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PHASE 2: GROUND INVESTIGATION REPORT

LAND NORTH OF HOLME HOUSE RESIDENTIAL HOME

OXFORD ROAD

GOMERSAL

CLECKHEATON

WEST YORKSHIRE

Project No: 17-174

Prepared By:
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Date: 15th September 2017

Approved By:
Kevin Moir

Date: 15th September 2017

The information and/or advice contained in this Phase 2: Ground Investigation Report is based solely on, and is limited to, the boundaries of the site, the immediate area around the site, and the historical use(s) unless otherwise stated. This 'Report' has been prepared in order to collate information relating to the physical, environmental and industrial setting of the site, and to highlight, where possible, the likely problems that might be encountered when considering the future development of this site for the proposed end use. All comments, opinions, diagrams, cross sections and/or sketches contained within the report, and/or any configuration of the findings is conjectural and given for guidance only and confirmation of the anticipated ground conditions should be considered before development proceeds. Agreement for the use or copying of this report by any Third Party must be obtained in writing from Arc Environmental Limited (ARC). If a change in the proposed land use is envisaged, then a reassessment of the site should be carried out.

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APPENDICES

1.0 Introduction

September 2017

In conjunction with the completion of the Phase 1: Desk Top Study Report for this site (Arc Environmental Ltd., ref. no.: 17-174, August 2017), Arc Environmental Ltd. have been instructed by Heritage Planning Design on behalf of Mr Robert Martin, to undertake a programme of intrusive ground investigation works for a proposed residential development located to the north of Holme House Residential Home, Oxford Road, Gomersal, in West Yorkshire. The proposed residential development comprises the construction of 26 no. properties with private gardens, road infrastructure and car parking.

The site currently comprises agricultural grassed fields, with a track running along the southern boundary leading to the northwestern corner of the site where there is an area of hard standing used as a horse stable, storage containers/lorry trailers and farm machinery. There are also a number of spoil heaps of unknown origin and various age, comprising sandstone rubble and possible asphalt road planings, soil, horse manure, and timber logs located on the southeast and eastern portions of the site. It is understood from the current site owner that most of these stockpiles will be removed prior to development of the site, with the exception of the southeastern stockpile. There is also a surface watercourse running west to east, from the northwestern corner of the site towards the eastern portion of the site.

This intrusive ground investigation has been designed to provide an assessment of the potential contamination issues across the site as a whole for potential risks to human health and Controlled Waters, in addition to the geotechnical issues associated with the proposed development works, as highlighted from the results of the Phase 1 desk study data.

The intrusive investigation works comprised the sinking of 11 no. mechanically excavated trial pits, 3 no. manually (hand-dug) excavated trial pits, 5 no. windowless sampling boreholes, accompanied by the installation of 3 no. ground gas and water monitoring wells, and 3 no. openhole rotary boreholes. All the investigation positions put down can be seen on the Trial Pit & Borehole Location Plan, a copy of which can be seen in Appendix II. It should be noted that the plan should be used for orientating purposes only, as the location of the positions are approximate.

2.0 Site Details

Table 2.1 N = north, S = south, E = east, W = west

Site Name & Address:	Land North of Holme House Residential Home, Oxford Road, Gomersal, Cleckheaton, West Yorkshire, BD19 4LA.
OS Grid Reference:	420420, 427100 (representative for the central part of the site).
Description of Location	The site is located adjacent to Oxford Road, on the northern outskirts of Gomersal, in West Yorkshire.
Site Boundaries:	N & W = Agricultural land, E = Oxford Road (A651) with residential properties beyond, S = Access road and Holme House Residential Home.
Site Setting:	Residential in an agricultural setting.

3.0 Scope of Works

Table 3.1

Client:	Mr R. Martin.
Project type:	It is proposed to develop the site with 26 no. residential properties with private gardens, access roads, and areas of car parking.
Site Location plan:	See Appendix I.
Layout plans (existing):	See Appendix I.
Layout plans (proposed):	See Appendix I.

3.0 Scope of Works (Cont'd)

Table 3.1 (Cont'd)

Investigation Works:	11 no. mechanically excavated trial pits (TP's 01 – 11), 3 no. manually (hand-dug) excavated trial pits, (HP's 01 – 03), 5 no. windowless sampling boreholes (BH's 01 – 05), accompanied by the installation of 3 no. combined gas and groundwater monitoring wells (BH's 01, 03 & 04), and 3 no. openhole rotary boreholes (RBH's 01 – 03).
Laboratory Testing:	Geotechnical & Ground Contamination.
CLEA End-Use Classification:	Level 1 GQRA – Residential with home-grown produce.
Reporting:	Factual & Interpretative including GQRA's for Human Health, Controlled Waters and Hazardous Ground Gas risk assessments.
Site History Summary:	Historically, the site has remained undeveloped from as early as c.1854 to the present day. Currently, there is a track running along the southern boundary leading to the northwestern corner of the site where there is an area of hard standing used as a horse stable, storage containers/lorry trailers and farm machinery. Historically, a small pond was also recorded on the northwestern corner of the site, which is now occupied by the existing horse stable, and this flowed into the surface watercourse which runs from west to east, from the northwestern corner of the site towards the eastern portion of the site.
Other Comments:	The site has a number of spoil heaps of unknown origin and various age, comprising sandstone rubble and possible asphalt road planings, soil, horse manure, and timber logs located on the southeast and eastern portions of the site. It is understood from the current site owner that most of these stockpiles will be removed prior to development of the site. There is a circular fenced off area in the middle of the site comprising asphalt planings, associated with a holding pen for animals. The presence of Himalayan Balsam has been noted along the route of the surface watercourse and on the southeastern portion the site

The information contained in this report is limited to the area of the site, as indicated on the Existing & Proposed Site Layout Plans shown in Appendix I, and to those areas accessible during the ground investigation. When considering the full scope of the development any features and / or issues not specifically mentioned in this report cannot be assumed to have been covered.

4.0 Investigation Rationale

This ground investigation has been designed to provide information on the issues highlighted in the previous section. The rationale behind the location of each exploratory hole is summarised in Table 4.1 below.

Table 4.1

Potential issue	Exploratory hole
Geotechnical ground conditions for foundation design and concrete classification.	TP's 01 – 11 and BH's 01 – 05.
Potential ground contamination and classification for off-site disposal.	TP's 01 – 11, BH's 01 – 05, and HP's 01 – 03.
Assessment of potential shallow coal workings.	RBH's 01 – 03.
Targeting area of hardstanding (NW corner of site) and stockpiles.	HP's 01 – 03.
Assessment of Hazardous Ground Gases and groundwater levels.	BH's 01, 03 & 04.

4.0 Investigation Rationale (Cont'd)

4.1 Contamination Related Sampling & Site Protocols:-

All works associated with this ground contamination assessment and investigations have generally been completed in accordance with BS5930:2015 – Code of Practice for Ground Investigations, BS10175:2011 + A1:2013: Investigation of Potentially Contaminated Sites – Code of practice & CLR11, with the following precautions specific to this project.

4.1.1 Ground Contamination Sampling:-

Samples of soil retrieved for chemical analysis were placed into air tight plastic containers, amber glass jars and VOC jars, in order to maintain the integrity of the samples (with particular regard to volatiles), by a representative of Arc Environmental Ltd. during the intrusive investigation works. The samples were transported and stored between c.2ºC – c.8ºC using cool boxes and ice packs, prior to delivery to a UKAS/MCERTS accredited laboratory.

4.1.2 Avoiding Cross-Contamination between Sample Locations:-

Within the boreholes, dedicated disposable plastic liners to collect samples from the windowless sampling boreholes carried out. To avoid cross-contamination of materials, the samples were recovered manually using dedicated disposable plastic gloves, replaced between each sample recovery, and drill pipe casing was cleaned between positions.

4.1.3 Onsite Health & Safety Requirements:-

All site representatives wore relevant and appropriate PPE including (where appropriate) safety footwear, high visibility jacket/vest, hard hat, eye protection and overalls, in accordance with site Health & Safety policy. In addition, disposable latex gloves were used when handling any potentially contaminated materials and when rinsing all sampling tools. Each site vehicle contained a suitable First Aid kit with hand wash station/cleansing products (i.e. sanitary wipes).

5.0 Ground Conditions

5.1 Soil Profile:-

For an accurate description of the ground conditions encountered at each investigation position, reference should be made to the trial pit & borehole record sheets in Appendix II, and the depths of strata on the record sheets are recorded from current ground levels. A summary of the soil profile for this site can be found in Table 5.1 below and continuing on the following page.

Table 5.1

Type of Strata	Depths Recorded (BGL)	Description & General Comments
MADE GROUND:	From 0.00m up to at least c.0.40m and c.0.80m	Made ground was generally constrained to the northwestern corner of the site (horse stables, etc.) comprising dark brown and dark grey gravelly sand with fragments of sandstone, brick and concrete, and also BH05 on the southeastern portion of the site comprising soil underlain by blackish dark grey sandy gravels of mudstone.
TOPSOIL:	From 0.00m up to c.0.10m and c.0.82m	Across much of the site, the initial surfacing comprises grass underlain by brown slightly sandy silty friable clay TOPSOIL. The initial topsoil deposits were noted to be disturbed at the locations of TP's 03, 07 & 11 containing occasional brick, concrete and sandstone fragments.

5.0 Ground Conditions (Cont'd)

5.1 Soil Profile (Cont'd):-

Table 5.1 (Cont'd)

Type of Strata	Depths Recorded (BGL)	Description & General Comments
DRIFT GEOLOGY:	From c.0.10m to c.0.82m up to c.1.00m and c.1.90m	The natural deposits comprise typically firm and stiff (medium and high strength) brown and grey mottled slightly sandy silty CLAY.
SOLID GEOLOGY: Lower Coal Measures	From c.1.00m to c.1.90m up to c.30.00m	The solid geology comprises a dark grey silty and shaley MUDSTONE with occasional sandstone bands, which is noted to be initially weathered becoming more intact with depth. No coal seams were encountered during the completion of the deep rotary boreholes.

Across the southeasten portion of the site there are 5 no. stockpiles, which comprise 'topsoil' from localised on-site stripping of the ground to create the hardstanding in the northwestern corner of the site, horse manure, sandstone rubble and asphalt road planings, and timber log storage. It is understood from the current site owner that most of these stockpiles will be removed prior to development of the site, with the exception of the southeastern stockpile (targeted by HP03).

5.2 Shallow Coal Mining Assessment:-

Following the completion of the Coal Mining Risk Assessment for this site, contained within the Phase 1: Desk Top Study report (ref. no.: 17-174), the site is in an area where it is believed that coal seams may exist at shallow depth and within which unrecorded workings could exist. According to the BGS geological plans, a conjectured coal seam is shown to sub-crop to the east and west of the site dipping below the site, and this is believed to represent the Middleton Little coal seam. As such, 3 no. open hole rotary boreholes have been completed in order to determine the level of risk from unrecorded workings in the Middleton Little coal seam.

As can be seen from the rotary borehole logs, copies of which can be found in Appendix II, no intact coal seams, or evidence of workings, in the form of broken ground, voids or soft ground were recorded below the site during the creation of the boreholes. During the works 100% of the flush medium was returned within the deep boreholes, which were taken to terminal depths of c.30.00m bgl.

In conclusion, it is felt that the site is not at risk from shallow coal workings, nor future subsidence as a direct result of shallow coal workings collapsing (i.e. voiding and/or broken ground), and therefore no remediation or further investigation works are deemed necessary for this site with regard to coal workings.

5.3 Groundwater:-

Generally, all the investigation positions remained dry during the exploratory period, with the exception of TP03 where a slight seepage was noted at a depth of c.2.30m bgl within the solid geology (Mudstone).

The findings of these fieldworks would suggest that a continuous shallow groundwater surface (water table) is not present below the site. Nonetheless, it would be considered prudent to allow for the introduction of suitable groundwater control measures and adequate shoring, in order to take care of any potential future shallow water ingresses within the underlying deposits particularly where open excavations are present and are to remain open to the natural elements.

Further groundwater monitoring has been undertaken within the combined gas and groundwater monitoring standpipes installed across the site. The results of the monitoring are discussed in Section 6.4.

6.0 Insitu Testing

6.1 Insitu Standard Penetration Tests:-

Insitu standard penetration tests were carried out within the boreholes with the use of a split spoon sampler, in order to determine the relative density/strength of the natural deposits. The results are shown as uncorrected 'N' values on the graphic borehole record sheets, adjacent to the appropriate sample level. Where the full penetration depth, including seating blows (450mm), could not be achieved, the bottom sampling depth is indicated as less than 0.45m from the top (start of test), with the actual depth of penetration and number of blows undertaken also being recorded. A summary of the findings is given below:-

- Tests completed within the mudstone deposits, recorded 'N' values ranging between 22 and 25, and also blow counts of up to 74 for limited penetration, indicating medium dense becoming very dense/hard strata.

6.2 Insitu Hand Shear Vane Tests:-

Insitu hand vane tests were carried out using a portable hand vane tester (upper limit 120kN/m^2) on the natural clay deposits encountered in the trial pits and boreholes. The results obtained can be found adjacent to the appropriate sample level, on the graphic trial pit and borehole record sheets in Appendix II.

From the results of the testing completed within the natural clay deposits, typically shear strength values ranging between 48N/m^2 up to 100kN/m^2 were recorded, equating to medium and high strength deposits.

6.3 Insitu Equivalent CBR Tests:-

Insitu CBR tests were carried out using a MEXE Cone Penetrometer, in accordance with the manufacturer's instructions, in order to obtain the insitu CBR value of the natural deposits noted within the trial pits. In each case a series of tests were carried out and an average of the results noted can be seen on the trial pit record sheets enclosed, adjacent to the appropriate sample depth.

The results of the insitu CBR tests undertaken within the natural deposits at shallow depths across the site area recorded values ranging between 1.5% up to 5.0%. Therefore, from the intrusive investigation works and based on visual observations, it can be seen that a typical characteristic design CBR value of 2.0% should be taken where the natural deposits are to be used as an undisturbed sub-grade for any new areas of hardstanding and ground bearing floor slabs constructed across the site.

6.4 Insitu Ground Gas & Groundwater Monitoring:-

Combined ground gas & water monitoring standpipes were installed within three of the windowless boreholes put down (labelled as BH's 01, 03 & 04), to assess the site from potential hazardous ground gas generation from on-site and off-site sources, although these risks are considered to be very low.

A standard 50mm diameter HDPE standpipe, with gravel and geo-wrap surround, bentonite seal, gas valve cap and security cover, was installed within each borehole, and ground gas and water levels were allowed to reach equilibrium, prior to the first monitoring visit. A bentonite seal was provided to prevent excessive surface water ingress or venting of soil gas, with the resulting response zone covering the remaining depths of the installations. Monitoring was undertaken using a Gas Data GFM series infra red gas analyser, with integral flow meter, and an electronic dipmeter.

Based on the findings of the Phase 1: DTS and these intrusive works, and in accordance with CIRIA Report C665, November 2007, BS8485:2015: Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings, and BS8576:2013: Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds, the risk assessment for this site would be based on the following limiting factors:

6.0 Insitu Testing (Cont'd)

6.4 Insitu Ground Gas & Groundwater Monitoring (Cont'd):-

- The proposed residential development has been considered as *high* sensitivity (Tables 5.5a & 5.5b – Typical/Idealised frequency and period of monitoring, after Wilson et al, 2005).
- The risk associated with the generation potential of a source is considered as *very low* (assessment based on the findings of the intrusive works).
- Monitoring over a minimum of *three* months with *six* recorded readings (Tables 5.5a & 5.5b – Typical /idealised frequency and period of monitoring after Wilson et al, 2005).
- No detectable concentrations of Methane or Carbon Dioxide have been recorded exceeding the action trigger levels of 1% & 5% respectively. (Table 8.5 – Modified Wilson & Card classification).
- *Negligible* (<0.1l/hr.) and slightly positive (up to 0.7l/hr) flow rates have been recorded during the monitoring period to date (Table 8.5 – Modified Wilson & Card classification).
- A targeted and phased programme of gas monitoring will be completed, which will obtain gas monitoring readings during varying atmospheric conditions, which covers the 'worst case' scenario for ground gas emissions to occur, particularly during rapid falls in atmospheric pressure (i.e. from c.1020mb and c.1010mb), and also during low atmospheric pressure events (i.e. c.1000mb and below).

A summary of the results for the visits undertaken are presented in Table 6.1 below, with a copy of the monitoring results contained in Appendix III.

Table 6.1

Position	Date	Atmospheric Pressure (mbar)	Water (m bgl)	CH_4 (%v/v)	LEL (%v/v)	CO_2 (%v/v)	O_2 (%v/v)	Flow Rate (l/hr)
BH01	31/07/2017	998 (trend - rising 997-1009)	1.82	0.0	0.0	2.4	13.2	<0.1
BH03			1.44	0.0	0.0	1.5	14.7	<0.1
BH04			Dry	0.0	0.0	1.0	18.8	<0.1
BH01	21/08/2017	1020 (trend - steady 1022-1020)	1.86	0.0	0.0	0.5	19.5	0.6
BH03			1.38	0.0	0.0	0.0	20.7	0.7
BH04			1.42	0.0	0.0	1.0	18.2	0.5
BH01	15/09/2017	991-993 (trend – rising 981-1013)	1.60	0.0	0.0	0.3	19.9	<0.1
BH03			1.10	0.0	0.0	0.0	20.3	<0.1
BH04			1.34	0.0	0.0	0.0	20.5	<0.1
3 no. outstanding visits to be completed								

Note – Atmospheric trend taken from Wunderground for Leeds-Bradford Airport.

As can be seen from the results to date, no concentrations of detectable Methane (CH_4) have been recorded. Concentrations of Carbon Dioxide (CO_2) have currently been recorded up to a maximum of 2.4% *v/v*, with reduced Oxygen (O_2) concentrations (minimum 13.2% *v/v).* Negligible (<0.1 l/hr.) and slightly positive (up to 0.7l/hr) flow rates have been recorded during the monitoring visits completed to date.

For the purposes of the proposed residential development, the site is characterised based on the limiting borehole gas volume flow for Methane and Carbon Dioxide known as the Gas Screening Value (GSV) which inturn determines the level of protection required. Therefore, in order to complete the risk assessment, the maximum GSV (Gas Screening Value) for the CH_4 and CO_2 levels recorded have been determined as follows:

- Methane (CH_4) – Due to the lack of Methane no GSV can be calculated.
- Carbon Dioxide (CO_2) - multiplying the maximum concentration recorded (taken as 2.4%) by the maximum flow rate (taken as 0.7 l/hr.) which gives a GSV of 0.01 l/hr. (calculated from 0.024 x 0.7 l/hr. maximum flow rate).

6.0 Insitu Testing (Cont'd)

6.4 Insitu Ground Gas & Groundwater Monitoring (Cont'd):-

From the results it can be seen that the presence of hazardous ground gases do not exceed the GSV assessment value of 0.07 l/hr. (Characteristic Situation 1) or 0.78 l/hr. (Green Classification – NHBC Traffic light system), indicating that no gas protection measures would be required for the proposed residential development. However, this will need to be reassessed following the completion of the 3 no. outstanding gas monitoring visits, with the results issued as an addendum letter report.

From the results of the groundwater monitoring carried out in the standpipes, it can be seen that standing water levels have been recorded between depths of c.1.10m and c.1.86m bgl.

When considering the lack of significant shallow water ingresses encountered during the intrusive works, and the standing water recorded during the monitoring visits, it is felt that this water is likely to be representative of perched/trapped surface water drainage within the standpipes. Therefore, some shallow ingresses of water should be anticipated where construction related excavations are taken down near to the depths where standing water has been recorded, and therefore it would be considered prudent to allow for the introduction of appropriate groundwater control measures, in order to take care of any future water ingresses within the underlying deposits particularly where excavations are to remain open to the elements for any significant period of time.

7.0 Laboratory Testing

All geotechnical testing was carried out in accordance with BS1377:1990: Parts 1-9 by Professional Soils Laboratory Limited (PSL) of Doncaster, South Yorkshire (UKAS accredited). Ground contamination was undertaken by Chemtech Environmental of Stanley, Co. Durham (UKAS & MCERTS accredited).

