PHASE II GEO-ENVIRONMENTAL SITE ASSESSMENT

Land off Long Lane
Chapel-en-le-Frith
Derbyshire
SK23 0TA

Prepared for:

Seddon Homes

Report Ref: 10-633-r1
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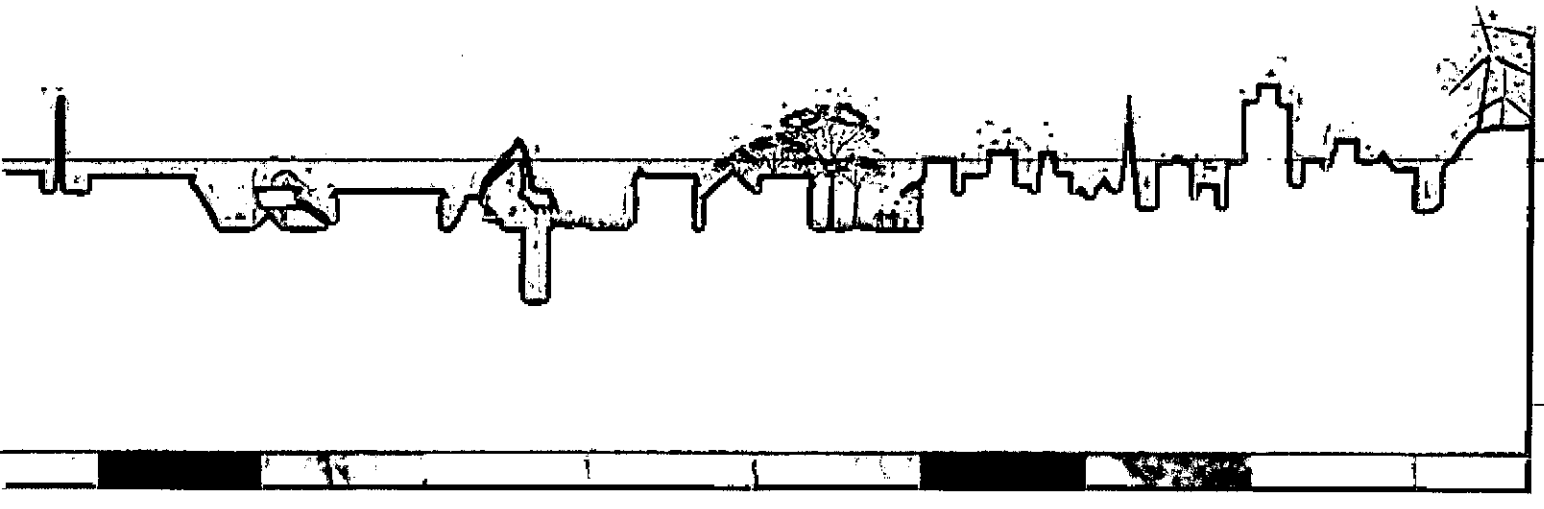

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QUALITY ASSURANCE

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PROJECT NUMBER	10-633

Executive Summary		
Site Address	Land off Long Lane, Chapel en le Frith, Derbyshire, SK23 0TA	
Grid Reference	E 405620, N 379740	
Site Area	Circa 6.2 Ha.	
Current Site Use	The site is undeveloped farmland, subdivided into individual fields by hedges and mounds. Warm Brook watercourse is present on the south eastern edge of the site. A railway embankment forms the western boundary which has an estimated height of 7m about the site level.	
Proposed Development	Seddon Homes intend to construct a low rise residential development with associated garden and landscaped areas, adopted estate roads and infrastructure.	
Environmental Setting	*Drift Geology*	Till (Devensian – Clay)
	Bedrock Geology	Millstone Grit Formation.
	Hydrogeology	Unproductive (drift) over Secondary A Aquifer in the bedrock geology.
	Hydrology	Warm Brook watercourse is present on the south eastern edge of the site.
	Flood Risk	The site is not located within a currently defined flood risk zone.
	Compressible Ground and Subsidence Hazards	Very Low Hazard.
Site History	Historical maps indicate the site has been undeveloped land since the earliest mapping series.	
Utility Locations	A formal utility survey has not been completed, however utility connections are available in Long Lane to the east of the site.	
Landfill Sites & Ground Gases	There are no recorded or historical landfill sites located within 250m of the subject site. Any ground gas risk would be associated with potential depths of Made Ground or alluvial soils on the site.	
Radon	Unaffected-no special precautions required.	

E3P Intrusive Ground Investigation	
Ground and Groundwater Conditions	Made Ground Made Ground was encountered in just two exploratory hole locations, ranging in thickness from 0.70m to 2.10mbgl. The Made Ground in TP101, on the edge of the stockpile of materials in the eastern corner of the site, comprised a dark brown gravelly sand (topsoil) with gravel of mudstone and clinker over firm gravelly clay with occasional cobbles and boulders. Gravel comprised sandstone, mudstone, concrete and shale. Large obstructions were encountered in TP101 in a mound in the eastern corner of the proposed development sector comprising large pieces of timber, concrete and shale with concrete obstructions to the north and south of the trial pit, where drainage runs are present. In TP107 in the north western sector of the site, the localised Made Ground comprised dark brown gravelly sand (topsoil) over orange brown very gravelly sand with gravel of sandstone over a soft black sandy gravelly clay with gravel of brick, shale, sandstone and mudstone. Drift Deposits Drift deposits were encountered in all exploratory hole locations from depths of between 0.10m and 2.10m bgl to a maximum proven depth of 5.45m bgl (full depth not proven). Drift deposits generally comprised firm orange brown sandy CLAY in the shallow horizons overlying stiff to very stiff high strength brown slightly gravelly CLAY with occasional gravel of sandstone and mudstone.
	Solid Geology The solid geology was not encountered during this investigation. Groundwater Groundwater was encountered as occasional seepages between 1.0m and 4.2mbgl.
Contaminated Land Risk Assessment	
Human Health	Chemical analysis completed to date has not highlighted any elevated determinants within the topsoil or underlying natural drift deposits and is therefore considered to be suitable for use within the residential development with no specialist mitigation measures required.
Controlled Waters	No significant sources of potential contamination have been identified at the site which are considered likely to pose a risk to controlled waters or the wider environ.
Ground Gas	Ground gas monitoring is currently being completed and a detailed ground gas risk assessment will be provided on completion of the final monitoring surveys. However, initial monitoring indicates that the site is Characteristic Situation 2 / Amber 1 which suggests low level protection measures
Potable Water Infrastructure	Chemical analysis would suggest that Polyethylene (PE) pipeline will be suitable for the proposed residential development.

Geotechnical Assessment	
Underground Obstructions	Obstructions were only encountered in TP101 in a mound in the south eastern corner of the proposed development sector comprising large pieces of timber, concrete and shale with concrete obstructions to the north and south of the trial pit, where drainage runs are present, however not within the main of the site.
Allowable Bearing Potential	The underlying natural clays were encountered at a shallow depth throughout the site and were found to have a net Allowable Bearing Pressure of 82kN/m² to 155kN/m² at circa 1.00m and 75kN/m² to 131kN/m² at 2.0mbgl.
Foundation Options	Foundation depths should take account of the presence of existing trees with foundations deepened locally in accordance with the requirements of NHBC standards for a clay of intermediate plasticity. It is recommended that at working drawing stage a foundation schedule is prepared for the development taking account of the soil plasticity and the locations of trees. It is considered that proposed dwellings can be constructed using a traditional spread foundation bearing on the target founding stratum of firm medium strength to stiff high strength clays. Foundations will require deepening in locations where significant depths of Made Ground are encountered. Heave precautions will be required within foundations to be constructed within the area influenced by former / current trees due to the presence of moderate plasticity soils.
Heave Precautions	Heave precautions will be required within foundations to be constructed within the areas influenced by former / current trees.
Floor Slabs	The presence of moderate plasticity clay soils and variable localised areas of Made Ground will necessitate the use of a suspended floor slab in the construction of the proposed dwellings.
Soakaway Drainage	Soakaway drainage is unlikely to be suitable due to the presence of widespread cohesive deposits.
Sulphate Assessment	Concrete classification will in all likelihood be DS1 AC2z due to the slightly acidic nature of the natural soils in the area.
CBR Design %	The clay soil will provide a CBR in the region of 3-6% depending on climatic conditions during earthworks.
Cut / Fill	Topsoil will be generated during the site strip and it is understood that a phase of cut/fill works will be required in accordance with the planning permission. It is recommended that a detailed isopachyte cut/fill model is completed at the site once development levels are available. This model can be used to inform the whole project spoil management. This model will also be used to define the most cost effective ground engineering solution to support foundations for dwellings and infrastructure.
Waste Classification	Stable Non-Reactive Inert

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APPENDICES

1. INTRODUCTION

1.1 Background

E3P Ltd have been commissioned by Seddon Homes to undertake a Phase II Intrusive Geo-Environmental Site Investigation at land off Long Lane in Chapel-en-le-Frith.

The scope of work consisted of an intrusive Ground Investigation, laboratory testing and interpretive geotechnical and contamination risk which comprised the following key elements:

- *Six window sample probeholes with all six being completed as environmental monitoring installations;*
- *Fifteen Mechanically Excavated Trial Holes;*
- *In-situ Geotechnical Testing;*
- *Dynamic Cone Penetrometer Testing;*
- *Laboratory analysis;*
- *Groundwater monitoring and sampling;*
- *Ground gas monitoring;*
- *Contamination Risk Assessment;*
- *Geotechnical Assessment & Interpretation; and,*
- *Factual and interpretive reporting.*

1.2 Proposed Development

Seddon Homes intend to construct a low rise residential development with associated garden and landscaped areas, adopted estate roads and infrastructure. An initial proposed development layout is detailed in Figure 1.1 below and is included in Appendix III as Drawing 10-663-006.

Figure 1.1 Proposed Development Layout

1.3 Objectives

- Undertake a preliminary stage of sampling and analysis to provide an overview of environmental issues identified;
- Assess the implications of any potential environmental risks, liabilities and development constraints associated with the site in relation to the future use of the site and in relation to off-site receptors;
- Assess the geotechnical information and provide preliminary recommendations in relation to foundations, pavement construction and floor slabs; and,
- Provide recommendations regarding future works required

1.4 Limitations

The limitations of this report are presented in Appendix I.

1.5 Previous Reports

The following report has previously been completed for the site and should be read in conjunction with this report:

Carley Daines & Partners – Phase I Preliminary Risk Assessment. Ref: 13-B-10103

E3P has reviewed the above mentioned report and the pertinent points are summarised below:

- *The site is undeveloped farmland, subdivided into individual fields by hedges and mounds. Warm Brook watercourse is present on the south eastern edge of the site. A railway embankment forms the western boundary which has an estimated height of 7m about the site level;*
- *Historical maps indicate the site has been Greenfield land since the earliest mapping series;*
- *Geological maps indicate the site is underlain by Glacial Till which is in turn underlain by Millstone Grit; and,*
- *The initial Conceptual Site Model identifies the site is at low level potential risk of contamination from heavy metals, PAHs and TPHs from the adjacent railway.*

The findings of the above mentioned report were utilised to inform the design of the Ground Investigation.

1.6 Confidentiality

E3P has prepared this report solely for the use of the Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from E3P; a charge may be levied against such approval.

2. E3P GROUND INVESTIGATION

2.1 General

A Ground Investigation has been designed with exploratory holes advanced to provide information on baseline conditions across the site. The investigation has also been used to collect preliminary geotechnical information to assist in the design and construction of the development.

