore PAH compounds are not considered to pose a potential hazard to long term end users of the site.

7.5 Sulphates

7.5.1 Within the program of laboratory testing each sample has also been analysed to determine the concentration of water soluble sulphates within the ground. Reference to the laboratory results presented by Exova confirms that soluble sulphates are present at concentrations of 0.001 – 0.01g/l. Reference to BRE Special Publication 1 : 2005 "Concrete in Aggressive Ground" confirms that at <0.5g/l, the design sulphate class for this site is DS-1. Accordingly the ACEC class for the site is assessed to be AC-1s on the basis that the site does not have mobile groundwater and the pH value is >5.5. Reference to Table D of BRE Special Publication 1 indicates that the DC class for this site should be considered to be DC-1.

8.0 DISCUSSIONS

8.1 General

8.1.1 The desk study information has identified a recorded history of the site as remaining in agricultural usage throughout its entire history with the presence of a former Roman road located within the eastern area of the site. The site investigation has identified topsoil deposits overlying natural strata over the whole site.

8.1.2 The results of the chemical analyses undertaken upon representative samples of strata obtained from this site have been assessed in Section 7 above and subject to further discussion below.

8.2 Metals & Inorganics

8.2.1 The chemical analyses has not identified any elevated concentrations of metals or inorganics within the topsoil and therefore it is considered suitable for reuse within the proposed residential development.

8.3 PAH Suite

8.3.1 PAH analysis has not identified any elevated concentrations of PAH compounds within the topsoil therefore no remedial action is required in terms of PAH compounds.

8.4 Revised Conceptual Site Model

8.4.1 As a result of these intrusive ground investigations and subsequent program of chemical analyses, it has been possible to revise the preliminary conceptual site model presented in Section 3. The revised conceptual site model is now shown in table 11 overleaf. This report adopts the methodology for risk evaluation presented in CIRIA report C552 'Contaminated Land Risk Assessment – A Guide to Good Practice', 2001. The method is qualitative and involves the classification of the following:

8.4.2 In the context of regulatory definition of 'Contaminated Land' (as defined by the EPA 1990), 'very high' and 'high' risks would fall under the classification of 'Contaminated Land'. 'Moderate' risk could also potentially be classified as 'Contaminated Land' but any lower risk rating would not. Thus the following potential exposure pathways between potential and known contaminant sources based on information provided to date and receptors are tentatively identified in table 9 below.

Table 9: Revised Conceptual Site Model						
Potential Source	Potential Receptor	Possible Pathway	Probability	Consequence	Risk	Mitigation / Investigation
Natural strata	Site personnel during construction	Direct contact of soils Inhalation or ingestion of soil / dust	Lw	Mi	Low	No remediation required. Topsoil is suitable for reuse.
	Future site users	Direct contact of soils Inhalation or ingestion of soil / dust	UI	Md	Low	
	Surface water in the vicinity of the site	Leaching of contaminants through drainage system	UI	Md	Low	
	Ground water in aquifer	Leaching of contaminants to ground water	UI	Md	Low	
	Future site users	Vapour migration from soils	Lw	Mr	Very Low	
	Proposed buildings and services	Direct contact with contaminated soils	Lw	Mi	Low	
	Plants in gardens and soft landscaping	Direct contact	Lw	Mi	Low	
Contaminated ground water	Site personnel during construction	Water entering excavations	Lw	Mi	Low	Groundwater considered to be at significant depth below the site.
	Future site Users	Retained surface water	Lw	Mi	Low	
Toxic and explosive gases	Proposed buildings and occupiers	Ground gas migration into buildings	Lw	Md	Low	CS1 (NHBC Green).
Radon gases	Proposed buildings and occupiers	Ground gas migration into buildings	UI	Sv	Low	No radon ground gas precautions required.
Key: Sv = Severe, Md = Medium, Mi = Mild, Mr = Minor Hi = High, Li = Likely, Lw = Low Likelihood, UI = Unlikely						

8.5 Preliminary Remediation Proposals

8.5.1 Chemical analysis has confirmed that the topsoil material within the site is suitable for reuse within the proposed residential development.

8.6 Foundations

- 8.6.1 *This ground investigation has identified topsoil deposits overlying natural strata comprising mainly of firm to stiff cohesive clays which are considered to offer a safe bearing capacity in the order of 100kN/m² at a minimum depth of 0.9m below ground level. It is anticipated that the majority of the site will adopt traditional strip type foundations constructed at depths varying between 0.9m - 1.5m below ground level.*
- 8.6.2 *Within position TP01 bedrock was identified at depths between 1.7 – 1.9m comprising of dark grey limestone which is considered to offer a safe bearing capacity in excess of 300kN/m². If any foundations extend down onto the bedrock then all remaining foundations should also extend to bedrock to avoid differential settlement. Within positions TP5 and TP6 a dark brown clayey sand has been identified at depths between 0.6 – 1.4m bgl, it is considered that this sand material is capable of offering a reduced safe bearing capacity in the order of 75kN/m².*
- 8.6.3 *The development of the site in close proximity to the existing boundary hedgerows and trees which will require suitable foundation precautions in accordance with NHBC Handbook Chapter 4.2. The depth of foundation required will depend upon the relationship of the tree type and its distance from the proposed structure. The clay material within the site has been identified to have a low volume change potential and based upon this information it is possible that foundations may need locally to extend to depths up to 2.5m or so below existing ground level. A full appraisal of the foundation requirements and precautions should be undertaken by the foundation engineer in conjunction with the detailed arboriculturists report.*