7.1 Determination of Liquid & Plastic Limits:-

Representative samples of the natural clay and mudstone deposits recovered from the trial pits have been tested in order to determine their liquid and plastic limits, so that these materials can be classified. In addition, the moisture contents of the samples were also derived. The results are summarised in Table 7.1 below and are also contained in the PSL Analytical Report (ref no.: PSL17/3491), a copy of which is contained in Appendix IV.

Table 7.1

Position	Depth (m)	M/C (%)	LL	PL	PI	Class	% Passing 425µm Sieve
TP02	1.10	16		NP			
TP06	0.60	28	65	27	38	CH	100
TP08	1.00	20	62	26	36	CH	93
TP10	0.50	24	60	26	34	CH	100

M/C = Moisture Content, LL = Liquid Limit, PL = Plastic Limit, PI = Plasticity Index, CH = Clay High, NP = Non plastic.

From these results it can be seen that the samples tested are inorganic in nature, and when plotted on the plasticity chart fall within the high plasticity range. From the resulting plasticity indices, these materials tested display a moderate volume change (shrinkage or swelling) potential, when taking into account the amount passing the 425µm sieve. One sample was recorded to be non-plastic in nature and therefore this will exhibit a negligible volume change potential.

Therefore, it can be seen that some of these materials may undergo significant changes in volume, if large changes in their natural moisture content were to occur due to seasonal variations or the like, and if new foundations were to be based within these clay deposits, they would need to be taken down to a minimum depth of 0.90m below finished ground levels.

7.0 Laboratory Testing (Cont'd)

7.1 Determination of Liquid & Plastic Limits (Cont'd):-

However, an increase in the minimum foundation depths may be required to reach competent strata and if foundations are within close proximity to existing or proposed trees. Reference should be made to BS5837: 2012 - 'Trees in relation to design, demolition & construction - Recommendations', along with the NHBC Standards, 'Building near trees'.

7.2 Determination of Chemical Attack on Buried Concrete:-

One representative sample of the natural mudstone deposits has been tested in order to determine the pH value, soluble and total sulphate (SO_4), soluble Chloride (CL), soluble Magnesium (Mg), total Sulphur (S) and Nitrate (NO_3) levels. A further eight soils were tested for their pH value and soluble sulphate levels (SO_4) only. The samples screened were generally targeted for the deposits where future foundations or buried concrete will either be placed or will encounter these materials.

The results are shown in Table 7.2 below, and are also contained in the Chemtech Environmental Limited analytical report (ref. no.: 66115(2)), a copy of which can be seen in Appendix IV.

Table 7.3

Position	Depth (m)	pH Value	SO_4 2:1 water soluble (mg/l)	Cl 2:1 water soluble (mg/l)	NO_3 water soluble (mg/l)	Mg 2:1 water soluble (mg/l)	SO_4 Total (mg/kg)	S Total (mg/kg)
BH03	1.50-2.00	6.7	15	1.2	<1	22	<100	<100
HP01	0.00-0.40	8.0	182	-	-	-	-	-
HP03	0.00-0.70	7.2	27	-	-	-	-	-
TP03	0.25	7.3	62	-	-	-	-	-
TP04	1.20	6.2	17	-	-	-	-	-
TP05	0.10	7.1	34	-	-	-	-	-
TP08	1.40	6.9	19	-	-	-	-	-
TP10	0.10	6.8	32	-	-	-	-	-
TP11	0.40	7.5	94	-	-	-	-	-

ACEC = Aggressive Chemical Environment for Concrete site classification

From these results for the samples of soil tested, it can be seen that the amount of soluble sulphate present ranges between 15mg/l up to 182mg/l, and the pH values range between 6.2 up to 8.0. Concentrations of total sulphate and total sulphur are considered to fall within the negligible range.

Based on the mean value of the two highest results obtained, this site should be given a classification of Class DS-1, in accordance with BRE Special Digest 1: 2005 (3rd Edition) and the procedures for determining Sulphate Classification for natural ground locations. When considering the pH values of the materials tested, and assuming potentially mobile groundwater, the assessment of the Aggressive Chemical Environment for Concrete (ACEC) is AC-1.

7.3 Contamination Screening:-

Representative samples of the made ground, a stockpile sample and the 'topsoil' materials recovered from this site were passed onto Chemtech Environmental of Stanley, Co. Durham, so that soil and leachate screening could be carried out. The catalogue of testing results can be found in the Chemtech Environmental analytical report (ref no.: 66115(2)), a copy of which is contained in Appendix IV, and the total analysis carried out is summarised below.

7.0 Laboratory Testing (Cont'd)

7.3 Contamination Screening (Cont'd):-

Soils:-

- 6 no. Generic Soils Suites - comprising; Arsenic, Cadmium, Chromium (III & VI), Copper, Lead, Mercury, Nickel, Selenium, Zinc, pH, Soluble Sulphate, free Cyanide, and Total Organic Carbon (TOC).
- 6 no. Speciated Poly-cyclic Aromatic Hydrocarbons (PAH's) – based on the current USEPA 16 PAH's + Benzo(j)fluoranthene.
- 6 no. Speciated Total Petroleum Hydrocarbons (TPH – 8 Carbon Band Split).
- 6 no. Asbestos screens (presence).
- 1 no. Asbestos Quantification.

Leachate:-

- 1 no. Generic Suites – suite comprises; Arsenic, Boron, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Zinc, pH, Sulphate and free Cyanide.
- 2 no. Speciated Poly-cyclic Aromatic Hydrocarbons (PAH's).

The soil and leachate screening contamination results have been used to carryout risk assessments for Human Health and Controlled Waters for potential ground contamination present, and these are discussed in Section 8.0 below and on the following pages.

8.0 Ground Contamination Risk Assessment

8.1 Methodology:-

Following completion of the contamination screening undertaken on various samples from this site, a Level 1 quantitative ground contamination risk assessment has been undertaken, generally in accordance with CLR11: Model Procedures for the Management of Land Contamination. A detailed description of the Assessment Framework and Methodology used by ARC for these risk assessments can be found in Appendix V.

This quantitative ground contamination risk assessment uses the current UK practice for assessing the risks from land contamination, which is based on the established *source-pathway-receptor* pollutant linkage methodology and 'suitable for use' approach (Part IIA, EPA 1990 - inserted through Section 57 EA 1995).

Based on the Conceptual Site Model (CSM) for this site (described further in the following Section 8.2), a site specific screening strategy for the site has been developed (see Section 8.3) and the risks from potential contaminants has been assessed for human health and Controlled Waters. The results of the risk assessments can be found in Sections 8.4, 8.5 and 8.6 (Human Health) and 8.7 (Controlled Waters).

8.2 Revised Conceptual Site Model (CSM):-

Following the results of the intrusive investigation works, a Revised Conceptual Site Model (CSM) has been developed, and this has identified the potential for land contamination to exist on this site, comprising the presence of localised made ground & disturbed 'topsoil' materials, stockpiles, as well as possible sources of hazardous ground gases. Table 8.1 on the following page summarises the *source(s)*, *pathways* and potentially sensitive *receptors* for this site, assuming no remediation, additional protection measures and/or removal of the sources contamination takes place.

8.0 Ground Contamination Risk Assessment (Cont'd)

8.2 Revised Conceptual Site Model (CSM) (Cont'd):-

Table 8.1

	Sources (S)		***Pathways (P)***		***Receptors (R)***
S1	Localised made ground (where present) associated with the existing horse stables, storage of farm machinery etc., and partial culverting of surface watercourse	P1	Ingestion & Dermal Contact	R1	Human health – Future end users
		P2	Inhalation of indoor / outdoor air	R2	On-site surface watercourse
S2	Stockpiles	P3	Plant Uptake and attached soil	R3	Deep groundwater – ***considered at low risk***
S3	Generation of hazardous ground gases (made ground – off-site sources) – ***considered to be very low risk***	P4	Migration through existing services	R4	Adjacent sites
		P5	Direct contact with building materials	R5*	Building materials & protection of water pipes
		P6	Surface runoff & Infiltration	R6*	Flora and fauna

* = Not included in the Human Health & Controlled Waters Risk Assessment

8.2.1 Sources:-

From the intrusive works undertaken, localised made ground was recorded on the northwestern and southeastern corners of the site (HP01 and BH05), and occasional disturbed natural strata containing fragments of brick, concrete and sandstone was recorded in 3 no. localised positions (TP's 03, 07 & 11). The site has also been used to store agricultural machinery, which may represent localised sources of historical fuel/oil leakage.

Across the southeastern portion of the site there are 5 no. stockpiles, which comprise 'topsoil' from localised on-site stripping of the ground to create the hardstanding in the northwestern corner of the site, horse manure, sandstone rubble and asphalt road planings, and timber log storage. It is understood from the current site owner that most of these stockpiles will be removed prior to development of the site, apart from the southeastern stockpile (targeted by HP03).

Elsewhere across the majority of the site, no other made ground material was present, with natural topsoil proven to overlie the superficial deposits. The topsoil was generally recorded as a silty clayey material, and is not considered represent a potential source of contamination.

When considering the nature and limited/isolated thickness of made ground on the northwestern and southeastern portions of this site, and the localised disturbed natural strata, these deposits are not considered to represent a source of potential on-site generation of hazardous ground gases, and as such the risk has been considered as negligible. In addition, the site is not affected by shallow coal mining geohazards, including mine gasses. Although there are limited potential off-site sources of ground gasses, the initial ground gas monitoring undertaken to date suggests that no gas protection measures will be required. Once the monitoring regime has been completed a final risk assessment will determine whether any remedial measures are required.

8.2.2 Pathways:-

When considering the proposed end use (*Residential development*), and without considering treatment, removal or protection measures, there are some potential plausible pathways available for direct contact, dermal contact, ingestion, inhalation, wind (dust / particulate), volatilization, and vertical and lateral transportation below the site, both within the existing structure and externally, where there is no hard cover or vapour barriers present.

8.0 Ground Contamination Risk Assessment (Cont'd)

8.2 Revised Conceptual Site Model (CSM) (Cont'd):-

8.2.2 Pathways (Cont'd):-

Within the CLEA Risk Assessment Model for Human Health, there are 3 exposure mediums considered for on site receptors, comprising ingestion of soil containing contaminants, inhalation of contaminated dust/vapours and dermal contact, with up to 10 no. exposure pathways considered, as shown below.

1. Ingestion of soil and indoor dust 2. Consumption of home-grown produce and attached soil 3. Dermal contact (indoor) 4. Dermal contact (outdoor) 5. Inhalation of dust (indoor) 6. Inhalation of dust (outdoor) 7. Inhalation of vapour (indoor) 8. Inhalation of vapour (outdoor) 9. Oral background intake 10. Inhalation background intake.

Where the future site layout has hard cover and below the actual new structures, some of these pathways will not be available, except where building materials / structures and services come into direct contact with the made ground. In addition, when considering the potential pathways for leachate migration, where either hard cover and/or future surface water drainage systems are present, the potential effects of surface infiltration or contaminated surface water runoff will be greatly reduced.

Similarly, when considering the construction work force, exposure pathways through direct contact, ingestion and dust inhalation will be available during part of the construction process, and therefore suitable PPE should be provided to protect the work force during this period.

8.2.3 Receptors:-

Within the CLEA Risk Assessment Model for Human Health, the potential receptors are assessed initially on site end use, followed by a delineation of age category (i.e. child or adult), with default settings for *Residential, Allotment* and *Public Open Space (Park)* end uses based on a child aged 0 to 6 years, *Public Open Space (Residential)* based on a child aged 3 to 9 and *Commercial* end uses based upon an adult working exposure period of up to 49 years (i.e. 16 to 65).

Key generic assumptions for *Residential* and *Public Open Space (Residential)* are based upon a typical residential property, consisting of a two-storey small terraced house, with private garden, and a *Commercial* end use based upon a typical commercial or light industrial property, consisting of a three-storey office building (pre-1970). No buildings are anticipated for *Allotment* or *Public Open Space (Park)* end uses.

Within the CLEA Risk Assessment Model for Human Health there are 6 no. generic end use categories presently in use, as follows;

1) Residential - with home-grown produce, 2) Residential - without home-grown produce, 3) Allotments, 4) Commercial 5) Public Open Space – Residential, 6) Public Open Space - Park

When considering the proposed end use of this site (residential development), the Level 1 Risk Assessment has taken the best fit end use category as:

1) Residential - with home-grown produce

For Controlled Waters and assuming a worst case scenario, the primary receptor for the Level 1 Risk Assessment is the on-site surface watercourse.

8.0 Ground Contamination Risk Assessment (Cont'd)

8.3 Screening Strategy:-

Representative samples of the localised made ground, disturbed natural strata present on this site, as well as the stockpile on the southeastern corner of the site, have been screened using a standard generic contamination suite (metals, metalloids and non-organics), which is used to assess typical made ground (disturbed natural strata mixed with anthropogenic debris) of an unknown source.

Generally, across the site as a whole, there was no significant visual or olfactory evidence of hydrocarbon based contamination (i.e. fuel or oil, etc.), significant deposits of 'ashy' materials or asbestos containing materials. However, in order to assess potential risks to human health samples have been screened for speciated PAH's, speciated TPH and asbestos screening.

Selected samples of the 'topsoil' materials from across the site have also been screened for using the generic contamination suite, speciated PAH's, speciated TPH's and asbestos in order to assess potential risks to human health and also potential suitability for re-use in a residential setting.

When considering the findings of the investigation works and the results of the contamination screening, in order to determine if potential contamination on this site represents a potential risk to Controlled Waters and adjacent sites, two soil samples have been subjected to leachate testing.

8.4 Level 1 Generic Quantitative Risk Assessment - Human Health:-

Samples of the targeted made ground on the northwestern corner of the site, the stockpile on the southeastern corner of the site and the disturbed natural strata encountered on the southeastern portion of the site, have been considered independently of the remainder of the site given the localised nature of these materials encountered.

The results of the contamination screening have been risk assessed by comparing the maximum values recorded for each analyte to the critical concentration values chosen for this site, and a summary of the results of the soil concentrations recorded and the human health risk assessment has been summarised in Table 8.2 below and continues on the following page.

Table 8.2

Analyte	Critical Conc. (C_C)	No. of Samples Screened	Max. Conc. (C_M) recorded	Does C_M exceed C_C?	No. of Samples > C_C
Generic Suite					
Arsenic	37[1]	3	23	No	0
Cadmium	11[1]	3	0.4	No	0
Chromium III	910[1]	3	175	No	0
Chromium VI	6[1]	3	<1	No	0
Copper	2,400[1]	3	52	No	0
Lead	200[2]	3	115		
Mercury	40[1]	3	<0.5	No	0
Nickel	130[1]	3	118	No	0
Selenium	250[1]	3	1.1	No	0
Zinc	3,700[1]	3	183	No	0
Cyanide	34[3]	3	<1	No	0
Asbestos	**Presence or Quantification**	**3**	**Chrysotile (<0.001% *w/w*)**	**~**	**1 (HP01)**

[1] = LQM S4UL's (2015) – *Residential with home-grown produce* – 6% SOM adopted for organic analytes, [2] = CL:AIRE C4SL's – *Residential with home-grown produce*, [3] = ATRISK^{SOIL} SSV, * = most conservative TPH aliphatic/aromatic value adopted for each speciated fraction, **Bold** = result exceeds critical concentration, Note = All units are mg/kg.

8.0 Ground Contamination Risk Assessment (Cont'd)

8.4 Level 1 Generic Quantitative Risk Assessment - Human Health (Cont'd):-

Table 8.2 (Cont'd)

Analyte	Critical Conc. (C_C)	No. of Samples Screened	Max. Conc. (C_M) recorded	Does C_M exceed C_C?	No. of Samples > C_C
Speciated PAH's					
Acenaphthene	1,100[1]	3	1.14	No	0
Acenaphthylene	920[1]	3	0.11	No	0
Anthracene	11,000[1]	3	2.62	No	0
Benzo(a)anthracene	13[1]	3	4.03	No	0
Benzo(a)pyrene	**3.0[1]**	**3**	**5.64**	**Yes**	**2 (HP01 & TP11)**
Benzo(b)fluoranthene	**3.7[1]**	**3**	**5.51**	**Yes**	**2 (HP01 & TP11)**
Benzo(ghi)perylene	350[1]	3	3.69	No	0
Benzo(k)fluoranthene	100[1]	3	2.17	No	0
Chrysene	27[1]	3	3.84	No	0
Dibenz(ah)anthracene	**0.3[1]**	**3**	**0.66**	**Yes**	**2 (HP01 & TP11)**
Fluoranthene	890[1]	3	9.14	No	0
Fluorene	860[1]	3	1.17	No	0
Indeno(123cd)pyrene	41[1]	3	3.54	No	0
Naphthalene	13[1]	3	0.73	No	0
Phenanthrene	440[1]	3	8.29	No	0
Pyrene	2,000[1]	3	7.54	No	0
Speciated TPH's					
VPH (>C5-C7)*	160[1]	3	<0.1	No	0
VPH (>C7-C8)*	530[1]	3	<0.1	No	0
VPH (>C8-C10)*	150[1]	3	<0.1	No	0
EPH (>C10-C12)*	380[1]	3	5	No	0
EPH (>C12-C16)*	660[1]	3	23	No	0
EPH (>C16-C21)*	930[1]	3	116	No	0
EPH (>C21-C35)*	1,700[1]	3	1,566	No	0
EPH (>C35-C44)*	1,700[1]	3	1,196	No	0

[1] = LQM S4UL's (2015) – *Residential with home-grown produce* – 6% SOM adopted for organic analytes, [2] = CL:AIRE C4SL's – *Residential with home-grown produce*, [3] = ATRISK^{SOIL} SSV, * = most conservative TPH aliphatic/aromatic value adopted for each speciated fraction, **Bold** = result exceeds critical concentration, Note = All units are mg/kg.

The results have identified the following:

- The maximum concentration (C_M) values for Benz(a)pyrene, Benzo(b)fluoranthene and Dibenz(ah)anthracene exceed the critical concentration (C_C) values chosen for this site at the locations of HP01 associated with the existing area of hardstanding, and also the disturbed natural strata at the location TP11 on the southeastern portion of the site.
- None of the C_M values for any of the generic metals, the remaining speciated PAH's or speciated TPH's screened exceed the C_C values chosen for this site at the locations of HP01 or TP11.
- The presence of Chrysotile asbestos has been recorded within the sample taken at HP01, and therefore further quantitative screening has been carried out in order to assess the level of risk posed to future end users from the asbestos recorded, and this is discussed in further detail in Section 8.5
- None of the generic metals, speciated PAH' or speciated TPH's screened exceed the C_C values within the sample obtained from the stockpile (HP03) on the southeastern corner of the site, and therefore this material can be considered suitable for re-use in a residential setting.
- However, the results of the contamination screening have identified some levels of PAH's within the materials encountered at the locations of HP01 and TP11, which are considered to pose a risk to human health where exposure pathways are available, and as such either further risk assessment, removal or the provision of a clean cover barrier would be required.

8.0 Ground Contamination Risk Assessment (Cont'd)

8.5 Asbestos Quantification & Detailed Risk Assessment:-

Further quantitative screening has been carried out in order to assess the level of risk posed to future end users from the Chrysotile asbestos recorded at the location of HP01. The results of the testing has identified concentrations of <0.001% *w/w*. At present, whilst there are currently no suitable generic assessment criteria for assessing risks from asbestos within the soil in the UK, further risk assessment can be undertaken based upon the considered fibre release potential, in accordance with current guidance (CIRIA C733 – Asbestos in soil and made ground: a guide to understanding and managing risks (2014)).

Currently, there is limited published data relating to the potential release of fibres from asbestos containing soils following physical disturbances (i.e. excavation, vehicle movement, children playing, etc.) either in the UK or elsewhere. However, one of the few empirical studies was conducted by Addison *et al* (1988), which simulated the potential release of three types of Asbestos (Chrysotile, Amosite and Crocidolite) for three soil types (sandy, intermediate and clay), at asbestos concentrations of 0.1%, 0.01% and 0.001% *w/w*. From this study, it was determined that asbestos concentrations as low as 0.001%*w/w* had the potential to give rise to airborne asbestos concentrations greater than 0.1 f/ml^{-1}, with these results being determined for dry soils with no moisture content.