Exploratory fieldwork was completed on the 29th June 2015. The works are summarised in Table 2.1 below:

Table 2.1 Summary of Fieldwork

POTENTIAL SOURCE / RATIONALE	LOCATION HOLE	TYPE	MONITORING INSTALLATION	MAXIMUM DEPTH (m bgl)
Investigation of ground conditions, depth and nature of any Made Ground within the northern field.	TP101-TP106	Mechanically Excavated Trial Pit	N/A	3.10
Investigation of ground conditions, depth and nature of any Made Ground within the western field.	TP107-TP111	Mechanically Excavated Trial Pit	N/A	2.70
Investigation of ground conditions, depth and nature of any Made Ground within the eastern field.	TP112-TP115	Mechanically Excavated Trial Pit	N/A	2.20
Investigation of ground conditions, in-situ geotechnical testing and installation of environmental monitoring well in northern field.	WS101	Window Sample	1.00-5.00	5.45
	WS102	Window Sample	1.00-4.00	5.00
	WS103	Window Sample	1.00-4.00	5.45
Investigation of ground conditions, in-situ geotechnical testing and installation of environmental monitoring well in western field.	WS104	Window Sample	0.50-3.50	5.45
	WS105	Window Sample	0.50-3.00	3.00
Investigation of ground conditions, in-situ geotechnical testing and installation of environmental monitoring well in eastern field.	WS106	Window Sample	1.00-4.00	5.45

The sampling locations are illustrated in Drawing 10-663-004 (Appendix III). The ground conditions encountered are indicated on the logs which are provided in Appendix V.

2.2 In-Situ Standard Penetration Testing (SPT)

In-situ geotechnical testing was conducted using the Standard Penetration Test (SPT) and where the ground is granular, a 60° cone (SPT(C)) was used instead of the sampling tube. The results are shown in the probehole logs in Appendix V, presented in Table 3.2 and discussed in Section 5.0.

2.3 In-Situ California Bearing Ration (CBR)

In-situ CBR tests were undertaken at selected locations using a TRL probe. Tests were undertaken at depths of between 300mmm and 1m below ground level in order to intersect the likely pavement sub formation level. The results are presented in Table 3.8 and discussed in Section 5.0.

2.4 Laboratory Analysis

Selected soil and groundwater samples were submitted to I2 Analytical for a range of chemical analysis comprising:

- Metals, cyanide, pH, total sulphate, water soluble sulphate (2:1 extract), sulphide;
- Asbestos;
- Phenols;
- Total and speciated poly-aromatic hydrocarbons (PAHs);
- Semi-Volatile Organic Compounds (SVOCs)
- Total and speciated petroleum hydrocarbon (TPH); and
- Total Organic Carbon (TOC).

Laboratory analysis sheets are included in Appendix VI and are discussed in Section 4.0.

Selected samples were submitted to Professional Soils Laboratory (PSL) where the following geotechnical tests were undertaken:

- Atterberg Limits Determinations;
- Moisture Content; and,
- Undrained Shear Strength-Single Stage Triaxial

Laboratory analysis sheets are included in Appendix VIII and are summarised in Section 3.0.

3. GROUND AND GROUNDWATER CONDITIONS

3.1 Ground and Groundwater Conditions

3.1.1 Summary of Ground Conditions

The Ground Investigation generally confirms the published geology and identifies the strata set out in Table 3.1 below:

Table 3.1 Summary of Strata

STRATA:	GENERAL DESCRIPTION:	TYPICAL DEPTH (MBGL):				LOCATION
		TOP:		BASE:		
		MIN:	MAX:	MIN:	MAX:	
MADE GROUND	Firm dark brown sandy slightly gravelly clay with plastic sheets and occasional cobbles and boulders.	0.20	0.20	2.10	2.10	TP101
MADE GROUND	Orange brown very gravelly fine to coarse sand. Gravel is fine to coarse angular to sub-angular of mudstone and sandstone.	0.10	0.10	0.40	0.40	TP107
TOPSOIL-CLAY	Soft dark brown very sandy CLAY (TOPSOIL) with rootlets.	0.00	0.00	0.10	0.30	TP102-TP106, TP109-TP110, TP111, TP113-TP115, WS102, WS103
TOPSOIL-SAND	Dark brown clayey fine to coarse SAND with rootlets (Topsoil).	0.00	0.00	0.10	0.30	TP108, TP112, WS104, WS105, WS106
CLAY[1]	Soft to firm orange brown very sandy slightly gravelly CLAY. Gravel is fine to coarse sub-angular to sub-rounded of sandstone.	0.10	0.70	0.90	1.8	TP102-TP115, WS101-WS105
CLAY[2]	Stiff to very stiff very high strength dark grey brown slightly sandy slightly gravelly CLAY. Gravel is fine to coarse sub-rounded of mudstone.	0.90	2.10	1.80	5.45	TP101-TP115, WS101-WS102, WS104-WS106

3.1.2 Made Ground

Made Ground was encountered in just two exploratory hole locations, ranging in thickness from 0.70m to 2.10mbgl. The Made Ground in TP101, on the edge of the stockpile of materials in the eastern corner of the site, comprised a dark brown gravelly sand (topsoil) with gravel of mudstone and clinker over firm gravelly clay with occasional cobbles and boulders. Gravel comprised sandstone, mudstone, concrete and shale.

Large obstructions were encountered in TP101 in a mound in the eastern corner of the proposed development sector comprising large pieces of timber, concrete and shale with concrete obstructions to the north and south of the trial pit, where drainage runs are present.

In TP107 in the north western sector of the site, the localised Made Ground comprised dark brown gravelly sand (topsoil) over orange brown very gravelly sand with gravel of sandstone over a soft black sandy gravelly clay with gravel of brick, shale, sandstone and mudstone.

3.1.3 Drift

Drift deposits were encountered in all exploratory hole locations from depths of between 0.10m and 2.10m bgl to a maximum proven depth of 5.45m bgl (full depth not proven). Drift deposits generally comprised firm to stiff orange brown sandy CLAY in the shallow horizons overlying stiff to very stiff high strength brown slightly gravelly CLAY with occasional gravel of sandstone and mudstone.

3.1.4 Bedrock

The bedrock geology was not encountered as part of the Ground Investigation.

Table 3.2 Standard/Cone Penetration Test Results

BOREHOLES	DEPTH (M BGL)	MATERIAL FIELD DESCRIPTION	CPT/SPT "N" VALUE	CORRECTED "N" VALUE $(N_1)_{60}$	TERZAGHI & PECK RELATIVE DENSITY (SANDS)	EUROCODE SOIL STRENGTH	CONSISTENCY (BS5930)	TERZAGHI & PECK APPROXIMATE UNDRAINED SHEAR STRENGTH (KN/M²)
WS101	1.00	Stiff sandy gravelly CLAY	15	15.12	N/A	High strength	Very Stiff	75.61
	2.00	Stiff gravelly CLAY	13	11.88	N/A	Medium strength	Stiff	59.38
	3.00	Stiff gravelly CLAY	12	10.44	N/A	Medium strength	Stiff	52.18
	4.00	Stiff gravelly CLAY	12	10.14	N/A	Medium strength	Stiff	50.69
	5.00	Stiff gravelly CLAY	23	19.08	N/A	High strength	Very Stiff	95.41
WS102	1.00	Firm to stiff CLAY	9	9.07	N/A	Medium strength	Stiff	45.37
	2.00	Firm to stiff slightly gravelly CLAY	14	12.79	N/A	Medium strength	Stiff	63.95
	3.00	Firm to stiff slightly gravelly CLAY	10	8.70	N/A	Medium strength	Stiff	43.48
	4.00	Firm to stiff slightly gravelly CLAY	9	7.60	N/A	Low strength	Firm	38.02
WS103	1.00	Firm to stiff CLAY	12	12.10	N/A	Medium strength	Stiff	60.49
	2.00	Firm becoming stiff slightly gravelly CLAY	8	7.31	N/A	Low strength	Firm	36.54
	3.00	Firm becoming stiff slightly gravelly CLAY	8	6.96	N/A	Low strength	Firm	34.79
	4.00	Firm becoming stiff slightly gravelly CLAY	10	8.45	N/A	Medium strength	Stiff	42.24
	5.00	Firm becoming stiff slightly gravelly CLAY	13	10.79	N/A	Medium strength	Stiff	53.93
WS104	1.00	Stiff gravelly CLAY	12	12.10	N/A	Medium strength	Stiff	60.49
	2.00	Stiff gravelly CLAY	11	10.05	N/A	Medium strength	Stiff	50.24
	3.00	Stiff gravelly CLAY	10	8.70	N/A	Medium strength	Stiff	43.48
	4.00	Stiff gravelly CLAY	11	9.29	N/A	Medium strength	Stiff	46.47
	5.00	Stiff gravelly CLAY	45	37.33	N/A	Very high strength	Very Stiff	186.66

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BOREHOLES	DEPTH (M BGL)	MATERIAL FIELD DESCRIPTION	CPT/SPT "N" VALUE	CORRECTED "N" VALUE $(N_1)_{60}$	TERZAGHI & PECK RELATIVE DENSITY (SANDS)	EUROCODE SOIL STRENGTH	CONSISTENCY (BS5930)	TERZAGHI & PECK APPROXIMATE UNDRAINED SHEAR STRENGTH (KN/M²)
WS105	1.00	Stiff slightly gravelly CLAY	8	8.07	N/A	Medium strength	Stiff	40.33
	2.00	Stiff slightly gravelly CLAY	20	18.27	N/A	High strength	Very Stiff	91.35
	3.00	Stiff slightly gravelly CLAY	50	43.48	N/A	Very high strength	Very Stiff	217.41
WS106	1.00	Stiff slightly gravelly CLAY	9	9.07	N/A	Medium strength	Stiff	45.37
	2.00	Stiff slightly gravelly CLAY	18	16.44	N/A	High strength	Very Stiff	82.22
	3.00	Stiff slightly gravelly CLAY	12	10.44	N/A	Medium strength	Stiff	52.18
	4.00	Stiff slightly gravelly CLAY	11	9.29	N/A	Medium strength	Stiff	46.47
	5.00	Stiff slightly gravelly CLAY	10	8.30	N/A	Medium strength	Stiff	41.48

3.2 pH and Sulphate

Chemical analyses for pH and soluble sulphate content contained in Appendix VI (summarised below in Table 3.3, shows that the soils at the site generally meet Class DS-1, Aggressive Chemical Environment for Concrete Classification (ACEC) AC-1s in accordance with BRE Special Digest 1 (2005). However five of the tested samples returned pH values of <6.5 indicating concrete class AC-2z classification should be used.

Soils are known to be slightly acidic in the site locality and within the Peak District where there are expanses of rough scrubland and heath therefore these slightly acidic results are thought to be associated with the nature of the natural soils in this area.

Table 3.3 Summary of pH and Sulphate Data

LOCATION	DEPTH (m)	SO_4 IN 2:1 WATER / SOIL (g/l)	pH VALUE
WS103	2.40	0.018	8.3
WS105	2.30	0.0040	5.2
WS106	3.20	0.023	8.3
TP101	1.10	0.041	8.1
TP103	2.00	0.017	8.2
TP104	0.20	0.031	6.1
TP106	2.20	0.014	6.8
TP107	0.50	0.11	6.0
TP109	0.20	0.018	5.7
TP111	0.60	0.026	6.5
TP113	0.10	0.082	5.5

3.3 Groundwater Conditions

Groundwater was encountered as occasional seepages between 1.00m and 4.20mbgl. The depth of the seepages and the depth to which groundwater rose are shown on the exploratory hole records and summarised in Table 3.4 below:

Table 3.4 Summary of Groundwater Strikes

LOCATION	DEPTH TO STRIKE (m)	NOTES
TP106	2.10	Seepage
WS103	2.40	
WS103	3.20	
TP107	2.30	
TP108	1.30	
TP110	1.00	
WS104	2.00	
WS104	3.00	
WS104	4.20	
WS105	2.00	
WS106	3.20	

3.4 Soil Consistency

Undrained shear strength values were measured using field hand shear vane tests and laboratory tests. Results of the tests are presented in Tables 3.5 and 3.6 and show the clay soils to vary between stiff and very stiff. Strength test data is generally consistent with the field descriptions of the soils given above.