8.7 Ground Floor Construction

- 8.7.1 *It is recommended that suspended ground floor construction be adopted for all properties located within this site. These floors may be of a pre cast concrete beam and block arrangement or of a suitably designed cast insitu reinforced concrete. In those areas where tree root effects are important it is recommended that a pre cast concrete beam and block type floor is utilised to allow for the provision of a suitable air void and heave precautions below the ground floor construction.*

9.0 CONCLUSIONS & RECOMMENDATIONS

9.1 Remediation

- 9.1.1 *Chemical analysis has confirmed that the topsoil material present within the site is suitable for reuse within the garden landscaped areas of the proposed residential development.*

9.2 Foundations

- 9.2.1 *This ground investigation has identified topsoil deposits overlying natural strata comprising mainly of firm to stiff cohesive clays which are considered to offer a safe bearing capacity in the order of 100kN/m² at a minimum depth of 0.9m below ground level. It is anticipated that the majority of the site will adopt traditional strip type foundations constructed at depths varying between 0.9m - 1.5m below ground level.*
- 9.2.2 *Within position TP01 bedrock was identified at depths between 1.7 – 1.9m comprising of dark grey limestone which is considered to offer a safe bearing capacity of 300kN/m². If any foundations extend down onto the bedrock then all remaining foundations should also extend to bedrock to avoid differential settlement.*

Within positions TP5 and TP6 a dark brown clayey sand has been identified at depths between 0.6 – 1.4m bgl, it is considered that this sand material is capable of offering a reduced safe bearing capacity in the order of 75kN/m².

- 9.2.3 *The development of the site in close proximity to the existing boundary hedgerows and trees which will require suitable foundation precautions in accordance with NHBC Handbook Chapter 4.2. The depth of foundation required will depend upon the relationship of the tree type and its distance from the proposed structure. The clay material within the site has been identified to have a low volume change potential and based upon this information it is possible that foundations may need locally to extend to depths up to 2.5m or so below existing ground level. A full appraisal of the foundation requirements and precautions should be undertaken by the foundation engineer in conjunction with the detailed arboriculturists report.*

9.3 Ground Floor Construction

- 9.3.1 *It is recommended that suspended ground floor construction be adopted for all properties located within this site. These floors may be of a pre cast concrete beam and block arrangement or of a suitably designed cast insitu reinforced concrete. In those areas where tree root effects are important it is recommended that a pre cast concrete beam and block type floor is utilised to allow for the provision of a suitable air void and heave precautions below the ground floor construction.*

9.4 SUDS

- 9.4.1 *Assessment of the ground conditions present within this site in terms of sustainable urban drainage confirms that the superficial deposits throughout the site comprise of impermeable cohesive clay and it is considered that the site will not be capable of a soakaway system of surface water disposal and drainage will have to connect to existing sewers.*

9.5 Further Work

- 9.5.1 *If any unusual or suspicious strata or ground conditions are encountered during the subsequent site stripping preparation work, it will be necessary for these areas to be brought to the attention of the appropriate authorities so that all necessary inspection, sampling and testing may be undertaken to determine whether these materials present a hazard to human health. It is incumbent upon the site contractors to advise a responsible authority of any unusual findings within the site which may then be further investigated.*

10.0 NOTES

- 10.1 *All reports are for advisory purposes only and all design decisions are the ultimate responsibility of others.*
- 10.2 *Unless stated otherwise the investigation has been undertaken in general accordance with the recommendations given in BS 5930 : 1999 "A Code of Practice for site Investigations" and the laboratory testing has been carried out in accordance with BS 1377 : 1990 "Methods of Test for Civil Engineering Purposes".*
- 10.3 *Soil and rock descriptions are generally based on the scales of strength and relative density within BS 5930 although it should be noted that in certain circumstances descriptions are based on site records or a qualitative assessment without the benefit of in-situ or laboratory test results.*

- 10.4** *The assessment of ground conditions given in this report is based on the results of the fieldwork and laboratory testing carried out and there may be other conditions at the site not encountered by these works, which have not been taken into account.*
- 10.5** *The scope of the investigation and information provided may not necessarily reflect all the geotechnical and environmental aspects related to the site, and the omission of certain items does not mean that the site is unaffected by such problems.*
- 10.6** *It should be noted that groundwater levels can vary and may at times be significantly different to those recorded during the investigation and attention is drawn to BS 5930 which indicates that measurements may be necessary over an extended period of time to investigate changes in groundwater pressures due to seasonal, tidal and other causes.*
- 10.7** *Any recommendations on construction methods within this report are for initial guidance only and all design proposals remain the responsibility of the appropriate contractor/consultant.*
- 10.8** *Further assessment, investigation, construction activities or time may reveal conditions that were not found during the period of investigation and, therefore, could not have been taken into account in the preparation of the report and where such information might impact upon the stated opinion R. E. Fry & Associates Ltd request the opportunity to review such information and modify the report if necessary.*
- 10.9** *Where information has been obtained from sources other than the direct findings of the investigation, R. E. Fry & Associates Ltd cannot and does not guarantee the authenticity or reliability of this information.*
- 10.10** *Where opinions expressed in this report are based on current available guidelines and legislation, no liability can be accepted by R. E. Fry & Associates Ltd for the effects of any future changes to such guidelines and legislation.*
- 10.11** *This report has been prepared on the instructions and to the requirements of the named client and any unauthorised party using this information for any purpose does so at his own risk and any duty of care to that party is excluded.*

Signed for and on behalf of
R E FRY & ASSOCIATES LIMITED



Mark Davies B.Sc(Hons)
R E FRY & ASSOCIATES LTD

Signed for and on behalf of
R E FRY & ASSOCIATES LIMITED



R E FRY B Sc (Hons), C Eng., MI Struct.E.