Exposure Estimation:-

The maximum asbestos concentration has been recorded as <0.001% *w/w* of Chrysotile within the made ground sample obtained from HP01. In accordance with the guidance it is felt that these materials would not be capable of generating fibre concentrations in excess of 0.1 f/ml^{-1}, indicating a level of risk not exceeding 'insignificant'.

Further Considerations:-

The release of airbourne asbestos is strongly influenced by soil moisture content, with the addition of 5% moisture reducing potential airbourne asbestos by 80% to 95%, with no fibres being detected at above 25% moisture contents. The moisture contents of the samples analysed range from 9.6% therefore further reducing the level of potential risk with regards to airbourne release of asbestos fibres from these materials.

Detailed Risk Assessment Conclusions:-

When considering the concentration of Chrysotile asbestos identified within the made ground at HP01 (<0.001% *w/w)*, the generation potential of the asbestos fibres becoming airborne is considered to be 'insignificant', resulting in no significant level of risk posed to human health associated with these materials, with no further assessment being required.

8.6 Screening of 'Topsoil' Materials:-

Representative samples of the 'topsoil' materials encountered across the site have been screened in order to assess if these materials are suitable for potential re-use in a residential setting. The metals, metalloids, non-organics, speciated PAH and speciated TPH results have been risk assessed by comparing the maximum values recorded for each analyte to the critical concentration values chosen for this site, and a summary of the results of the soil concentrations recorded and the human health risk assessment have been summarised in Table 8.3 on the following page.

The results have identified the following:

- None of the maximum concentration (C_M) values for any of the generic contaminants (metals, metalloids), speciated PAH's or speciated TPH's exceed the critical concentration (C_C) values for this site.

8.0 Ground Contamination Risk Assessment (Cont'd)

8.6 Screening of 'Topsoil' Materials (Cont'd):-

- The results of the asbestos screening has not identified the presence of any asbestos fibres.
- The results of the contamination screening and risk assessment has identified that the 'topsoil' materials present on this site are not felt to represent a significant risk to human health, and therefore these soils can be considered suitable for re-use in gardens and soft landscaping areas.

Table 8.3

Analyte	Critical Conc. (C_C)	No. of Samples Screened	Max. Conc. (C_M) recorded	Does C_M exceed C_C?	No. of Samples > C_C
Generic Suite					
Arsenic	37[1]	3	31	No	0
Cadmium	11[1]	3	0.3	No	0
Chromium III	910[1]	3	57	No	0
Chromium VI	6[1]	3	<1	No	0
Copper	2,400[1]	3	69	No	0
Lead	200[2]	3	94	No	0
Mercury	40[1]	3	<0.5	No	0
Nickel	130[1]	3	22	No	0
Selenium	250[1]	3	1.6	No	0
Zinc	3,700[1]	3	107	No	0
Cyanide	34[3]	3	<1	No	0
Asbestos	Presence or Quantification	3	NAD	~	~
Speciated PAH's					
Acenaphthene	1,100[1]	3	0.10	No	0
Acenaphthylene	920[1]	3	<0.01	No	0
Anthracene	11,000[1]	3	0.42	No	0
Benzo(a)anthracene	13[1]	3	1.19	No	0
Benzo(a)pyrene	3.0[1]	3	1.24	No	0
Benzo(b)fluoranthene	3.7[1]	3	1.40	No	0
Benzo(ghi)perylene	350[1]	3	0.70	No	0
Benzo(k)fluoranthene	100[1]	3	0.70	No	0
Chrysene	27[1]	3	1.23	No	0
Dibenz(ah)anthracene	0.3[1]	3	0.19	No	0
Fluoranthene	890[1]	3	2.69	No	0
Fluorene	860[1]	3	0.07	No	0
Indeno(123cd)pyrene	41[1]	3	0.66	No	0
Naphthalene	13[1]	3	0.20	No	0
Phenanthrene	440[1]	3	1.28	No	0
Pyrene	2,000[1]	3	2.41	No	0
Speciated TPH's					
VPH (>C5-C7)*	160[1]	3	<0.1	No	0
VPH (>C7-C8)*	530[1]	3	<0.1	No	0
VPH (>C8-C10)*	150[1]	3	<0.1	No	0
EPH (>C10-C12)*	380[1]	3	15	No	0
EPH (>C12-C16)*	660[1]	3	21	No	0
EPH (>C16-C21)*	930[1]	3	43	No	0
EPH (>C21-C35)*	1,700[1]	3	246	No	0
EPH (>C35-C44)*	1,700[1]	3	83	No	0

[1] = LQM S4UL's (2015) – *Residential with home-grown produce* – 6% SOM adopted for organic analytes, [2] = CL:AIRE C4SL's – *Residential with home-grown produce*, [3] = ATRISK^{SOIL} SSV, * = most conservative TPH aliphatic/aromatic value adopted for each speciated fraction, **Bold** = result exceeds critical concentration, Note = All units are mg/kg.

8.0 Ground Contamination Risk Assessment (Cont'd)

8.7 Level 1 Generic Quantitative Risk Assessment – Controlled Waters:-

Based on the results of the soil screening carried out, generic metals, metalloids and speciated PAH leachate screening has been carried out on two representative soil samples. The results have been used to complete a Level 1 Risk Assessment for the potential impact on Controlled Waters and adjacent sites. The results are summarised in Table 8.4 below.

Table 8.4

Analyte	Target Conc. (C_T)	Max. Conc. (C_M) Recorded	Has max. C_T Value Been Exceeded?	Number of samples >C_T
Arsenic	10[1]	3.86	No	0
Boron	1000[1]	19	No	0
Cadmium	5[1]	<0.07	No	0
Chromium	50[1]	0.7	No	0
Copper	2000[2]	6.0	No	0
Lead	25[2]	1.7	No	0
Mercury	1[1]	0.009	No	0
Nickel	20[1]	0.8	No	0
Selenium	10[2]	0.68	No	0
Zinc	5000[2]	<1	No	0
Sulphate	250mg/l[1]	<10mg/l	No	0
Cyanide	50[2]	<20	No	0
Speciated PAH's				
Acenaphthene	1.2[1]	0.2	No	0
Acenaphthylene	0.1[3]	0.4	No	0
Anthracene	0.4[1]	<0.1	No	0
Benzo(a)anthracene	0.1[3]	<0.1	No	0
Benzo(a)pyrene	0.01[3]	<0.1	No	0
Benzo(b)fluoranthene	0.1[3]	<0.1	No	0
Benzo(ghi)perylene	0.1[3]	<0.1	No	0
Benzo(k)fluoranthene	0.1[3]	<0.1	No	0
Chrysene	0.1[3]	<0.1	No	0
Dibenz(ah)anthracene	0.1[3]	<0.1	No	0
Fluoranthene	1.0[1]	<0.1	No	0
Fluorene	0.1[3]	<0.1	No	0
Indeno(123cd)pyrene	0.1[3]	<0.1	No	0
Naphthalene	10[1]	1.9	No	0
Phenanthrene	0.1[3]	<0.1	No	0
Pyrene	0.1[3]	<0.1	No	0

[1] = UK EQS Value for Priority Substances, [2] = UK Drinking Water Standard, [3] = UK Drinking Water Standard for PAH's, [4] = UK Non-Statutory EQS Values, **Bold** = result exceeds critical concentration, Note = All units are µg/l unless stated.

The results have identified the following:

- The C_M values for all the generic metals, metalloids and non-organics screened do not exceed the C_T values taken for this site.
- Marginally elevated values of Acenaphthene and Acenaphthylene have been recorded, which exceed the most stringent EQS assessment values, however these values are not felt to represent significant 'heavy' or 'gross' contamination.
- From these results and the risk assessment completed, it can be seen that the made ground present does not represent a risk to any Controlled Waters or adjacent sites, and therefore there is no requirement for further risk assessment (DQRA) and/or remedial measures to be implemented.

9.0 Conclusions & Recommendations

9.1 Ground Conditions & Coal Mining Risk Assessment:-

From the investigation works completed, localised made ground appears to be constrained to the northwestern portion of the site currently used as horse stable and the storage of farm machinery, comprising dark brown and dark grey gravelly sand with fragments of sandstone, brick and concrete, and also on the southeastern portion of the site comprising blackish dark grey sandy gravels of mudstone, to depths of between c.0.40m up to c.0.80m below current ground levels (bcgl's).

Across the remainder of the site investigated, natural topsoil was recorded to depths of between c.0.10m and c.0.82m bcgl's, although the 'topsoil' was noted to be disturbed at the locations of TP's 03, 07 & 11, containing occasional brick, concrete and sandstone fragments.

Below the made ground and topsoil, natural superficial deposits were recorded to depths of between c.1.00m and c.1.90m bcgl's, generally comprising brown and grey mottled slightly sandy silty clay, before encountering the solid geology.

The solid geology was recorded to initially comprise of a dark grey shaley mudstone, alternating with layers of sandstone to depths of at least c.30m bgl. Within the solid deposits, no coal seams were encountered, nor any voiding or soft ground indicative of broken ground associated with underground mine workings below the site. Therefore, it is felt that the proposed development can be constructed without the need for incorporating any remedial measures to mitigate against future shallow mining related ground movement.

Across the southeastern portion of the site there are 5 no. stockpiles, which comprise 'topsoil' from localised on-site stripping of the ground to create the hardstanding in the northwestern corner of the site, horse manure, sandstone rubble and asphalt road planings, and timber log storage. It is understood from the current site owner that most of these stockpiles will be removed prior to development of the site, with the exception of the southeastern stockpile (targeted by HP03).

There was no significant evidence of 'ashy' materials, potential hydrocarbon contamination (i.e. fuels or oils), nor any visual evidence of potential asbestos containing materials (ACM's – cemented sheets, lagging, etc.) encountered within any of the exploratory positions.

9.2 Groundwater:-

During the investigation period, generally all the exploratory positions remained dry, with the exception of a slight water seepage noted within TP03 at a depth of c.2.30m bgl.

From the results of the groundwater monitoring carried out in the standpipes, it can be seen that standing water levels have been recorded between depths of c.1.10m and c.1.86m bgl.

When considering the nature of the deposits encountered below the site, it is felt that the water encountered is not representative of a shallow continuous groundwater surface (i.e. water table), but represents the presence of perched and trapped water surface drainage. Therefore, it would be prudent to allow for the introduction of suitable groundwater control measures (i.e. pumping equipment) and adequate shoring, in order to take care of any localised ingresses of water during the construction period, and especially during the wetter periods of the year.

9.3 Hazardous Ground Gas Risk Assessment:-

From the results of the gas monitoring visits carried out to date, no detectable concentrations of Methane (CH_4) have been recorded. Concentrations of Carbon Dioxide (CO_2) have currently been recorded up to a maximum level of 2.4%, and negligible & slightly positive flow rates have been recorded (<0.1 up to 0.7l/hr).

9.0 Conclusions & Recommendations (Cont'd)

9.3 Hazardous Ground Gas Risk Assessment (Cont'd):-

Based on these results to date, it is felt that the site can be classified as Characteristic Situation 1 (CS1) and Green (in accordance with the NHBC Traffic light system), indicating that no gas protection measures would be required for the proposed residential development. However, it should be noted that a final risk assessment will be undertaken following the completion of the remaining three gas monitoring visits, and a reassessment of the site characterisation can be made. This will be issued as an addendum to this report.

9.4 Foundation Options:-

Based on the findings of the investigation works, it is felt that conventional shallow strip foundations can be utilised, taken down through the existing topsoil and made ground (where present), based within the natural clay deposits, and designed to a maximum allowable bearing pressure of 120kN/m^2. Foundations should be maintained at a minimum depth of 0.90m below finished ground levels, to take into account potential shrinkage and swelling of the clays.

An increase in minimum foundation depth may be required, if made ground is encountered or there is an increase in the depth to competent strata. Also, if any of the proposed buildings are within close proximity to existing or envisaged vegetation/trees, then an increase in the minimum foundation depth may also be required, even if trees are to be removed, in order to ensure no additional future shrinkage and swelling of these materials occurs. Reference should be made to BS5837: 2012 - 'Trees in relation to design, demolition & construction - Recommendations', along with the NHBC Standards, 'Building near trees'.

Founding soils are likely to be susceptible to poor weather conditions and therefore it is recommended that excavations remain open for as short a period as possible, since most of these materials will be susceptible to significant deterioration, if left open to the natural elements even for short periods of time. Similarly, foundation excavations could be protected further with a layer of blinding concrete.

From the results of the pH and soluble sulphate testing, it can be seen that future foundations and buried concrete should be constructed utilising a concrete design class of DS-1, and ACEC class of AC-1.

In terms of the construction of ground bearing floor slabs, road pavement and car park areas, and based on the results of the insitu CBR testing completed on site, a characteristic design CBR value of 2% can be taken for the initial natural deposits, where these materials are to be used as an undisturbed subgrade.

9.5 Ground Contamination:-

9.5.1 Made Ground:-

From the results of the contamination screening carried out on this site and the Level 1 Risk Assessment (Section 8.0), it can be seen that the made ground encountered on the northwestern portion of the site and the disturbed 'topsoil' materials encountered at TP11 represent a potential risk to future end users from the presence of some elevated PAH's, and therefore remedial measures are required in these areas. The metals, metalloids, non-organics and remaining speciated PAH's, speciated TPH's screened for, and asbestos screening, do not pose a significant risk to human health.

The results of the screening carried out on the existing southeastern stockpile (targeted by HP03), identified no elevated concentrations of metals, metalloids, non-organics, speciated PAH's, speciated TPH's or asbestos, and therefore it can be seen that this stockpile material does not represent a significant potential risk to human health, and can be considered suitable for re-use in garden and soft landscaping areas.

9.0 Conclusions & Recommendations (Cont'd)

9.5 Ground Contamination (Cont'd):-

9.5.1 Made Ground (Cont'd):-

When considering the above results, it is felt that remedial measures, in the likely form of either localised removal or the provision of a clean cover barrier system, will be required in order to protect future end users (i.e. no risk to human health) from the localised contamination identified on this site. This would remove the potential exposure pathway between future residents and the potential elevated concentrations of PAH's identified on the northwestern and southeastern portions of the site. Once the final layout has been determined for this site, a Remediation Strategy should be prepared, which will need to be submitted and agreed with the Local Authority.

Consideration may need to be given to the protection of service pipes for the proposed development, and therefore a supplementary suite of contamination testing (UKWIR) may be required in order to meet the requirements of the local utilities service provider for their 'pipe selection risk assessment' (PSRA), once the location and depth of future services have been determined.

9.5.2 'Topsoil' Materials:-

From the results of the contamination screening carried out on samples of 'topsoil' materials present across the site, it can be seen that these soils do not represent a significant potential risk to human health, and therefore these soils can be considered to be suitable for re-use in garden and soft landscaping areas.

9.5.3 Controlled Waters:-

From the results of the leachate screening carried out, marginally elevated values of some PAH's were recorded, however this is not felt to represent significant heavy or gross contamination. Furthermore, concentrations for the remaining contaminants screened were not recorded to be elevated, and therefore Controlled Waters and adjacent sites are not considered to be at risk from potential contaminants identified on this site.

9.5.4 Construction Workforce:-

When considering the risks to any future maintenance or construction workforce, appropriate PPE should be provided to protect against the levels of potential contaminants recorded during these investigation works. Similarly, the results can also be used by the Main Contractor / Project Coordinator, when devising an adequate Site Health & Safety Plan, in accordance with current CDM Regulations. For further guidance reference should be made to the Health and Safety Executive (HSE) document EH40/2005 (2nd Edition, 2011) Workplace exposure limits.

9.6 General Comments:-

If during future redevelopment works, any excavated materials are to be discarded and removed from this site as a waste to landfill, these materials will need to be classified in accordance with the 'Guidance on the Classification and Assessment of Waste (1st Edition 2015) – Technical Guidance WM3'.

Where possible, removal of materials from site as a 'waste' should be kept to a minimum and ideally excavated materials should all be reused on site. However, if excavated materials have to be discarded to accommodate finished ground levels etc., it should be noted that additional analysis and screening is likely to be required once each specific waste stream has been identified and the volume of material to be disposed of has been calculated, since the amount of screening required, including any pre-disposal WAC screening, will be dependent upon the final volume of material to be disposed of.

9.0 Conclusions & Recommendations (Cont'd)

9.6 General Comments (Cont'd):-

When considering the construction, and bearing in mind the nature of the materials encountered on this site as well as the presence of perched water within the made ground, lateral trench support will be required for most excavations, including drainage, service runs, etc., in order to prevent trench wall collapse or over excavation, as well as to provide a safe working environment below a depth of 1.20m. Reference to CIRIA 97 'Trenching Practice' would be beneficial to establish a suitable means of support or battering of excavation sides during construction.

It is also recommended for any new developments, adequate surface drainage should be designed and installed by a competent contractor, in order to prevent surface water 'ponding' or collection, during and post construction, particularly where existing surface drainage systems are disrupted or damaged.

Furthermore, for deeper excavations, drainage, service runs or the like that may pass close to or beneath any proposed new foundations, these should be undertaken with care and completed prior to the preparation of any new foundations, so as not to allow any loose or granular material to move or 'flow', thus causing settlement to occur to any new foundations based at a higher level.

An "observational technique" can be applied to the design and construction of this site, and where ground conditions seem to vary from that indicated from the conceptual ground model derived from works to date, then advice from a suitably qualified Engineering Geologist/Geotechnical Engineer should be sought.