Table 3.5 Summary of Hand Shear Vane Field Tests

LOCATION	DEPTH	SHEAR STRENGTH KPA	CALCULATED ALLOWABLE BEARING PRESSURE KN/M²
TP103	0.75	34	79.9
TP103	1.40	84	197.4
TP105	1.50	120	282
TP105	2.50	72	169.2
TP106	2.50	85	199.75
TP111	0.80	62	145.7
TP111	1.20	106	249.1
TP113	1.00	70	164.5
TP115	0.80	54	126.9
TP115	1.80	120	282
TP101	0.50	35	82.25
TP101	2.20	116	272.6
TP102	2.00	89	209.15
TP102	2.20	62	145.7
TP104	2.00	98	230.3
TP104	1.50	91	213.85
TP107	1.00	89	209.15
TP108	1.50	120	282
TP108	0.30	74	173.9
TP109	0.60	68	159.8
TP109	1.40	120	282
TP110	0.90	86	202.1
TP112	1.50	120	282

Table 3.6 Summary of Undrained Shear Strength Test Results

LOCATION	SAMPLE DEPTH (M)	LAB DESCRIPTION	UNDRAINED SHEAR STRENGTH (KN/M²)	CONSISTENCY
WS104	2.5-3.0	Stiff brown slightly gravelly sandy CLAY.	84	Stiff
WS106	0.5-1.0	Soft brown slightly sandy CLAY	34	Soft

Results of the Standard Penetration Tests, including undrained shear strengths derived from SPTs are included on Table 3.2.

3.5 Soil Plasticity

The Liquid and Plastic Limits of samples of natural in-situ clay are determined using the cone penetrometer method and the rolling thread test. These tests enable determination of an average Plasticity Index (PI) for each "type" of clay, although judgement is applied where variable results are reported.

PI can be related to shrinkability (low, medium or high) and then to minimum founding depth.

E3P typically only consider a soil to be shrinkable if the proportion finer than 63µm is >35%. PI results are compared against guidance given in the NHBC Standards, Chapter 4.2 (revised January 2014), which advocates the use of modified Plasticity Index (I'p), defined as:

I'p = Ip * (%< 425µm/100)

ie if PI is 30%, but the soil contains 80% < 425µm, then: I'p = 30 * 80/100 = 24%.
It should be noted that in accordance with the requirements of BS 1377, the % passing the 425µm sieve is routinely reported by testing labs.

E3P apply engineering judgment where PI results are spread over a range of classifications. Consideration is given to the average values for each particular soil type (ie differentiate between residual soil and alluvium), the number of results in each class and the actual values.

Table 3.7 Summary of Plasticity Index Test Results

LOCATION	DEPTH (m)	NATURAL MOISTURE CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	% PASSING 425µm SIEVE	MODIFIED PLASTICITY INDEX
WS101	2.00	24	21	42	21	100	21
WS102	1.00	27	27	61	34	100	34
WS104	3.00	29	29	67	38	100	38
WS105	1.00	27	24	48	24	100	24
WS106	2.00	23	24	50	26	100	26

The results of the plasticity tests show the clay at the site to be of intermediate plasticity.

3.6 California Bearing Ratio

The California Bearing Ratio (CBR) for the soils were measured using in situ Dynamic Cone Penetrometer Tests. The results are summarised in Table 3.8 (overleaf).

In situ tests were undertaken using a TRL probe. The result certificates are included in Appendix IX and the locations are shown on Drawing 10-633-004 (Appendix III). CBR results have been averaged from the blow counts across the strata tested and any abnormally high blow counts ignored as these are likely to be from larger granular material and so represent anomalies.

Table 3.8 Summary of CBR Testing

LOCATION	DEPTH (m)	STRATA	CBR (%)
DCP101	0.00-0.24	Soft sandy CLAY (TOPSOIL)	1.91
	0.24-0.63	Firm very sandy slightly gravelly CLAY	4.95
	0.63-0.86	Firm very sandy slightly gravelly CLAY	11.24
DCP102	0.00-0.31	Soft sandy slightly gravelly CLAY (TOPSOIL)	2.24
	0.31-0.65	Soft to firm CLAY	6.44
	0.65-0.82	Soft to firm CLAY	12.32
DCP103	0.00-0.21	Soft slightly gravelly CLAY (TOPSOIL)	3.37
	0.33-0.82	Firm to stiff sandy CLAY	14.53
DCP104	0.00-0.22	Soft sandy CLAY (TOPSOIL)	2.13
	0.22-0.67	Soft to firm sandy gravelly CLAY	4.29
	0.67-0.77	Soft to firm sandy gravelly CLAY	7.26
DCP105	0.00-0.32	Gravelly fine to medium SAND (TOPSOIL)	3.74
	0.32-0.63	Firm sandy slightly gravelly CLAY	4.68
	0.63-0.84	Firm sandy slightly gravelly CLAY	10.87
DCP106	0.00-0.19	Soft sandy slightly gravelly CLAY (TOPSOIL)	2.43
	0.19-0.50	Firm to stiff sandy slightly gravelly CLAY	3.82
	0.50-0.76	Firm to stiff sandy slightly gravelly CLAY	4.73
DCP107	0.00-0.19	Fine to medium SAND (TOPSOIL)	2.37
	0.19-0.55	Soft sandy CLAY	7.61
	0.55-0.70	Soft sandy CLAY	12.63
	0.70-0.85	Soft sandy CLAY	6.50

3.7 Ground Gas

Concentrations of methane (CH_4), carbon dioxide (CO_2) and Oxygen (O_2) were measured using a calibrated infra-red gas analyser with gas flow rates measured using an integrated flow meter.

Gas measurements were recorded for a minimum of sixty seconds at each location, at which point the maximum concentration of CH_4 and CO_2 together with the lowest concentration of O_2 were recorded. The results of the ground gas monitoring are presented in Table 3.9 overleaf.

Table 3.9 Summary of Ground Gas and Groundwater Monitoring

WELL	DATE	CH_4 INITIAL %V/V	CH_4 STEADY %V/V	CH_4 GSV L/HR	CO_2 INITIAL %V/V	CO_2 STEADY %V/V	CO_2 GSV L/HR	O_2 %V/V	ATMOS (MB)	ATMOS. DYNAMIC	FLOW (L/HR)	RESPONSE ZONE (MBGL)	DEPTH TO BASE (MBGL)	DEPTH TO WATER (MBGL)
WS101	08/07/2015	0.10	0.10	-0.00463	0.80	0.80	-0.03704	20.30	984	Rising	-4.63	1.00-5.00	4.43	0.75
	23/07/2015	0.10	0.10	-0.0023	0.70	0.70	-0.0161	20.50	999	Steady	-2.30		4.45	0.80
	12/08/2015	0.10	0.10	0.00205	3.10	3.10	0.06355	19.20	999	Falling	2.05		4.45	0.97
WS102	08/07/2015	0.10	0.10	0.00013	2.50	2.50	0.00325	18.40	984	Rising	0.13	1.00-4.00	3.95	3.11
	23/07/2015	0.10	0.10	0.0001	2.10	2.10	0.0021	19.50	999	Steady	0.10		3.96	3.20
	12/08/2015	0.10	0.10	0.00079	0.20	0.10	0.00158	20.90	999	Falling	0.79		3.94	0.87
WS103	08/07/2015	0.10	0.10	0.00039	1.10	1.10	0.00429	20.00	984	Rising	0.39	1.00-4.00	3.13	0.94
	23/07/2015	0.10	0.10	0.00013	0.90	0.90	0.00117	20.20	999	Steady	0.13		3.15	0.90
	12/08/2015	0.10	0.10	0.00039	4.70	4.70	0.01833	17.00	999	Falling	0.39		3.10	1.27
WS104	08/07/2015	0.10	0.10	0.00013	0.50	0.50	0.00065	20.60	984	Rising	0.13	1.00-3.00	3.23	1.21
	23/07/2015	0.10	0.10	0.00013	0.40	0.40	0.00052	20.70	999	Steady	0.13		3.24	1.25
	12/08/2015	0.10	0.10	0.00052	0.10	0.10	0.00052	21.30	999	Falling	0.52		3.18	1.60
WS105	08/07/2015	0.10	0.10	0.00908	0.80	0.80	0.07264	20.40	984	Rising	9.08	1.00-3.00	2.70	0.90
	23/07/2015	0.10	0.10	0.0071	0.90	0.90	0.0639	20.10	999	Steady	7.10		2.71	1.10
	12/08/2015	0.10	0.10	0.00039	0.10	0.10	0.00039	21.20	999	Falling	0.39		2.67	1.07
WS106	08/07/2015	0.10	0.10	0.00013	0.30	0.30	0.00039	20.40	984	Rising	0.13	1.00-4.00	3.85	3.54
	23/07/2015	0.10	0.10	0.00013	0.40	0.40	0.00052	20.10	999	Steady	0.13		3.85	3.60
	12/08/2015	0.10	0.10	0.00052	0.10	0.10	0.00052	21.00	999	Falling	0.52		3.83	0.58

4. CONTAMINATED LAND RISK ASSESSMENT

4.1 Human Health Risk Assessment

At a Tier 1 stage the long term (chronic) human health toxicity of the soil has been assessed by comparing the on-site concentrations of organic and inorganic compounds with reference values published by the EA (Contaminated Land Exposure Assessment (CLEA) Soil Guideline Values (SGV)) and where absent, Generic Assessment Criteria (GACs) published by LQM/CIEH (2nd edition).

The results of this comparison have been summarised within Table 4.1 (overleaf).