END OF REPORT

GENERAL REFERENCES

- Arc Environmental Ltd, Phase 1: Desk Top Study Report, 17-174, august 2017
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  CLR 2: Guidance on preliminary site inspection of contaminated land. Report by Applied Environmental Research Centre Ltd. Volume 1. DOE, 1994.
  CLR 3: Documentary research on industrial sites. Report by RPS Group plc. DoE, 1994.
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  CLR 5: Information systems for land contamination. Report by Meta Generics Ltd. DoE, 1994.
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  CLR11: Model Procedures for the Management of Land Contamination. DEFRA/EA, 2004.
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- BS 1377: 1990: Methods of test for soils for civil engineering purposes. British Standards Institution (BS 1377-9:1990 is partially superseded by BS EN 1997-2: 2007)
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- BS10175:2011 + A1:2013: Investigation of potentially contaminated sites – Code of practice
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- BS EN 1997-2: 2007: Eurocode 7 - Geotechnical design. Part 2: Ground investigation and testing British Standards Institution
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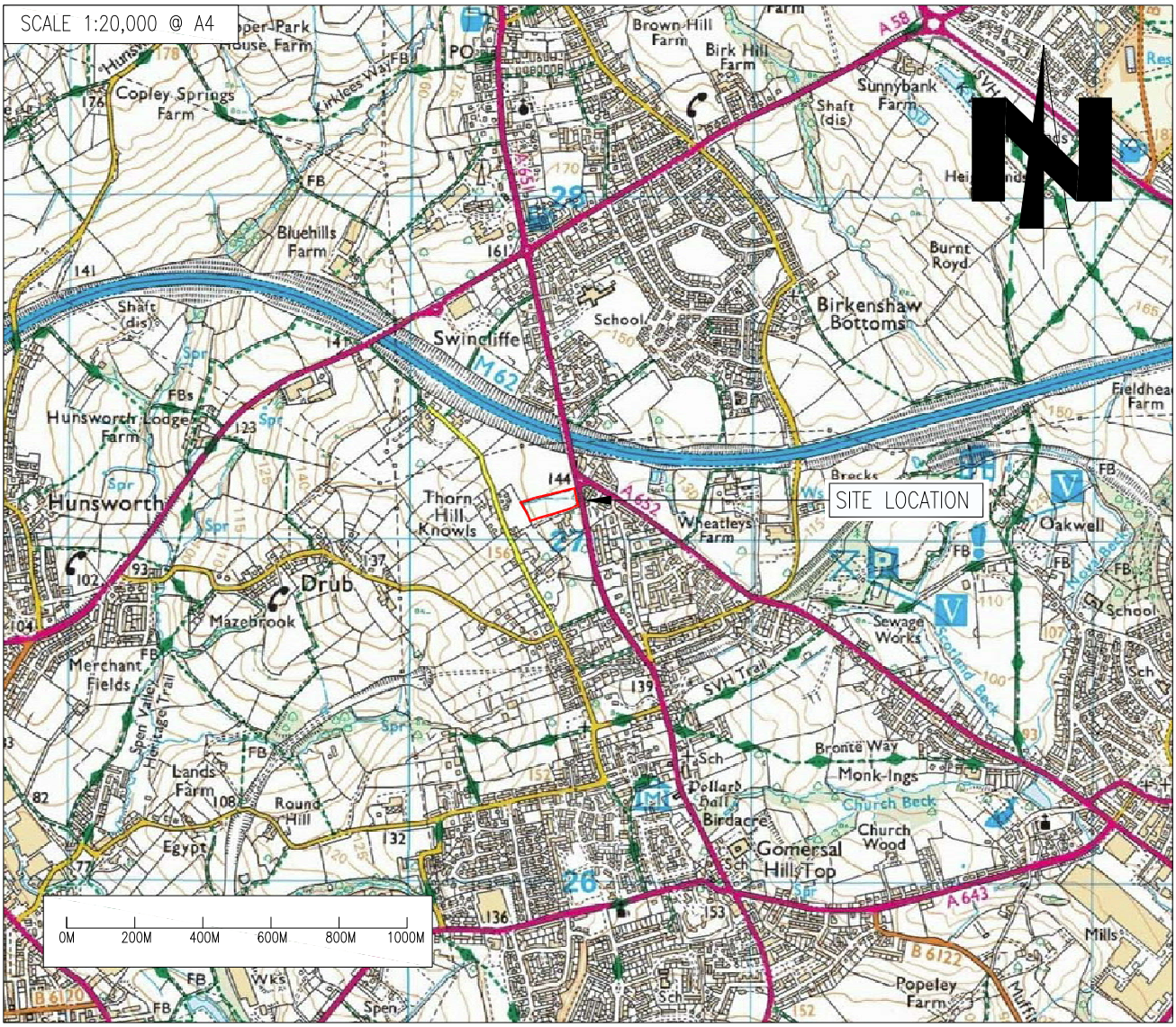
- BS5837: 2012: Trees in relation to design, demolition and construction - recommendations
- BS8002: 2015: Code of Practice for Foundations
- BRE Special Digest 1 2005: Concrete in Aggressive Ground 3rd Edition
- Guidance for the Safe Development of Housing on Land Affected by Contamination, R&D66, 2008 (NHBC, EA, CIEH)
- Asbestos in soil and made ground: a guide to understanding and managing risks, CIRIA C733, 2014
- Assessing Risks Posed by Hazardous Ground Gases to Buildings, CIRIA C665, 2007
- Methane and Associated Hazards to Construction - CIRIA Reports 149,150,151 & 152
- BS8485: 2015: Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings
- BS8576:2013: Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds
- Guidance on Comparing Soil Contamination Data with Critical Concentrations, CL:AIRE/CIEH, May 2008

APPENDIX I

Location Plan
Aerial Photograph
Existing Site Layout and Proposed Development Plans

SCALE 1:20,000 @ A4



Client:

MR ROBERT MARTIN

Project Title:	Drawing Title:
Land North of Holme House Residential Home, Oxford Road Cleckheaton, West Yorks., BD19 4LA	Location Plan

rev.	date	amendments	drawn	chckd

Job Reference:	Drawing Number:	Revision:
17-174	-	-

Drawn by:	Date:	Scale at A4:
P.D	27.07.17	As Shown

Checked by:	Approved by:	
I.H	I.H	The contractor shall check all dimensions on site before commencement of any works. No dimensions to be scaled off this drawing.

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e-mail: admin@arc-environmental.com
web: www.arc-environmental.com

LEGEND

	APPROXIMATE SITE BOUNDARY

rev.	date	amendments	drawn	chckd

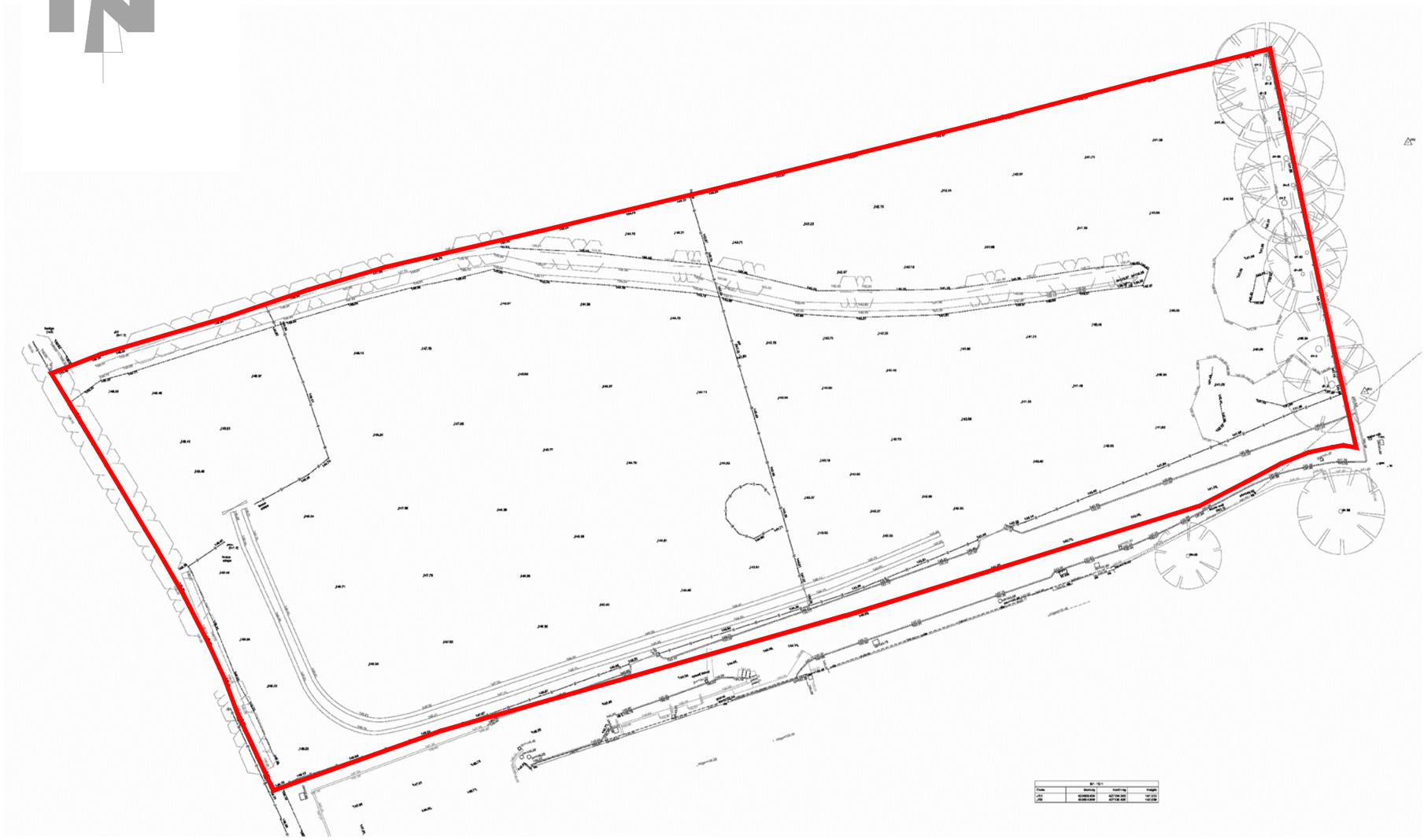
Client:
MR ROBERT MARTIN

Project Title:
Land North of Holme House Residential Home
Oxford Road, Gomersal, Cleckheaton
West Yorkshire, BD19 4LA

Drawing Title:
Aerial Photograph

Scale at A3:	Date:	Drawn by:	Approved by:
NTS @ A3	27.07.17	P.D	I.H

Job Ref:	Drg no:	Rev:
17-174	–	–



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web: www.arc-environmental.com

LEGEND

	APPROXIMATE SITE BOUNDARY

rev.	date	amendments	drawn	chckd

Client:
MR ROBERT MARTIN

Project Title:
Land North of Holme House Residential Home
Oxford Road, Gomersal, Cleckheaton
West Yorkshire, BD19 4LA

Drawing Title:
Existing Site Layout Plan

Scale at A3:	Date:	Drawn by:	Approved by:
NTS @ A3	27.07.17	P.D	I.H

Job Ref:	Drg no:	Rev:
17–174	–	–

PREFERRED LAYOUT
OPTION TO BE CONFIRMED

Accommodation
4no. 2 Bed Houses at 80 sq.m
10no. 3 Bed Houses at 91 sq.m
10no. 3 Bed Houses at 96 sq.m
2no. 4 Bed Houses at 103 sq.m
26no. Total

Note:
This sketch viability layout is subject to confirmation of site boundaries, easements, restrictive covenants etc; consultation with Local Authority, Public Utilities etc.

Accommodation
8no. 2 Bed Houses

Note:
This sketch viability layout is subject to confirmation of site boundaries,

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web: www.arc-environmental.com

LEGEND

	APPROXIMATE SITE BOUNDARY

rev.	date	amendments	drawn	chckd

Client:
MR ROBERT MARTIN

Project Title:
Land North of Holme House Residential Home
Oxford Road, Gomersal, Cleckheaton
West Yorkshire, BD19 4LA

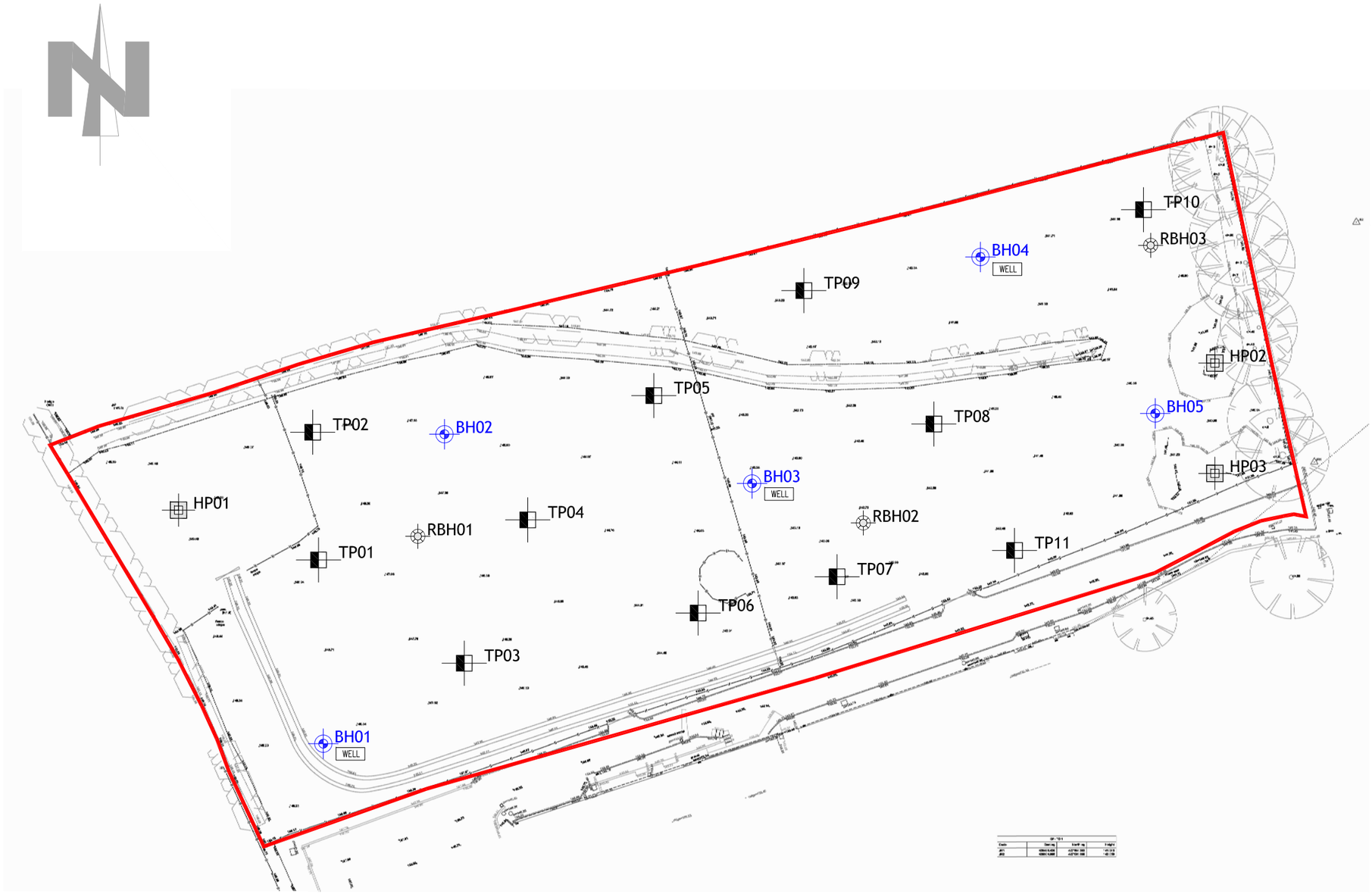
Drawing Title:
Proposed Development Layout Plan

Scale at A3:	Date:	Drawn by:	Approved by:
NTS @ A3	27.07.17	P.D	I.H

Job Ref:	Drg no:	Rev:
17–174	–	–

APPENDIX II

Trial Pit & Borehole Location Plan, and Trial Pit & Borehole Record Sheets



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LEGEND	
	MECHANICALLY EXCAVATED TRIAL PIT POSITION
	WINDOWLESS SAMPLING BOREHOLE POSITION
WELL	COMBINED GAS & GROUNDWATER MONITORING WELL INSTALLED
	MANUALLY EXCAVATED TRIAL PIT (CONTAMINATION)
	ROTARY BOREHOLE POSITION

rev.	date	amendments	drawn	chckd

Client:
MR ROBERT MARTIN

Project Title:
Land North of Holme House Residential Home
Oxford Road, Gomersal, Cleckheaton
West Yorkshire, BD19 4LA

Drawing Title:
Trial Pit & Borehole Location Plan (Existing)

Scale at A3:	Date:	Drawn by:	Approved by:
NTS @ A3	27.07.17	R.S	R.S

Job Ref:	Drg no:	Rev:
17–174	–	–

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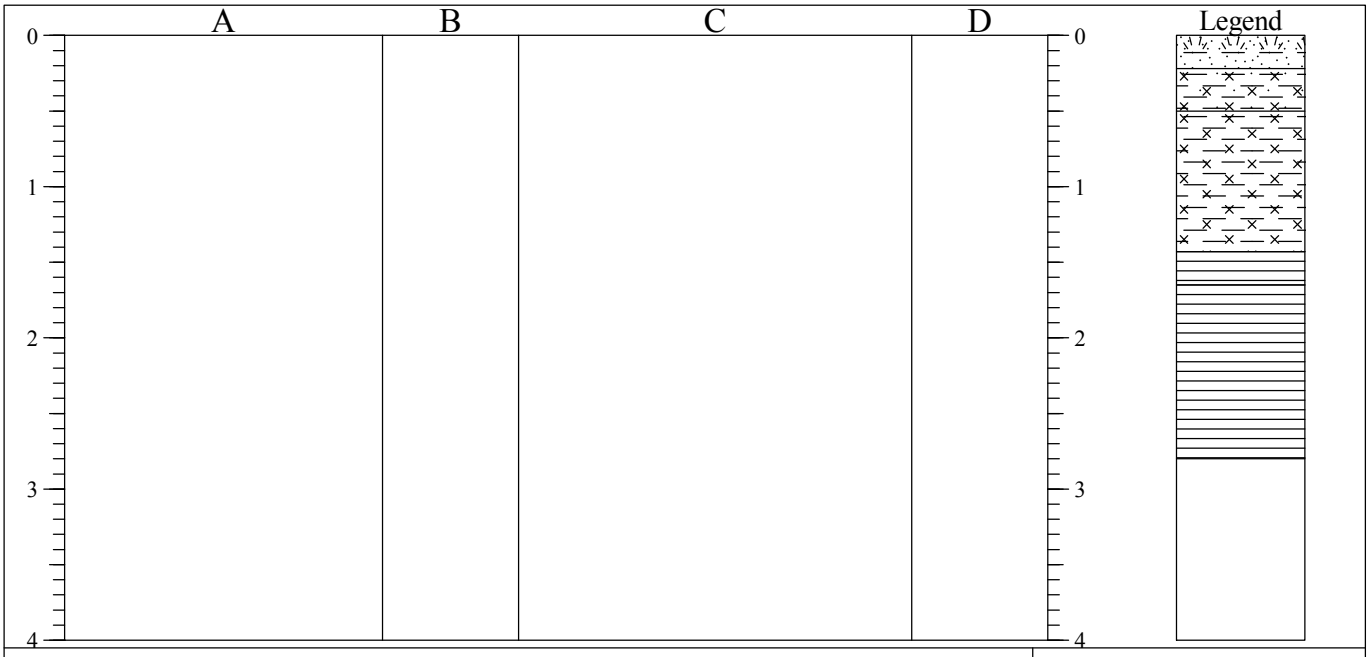
St Johns Road, Meadowfield
Durham, DH7 8PN
Telephone: 01913786380

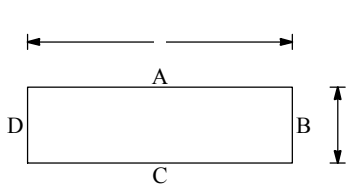
TRIAL PIT LOG

Project				TRIAL PIT No
Land North of Holme House, Oxford Road, Gomersal				**TP01**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
17-174	17-07-17			
Contractor				Sheet
Arc Environmental Ltd				1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.22		Grass over brown slightly sandy silty friable CLAY (TOPSOIL).			
0.22-0.50		Stiff grey mottled orange and brown slightly sandy silty CLAY.	0.15	J/D	
0.50-1.43		Stiff (medium becoming high strength) grey mottled brown silty CLAY.	0.70	V	70kN/m^2
			0.80	B	
			0.80	CBR	5%
			0.80	V	88kN/m^2
			1.20	V	99kN/m^2
1.43-1.65		Extremely weak dark grey mottled black with orange staining weathered MUDSTONE, recovered as clayey gravel.	1.45	B	
1.65-2.80		Very weak partially weathered silty MUDSTONE, recoverd as a friable gravelly clay.	2.30	B	
2.80		Trial pit terminated at c.2.80m bgl.			

Shoring/Support:
Stability:



GENERAL REMARKS

WATER: Trial pit remained dry during exploratory period.