Table 4.1 Summary of Inorganic and Hydrocarbon Toxicity Assessment for a Residential End Use

DETERMINANT	UNIT	GAC	N	MC	LOC. OF EX/(m)	PATH WAY	ASSESSMENT
Arsenic**	mg/kg	37	16	17		1	
Cadmium**	mg/kg	17	16	0.4		1	
Chromium (VI)**	mg/kg	6.1	11	<4.0		1	
Lead**	mg/kg	200	16	110		1	
Mercury(ii)	mg/kg	11	16	0.4		2	
Nickel	mg/kg	180	16	62		1	
Selenium	mg/kg	250	16	<1.0		1	
Copper(i)	mg/kg	2400	16	48		1	
Zinc(i)	mg/kg	3700	16	130		1	
Cyanide - Total	mg/kg	791	11	<1.0		1	
Phenols - Total.	mg/kg	210	11	<1.0		1	
Asbestos	Fibres	NFD	5	NFD			
Naphthalene	mg/kg	2.3	16	0.29		2	
Acenaphthylene	mg/kg	170	16	<0.10		3	
Acenaphthene	mg/kg	210	16	0.43		1	
Fluorene	mg/kg	170	16	0.27		1	
Phenanthrene	mg/kg	95	16	1.4		3	
Anthracene	mg/kg	2400	16	0.32	N/A	3	No Further Action
Fluoranthene	mg/kg	280	16	1.7		3	
Pyrene	mg/kg	620	16	1.4		3	
Benzo(a)Anthracene	mg/kg	7.2	16	0.61		3	
Chrysene	mg/kg	15	16	0.74		3	
Benzo(b)Fluoranthene	mg/kg	2.6	16	0.72		3	
Benzo(k)Fluoranthene	mg/kg	77	16	0.55		3	
Benzo(a)Pyrene**	mg/kg	5	16	0.49		3	
Indeno(123-cd)Pyrene	mg/kg	27	16	0.27		3	
Dibenzo(a,h)Anthracene	mg/kg	0.24	16	<0.10		3	
Benzo(ghi)Perylene	mg/kg	320	16	0.35		3	
TPH C5-C6 (aliphatic)*	mg/kg	42	16	<1.0		2	
TPH C6-C8 (aliphatic)*	mg/kg	100	16	<0.1		2	
TPH C8-C10 (aliphatic)*	mg/kg	27	16	<0.1		2	
TPH C10-C12 (aromatic)*	mg/kg	74	16	3.0		2	
TPH C12-C16 (aromatic)*	mg/kg	140	16	5.0		2	
TPH C16-C21 (aromatic)*	mg/kg	260	16	15		1	
TPH C21-C35 (aromatic)*	mg/kg	1100	16	42		1	

Notes
Main Exposure Pathways: 1 = Soil Ingestion, 2 = Vapour Inhalation (indoor), 3 = Dermal Contact & Ingestion, 4 = Dust Inhalation.
Abbreviations: GAC = General Assessment Criteria, n = number of samples, MC = Maximum Concentration; Loc of Ex/m = Location of Exceedance and depth in metres; NFD = No Fibres Detected, S4UL = LQM/CIEH Suitable For Use Levels
* The Tier 1 GAC for the hydrocarbon fraction is derived from the CIEH assessment for petroleum hydrocarbons Criteria Working Group (CWG) for both aliphatic and aromatic compounds. E3P has utilised the Tier 1 values for aliphatic compounds for the volatile and semi volatile fractions (C_5-C_{12}) and the Tier 1 values for aromatic compound for the non-volatile fractions (C_{12}-C_{35}). The comparison of a total (aliphatic/aromatic) compounds to an individual fraction is considered to be a conservative approach and satisfactory for the protection of human health.

The Tier I risk assessment has not identified any exceedances within any of the samples tested for inorganic heavy metals, SVOC or TPH compounds.

Chemical analysis completed to date has not highlighted any elevated determinants within the topsoil or underlying natural drift deposits and is therefore considered to be suitable for use within the residential development with no mitigation measures required.

Asbestos has not been identified in any of the topsoil or Made Ground samples submitted for analysis.

Additionally, a sample obtained from the material stockpiled in the eastern corner of the site did not identify any elevated contaminant concentrations.

4.2 Controlled Waters

Risk Profile	Discussion	Risk Rating & Rationale
Source Protection Zone (SPZ)	No	Low
Distance to the closest groundwater abstraction point.	>1000m	Low
Aquifer classification in Superficial Drift Deposits	Secondary A	Low to Moderate – Shallow sandy gravels are underlain by low permeability clay soils to depths in excess of 10.0m which will offer significantly reduce the potential for mobile phase contaminants to migrate towards a viable receptor.
Aquifer classification in Bedrock.	Secondary A	Low to Moderate
Surface water or Groundwater protection Zones.	No	Low
Viability for Anthropogenic soil in direct contact with aquifer (drift or bedrock).	Yes	Low to Moderate – Only very minimal Made Ground present on site in very localised areas.
Is the site underlain by low permeability Drift to depths in excess of 10.0m	Yes	Yes – The overall risk classification is reduced due to the known presence of in excess of 10.0m of low permeability clay soil extending to depths in excess of 10.0m bgl beneath the shallow granular soils.
Is the site located within 50m of a surface water course	Yes	Yes – Warm Brook watercourse is present on the south eastern edge of the site.
Summary		
The ICSM developed within the context of the site setting has identified two low risk viable pollutant risks which would be the downward migration of potentially mobile phase soluble contaminants towards the underlying Secondary A Aquifer and the lateral migration of mobile contaminants to Warm Brook. However the overall sensitivity of this receptor is reduced given the presence of low permeability clay drist deposits and the absence of any ground water abstraction and thus the potential for the creation of a complete pollutant linkage.		

To further refine the ICSM, E3P has undertaken an initial assessment of the soil data analysis to assess the potential for a source of separate phase or dissolved phase contamination originating from either a defined on-site source or from impacted soils. This assessment has taken qualitative analysis of the soil data set to inform the development of the ICSM.

Preliminary Risk Assessment – Soil Data Analysis Risk to Controlled Waters	
The soil data obtained from the SI has been assessed within the context of a preliminary assessment to determine the potential presence of a contamination source. ass **BTEX - <1ppm** **Total VOC - <1ppm** **Total SVOC -<1ppm** **C5-C10 <5ppm** **C10-C12 <10ppm** **C12-C16 <50ppm** **Phenols – <2ppm** **Naphthalene - <2ppm** **Total PAH <10ppm** **Heavy metals - <500ppm**	• The soil data analysis has not identified any detectable concentrations of VOC's which could be deemed to represent either evidence of impact within the sub-surface soils or a potential source impacting the underlying stratum; • The most soluble SVOC (Naphthalene) could not be detected at concentrations above the detection limit for the analytical technique and thus no source within the soil has been identified; and, • Heavy metals have not been detected at concentrations that would be likely to generate a dissolved phase contamination plume.

In due consideration of the ICSM which has identified a potential pollutant linkage associated with the migration towards the aquifer within the superficial drift and underlying bedrock (albeit the sensitivity is significantly reduced) E3P has undertaken a Tier I controlled waters risk assessment.

This assessment comprises the analysis of dissolved phase compounds within the groundwater samples (where present).

The results of this assessment are presented in Table 4.2 overleaf.

Table 4.2-Tier I Controlled Water Screening Values

DETERMINAND	UNITS	EQS	DWS	N	MC	STRATA	LOC OF EX	ASSESSMENT
Inorganics								
Arsenic	µg/l	50	10	4	0.64	N/A	N/A	No Further Assessment
Cadmium	µg/l	5	5	4	0.23			
Chromium	µg/l	2	50	4	0.3			
Copper	µg/l	5	2000	4	5.2	CLAY	WS101	Further Assessment
Total Cyanide	µg/l	-	50	4	<10	N/A	N/A	No Further Assessment
Lead	µg/l	4	10	4	0.4			
Mercury	µg/l	1	1	4	<0.05			
Nickel	µg/l	8	20	4	4.9			
Selenium	µg/l	-	10	4	1.8			
Zinc	µg/l	30	5000	4	7.1			
pH	-	6-9	-	4	7.1			
Organics								
Naphthalene	µg/l	10	-	4	<0.01	N/A	N/A	No Further Assessment
Benzo(a)pyrene	µg/l	0.05	0.01	4	<0.01	N/A	N/A	No Further Assessment
benzo[b/k]fluoranthene	µg/l	0.03	-	4	<0.01	N/A	N/A	No Further Assessment
benzo[g,h,i]perylene & indeno(1,2,3-cd]pyrene	µg/l	0.02	-	4	<0.01	N/A	N/A	No Further Assessment
TPH Aliphatic C5-C6	µg/l	-	10	4	<10	N/A	N/A	No Further Assessment
TPH Aliphatic C6-C8	µg/l	-	10	4	<10	N/A	N/A	No Further Assessment
TPH Aliphatic C8-C10	µg/l	-	10	4	<10	N/A	N/A	No Further Assessment
TPH Aliphatic C10-C12	µg/l	-	10	4	150	CLAY	WS101	Further Assessment
						CLAY	WS102	
TPH Aliphatic C12-C16	µg/l	-	10	4	68	CLAY	WS101	Further Assessment
						CLAY	WS102	
TPH Aliphatic C16-C35	µg/l	-	10	4	<10	N/A	N/A	No Further Assessment
TPH Aromatic C5-C7	µg/l	-	10	4	<10	N/A	N/A	No Further Assessment
TPH Aromatic C7-C8	µg/l	-	10	4	<10	N/A	N/A	No Further Assessment
TPH Aromatic C8-C10	µg/l	-	10	4	<10	N/A	N/A	No Further Assessment
TPH Aromatic C10-C12	µg/l	-	10	4	<10	N/A	N/A	No Further Assessment
TPH Aromatic C12-C16	µg/l	-	10	4	<10	N/A	N/A	No Further Assessment
TPH Aromatic C16-C35	µg/l	-	10	4	<10	N/A	N/A	No Further Assessment

The Tier 1 assessment indicates that the data exceeds for the following determinands:

- ***Copper;***
- ***TPH Aliphatic C10-C12; and,***
- ***TPH Aliphatic C12-C16.***

In the case of the copper exceedance, this was a marginal exceedance of 5.2 ug/l against a EQS screening value of 5ug/l, therefore given this marginal exceedance, it is unlikely that elevated copper will migrate to the surface watercourse.

With regards to the elevated TPH compounds, no elevated concentrations were identified within the soils to an extent where they would impact the groundwater.

The site is located within an area of extensive upland peat soils resulting in run-off of waters with a high humic acid content. It is very possible that the hydrocarbon concentrations reported within the dissolved phase are representative of naturally occurring humic acids as oppose to an anthropogenic hydrocarbon source.

It should be noted the Tier 1 assessment criteria provides a conservative review, which may over-state the risk, as the inorganic determinants identified above are predominantly of a low solubility suggesting that the recorded concentrations are more likely to represent suspended solid in the sample matrix than actual groundwater concentrations.

Further Assessment and Risk Mitigation

Summary Assessment	
Is the site deemed to be located within an area that would be classified as Moderate or High Risk in terms of a Controlled Waters Receptor.	**Yes**
Has the **SITE INVESTIGATION** accurately investigated all potential exposure pathways / potential pollutant linkages as defined within the ICSM to ensure the soil and groundwater analysis has targeted all potential contamination source.	**Yes**
Has the **SOIL** data analysis identified any source of potentially soluble phase compounds that could be indicative of a risk to controlled waters	**No**
Has the **GROUNDWATER / LEACHATE** analysis identified any elevated concentrations of potential contaminants of concern.	**Yes**
Conclusion & Recommendation	Given the lack of any elevated contaminant concentrations within the soils, it is considered that elevated TPH concentrations within the groundwater is more likely due to the presence of humic acids within the sample and not representative of the groundwater beneath the site. The presence of notable thickness of low permeability clay will inhibit the migration of any elevated contaminants vertically to the Secondary A Aquifer and laterally towards the adjacent Warm Brook. Based on the above, it is considered there is no unacceptable risk to controlled waters.

4.3 Ground Gas

The potential impact on the development from ground gases has been assessed with reference to standards and guidelines published in CIRIA Report 665 (*Assessing risks posed by hazardous ground gases to buildings*, 2007). However, it is recommended that the full ground gas assessment and recommended protection measures are agreed with the local authority prior to their adoption on-site. Furthermore, all protection measures adopted should be validated by a suitably qualified engineer.

The Phase I report and subsequent Ground Investigation has identified the following potential sources of ground gas:

- Localised areas of Made Ground.

During the monitoring visits completed to date, no significantly elevated concentrations of methane have been recorded within any of the probeholes and a maximum of 4.70% v/v carbon dioxide recorded in WS103.

The monitoring has been undertaken during a period of low atmospheric pressure and in a variety of atmospheric pressure scenarios with falling pressure indicating worst case scenario. Further monitoring should be undertaken during periods of low and falling atmospheric pressure episodes, demonstrating worst case scenario.

In accordance with the methodology outlined with the CIRIA publication C665, E3P have utilised the results of the ground gas monitoring surveys to calculate a tentative Gas Screening Value (GSV). The maximum GSV calculated for methane was 0.00908 l/hr (WS105) and for carbon dioxide was 0.07264 l/hr (WS105). These appear to be related to high flows recorded within the monitoring wells of up to 9.08l/hr in WS105, with elevated flow readings recorded across the site.