All dimensions in metres Scale 1:50	Client Mr Robert Martin	Method/ Plant Used JCB 3cx	Logged By SAB

AGS3 UK TP 17-174 LOGS.GPJ AGS3_ALL.GDT 28/7/17

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St Johns Road, Meadowfield
Durham, DH7 8PN
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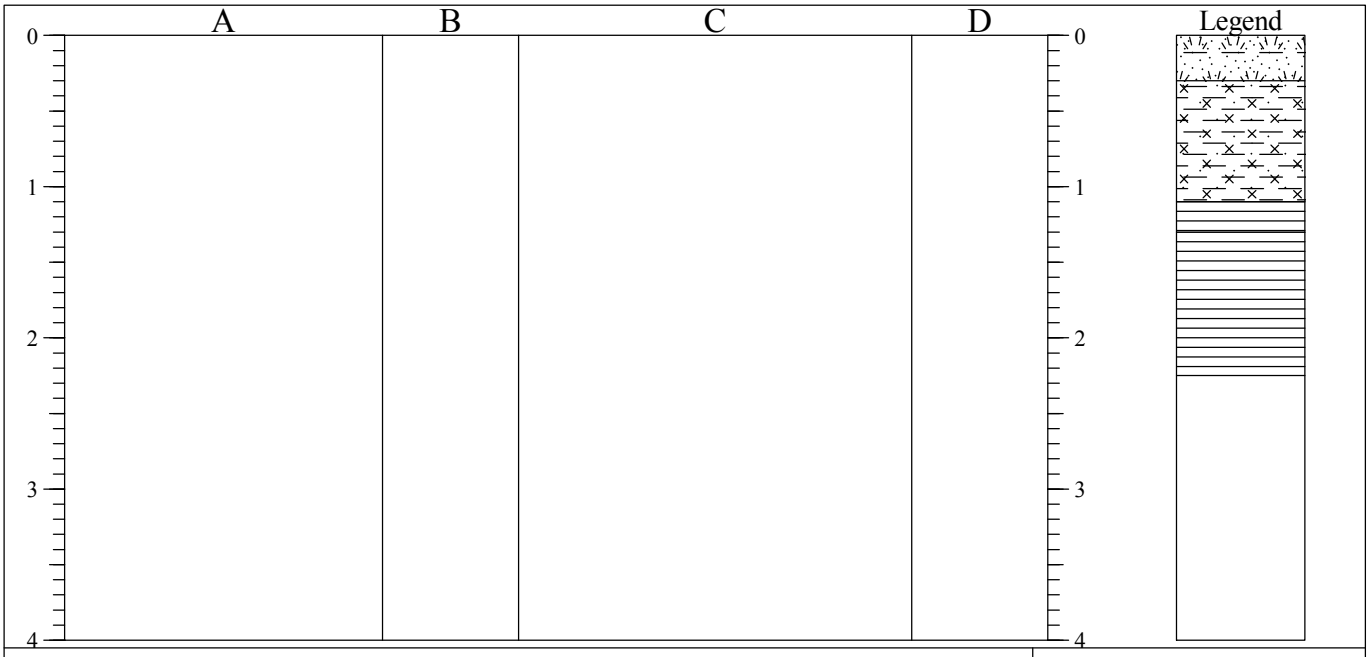
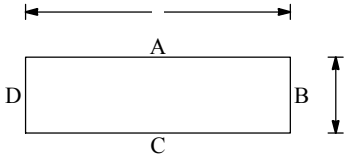
TRIAL PIT LOG

Project				TRIAL PIT No
Land North of Holme House, Oxford Road, Gomersal				**TP02**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
17-174	17-07-17			
Contractor				Sheet
Arc Environmental Ltd				1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.30		Grass over brown slightly sandy silty friable CLAY (TOPSOIL).			
			0.20	J/D	
0.30-1.10		Stiff (high strength) grey slightly sandy silty CLAY.	0.40	B	
			0.50	CBR	4%
			0.50	V	87kN/m^2
1.10-1.30		Extremely weak dark grey mottled black with orange staining weathered MUDSTONE, recovered as clayey gravel.	1.10	B	
1.30-2.25		Very weak partially weathered silty MUDSTONE, recoverd as a friable silty clayey gravel.			
2.25		Trial pit terminated at c.2.25m bgl.			

Shoring/Support:
Stability:



GENERAL REMARKS

WATER: Trial pit remained dry during exploratory period.

All dimensions in metres Scale 1:50	Client Mr Robert Martin	Method/ Plant Used JCB 3cx	Logged By SAB

AGS3 UK TP 17-174 LOGS.GPJ AGS3_ALL.GDT 28/7/17

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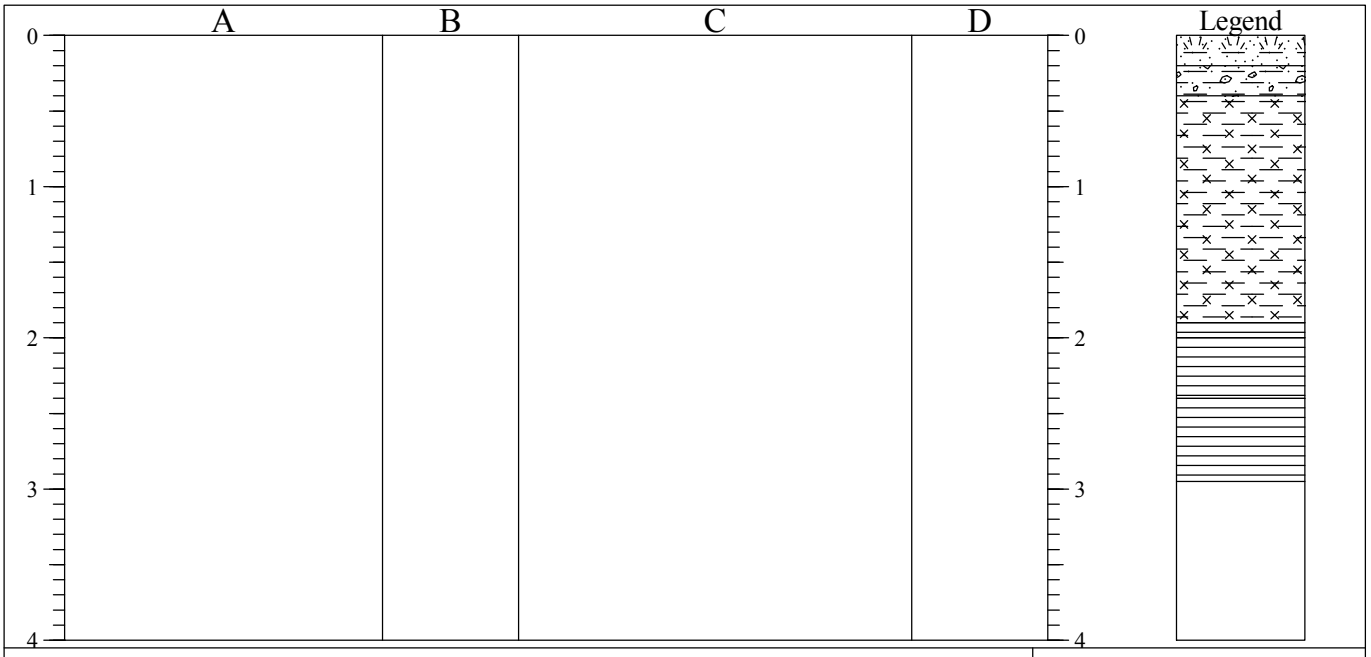
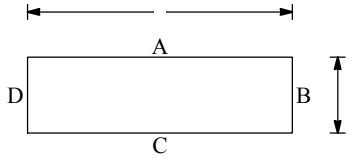
TRIAL PIT LOG

Project				TRIAL PIT No
Land North of Holme House, Oxford Road, Gomersal				TP03
Job No	Date	Ground Level (m)	Co-Ordinates ()	
17-174	17-07-17			
Contractor				Sheet
Arc Environmental Ltd				1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.20		Grass over brown slightly sandy silty friable CLAY with occasional brick fragments			
0.20-0.40		(Disturbed TOPSOIL).	0.15	J/D	
0.40-1.90		Firm orange and greyish brown slightly sandy slightly gravelly friable CLAY.	0.25	J/D	
		Firm to stiff (medium becoming high strength) orangish grey slightly sandy silty CLAY.			
			0.80	B	
			0.80	CBR	4%
			0.80	V	69kN/m^2
			1.60	V	86kN/m^2
			1.80	B	
1.90-2.00		Extremely weak dark grey mottled black with orange staining weathered MUDSTONE with			
2.00-2.40		occasional wood fragments, recovered as gravelly clay.	2.00	B	
		Extremely weak dark grey mottled black with orange staining weathered shaley MUDSTONE,			
2.40-2.95		recovered as silty gravelly clay.	2.45	B	
		Very weak grey fine grained MUDSTONE, recovered as a silty clayey gravel.			
2.95		Trial pit terminated at c.2.95m bgl.			

Shoring/Support:
Stability:



GENERAL REMARKS

WATER: Slight seepage at 2.30m.

All dimensions in metres Scale 1:50	Client Mr Robert Martin	Method/ Plant Used JCB 3cx	Logged By SAB

AGS3 UK TP 17-174 LOGS.GPJ AGS3_ALL.GDT 28/7/17

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Durham, DH7 8PN
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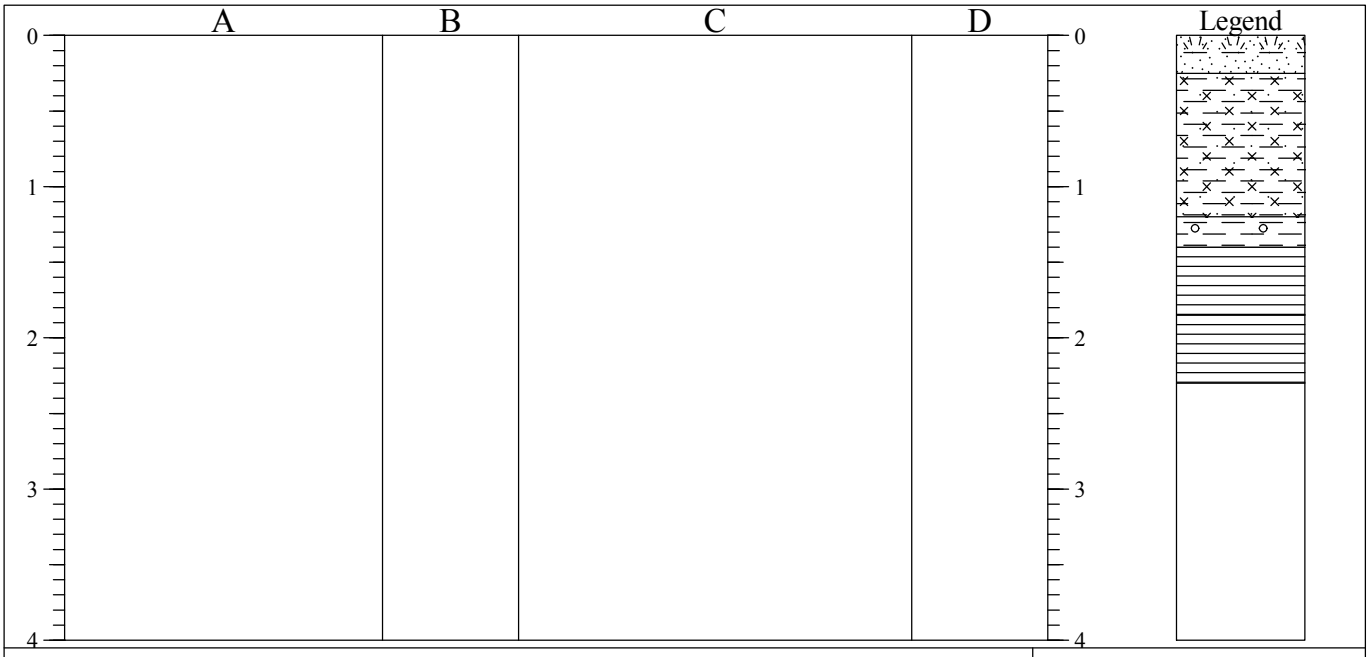
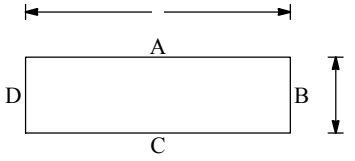
TRIAL PIT LOG

Project				TRIAL PIT No
Land North of Holme House, Oxford Road, Gomersal				**TP04**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
17-174	17-07-17			
Contractor				Sheet
Arc Environmental Ltd				1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.25		Grass over brown slightly sandy silty friable CLAY (TOPSOIL).	0.10	J/D	
0.25-1.20		Firm to stiff (medium strength) orangish grey slightly sandy silty CLAY.	0.40	B	
			0.50	CBR	1.5%
			0.50	V	48kN/m^2
			0.90	V	53kN/m^2
1.20-1.40		Stiff dark grey gravelly friable CLAY with mudstone lithorelics and occasional wood fragments.	1.20	B	
1.40-1.85		Extremely weak dark grey weathered MUDSTONE recovered as gravelly clay.			
1.85-2.30		Extremely weak grey weathered silty MUDSTONE with occasional nodules, recovered as a gravelly silty clay.	2.00	B	
2.30		Trial pit terminated at c.2.30m bgl.			

Shoring/Support:
Stability:



GENERAL REMARKS

WATER: Trial pit remained dry during exploratory period.

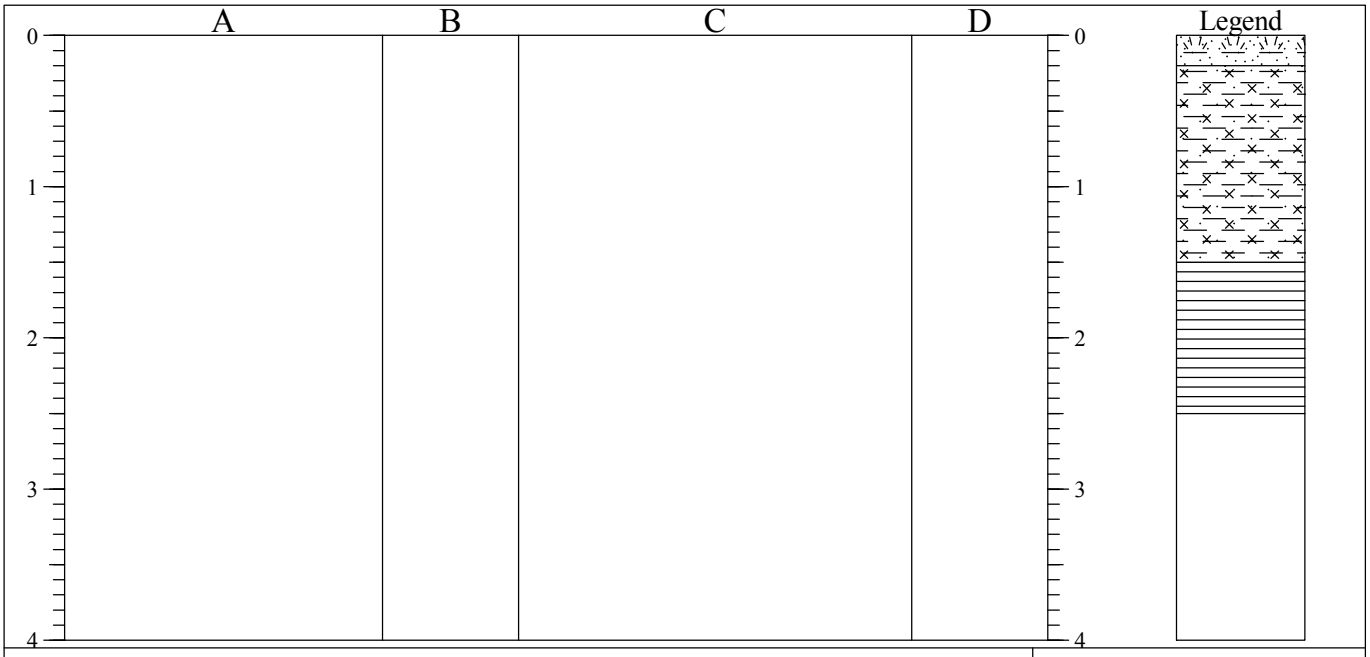
All dimensions in metres Scale 1:50	Client Mr Robert Martin	Method/ Plant Used JCB 3cx	Logged By SAB

AGS3 UK TP 17-174 LOGS.GPJ AGS3_ALL.GDT 28/7/17

Solum House, Unit 1 Elliott Court
St Johns Road, Meadowfield
Durham, DH7 8PN
Telephone: 01913786380

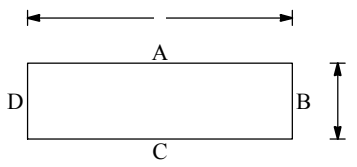
TRIAL PIT LOG

Project				TRIAL PIT No
Land North of Holme House, Oxford Road, Gomersal				**TP05**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
17-174	17-07-17			
Contractor				Sheet
Arc Environmental Ltd				1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.20		Grass over brown slightly sandy silty friable CLAY (TOPSOIL).	0.10	J/D	
0.20-1.50		Firm to stiff (medium strength) orangish grey slightly sandy silty CLAY.	0.45	B	
			0.50	CBR	1.5%
			0.50	V	56kN/m^2
			1.00	V	58kN/m^2
			1.25	B	
1.50-2.50		Extremely weak dark grey weathered silty MUDSTONE with occasional nodules, recovered as a gravelly silty clay.	1.50	B	
2.50		Trial pit terminated at c.2.50m bgl.	2.50	B	

Shoring/Support:
Stability:



GENERAL REMARKS

WATER: Trial pit remained dry during exploratory period.

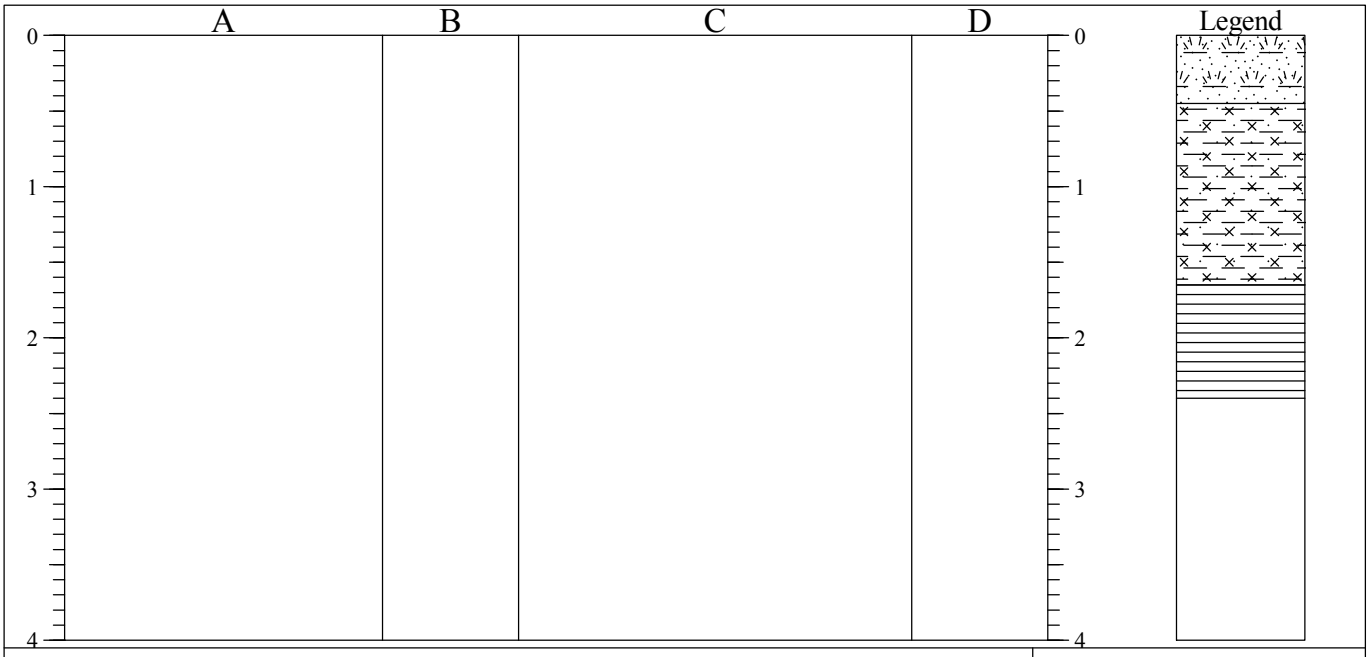
All dimensions in metres Scale 1:50	Client Mr Robert Martin	Method/ Plant Used JCB 3cx	Logged By SAB

AGS3 UK TP 17-174 LOGS.GPJ AGS3_ALL.GDT 28/7/17

Solum House, Unit 1 Elliott Court
St Johns Road, Meadowfield
Durham, DH7 8PN
Telephone: 01913786380

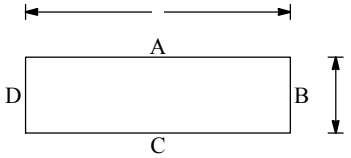
TRIAL PIT LOG

Project				TRIAL PIT No
Land North of Holme House, Oxford Road, Gomersal				**TP06**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
17-174	17-07-17			
Contractor				Sheet
Arc Environmental Ltd				1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.45		Grass over brown slightly sandy silty friable CLAY (TOPSOIL).	0.10	J/D	
0.45-1.65		Firm to stiff (medium strength) orangish grey slightly sandy silty CLAY.	0.60	B	
			0.70	CBR	3.5%
			0.70	V	60kN/m^2
			0.95	V	56kN/m^2
1.65-2.40		Extremely weak dark grey weathered silty MUDSTONE with occasional nodules, recovered as a gravelly silty clay.	1.65	B	
2.40		Trial pit terminated at c.2.40m bgl.	2.40	B	

Shoring/Support:
Stability:



GENERAL REMARKS

WATER: Trial pit remained dry during exploratory period.