In accordance with the methodology outlined with the CIRIA publication C665 and BS8485, E3P has utilised the results of the ground gas monitoring surveys to calculate a tentative Gas Screening Value (GSV). The calculated GSVs reflect the absence of any flow with CIRIA C665 stating that in instances where the maximum GSV for carbon dioxide and methane is <0.07 l/hr and typical methane and carbon dioxide are above 1% v/v and 5% v/v respectively, then this is equivalent to **Characteristic Situation 2.**

Characteristic Situation 2 requires ground gas measures to be constructed in accordance with BS8485 which requires a minimum of points be achieved by installation of a suitable combination of measures detailed overleaf.

PROTECTION ELEMENT / SYSTEM		SCORE	COMMENTS
a) Venting / dilution (see Annex A)			
Passive sub-floor ventilation (venting layer can be a clear void or formed using gravel, geocomposites, polystyrene void formers etc.)	Very good performance	2.5	Ventilation performance in accordance with Annex A. If passive ventilation is poor this is generally unacceptable and some form of active system will be required. There have to be robust management systems in place to ensure the continued maintenance of any ventilation system. Active ventilation can always be designed to meet good performance. Mechanically assisted systems come in two main forms: extraction and positive.
	Good performance	1	
Sub-floor ventilation with active abstraction / pressurization (venting layer can be a clear void or formed using gravel, geocomposites, polystyrene void formers etc.)		2.5	
Ventilated car park (basement of undercroft)		4	
b) Barriers			
Floor Slabs Block and beam floor slab.		0	It is good practice to install ventilation in all foundation systems to effect pressure relief as a minimum. Breaches in floor slabs such as joints have to be effectively sealed against gas ingress in order to maintain these performances.
Reinforced concrete ground bearing floor slab.		0.5	
Reinforced concrete ground bearing foundation raft with limited service penetrations that are cast into slab.		1.5	
Reinforced concrete cast in situ suspended slab with minimal service penetrations and water bars around all slab penetrations and at joints.		1.5	
Fully tanked basement.		2	
c) Membranes			
Taped and sealed membrane to reasonable levels of workmanship / in line with current good practice with validation.		0.5	The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation and the integrity of the joints.
Proprietary gas resistant membrane to reasonable levels of workmanship / in line with current good practice under independent inspection.		1	
Proprietary gas resistant membrane installed to reasonable levels of workmanship / in line with current good practice under CQA with integrity testing and independent validation.		2	
d) Monitoring and detection (not applicable to non-managed property, or in isolation			
Intermittent monitoring using hand held equipment	Installed in the underfloor venting / dilution system	0.5	Where fitted, permanent monitoring systems ought to be installed in the underfloor venting / dilution
Permanent monitoring and alarm system		2	
	Installed in the building	1	
e) Pathway Intervention			
Pathway intervention		-	This can consist of site protection

This is an interim assessment based on preliminary ground gas readings, the final classification will be supplied as an addendum to this report on completion of the remaining monitoring visits.

4.4 Potable Water Infrastructure

Chemical analysis would suggest that Polyethylene (PE) pipeline will be suitable for the proposed residential development. The requirements for appropriate pipeline selections for potable water supplies should be completed once any remediation and enabling works are finalised at the site to allow for an accurate assessment to be completed. For clarification of the requirements of each pipelines type, E3P have included the specific criteria for the pipe material in Table 4.3 overleaf:

Table 4.3 Pipeline Selection Risk Assessment Summary Criteria (PSRAS)

All Concentrations in mg/kg				
Test Group	**Testing Required**	**PE threshold**	**PVC threshold**	**Metal Pipes**
Total VOCs	Where Preliminary Risk Assessment (PRA) had identified land affected by contamination	0.5	0.125	Pass
Total BTEX & MTBE		0.1	0.03	Pass
Total SVOCs (excluding PAHs and those substances marked with an *)		2	1.4	Pass
EC5-EC10 aliphatic and aromatic hydrocarbons		2	1.4	Pass
EC10-EC16 aliphatic and aromatic hydrocarbons		10	Pass	Pass
EC16-EC40 aliphatic and aromatic hydrocarbons		500	Pass	Pass
Phenols* (from SVOC analysis)		2	0.4	Pass
Cresols and chlorinated phenols* (from SVOC analysis)		2	0.04	Pass
Ethers*	Only where identified	0.5	1	Pass
Nitrobenzene*		0.5	0.4	Pass
Ketones*		0.5	0.2	Pass
Aldehydes*		0.5	0.2	Pass
Amines		Fail	Pass	Pass
Corrosive	Conductivity, Redox and pH	Pass	Pass	See Note [1]

4.5 Developed Conceptual Model

Following the completion of the intrusive site investigation, chemical analysis and risk assessment the conceptual model shown in Table 4.4 has been prepared for the site.

Table 4.4 Conceptual Model

SOURCE	EXPOSURE	POTENTIAL PATHWAY
Human Health		
Hazardous Ground Gases	Volatilisation to Indoor Air / Asphyxiation	Residential End Users
Discussion: The ground gas risk assessment has identified marginally elevated carbon dioxide which coupled with the elevated flow readings places the proposed development site into the bracket for Characteristic Situation 2. Carbon dioxide has associated asphyxiation risks to the future residential site users, therefore, low level gas protection measures will be required within proposed dwellings to mitigate this risk.		

5. GEOTECHNICAL ASSESSMENT

5.1 Proposed Development

Seddon Homes intend to construct a low rise residential development with associated garden and landscaped areas, adopted estate roads and infrastructure.

Given the nature of the proposed development it is considered that the structure meets the criteria of Geotechnical Category 1 of Euro Code 7.

It is also considered that acceptable risk from settlement is a total settlement value of 25mm for a masonry structure.

5.2 Summary of Ground Conditions

E3P has completed an intrusive Ground Investigation comprising 15 No. Trial Pits and 6 No. Window Sample Probeholes with environmental monitoring installations placed in 6 No. probeholes. The ground conditions encountered are summarised below:

Made Ground

Made Ground was encountered in just two exploratory hole locations, ranging in thickness from 0.70m to 2.10mbgl. The Made Ground in TP101, on the edge of the stockpile of materials in the eastern corner of the site, comprised a dark brown gravelly sand (topsoil) with gravel of mudstone and clinker over firm gravelly clay with occasional cobbles and boulders. Gravel comprised sandstone, mudstone, concrete and shale.

Large obstructions were encountered in TP101 in a mound in the eastern corner of the proposed development sector comprising large pieces of timber, concrete and shale with concrete obstructions to the north and south of the trial pit, where drainage runs are present.

In TP107 in the north western sector of the site, the localised Made Ground comprised dark brown gravelly sand (topsoil) over orange brown very gravelly sand with gravel of sandstone over a soft black sandy gravelly clay with gravel of brick, shale, sandstone and mudstone.

Drift Deposits

Drift deposits were encountered in all exploratory hole locations from depths of between 0.10m and 2.10m bgl to a maximum proven depth of 5.45m bgl (full depth not proven). Drift deposits generally comprised firm orange brown sandy CLAY in the shallow horizons overlying stiff to very stiff high strength brown slightly gravelly CLAY with occasional gravel of sandstone and mudstone.

Solid Geology

The solid geology was not encountered during this investigation.

5.3 Site Preparation

The site should be cleared and any vegetation below areas of proposed development and stripped in accordance with Series 200 of the Specification for Highway Works. This should include:

- Roots present below the footprint of proposed structures and infrastructure should be grubbed out and the resulting void infilled with suitable compacted engineered fill;

- Redundant services should be sealed off and grubbed out and replaced with suitable compacted engineered fill; and,

- Underground obstructions should be excavated from below the proposed development foot print with the resulting void backfilled.

5.4 Foundation Conditions & Assessment of Potential Bearing Capacities

In due consideration of the identified ground conditions, in-situ and laboratory geotechnical testing, E3P has undertaken an assessment of the net safe Allowable Bearing Pressure (ABP) within the underlying natural stratum to assist in the detailed design of foundations and infrastructure and determine the target founding stratum. This assessment is summarised in Table 5.1.

Table 5.1 Summary of ABPs

COHESIVE SOILS			
Description	Depth (range m BGL)	Undrained Shear Strength (Cu) kN/m2	Allowable Bearing Pressure (kN/m2)
Firm to very stiff slightly gravelly CLAY	1.00–3.00	45-217	75-187

Consideration must be given to the varying soil matrices and differing settlement characteristics and where a foundation spans two varying matrices the sub-structure should be designed accordingly.

The target founding stratum is considered to be the natural firm medium strength to very stiff high strength cohesive deposits.

The underlying natural clays were encountered at a shallow depth throughout the site (with the exception of TP101 in the location of the stockpiled materials) and were found to have a net Allowable Bearing Pressure of 82kN/m² to 155kN/m² at circa 1.00m and 75kN/m² to 131kN/m² at 2.00mbgl.

Foundation depths should take account of the presence of existing trees with foundations deepened locally in accordance with the requirements of NHBC standards for a clay of intermediate plasticity. It is recommended that at working drawing stage a foundation schedule is prepared for the development taking account of the soil plasticity and the locations of trees.

It is considered that proposed dwellings can be constructed using a traditional spread foundation bearing on the target founding stratum of firm medium strength to stiff high strength clays. Foundations will require deepening in locations where significant depths of Made Ground are encountered.

5.5 Ground Floor Slabs

The presence of intermediate plasticity clay soils will necessitate the use of a suspended floor slab in the construction of the proposed dwellings.

5.6 Heave Precautions

The site has been proven to be underlain by clay soils which are susceptible to volumetric instability due to fluctuations in moisture content, particularly within influencing distance of trees as per the NHBC / LABC conjectured zones of influence.

As the clay is deemed to be moderate plasticity, Heave Precautions are required to the internal face of the external load bearing walls (within tree influence).

If a ground beam is to be constructed within the zone of tree influence, heave precautions are required to the underside of this and edge beams.

If the ground floor slab is to be constructed with a beam and block floor, a minimum sub-floor void of 200mm is required within any structures located in the zone of conjectured tree influence.

If the ground floor slab is constructed with a cast in-situ suspended floor slab heave precautions that can tolerate 50mm of clay swelling are required within any part of the floor slab to be located within the zone of influence of a tree.

Table 5.2 below summarises the heave precaution requirements for foundations, ground beams and suspended in-situ concrete ground floors.

Table 5.2 Summary of Heave Precaution Requirements

PLASTICITY INDEX OF SOIL	REQUIRED FOUNDATION DEPTH (M)	MINIMUM VOID DIMENSION FOR FOUNDATIONS, GROUND BEAMS AND SUSPENDED IN-SITU CONCRETE GROUND FLOORS		MINIMUM VOID DIMENSIONS UNDER PRE-CAST CONCRETE AND SUSPENDED TIMBER FLOORS
		Thickness of Void Former Against Side of Foundation or Ground Beam (mm)	Thickness of Void Former on Underside of Edge Beam and Floor Slab (mm)	Void Dimension (mm)
High Plasticity (>40)	>2.50	Engineer Design		Engineer Design
	2.00-2.50	35	150	300
	1.50-2.00	25	75	
Moderate Plasticity (20-40)	>2.50	Engineer Design		Engineer Design
	2.00-2.50	25	100	250
	1.50-2.00	25	50	
Low Plasticity (<20)	2.00-2.50	-	50	200
	>2.00	No Special Precautions		

5.7 Pavement Construction

An assessment of the likely California Bearing Ratio (CBR) for the natural clay has been assessed from the following sources:

- Description of the materials encountered in the exploratory holes;
- In-situ DCP tests.

Based on these data, it is considered that the natural clays within the upper 1.0m (excluding organic topsoil at the near surface) of the site may provide a CBR of 5%.

5.8 Drainage

Soakaway drainage is unlikely to be suitable due to the presence of widespread cohesive deposits.

The application of soakaway drainage will ultimately be dependent on the specific requirements of the development and design of the drainage solution by the infrastructure engineer. All soakaways should be designed in accordance with BRE Special Digest 365 – *Soakaway Design.*

5.9 Concrete Durability

Based upon the results of the chemical analyses it is considered that subsurface concrete should generally meet Class DS-1, Aggressive Chemical Environment for Concrete Classification (ACEC) AC-1s in accordance with BRE Special Digest 1 (2005). However five of the samples tested returned pH values of <6.5 indicating concrete class AC-2z classification should be used.

5.10 Excavations

Site observations indicated that excavations should be feasible in the near surface with normal plant due to a lack of obstructions.

Generally trial pits were stable throughout excavation. Due to the variability of the Made Ground in the south eastern sector of the site it is considered that all excavations are supported or battered back in accordance with guidance contained in CIRIA R97.

5.11 Minerals

There are no minerals of economic value underlying the site at shallow depth and mining is considered to be very unlikely. The site is considered to be minerally stable.

5.12 Further Works

- Foundations will require detailed consideration once development levels are known, however given the presence of stiff to very stiff clays it is likely that shallow spread foundations will be suitable for the majority of the plots; however consideration will need to be given to the potential requirement for piled plots in areas of tree influence;
- Isopachytes Cut/Fill Analysis to inform the optimum Ground Engineering solution;
- Development of a cost effective and pragmatic Remediation and Enabling Works Strategy; and,
- A detailed Materials Management Plan should be completed on receipt of the proposed Finished Floor Levels.

5.13 Construction Activity and Inspection

The following activities and inspections should be incorporated in to the site works:

Due to the variability of the soils at the site it is recommended that sufficient allowance is made for the inspection of formation and sub formations to foundations and pavement construction:

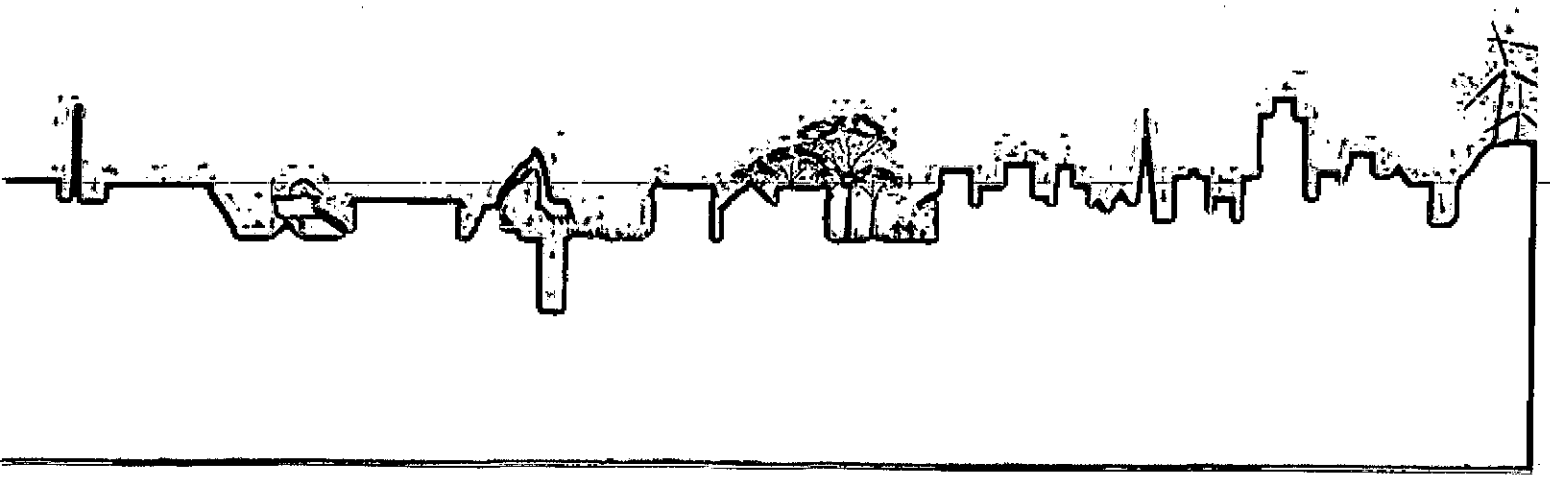
- Excavations where access is required should be subject to a risk assessment from a competent person and where appropriate mitigation measures such as benching back the sides or use of support systems in accordance with CIRIA R97 utilised;
- It is considered that de-watering may be required, especially following periods of heavy rainfall. Removal of surface water and water within trenches should be possible with conventional sump pumping. Discharge of any water should be agreed with the relevant regulatory body and be undertaken under a trade effluent discharge, where required. Measures to remove silt and suspended solids may be required and consideration should be given to provision of space for settling tanks or an attenuation pond;
- Where access to confined spaces is required appropriate mitigation measures should be addressed within the Construction Stage Health and Safety Plan. Particular account should be taken of the gas results;
- The presence of potential contamination and mitigation measures should be addressed as part of the Construction Stage Health and Safety Plan and should include measures to design out the risks, reduce their impact and finally the use of Personnel Protective Equipment (PPE).

6. CONCLUSIONS AND RECOMMENDATIONS

Current Environmental Impact	
The proposed development site is located within a predominantly residential and agricultural area. Further Greenfield land is located to the south and a railway line runs adjacent to the west of the site, up a relatively steep embankment.	
Revised Conceptual Site Model	
Human Health	Chemical analysis for PAH, TPH and inorganic heavy metal compounds has not highlighted any elevated determinants within the topsoil or underlying natural drift deposits and is therefore considered to be suitable for use within the residential development with no specialist mitigation measures required.
Controlled Waters	Low risk to controlled waters.
Ground Gas	Characteristic Situation 2 / Amber 1
Potable Water	Poly-Ethylene Pipe
Geotechnical	
The underlying natural clays were encountered at a shallow depth throughout the site (with the exception of TP101 in the location of the stockpiled materials) and were found to have a net Allowable Bearing Pressure of 82kN/m² to 155kN/m² at circa 1.00m and 75kN/m² to 131kN/m² at 2.00mbgl. Foundation depths should take account of the presence of existing trees with foundations deepened locally in accordance with the requirements of NHBC standards for a clay of intermediate plasticity. It is recommended that at working drawing stage a foundation schedule is prepared for the development taking account of the soil plasticity and the locations of trees. It is considered that proposed dwellings can be constructed using a traditional spread foundation bearing on the target founding stratum of firm medium strength to stiff high strength clays. Foundations will require deepening in locations where significant depths of Made Ground are encountered. Heave precautions will be required within foundations to be constructed within the area influenced by former / current trees due to the presence of moderate plasticity soils.	

END OF REPORT

APPENDIX I
LIMITATIONS



1. This report and its findings should be considered in relation to the terms of reference and objectives agreed between E3P and the Client as indicated in Section 1.2.

2. For the work, reliance has been placed on publicly available data obtained from the sources identified. The information is not necessarily exhaustive and further information relevant to the site may be available from other sources. When using the information it has been assumed it is correct. No attempt has been made to verify the information.

3. This report has been produced in accordance with current UK policy and legislative requirements for land and groundwater contamination which are enforced by the local authority and the Environment Agency. Liabilities associated with land contamination are complex and requires advice from legal professionals.

4. During the site walkover reasonable effort has been made to obtain an overview of the site conditions. However, during the site walkover no attempt has been made to enter areas of the site that are unsafe or present a risk to health and safety, are locked, barricaded, overgrown, or the location of the area has not be made known or accessible.

5. Access considerations, the presence of services and the activities being carried out on the site limited the locations where sampling locations could be installed and the techniques that could be used.

6. Site sensitivity assessments have been made based on available information at the time of writing and are ultimately for the decision of the regulatory authorities.

7. Where mention has been made to the identification of Japanese Knotweed and other invasive plant species and asbestos or asbestos-containing materials this is for indicative purposes only and do not constitute or replace full and proper surveys.

8. The executive summary, conclusions and recommendations sections of the report provide an overview and guidance only and should not be specifically relied upon without considering the context of the report in full.

9. E3P cannot be held responsible for any use of the report or its contents for any purpose other than that for which it was prepared.

10. New information, revised practices or changes in legislation may necessitate the re-interpretation of the report, in whole or in part.

APPENDIX II
GLOSSARY

TERMS

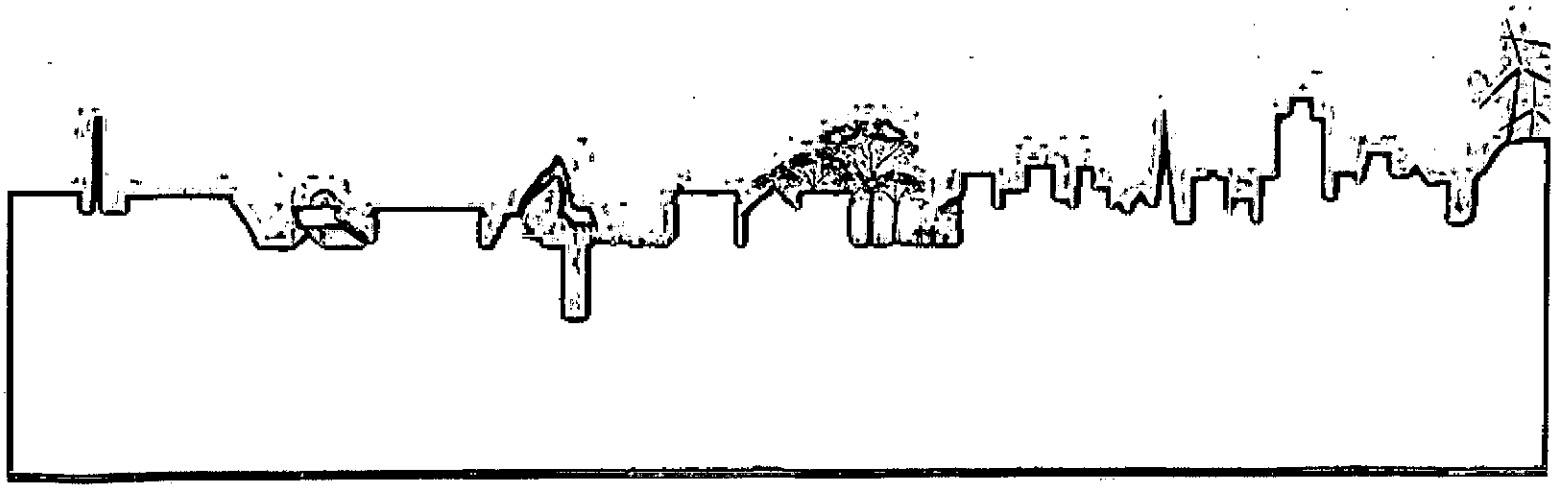
AST	Above Ground Storage Tank
BGS	British Geological Survey
BSI	British Standards Institute
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
CIEH	Chartered Institute of Environmental Health
CIRIA	Construction Industry Research Association
CLEA	Contaminated Land Exposure Assessment
CSM	Conceptual Site Model
DNAPL	Dense Non-Aqueous Phase Liquid (chlorinated solvents, PCB)
DWS	Drinking Water Standard
EA	Environment Agency
EQS	Environmental Quality Standard
GAC	General Assessment Criteria
GL	Ground Level
GSV	Gas Screening Value
HCV	Health Criteria Value
ICSM	Initial Conceptual Site Model
LNAPL	Light Non-Aqueous Phase Liquid (petrol, diesel, kerosene)
ND	Not Detected
LMRL	Lower Method Reporting Limit
NR	Not Recorded
PAH	Poly Aromatic Hydrocarbon
PCB	Poly-Chlorinated Biphenyl
PID	Photo Ionisation Detector
QA	Quality Assurance
SGV	Soil Guideline Value
SPH	Separate Phase Hydrocarbon
Sp.TPH (CWG)	Total Petroleum Hydrocarbon (Criteria Working Group)
SPT	Standard Penetration Test
SVOC	Semi Volatile Organic Compound
UST	Underground Storage Tank
VCCs	Vibro Concrete Columns
VOC	Volatile Organic Compound
WTE	Water Table Elevation