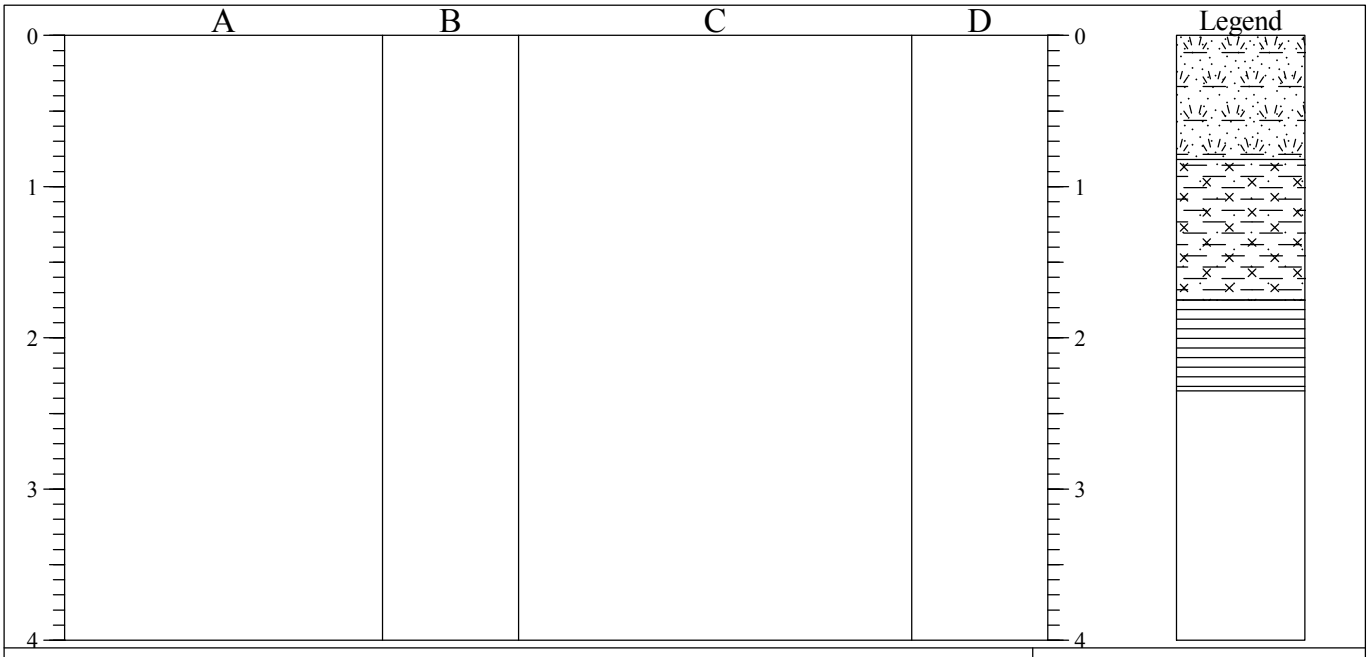
All dimensions in metres Scale 1:50	Client Mr Robert Martin	Method/ Plant Used JCB 3cx	Logged By SAB

AGS3 UK TP 17-174 LOGS.GPJ AGS3_ALL.GDT 28/7/17

Solum House, Unit 1 Elliott Court
St Johns Road, Meadowfield
Durham, DH7 8PN
Telephone: 01913786380

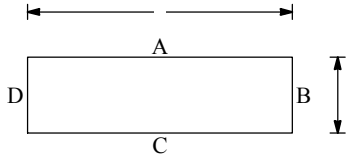
TRIAL PIT LOG

Project				TRIAL PIT No
Land North of Holme House, Oxford Road, Gomersal				**TP07**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
17-174	17-07-17			
Contractor				Sheet
Arc Environmental Ltd				1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.82		Grass over brown sandy silty friable CLAY with occasional fragments of brick and sandstone (Disturbed TOPSOIL).	0.25	J/D	
			0.70	J/D	
0.82-1.75		Firm to stiff (medium strength) orangish grey slightly sandy silty CLAY.	0.90	CBR	3%
			0.90	V	56kN/m^2
			1.00	B	
1.75-2.35		Extremely weak dark grey weathered silty MUDSTONE, recovered as a gravelly silty clay.	1.80	B	
2.35		Trial pit terminated at c.2.35m bgl.	2.35	B	

Shoring/Support:
Stability:



GENERAL REMARKS

WATER: Trial pit remained dry during exploratory period.

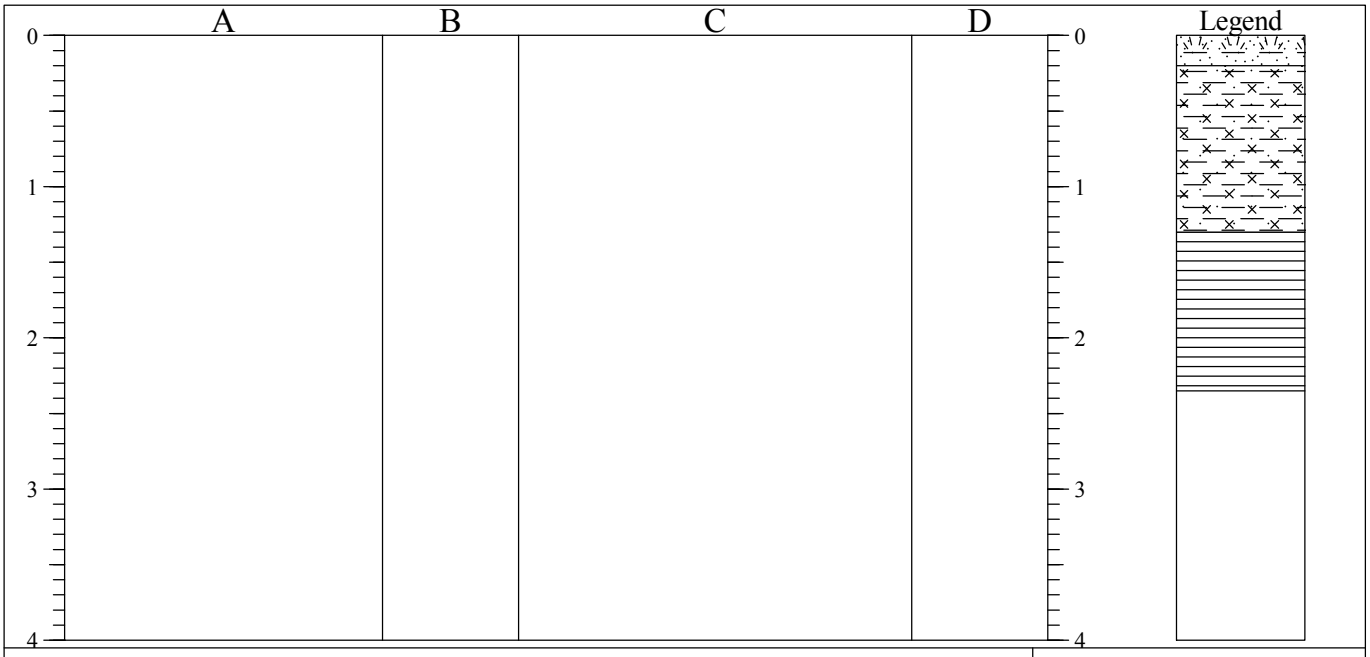
All dimensions in metres Scale 1:50	Client Mr Robert Martin	Method/ Plant Used JCB 3cx	Logged By SAB

AGS3 UK TP 17-174 LOGS.GPJ AGS3_ALL.GDT 28/7/17

Solum House, Unit 1 Elliott Court
St Johns Road, Meadowfield
Durham, DH7 8PN
Telephone: 01913786380

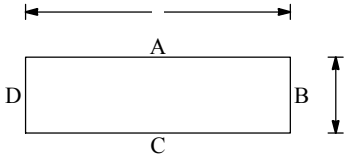
TRIAL PIT LOG

Project				TRIAL PIT No
Land North of Holme House, Oxford Road, Gomersal				**TP08**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
17-174	17-07-17			
Contractor				Sheet
Arc Environmental Ltd				1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.20		Grass over brown slightly sandy silty friable CLAY (TOPSOIL).	0.10	J/D	
0.20-1.30		Firm to stiff (medium becoming high strength) orangish grey slightly sandy silty CLAY.	0.20	V	54kN/m^2
			0.40	B	
			0.50	CBR	1.5%
			0.50	V	82kN/m^2
			1.00	B	
1.30-2.35		Extremely weak dark grey weathered silty MUDSTONE, recovered as a gravelly silty clay.	1.40	B	
2.35		Trial pit terminated at c.235m bgl.			

Shoring/Support:
Stability:



GENERAL REMARKS

WATER: Trial pit remained dry during exploratory period.

All dimensions in metres Scale 1:50	Client Mr Robert Martin	Method/ Plant Used JCB 3cx	Logged By SAB

AGS3 UK TP 17-174 LOGS.GPJ AGS3_ALL.GDT 28/7/17

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St Johns Road, Meadowfield
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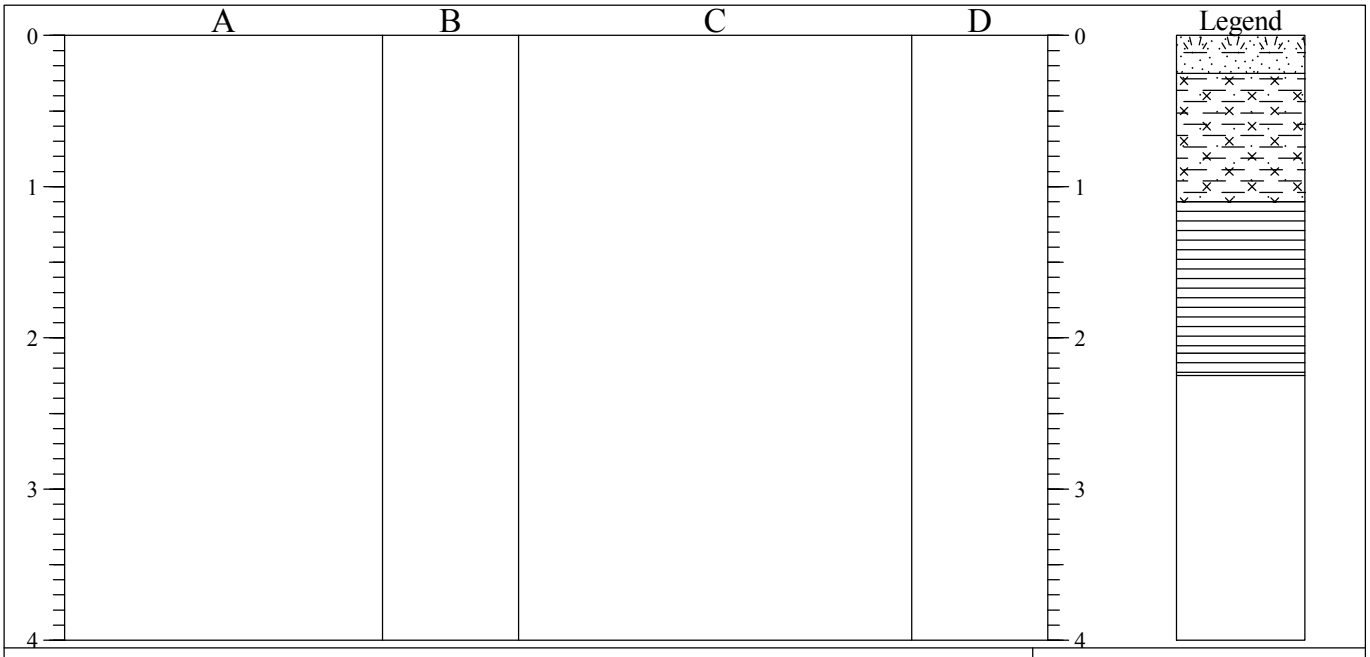
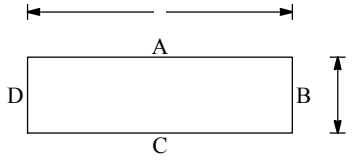
TRIAL PIT LOG

Project				TRIAL PIT No
Land North of Holme House, Oxford Road, Gomersal				**TP09**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
17-174	17-07-17			
Contractor				Sheet
Arc Environmental Ltd				1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.25		Grass over brown slightly sandy silty friable CLAY (TOPSOIL).			
0.25-1.10		Firm to stiff (medium strength) orangish grey slightly sandy silty CLAY.	0.20	J/D	
			0.40	B	
			0.60	CBR	2.5%
			0.60	V	62kN/m^2
1.10-2.10		Extremely weak grey with orange staining weathered MUDSTONE, recovered as silty gravelly clay.	1.00	V	74kN/m^2
			1.20	B	
2.10-2.25		Extremely weak dark grey weathered silty MUDSTONE, recovered as a gravelly silty clay.	2.10	B	
2.25		Trial pit terminated at c.2.25m bgl.			

Shoring/Support:
Stability:



GENERAL REMARKS

WATER: Trial pit remained dry during exploratory period.

All dimensions in metres Scale 1:50	Client Mr Robert Martin	Method/ Plant Used JCB 3cx	Logged By SAB

AGS3 UK TP 17-174 LOGS.GPJ AGS3_ALL.GDT 28/7/17

Solum House, Unit 1 Elliott Court
St Johns Road, Meadowfield
Durham, DH7 8PN
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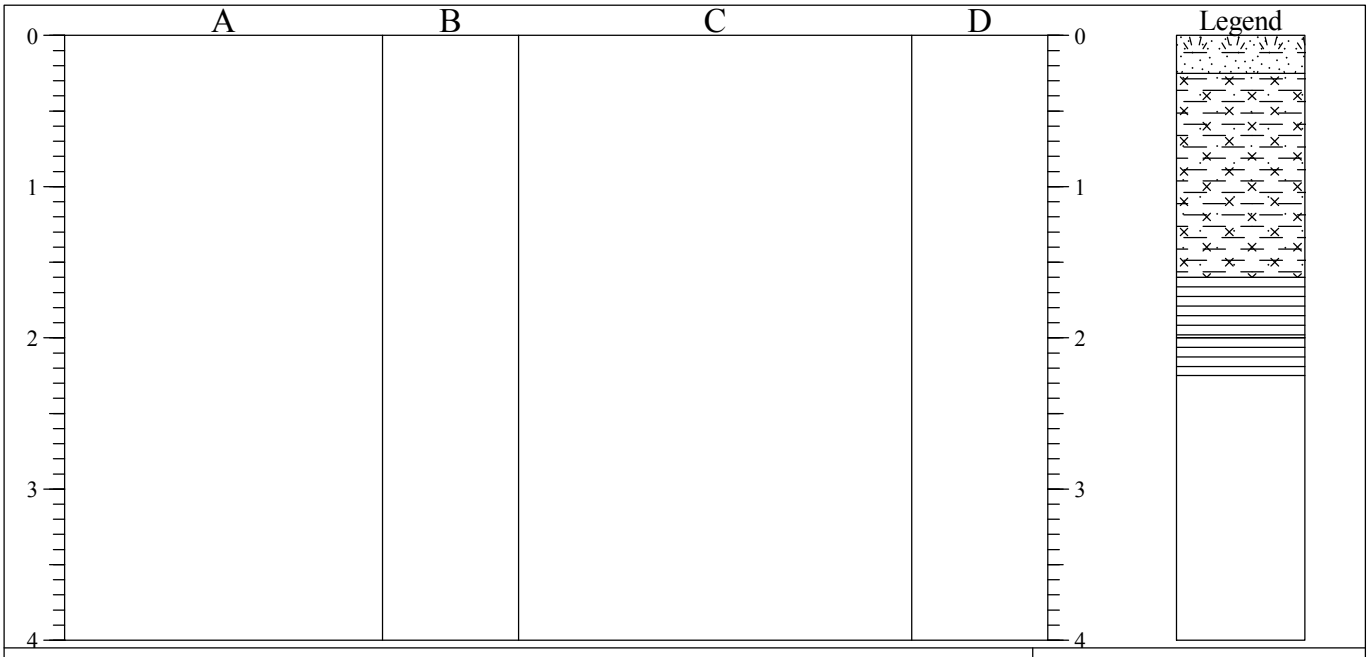
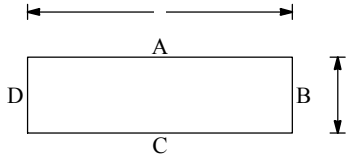
TRIAL PIT LOG

Project				TRIAL PIT No
Land North of Holme House, Oxford Road, Gomersal				**TP10**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
17-174	17-07-17			
Contractor				Sheet
Arc Environmental Ltd				1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.25		Grass over brown slightly sandy silty friable CLAY (TOPSOIL).	0.10	J/D	
0.25-1.60		Stiff (high strength) orangish brown slightly sandy silty CLAY.	0.50	B	
			0.55	CBR	3%
			0.55	V	98kN/m^2
			1.00	V	99kN/m^2
1.60-2.00		Extremely weak light grey mottled orange staining weatehred MUDSTONE, recovered as a silty gravelly clay.	1.75	B	
2.00-2.25		Very weak dark grey slightly weathered MUDSTONE recovered as clayey silty gravel.	2.10	B	
2.25		Trial pit terminated at c.2.25m bgl.			

Shoring/Support:
Stability:



GENERAL REMARKS

WATER: Trial pit remained dry during exploratory period.

All dimensions in metres Scale 1:50	Client Mr Robert Martin	Method/ Plant Used JCB 3cx	Logged By SAB

AGS3 UK TP 17-174 LOGS.GPJ AGS3_ALL.GDT 28/7/17

Solum House, Unit 1 Elliott Court
St Johns Road, Meadowfield
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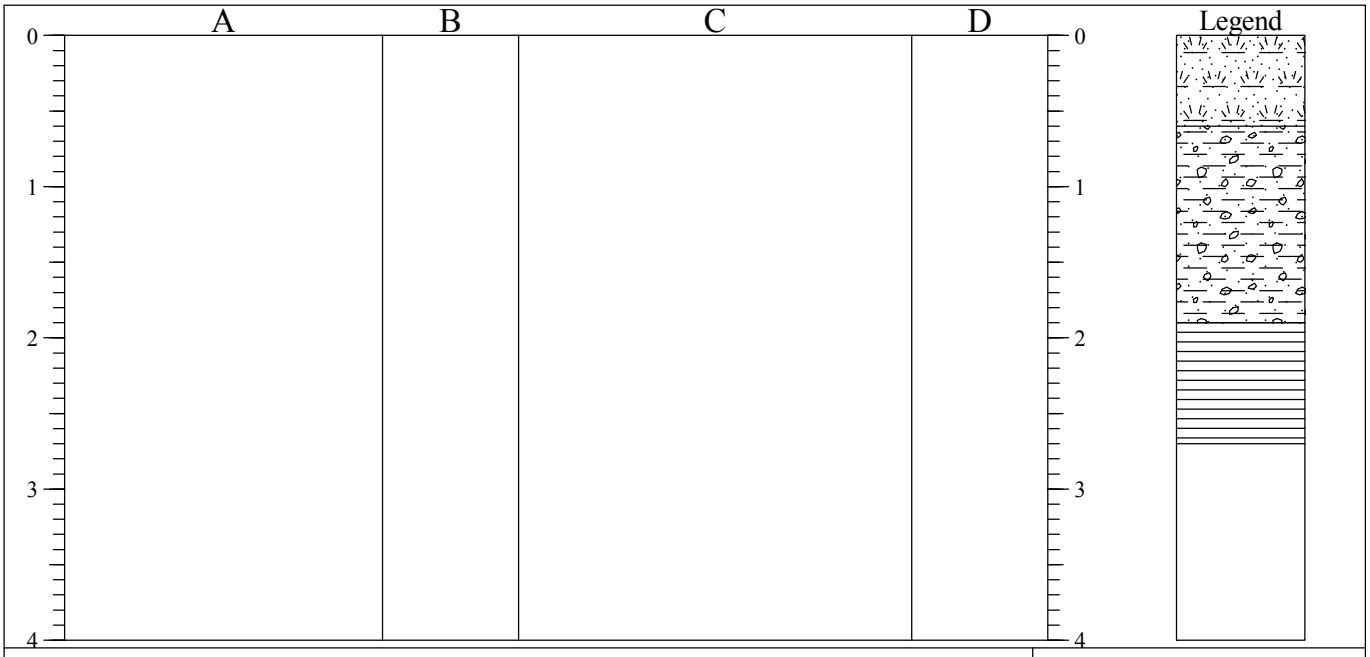
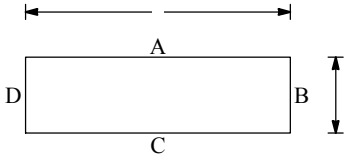
TRIAL PIT LOG

Project				TRIAL PIT No
Land North of Holme House, Oxford Road, Gomersal				**TP11**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
17-174	17-07-17			
Contractor				Sheet
Arc Environmental Ltd				1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.60		Soft to firm brown to dark brown slightly sandy slightly gravelly CLAY with fragments of brick, sandstone and concrete (Disturbed TOPSOIL).	0.40	J/D	
0.60-1.90		Firm (medium strength) brownish orange mottled grey slightly sandy slightly gravelly CLAY.	0.75	B	
			1.00	V	77kN/m^2
			1.50	B	
1.90-2.70		Extremely weak dark grey weathered silty MUDSTONE, recovered as a gravelly silty clay.	2.10	B	
2.70		Trial pit terminated at c.2.70m bgl.			