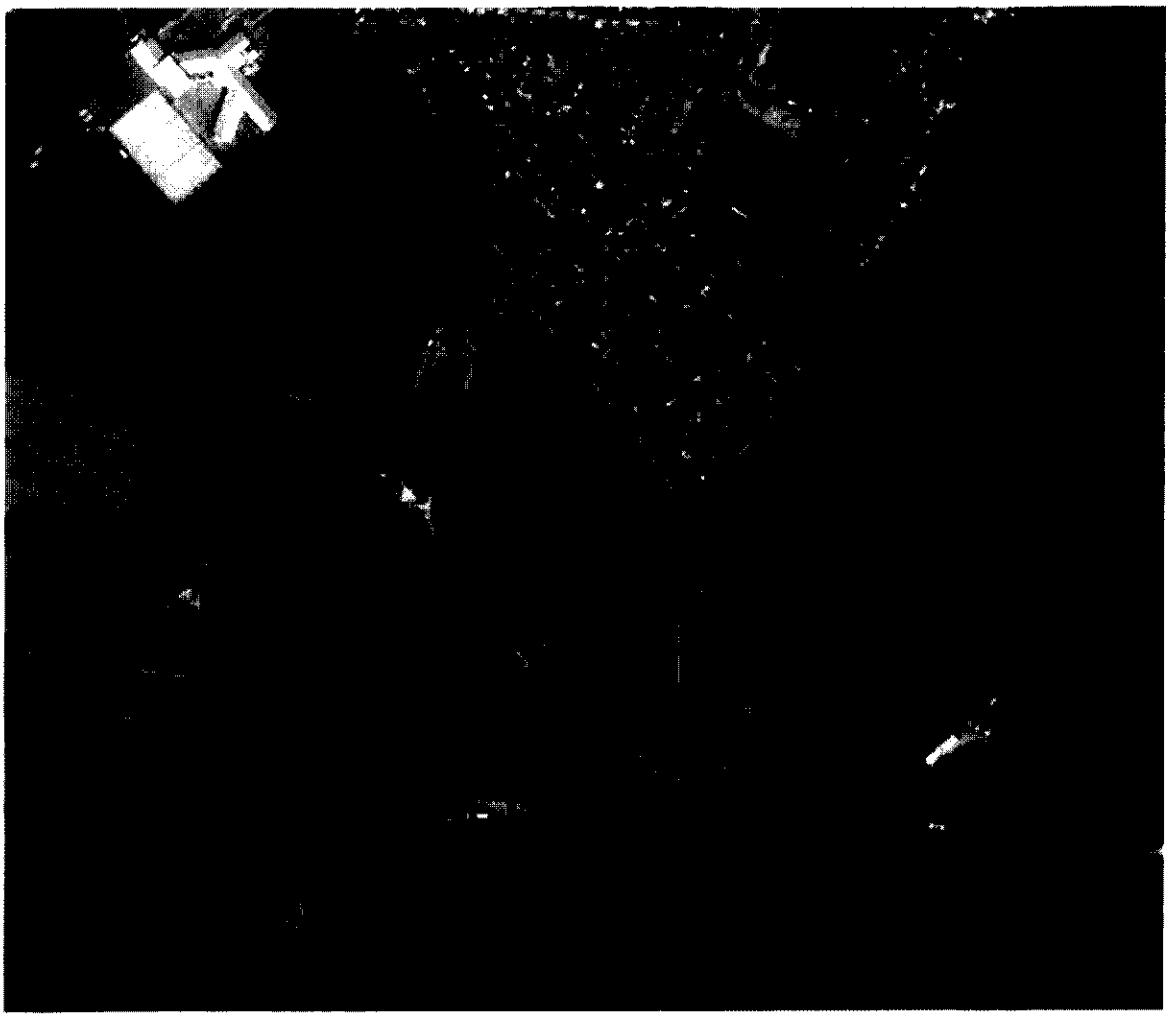
UNITS

m	Metres
km	Kilometres
%	Percent
%v/v	Percent volume in air
mb	Milli Bars (atmospheric pressure)
l/hr	Litres per hour
µg/l	Micrograms per Litre (parts per billion)
ppb	Parts Per Billion

mg/kg	Milligrams per kilogram (parts per million)
ppm	Parts Per Million
mg/m^3	Milligram per metre cubed
m bgl	Metres Below Ground Level
m bcl	Metre Below Cover Level
mAOD	Metres Above Ordnance Datum (sea level)
kN/m^2	Kilo Newtons per metre squared
µm	Micro metre

APPENDIX III
DRAWINGS

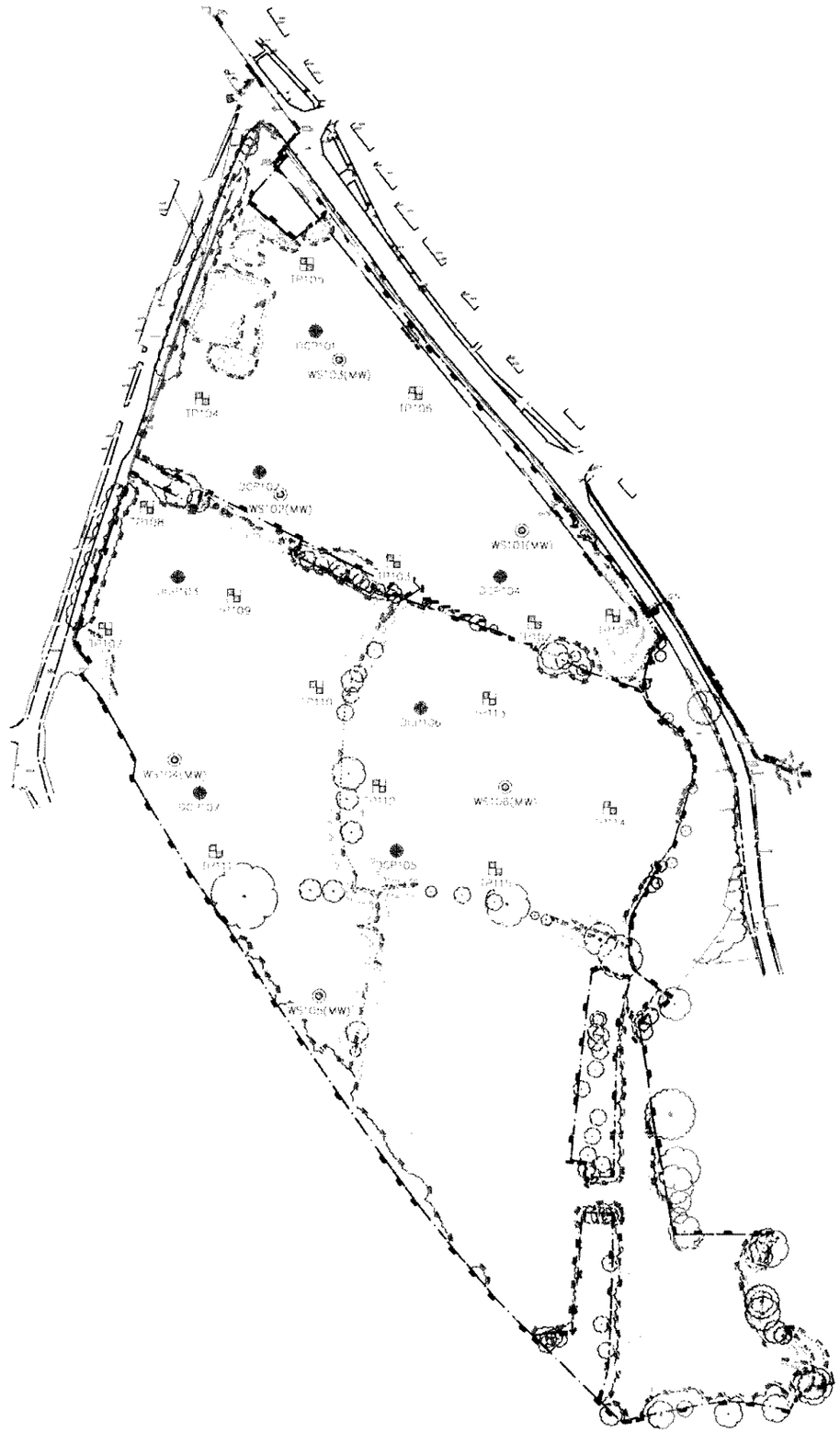




Drawing 10-633-001

Site Location Plan

e3p



Key

Location Symbols

- Approximate Window Sample Probehole Location with Install
- Approximate Trial Pit Location
- Approximate Dynamic Cone Penetrometer Test Location