Shoring/Support:
Stability:



GENERAL REMARKS

WATER: Trial pit remained dry during exploratory period.

All dimensions in metres Scale 1:50	Client Mr Robert Martin	Method/ Plant Used JCB 3cx	Logged By SAB

AGS3 UK TP 17-174 LOGS.GPJ AGS3_ALL.GDT 28/7/17

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BOREHOLE LOG

Project				BOREHOLE No
Land North of Holme House, Oxford Road, Gomersal				**BH01**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
17-174	17-07-17			
Contractor				Sheet
Arc Environmental Ltd				1 of 1

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION		
0.00-0.20	J/D					(0.20) 0.20	Grass over brown slightly sandy silty friable CLAY (TOPSOIL).		
0.20	B					(1.00)	Stiff (high strength) brown and grey mottled sandy silty CLAY.		
1.00	B								
1.00	V	100kN/m^2				1.20			
1.20	B					(0.90)	Grey with orange staining weathered silty MUDSTONE.		
2.00	B					2.10			
2.00-2.45	SPT	N=25					Grey slightly weathered MUDSTONE.		
2.10	B					(1.28)			
3.00-3.38	SPT	72 blows				3.38			
							Borehole terminated at c.3.38m bgl.		

Boring Progress and Water Observations					
Date	Time	Depth	Casing Depth	Casing Dia. mm	Water Dpt
17-07-17	00.00	2.38	1.00	115	Dry

Chiselling			Water Added	
From	To	Hours	From	To

GENERAL REMARKS

WATER: Borehole remained dry during exploratory period.

All dimensions in metres Scale 1:25	Client Mr Robert Martin	Method/ Plant Used Windowless Sampling	Logged By RS

AGS3 UK BH 17-174 LOGS.GPJ AGS3_ALL.GDT 28/7/17

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BOREHOLE LOG

Project				BOREHOLE No
Land North of Holme House, Oxford Road, Gomersal				**BH02**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
17-174	17-07-17			
Contractor				Sheet
Arc Environmental Ltd				1 of 1

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION		
0.00-0.10	J/D					0.10	Grass over brown slightly sandy silty friable CLAY (TOPSOIL).		
0.10-0.80	B					(0.70)	Brown and grey sandy silty CLAY.		
						0.80			
0.80-1.00	B					(0.30)	Stiff (medium strength) grey sandy silty CLAY.		
1.00-1.10	B					1.10			
1.00	V	70kN/m^2				(1.30)	Grey with orange staining weathered silty MUDSTONE.		
1.10-2.00	B								
2.00-2.40	B								
2.00-2.45	SPT	N=22				2.40			
2.40-3.00	B					(0.96)	Grey slightly weathered shaley MUDSTONE.		
3.00-3.36	SPT	71 blows				3.36			
							Borehole terminated at c.3.36m bgl.		

Boring Progress and Water Observations					
Date	Time	Depth	Casing Depth	Casing Dia. mm	Water Dpt
17-07-17	00.00	3.36	1.00	115	Dry

Chiselling			Water Added	
From	To	Hours	From	To

GENERAL REMARKS

WATER: Borehole remained dry during exploratory period.

All dimensions in metres Scale 1:25	Client Mr Robert Martin	Method/ Plant Used Windowless Sampling	Logged By RS

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BOREHOLE LOG

Project				BOREHOLE No
Land North of Holme House, Oxford Road, Gomersal				**BH03**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
17-174	17-07-17			
Contractor				Sheet
Arc Environmental Ltd				1 of 1

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION		
0.00-0.10	J/D					0.10	Grass over brown slightly sandy silty friable CLAY (TOPSOIL).		
0.10-1.00	B					(1.00)	Firm to stiff (medium strength) brown and grey sandy silty CLAY.		
1.00-1.10	B					1.10			
1.00	V	60kN/m^2					Stiff orangish brown and grey gravelly friable CLAY with mudstone lithorelics.		
1.10-1.50	B					(0.40)			
1.50-2.00	B					1.50	Grey slightly weathered shaley MUDSTONE.		
2.00-2.37	SPT	73 blows				(0.87)			
						2.37	Borehole terminated at c.2.37m bgl.		

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	
17-07-17	00.00	2.37	1.00	115	Dry						WATER: Borehole remained dry during exploratory period.

All dimensions in metres Scale 1:25	Client Mr Robert Martin	Method/ Plant Used Windowless Sampling	Logged By RS

AGS3 UK BH 17-174 LOGS.GPJ AGS3_ALL.GDT 28/7/17

Solum House, Unit 1 Elliott Court
St Johns Road, Meadowfield
Durham, DH7 8PN
Telephone: 01913786380

BOREHOLE LOG

Project				BOREHOLE No
Land North of Holme House, Oxford Road, Gomersal				**BH04**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
17-174	17-07-17			
Contractor				Sheet
Arc Environmental Ltd				1 of 1

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION		
0.00-0.20	J/D					(0.20) 0.20	Grass over brown slightly sandy silty friable CLAY (TOPSOIL).		
0.20-1.00	B					(0.80) 1.00	Firm to stiff (medium strength) brown and grey sandy silty CLAY.		
1.00-1.60	B					(0.60) 1.60	Brownish grey with orange staining weathered MUDSTONE, recovered as silty gravelly clay.		
1.00	V	60kN/m^2							
1.60-2.00	B					(0.78) 2.38	Grey with orange staining weathered silty MUDSTONE.		
2.00-2.38	SPT	74 blows							
							Borehole terminated at c.2.38m bgl.		

Boring Progress and Water Observations					
Date	Time	Depth	Casing Depth	Casing Dia. mm	Water Dpt
17-07-17	00.00	2.38	1.00	115	Dry

Chiselling			Water Added	
From	To	Hours	From	To

GENERAL REMARKS

WATER: Borehole remained dry during exploratory period.

All dimensions in metres Scale 1:25	Client Mr Robert Martin	Method/ Plant Used Windowless Sampling	Logged By RS

AGS3 UK BH 17-174 LOGS.GPJ AGS3_ALL.GDT 28/7/17

Solum House, Unit 1 Elliott Court
St Johns Road, Meadowfield
Durham, DH7 8PN
Telephone: 01913786380

BOREHOLE LOG

Project				BOREHOLE No
Land North of Holme House, Oxford Road, Gomersal				**BH05**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
17-174	17-07-17			
Contractor				Sheet
Arc Environmental Ltd				1 of 1

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION		
0.00	J/D					(0.30) 0.30	Grass over brown slightly sandy silty friable clay (MADE GROUND).		
0.30	J/D					(0.50) 0.80	Blackish dark grey sandy gravel of mudstone (MADE GROUND).		
0.80	B					(0.80) 1.60	Firm to stiff (medium strength) brown and grey sandy silty CLAY.		
1.00	B								
1.00	V	58kN/m^2							
1.60	B					(0.71) 2.31	Grey with orange staining weathered silty MUDSTONE.		
2.00-2.31	SPT	72 blows							
							Borehole terminated at c.2.31m bgl.		

Boring Progress and Water Observations					
Date	Time	Depth	Casing Depth	Casing Dia. mm	Water Dpt
17-07-17	00.00	2.31	1.00	115	Dry

Chiselling			Water Added	
From	To	Hours	From	To

GENERAL REMARKS

WATER: Borehole remained dry during exploratory period.

All dimensions in metres Scale 1:25	Client Mr Robert Martin	Method/ Plant Used Windowless Sampling	Logged By RS

AGS3 UK BH 17-174 LOGS.GPJ AGS3_ALL.GDT 28/7/17

Solum House, Unit 1 Elliott Court
St Johns Road, Meadowfield
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DRILLHOLE LOG

Project				DRILLHOLE No
Land North of Holme House, Oxford Road, Gomersal				**RBH01**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
17-174	23-08-17 23-08-17			
Contractor				Sheet
Arc Environmental Ltd				1 of 2

RUN DETAILS			STRATA							
Depth	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thick-ness)	DESCRIPTION			Geology	Instrument/ Backfill
						Discontinuities	Detail	Main		
					(2.00) 2.00			Brown sandy CLAY (Drillers Description).		
					(28.00)			Grey MUDSTONE with sandstone bands (Drillers Descritption).		

Drilling Progress and Water Observations						
Date	Time	Depth	Casing	Core Dia mm	Water Strike	Water Standing

Rotary Flush			
From	To	Type	Returns
0	30	WATER	100

GENERAL REMARKS

All dimensions in metres Scale 1:125	Client Mr Robert Martin	Method/ Plant Used Openhole Rotary	Logged By JP

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DRILLHOLE LOG

Project				DRILLHOLE No
Land North of Holme House, Oxford Road, Gomersal				**RBH01**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
17-174	23-08-17 23-08-17			
Contractor				Sheet
Arc Environmental Ltd				2 of 2

RUN DETAILS			STRATA							
Depth	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thick-ness)	DESCRIPTION Discontinuities	Detail	Main	Geology	Instrument/ Backfill
								Grey MUDSTONE with sandstone bands (Drillers Descritption). *(continued)*		
					30.00			Rotary borehole terminated at c.30.00m bgl. Descriptions are based purely on drillers interpretation of cuttings/flush brought to the surface, as well as drilling rates maintained during the drilling process. Full flush was maintained throughout the progession of the borehole to c.30.00m bgl. Gas readings: Methane - 0%, Carbon Dioxide - 0%, Oxygen - 21.6%.		

Drilling Progress and Water Observations							Rotary Flush				GENERAL REMARKS
Date	Time	Depth	Casing	Core Dia mm	Water Strike	Water Standing	From	To	Type	Returns	
23-08-17	00.00	30.00	3.00	110							

All dimensions in metres Scale 1:125	Client Mr Robert Martin	Method/ Plant Used Openhole Rotary	Logged By JP

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DRILLHOLE LOG

Project				DRILLHOLE No
Land North of Holme House, Oxford Road, Gomersal				**RBH02**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
17-174	23-08-17 24-08-17			
Contractor				Sheet
Arc Environmental Ltd				1 of 2

RUN DETAILS			STRATA							
Depth	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thick-ness)	DESCRIPTION Discontinuities	Detail	Main	Geology	Instrument/ Backfill
					(1.90) 1.90			Brown sandy CLAY (Drillers Description).		
					(28.10)			Grey MUDSTONE with sandstone bands (Drillers Descritption).		

Drilling Progress and Water Observations							Rotary Flush				GENERAL REMARKS
Date	Time	Depth	Casing	Core Dia mm	Water Strike	Water Standing	From	To	Type	Returns	
23-08-17	00.00	12.00	3.00	110			0	30	WATER	100	

All dimensions in metres Scale 1:125	Client Mr Robert Martin	Method/ Plant Used Openhole Rotary	Logged By JP

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DRILLHOLE LOG

Project				DRILLHOLE No
Land North of Holme House, Oxford Road, Gomersal				**RBH02**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
17-174	23-08-17 24-08-17			
Contractor				Sheet
Arc Environmental Ltd				2 of 2

RUN DETAILS			STRATA							
Depth	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thick-ness)	DESCRIPTION			Geology	Instrument/ Backfill
						Discontinuities	Detail	Main		
								Grey MUDSTONE with sandstone bands (Drillers Descritption). *(continued)*		
					30.00					
								Rotary borehole terminated at c.30.00m bgl. Descriptions are based purely on drillers interpretation of cuttings/flush brought to the surface, as well as drilling rates maintained during the drilling process. Full flush was maintained throughout the progession of the borehole to c.30.00m bgl. Gas readings: Methane - 0%, Carbon Dioxide - 0%, Oxygen - 21.6%.		

Drilling Progress and Water Observations							Rotary Flush				GENERAL REMARKS
Date	Time	Depth	Casing	Core Dia mm	Water Strike	Water Standing	From	To	Type	Returns	
24-08-17	00.00	30.00	3.00	110							

All dimensions in metres Scale 1:125	Client Mr Robert Martin	Method/ Plant Used Openhole Rotary	Logged By JP

AGS3 UK DH 17-174 LOGS.GPJ AGS3_ALL.GDT 14/9/17

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DRILLHOLE LOG

Project				DRILLHOLE No
Land North of Holme House, Oxford Road, Gomersal				**RBH03**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
17-174	24-08-17 24-08-17			
Contractor				Sheet
Arc Environmental Ltd				1 of 2

RUN DETAILS			STRATA							
Depth	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thick-ness)	DESCRIPTION			Geology	Instrument/ Backfill
						Discontinuities	Detail	Main		
					(1.30) 1.30			Brown sandy CLAY (Drillers Description).		
					(28.70)			Grey MUDSTONE with sandstone bands (Drillers Descritption).		

Drilling Progress and Water Observations						
Date	Time	Depth	Casing	Core Dia mm	Water Strike	Water Standing

Rotary Flush			
From	To	Type	Returns
0	30	WATER	100

GENERAL REMARKS

All dimensions in metres Scale 1:125	Client Mr Robert Martin	Method/ Plant Used Openhole Rotary	Logged By JP

AGS3 UK DH 17-174 LOGS.GPJ AGS3_ALL.GDT 14/9/17

Solum House, Unit 1 Elliott Court
St Johns Road, Meadowfield
Durham, DH7 8PN
Telephone: 01913786380

DRILLHOLE LOG

Project				DRILLHOLE No
Land North of Holme House, Oxford Road, Gomersal				**RBH03**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
17-174	24-08-17 24-08-17			
Contractor				Sheet
Arc Environmental Ltd				2 of 2

RUN DETAILS			STRATA							
Depth	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thick-ness)	DESCRIPTION Discontinuities	Detail	Main	Geology	Instrument/ Backfill
								Grey MUDSTONE with sandstone bands (Drillers Descritption). *(continued)*		
					30.00			Rotary borehole terminated at c.30.00m bgl. Descriptions are based purely on drillers interpretation of cuttings/flush brought to the surface, as well as drilling rates maintained during the drilling process. Full flush was maintained throughout the progession of the borehole to c.30.00m bgl. Gas readings: Methane - 0%, Carbon Dioxide - 0%, Oxygen - 21.6%.		

Drilling Progress and Water Observations							Rotary Flush				GENERAL REMARKS
Date	Time	Depth	Casing	Core Dia mm	Water Strike	Water Standing	From	To	Type	Returns	
24-08-17	00.00	30.00	3.00	110							

All dimensions in metres Scale 1:125	Client Mr Robert Martin	Method/ Plant Used Openhole Rotary	Logged By JP

AGS3 UK DH 17-174 LOGS.GPJ AGS3_ALL.GDT 14/9/17

APPENDIX III

Insitu Testing (Ground Gas & Groundwater Monitoring Certificate)

Arc Environmental Ground Gas & Groundwater Monitoring Certificate

Site:	Land adj. Holme House, Oxford Road, Gomersal
Ref:	17 - 174

Visit	Date	Time	Equipment	Weather	Initials	Comments	Borehole	Gas Flow (l/hr)	Atmospheric Pressure (mb)	Atmospheric Pressure Trend	Methane (% v/v)		Methane (% LEL)		Carbon Dioxide (% v/v)		Oxygen (% v/v)		Hydrocarbons (GFM 435 only)		Other Gases (PPM)			Depth to Water (m bgl)
											Initial	Steady	Initial	Steady	Initial	Steady	Initial	Steady	Hex %	PID Cf	PID (Isobutylene)	H_2S	CO	
1	31/07/2017	9.45am	GFM435	Sunny	KC		1	<0.1	988	Rising 997-1009		0.0		0.0		2.4		13.2						1.82
							3	<0.1	988	Rising 997-1009		0.0		0.0		1.5		14.7						1.44
							4	<0.1	986	Rising 997-1009		0.0		0.0		1.0		18.8						2.12 DRY
2	21/08/2017	11.40am	GFM435	Overcast , Dry	KC		1	0.6	1000	Steady 1022-1020		0.0		0.0		0.5		19.5						1.86
							3	0.7	1002	Steady 1022-1020		0.0		0.0		0.0		20.7						1.38
							4	0.5	1002	Steady 1022-1020		0.0		0.0		1.0		18.2						1.42
3	15/09/2017	11.05am	GFM435	Sunny, and partly overcast	KC		1	<0.1	991	Rising 981-1013		0.0		0.0		0.3		19.9						1.60
							3	<0.1	993	Rising 981-1013		0.0		0.0		0.0		20.3						1.10
							4	<0.1	991	Rising 981-1013		0.0		0.0		0.0		20.5						1.34
4																								
5																								
6																								

Notes:

Atmospheric pressure trend taken from www.wunderground.com for Leeds-Bradford Airport

Detection limits - Methane = 0.0%, Carbon Dioxide = 0.0%, LEL = 0.0%, Oxygen = 0.0%, Flow = 0.1l/hr

Monitoring order is from **Left to Right** across table

Monitoring should be for **Not Less** than 3 minutes However, if high concentrations of gasses initially recorded, monitoring should be for up to 10 minutes

N/A = Not applicable >>> = Off the scale

Cf = PID compensation Factor (1-10) - Must be used to multiply the PID reading to give an accuate measure of the total hydrocarbons in the borehole when methane is present

Hex = Hexane (Valid and in range up to 2.000%) - Recorded when abnormally high methane is present.

PID = Photo Ionisation Detector (Calibrated to Isobutylene)

APPENDIX IV

Laboratory Testing Results (Geotechnical & Ground Contamination)

LABORATORY REPORT

4043

Contract Number: PSL17/3491

Report Date: 09 August 2017

Client's Reference: 17-174

Client Name: Arc Environmental
Solum House
Unit 1 Elliott Court
St Johns Road, Meadowfield
Durham
DH7 8PN

For the attention of: Richard Stripp

Contract Title: Land North of Holme House, Oxford Road, Gomersal

Date Received: 20/7/2017
Date Commenced: 20/7/2017
Date Completed: 9/8/2017

Notes: Opinions and Interpretations are outside the UKAS Accreditation

Checked and Approved Signatories:

R Gunson (Director)	A Watkins (Director)	R Berriman (Quality Manager)
L Knight (Senior Technician)	S Eyre (Senior Technician)	A Fry (Senior Technician)

5 – 7 Hexthorpe Road, Hexthorpe,
Doncaster DN4 0AR
tel: +44 (0)844 815 6641
fax: +44 (0)844 815 6642
e-mail: rgunson@prosoils.co.uk
awatkins@prosoils.co.uk

SUMMARY OF LABORATORY SOIL DESCRIPTIONS

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Description of Sample
TP02		B	1.10		Brown mottled grey weathered MUDSTONE.
TP06		B	0.60		Brown mottled grey slightly sandy CLAY.
TP08		B	1.00		Brown mottled grey slightly gravelly slightly sandy CLAY.
TP10		B	0.50		Brown mottled grey slightly sandy CLAY.

UKAS TESTING 4043	PSL Professional Soils Laboratory	Land North of Holme House, Oxford Road, Gomersal	Contract No: PSL17/3491 Client Ref: 17-174

SUMMARY OF SOIL CLASSIFICATION TESTS

(BS1377 : PART 2 : 1990)

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Moisture Content % Clause 3.2	Linear Shrinkage % Clause 6.5	Particle Density Mg/m^3 Clause 8.2	Liquid Limit % Clause 4.3/4	Plastic Limit % Clause 5.3	Plasticity Index % Clause 5.4	Passing .425mm %	Remarks
TP02		B	1.10		16				NP			
TP06		B	0.60		28			65	27	38	100	High plasticity CH.
TP08		B	1.00		20			62	26	36	93	High plasticity CH.
TP10		B	0.50		24			60	26	34	100	High plasticity CH.