Notes

P1	-	03-07-2015	DRAFT	CB	MD
Phase	Revision	Date	Issue	Drawn	Authorised

Client: Seddon Homes

Job No.: 10633

Date: 03-07-2015

Drawing No.: 004

Scale: 1:2000 @ A3

Job Title: Long Lane, Chapel en le Frith

Drawing Title: Exploratory Hole Location Plan

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Key

Notes

P1	-	24-07-2015	DRAFT	JN	MD
Phase	Revision	Date	Issue	Drawn	Authorised

Client

Seddon Homes

Job No: 10633 | Date: 24-07-2015

Drawing No: 006 | Scale: NTS @ A3

Job Title

Long Lane, Chapel en le Frith

Drawing Title

Proposed Development Plan

e3p

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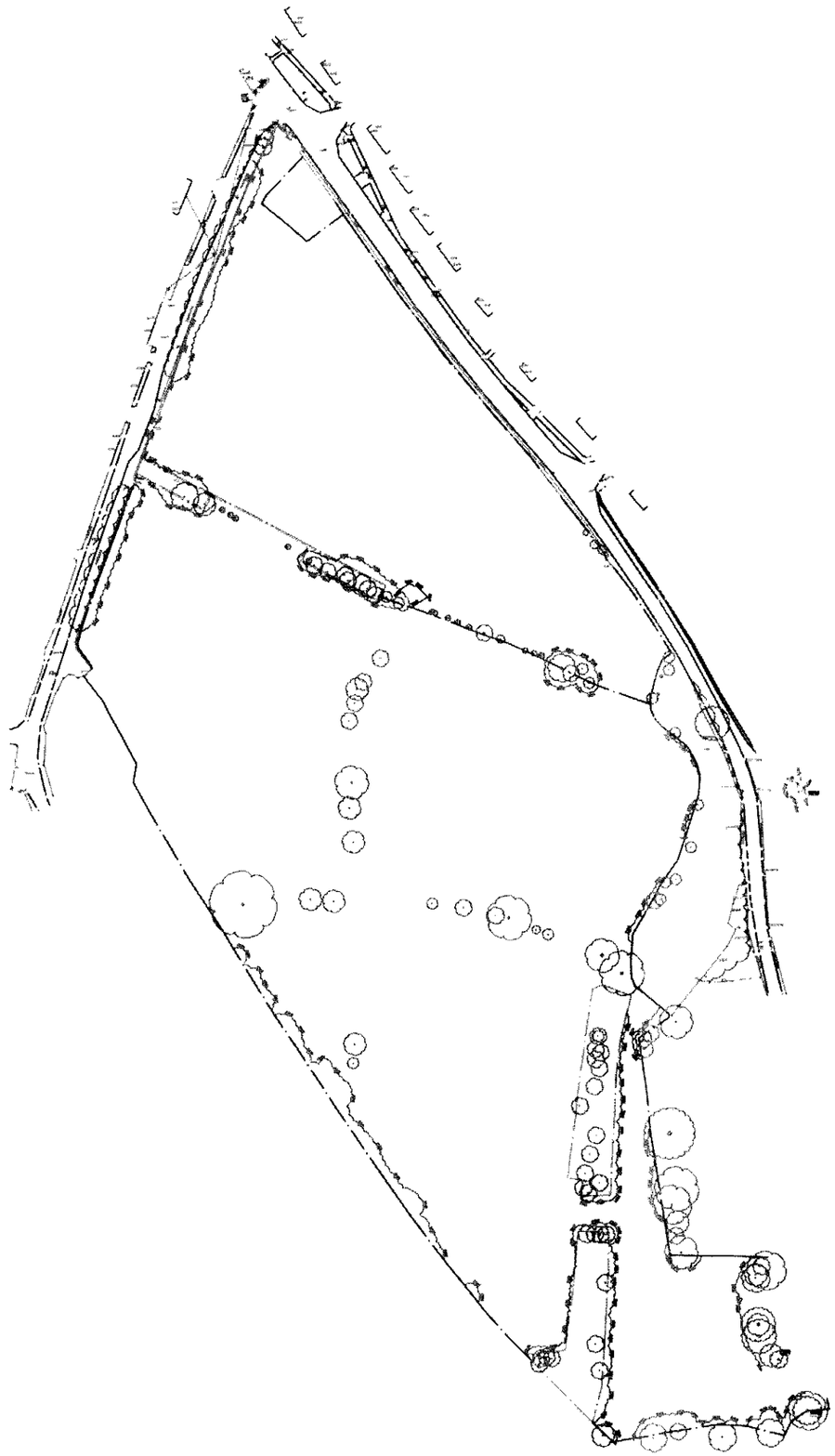

Key.

Historical Features

Area of Fences (Pre 2006 - Pre 2015)

Notes.

All Field Boundaries Still on Site Pre 1879 - Pre 2015

P1	-	27-08-2015	DRAFT	JN	MD
Phase	Revision	Date	Issue	Drawn	Authorised

Client.

Seddon Homes

Job No. 10633

Date 27-08-2015

Drawing No. 003

Scale 1:2000 @ A3

Job Title

Long Lane, Chapel en le Frith

Drawing Title

Historical Features Plan

e3p

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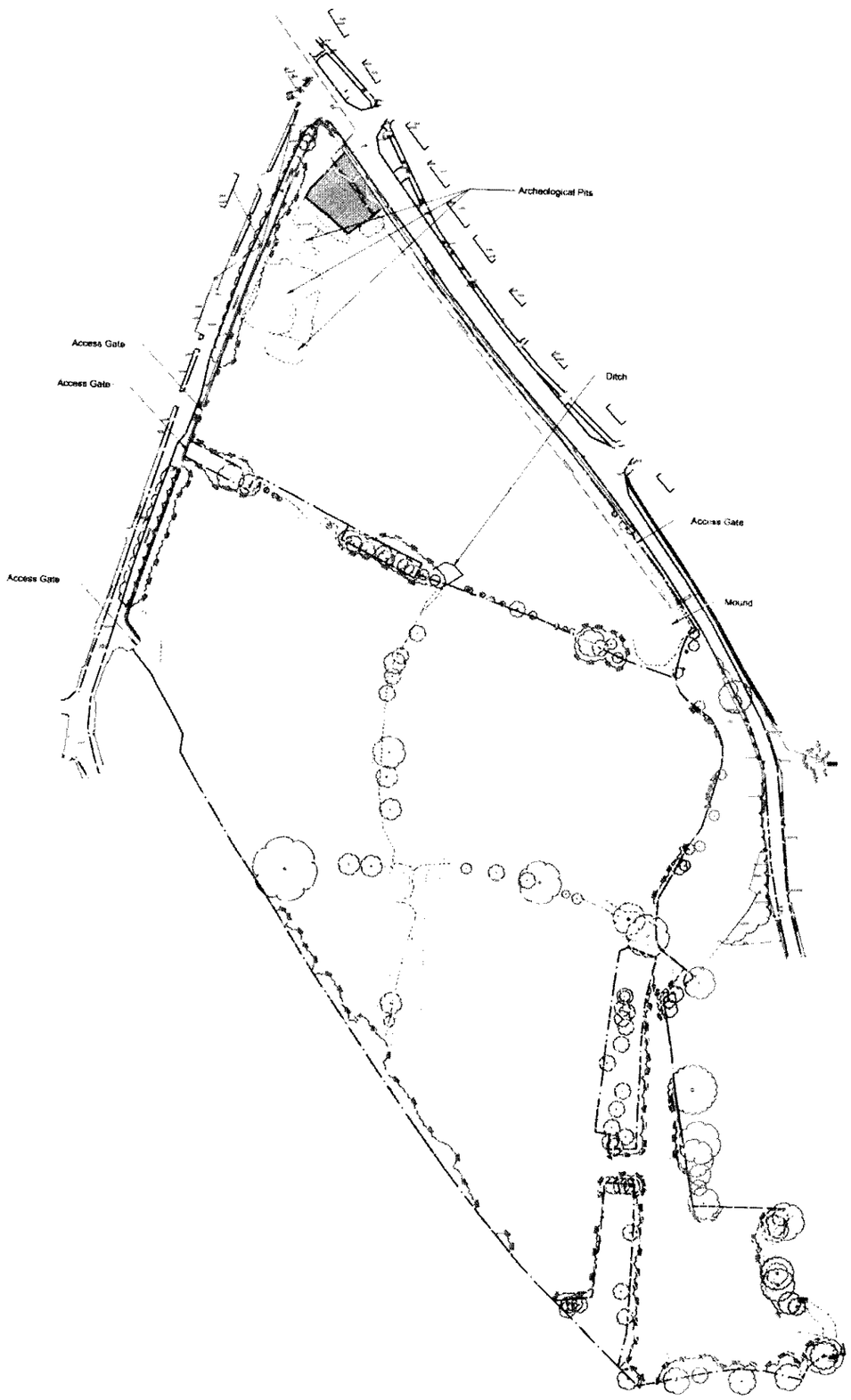

Key

Site Features

Seddon Homes Storage Area

Notes

P1	-	24-07-2015	DRAFT	JN	MD
Phase	Revision	Date	Issue	Drawn	Authorised

Client

Seddon Homes

Job No 10633 *Date* 24-07-2015

Drawing No 002 *Scale* 1:2000 @ A3

Job Title

Long Lane, Chapel en le Frith

Drawing Title

Site Features Plan

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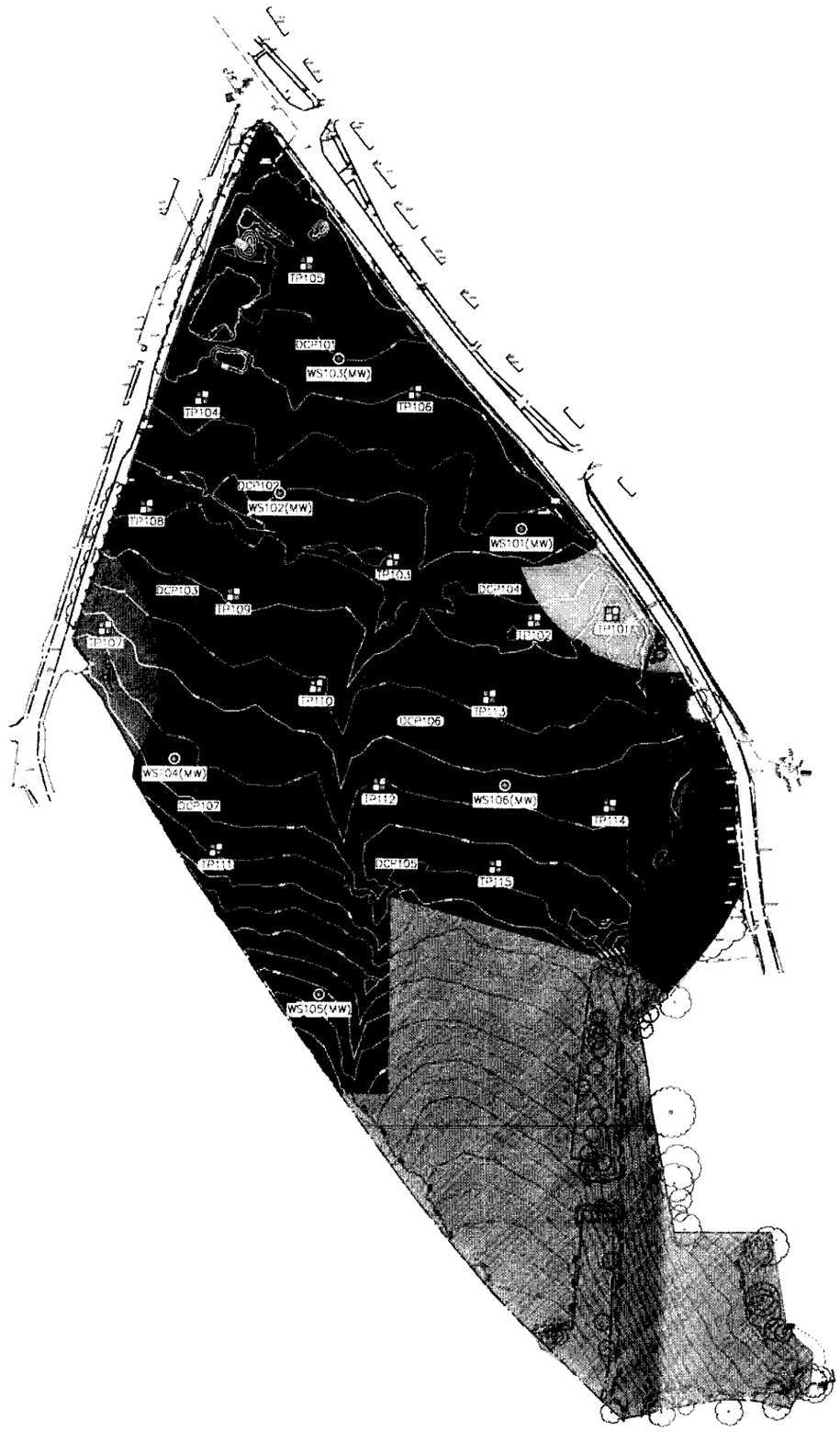

Key

Location Symbols

- Approximate Window Sample Probehole Location with Install
- Approximate Trial Pit Location
- Approximate Dynamic Cone Penetrometer Test Location

Made Ground Depth (m)

- No Made Ground Encountered
- Area Not Investigated
- Depth of Made Ground Between 0.00 - 0.99m
- Depth of Made Ground Between 1.00 - 1.99m
- Depth of Made Ground In Excess of 2.00m

Notes

Phase	Revision	Date	Issue	Drawn	Authorised
P1	-	17-07-2015	DRAFT	JN	MD

Client: Seddon Homes

Job No.: 10633 Date: 17-07-2015

Drawing No.: 005 Scale: 1:2000 @ A3

Job Title: Long Lane, Chapel en le Frith

Drawing Title: Depth of Made Ground Plan

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