SYMBOLS : **NP : Non Plastic** *** : Liquid Limit and Plastic Limit Wet Sieved.**

UKAS TESTING 4043

PSL Professional Soils Laboratory

Land North of Holme House, Oxford Road, Gomersal

Contract No:

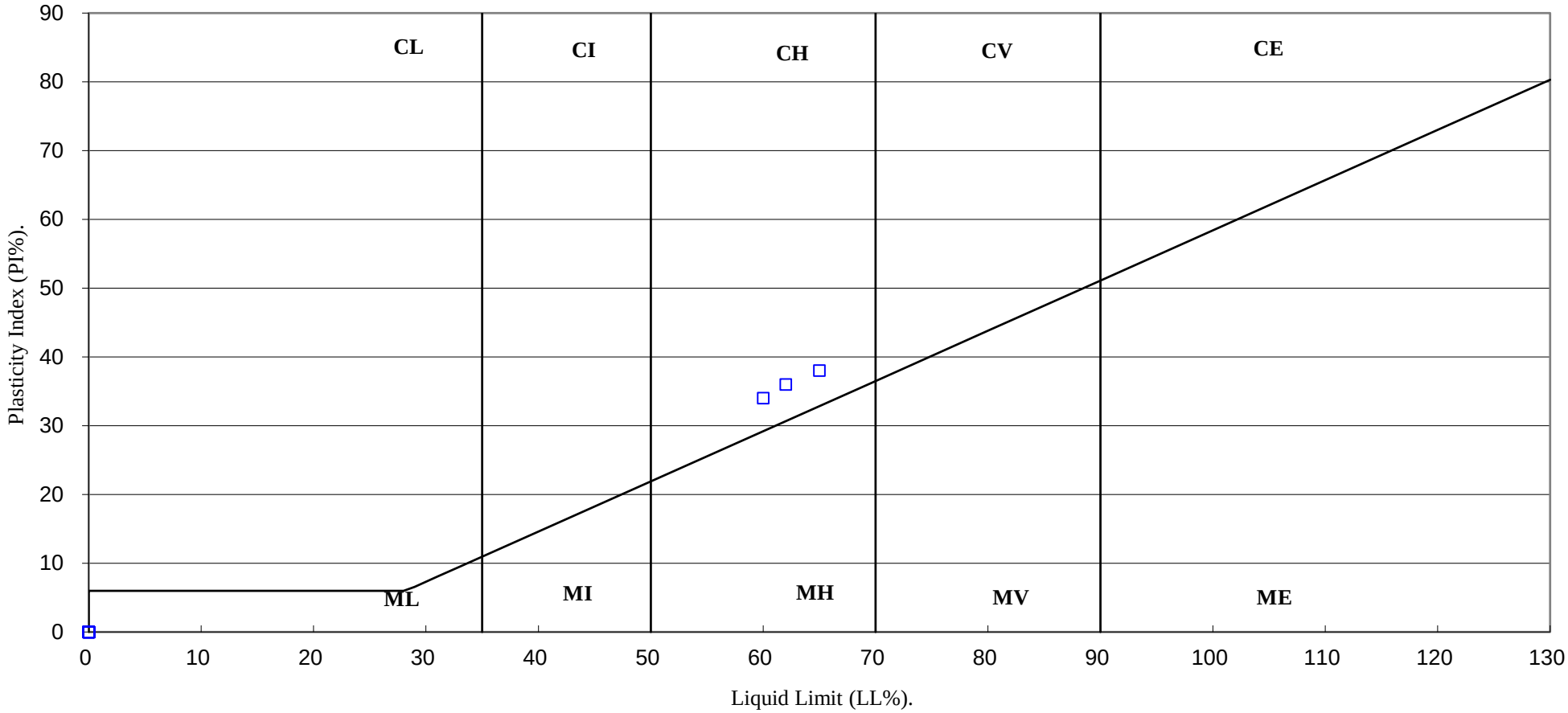
PSL17/3491

Client Ref:

17-174

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.

(BS5930 :2015)



UKAS TESTING 4043	PSL Professional Soils Laboratory	**Land North of Holme House, Oxford Road, Gomersal**	**Contract No:**
			PSL17/3491
			Client Ref:
			17-174

2531

ANALYTICAL TEST REPORT

Contract no: 66115(2)

Contract name: Land north of Holme House, Oxford Road, Gomersal

Client reference: 17-174

Clients name: ARC Environmental

Clients address: Solum House, Unit 1 Elliott Court
St Johns Road
Meadowfield
DH7 8PN

Samples received: 19 July 2017

Analysis started: 19 July 2017

Analysis completed 06 September 2017

Report issued: 06 September 2017

This is a supplementary report to report number 66115 issued 26 July 2017.

Notes:
Opinions and interpretations expressed herein are outside the UKAS accreditation scope.
Unless otherwise stated, Chemtech Environmental Ltd was not responsible for sampling.
Methods, procedures and performance data are available on request.
Results reported herein relate only to the material supplied to the laboratory.
This report shall not be reproduced except in full, without prior written approval.
Samples will be disposed of 6 weeks from initial receipt unless otherwise instructed.

Key:
U UKAS accredited test
M MCERTS & UKAS accredited test
$ Test carried out by an approved subcontractor
I/S Insufficient sample to carry out test
N/S Sample not suitable for testing
NAD No Asbestos Detected

Approved by:

Dave Bowerbank
Customer Services Co-ordinator

Chemtech Environmental Limited

SAMPLE INFORMATION

MCERTS (Soils):

Soil descriptions are only intended to provide a log of sample matrices with respect to MCERTS validation. They are not intended as full geological descriptions. MCERTS accreditation applies for sand, clay and loam/topsoil, or combinations of these whether these are derived from naturally occurring soils or from made ground, as long as these materials constitute the major part of the sample. Other materials such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

All results are reported on a dry basis. Samples dried at no more than 30°C in a drying cabinet.
Analytical results are inclusive of stones.

Lab ref	Sample id	Depth (m)	Sample description	Material removed	% Removed	% Moisture
66115-1	BH03	1.50-2.00	Mudstone	-	-	6.3
66115-2	HP01	0.00-0.40	Loam with Gravel & Concrete	-	-	9.6
66115-3	HP03	0.00-0.70	Loam with Gravel & Roots	-	-	13.7
66115-4	TP03	0.25	Clay	-	-	20.6
66115-5	TP04	1.20	Clay with Slag	-	-	14.3
66115-6	TP05	0.10	Loam with Gravel	-	-	25.6
66115-7	TP08	1.40	Clay with Mudstone	-	-	9.6
66115-8	TP10	0.10	Loam with Gravel	-	-	16.7
66115-9	TP11	0.40	Loam with Gravel	-	-	26.2

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SOILS

Lab number			66115-1	66115-2	66115-3	66115-4	66115-5	66115-6
Sample id			BH03	HP01	HP03	TP03	TP04	TP05
Depth (m)			1.50-2.00	0.00-0.40	0.00-0.70	0.25	1.20	0.10
Date sampled			17/07/2017	17/07/2017	17/07/2017	17/07/2017	17/07/2017	17/07/2017
Test	**Method**	**Units**						
Arsenic (total)	CE127 M	mg/kg As	-	4.7	20	9.3	-	31
Cadmium (total)	CE127 M	mg/kg Cd	-	0.4	0.3	<0.2	-	0.3
Chromium (total)	CE127 M	mg/kg Cr	-	175	79	57	-	53
Chromium (III)	-	mg/kg CrIII	-	175	79	57	-	53
Chromium (VI)	CE146	mg/kg CrVI	-	<1	<1	<1	-	<1
Copper (total)	CE127 M	mg/kg Cu	-	25	52	11	-	45
Lead (total)	CE127 M	mg/kg Pb	-	48	60	22	-	87
Mercury (total)	CE127 M	mg/kg Hg	-	<0.5	<0.5	<0.5	-	<0.5
Nickel (total)	CE127 M	mg/kg Ni	-	118	33	21	-	22
Selenium (total)	CE127 M	mg/kg Se	-	1.0	1.1	1.1	-	1.6
Zinc (total)	CE127 M	mg/kg Zn	-	78	183	94	-	107
pH	CE004 M	units	6.7	8.0	7.2	7.3	6.2	7.1
Sulphate (2:1 water soluble)	CE061 M	mg/l SO_4	15	182	27	62	17	34
Magnesium (2:1 water soluble)	CE061	mg/l Mg	22	-	-	-	-	-
Chloride (2:1 water soluble)	CE049 U	mg/l Cl	1.2	-	-	-	-	-
Nitrate (2:1 water soluble)	CE049 U	mg/l NO_3	<1	-	-	-	-	-
Sulphate (total)	CE062 M	mg/kg SO_4	<100	-	-	-	-	-
Sulphur (total)	CE127	mg/kg S	<100	-	-	-	-	-
Cyanide (free)	CE077	mg/kg CN	-	<1	<1	<1	-	<1
Total Organic Carbon (TOC)	CE072 M	% w/w C	-	2.97	4.26	0.52	-	5.22
PAH								
Acenaphthene	CE087 M	mg/kg	-	0.26	0.06	<0.01	-	0.10
Acenaphthylene	CE087 M	mg/kg	-	<0.01	<0.01	<0.01	-	<0.01
Anthracene	CE087 U	mg/kg	-	0.99	0.29	0.03	-	0.42
Benzo(a)anthracene	CE087 U	mg/kg	-	2.84	0.53	<0.02	-	1.19
Benzo(a)pyrene	CE087 U	mg/kg	-	5.64	0.64	<0.02	-	1.24
Benzo(b)fluoranthene	CE087 M	mg/kg	-	5.51	0.77	<0.02	-	1.40
Benzo(ghi)perylene	CE087 M	mg/kg	-	3.69	0.39	<0.02	-	0.70
Benzo(k)fluoranthene	CE087 M	mg/kg	-	2.17	0.37	<0.02	-	0.70
Chrysene	CE087 M	mg/kg	-	2.94	0.65	<0.01	-	1.23
Dibenz(ah)anthracene	CE087 M	mg/kg	-	0.60	0.11	<0.02	-	0.19
Fluoranthene	CE087 M	mg/kg	-	6.90	1.48	<0.02	-	2.67
Fluorene	CE087 U	mg/kg	-	0.16	0.05	<0.01	-	0.07
Indeno(123cd)pyrene	CE087 M	mg/kg	-	3.54	0.36	<0.02	-	0.66
Naphthalene	CE087 M	mg/kg	-	0.24	0.14	<0.01	-	0.20
Phenanthrene	CE087 M	mg/kg	-	2.04	0.93	<0.02	-	1.28
Pyrene	CE087 M	mg/kg	-	6.67	1.28	0.04	-	2.41
PAH (total of USEPA 16)	CE087	mg/kg	-	44.2	8.06	<0.27	-	14.5
Benzo(j)fluoranthene	CE087	mg/kg	-	0.62	0.11	<0.02	-	0.20
PAH (total of OIL 8)	CE087	mg/kg	-	23.9	3.54	<0.15	-	6.81
TPH								

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SOILS

Lab number			66115-1	66115-2	66115-3	66115-4	66115-5	66115-6
Sample id			BH03	HP01	HP03	TP03	TP04	TP05
Depth (m)			1.50-2.00	0.00-0.40	0.00-0.70	0.25	1.20	0.10
Date sampled			17/07/2017	17/07/2017	17/07/2017	17/07/2017	17/07/2017	17/07/2017
Test	**Method**	**Units**						
VPH (>C5-C7)	CE067	mg/kg	-	<0.1	<0.1	<0.1	-	<0.1
VPH (>C7-C8)	CE067	mg/kg	-	<0.1	<0.1	<0.1	-	<0.1
VPH (>C8-C10)	CE067	mg/kg	-	<0.1	<0.1	<0.1	-	<0.1
EPH (>C10-C12)	CE033 M	mg/kg	-	4	<4	15	-	<4
EPH (>C12-C16)	CE033 M	mg/kg	-	19	<4	21	-	7
EPH (>C16-C21)	CE033 M	mg/kg	-	116	21	17	-	37
EPH (>C21-C35)	CE033 M	mg/kg	-	1566	87	28	-	230
EPH (>C35-C44)	CE033 M	mg/kg	-	1196	39	35	-	75
Subcontracted analysis								
Asbestos (qualitative)	$	-	-	Chrysotile	NAD	NAD	-	NAD

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SOILS

Lab number			66115-7	66115-8	66115-9
Sample id			TP08	TP10	TP11
Depth (m)			1.40	0.10	0.40
Date sampled			17/07/2017	17/07/2017	17/07/2017
Test	**Method**	**Units**			
Arsenic (total)	CE127 M	mg/kg As	-	30	23
Cadmium (total)	CE127 M	mg/kg Cd	-	0.3	0.3
Chromium (total)	CE127 M	mg/kg Cr	-	46	85
Chromium (III)	-	mg/kg CrIII	-	46	85
Chromium (VI)	CE146	mg/kg CrVI	-	<1	<1
Copper (total)	CE127 M	mg/kg Cu	-	69	41
Lead (total)	CE127 M	mg/kg Pb	-	94	115
Mercury (total)	CE127 M	mg/kg Hg	-	<0.5	<0.5
Nickel (total)	CE127 M	mg/kg Ni	-	20	27
Selenium (total)	CE127 M	mg/kg Se	-	1.3	1.0
Zinc (total)	CE127 M	mg/kg Zn	-	95	108
pH	CE004 M	units	6.9	6.8	7.5
Sulphate (2:1 water soluble)	CE061 M	mg/l SO_4	19	32	94
Magnesium (2:1 water soluble)	CE061	mg/l Mg	-	-	-
Chloride (2:1 water soluble)	CE049 U	mg/l Cl	-	-	-
Nitrate (2:1 water soluble)	CE049 U	mg/l NO_3	-	-	-
Sulphate (total)	CE062 M	mg/kg SO_4	-	-	-
Sulphur (total)	CE127	mg/kg S	-	-	-
Cyanide (free)	CE077	mg/kg CN	-	<1	<1
Total Organic Carbon (TOC)	CE072 M	% w/w C	-	7.89	8.72
PAH					
Acenaphthene	CE087 M	mg/kg	-	0.05	1.14
Acenaphthylene	CE087 M	mg/kg	-	<0.01	0.11
Anthracene	CE087 U	mg/kg	-	0.11	2.62
Benzo(a)anthracene	CE087 U	mg/kg	-	0.13	4.03
Benzo(a)pyrene	CE087 U	mg/kg	-	0.12	3.89
Benzo(b)fluoranthene	CE087 M	mg/kg	-	0.13	4.37
Benzo(ghi)perylene	CE087 M	mg/kg	-	0.06	2.30
Benzo(k)fluoranthene	CE087 M	mg/kg	-	<0.02	2.03
Chrysene	CE087 M	mg/kg	-	0.15	3.84
Dibenz(ah)anthracene	CE087 M	mg/kg	-	<0.02	0.66
Fluoranthene	CE087 M	mg/kg	-	0.27	9.14
Fluorene	CE087 U	mg/kg	-	0.03	1.17
Indeno(123cd)pyrene	CE087 M	mg/kg	-	0.05	2.23
Naphthalene	CE087 M	mg/kg	-	0.06	0.73
Phenanthrene	CE087 M	mg/kg	-	0.22	8.29
Pyrene	CE087 M	mg/kg	-	0.26	7.54
PAH (total of USEPA 16)	CE087	mg/kg	-	1.64	54.1
Benzo(j)fluoranthene	CE087	mg/kg	-	<0.02	0.58
PAH (total of OIL 8)	CE087	mg/kg	-	0.58	21.6
TPH					

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SOILS

Lab number			66115-7	66115-8	66115-9
Sample id			TP08	TP10	TP11
Depth (m)			1.40	0.10	0.40
Date sampled			17/07/2017	17/07/2017	17/07/2017
Test	**Method**	**Units**			
VPH (>C5-C7)	CE067	mg/kg	-	<0.1	<0.1
VPH (>C7-C8)	CE067	mg/kg	-	<0.1	<0.1
VPH (>C8-C10)	CE067	mg/kg	-	<0.1	<0.1
EPH (>C10-C12)	CE033 M	mg/kg	-	<4	5
EPH (>C12-C16)	CE033 M	mg/kg	-	10	23
EPH (>C16-C21)	CE033 M	mg/kg	-	43	101
EPH (>C21-C35)	CE033 M	mg/kg	-	246	1017
EPH (>C35-C44)	CE033 M	mg/kg	-	83	427
Subcontracted analysis					
Asbestos (qualitative)	$	-	-	NAD	NAD

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PREPARED LEACHATES

Lab number			66115-2L	66115-9L
Sample id			HP01	TP11
Depth (m)			0.00-0.40	0.40
Test	**Method**	**Units**		
Arsenic (dissolved)	CE128 U	µg/l As	-	3.86
Boron (dissolved)	CE128 U	µg/l B	-	19
Cadmium (dissolved)	CE128 U	µg/l Cd	-	<0.07
Chromium (dissolved)	CE128 U	µg/l Cr	-	0.7
Copper (dissolved)	CE128 U	µg/l Cu	-	6.0
Lead (dissolved)	CE128 U	µg/l Pb	-	1.7
Mercury (dissolved)	CE128 U	µg/l Hg	-	0.009
Nickel (dissolved)	CE128 U	µg/l Ni	-	0.8
Selenium (dissolved)	CE128 U	µg/l Se	-	0.68
Zinc (dissolved)	CE128 U	µg/l Zn	-	<1
pH	CE004 U	units	-	7.4
Sulphate	CE049 U	mg/l SO_4	-	<10
Cyanide (free)	CE147	µg/l CN	-	<20
PAH				
Acenaphthene	CE051	µg/l	0.2	<0.1
Acenaphthylene	CE051	µg/l	<0.1	0.4
Anthracene	CE051	µg/l	<0.1	<0.1
Benzo(a)anthracene	CE051	µg/l	<0.1	<0.1
Benzo(a)pyrene	CE051	µg/l	<0.1	<0.1
Benzo(b)fluoranthene	CE051	µg/l	<0.1	<0.1
Benzo(ghi)perylene	CE051	µg/l	<0.1	<0.1
Benzo(k)fluoranthene	CE051	µg/l	<0.1	<0.1
Chrysene	CE051	µg/l	<0.1	<0.1
Dibenz(ah)anthracene	CE051	µg/l	<0.1	<0.1
Fluoranthene	CE051	µg/l	<0.1	<0.1
Fluorene	CE051	µg/l	<0.1	<0.1
Indeno(123cd)pyrene	CE051	µg/l	<0.1	<0.1
Naphthalene	CE051	µg/l	<0.1	1.9
Phenanthrene	CE051	µg/l	<0.1	<0.1
Pyrene	CE051	µg/l	<0.1	<0.1
PAH (total of USEPA 16)	CE051	µg/l	<1.6	2.2
Benzo(k)fluoranthene	CE051	µg/l	<0.1	<0.1
PAH (total of USEPA 16)	CE051	µg/l	<0.8	<0.8

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METHOD DETAILS

METHOD	SOILS	METHOD SUMMARY	SAMPLE	STATUS	LOD	UNITS
CE127	Arsenic (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg As
CE127	Cadmium (total)	Aqua regia digest, ICP-MS	Dry	M	0.2	mg/kg Cd
CE127	Chromium (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg Cr
-	Chromium (III)	Calculation: Cr (total) - Cr (VI)	Dry		1	mg/kg CrIII
CE146	Chromium (VI)	Acid extraction, Colorimetry	Dry		1	mg/kg CrVI
CE127	Copper (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg Cu
CE127	Lead (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg Pb
CE127	Mercury (total)	Aqua regia digest, ICP-MS	Dry	M	0.5	mg/kg Hg
CE127	Nickel (total)	Aqua regia digest, ICP-MS	Dry	M	1	mg/kg Ni
CE127	Selenium (total)	Aqua regia digest, ICP-MS	Dry	M	0.3	mg/kg Se
CE127	Zinc (total)	Aqua regia digest, ICP-MS	Dry	M	5	mg/kg Zn
CE004	pH	Based on BS 1377, pH Meter	Wet	M	-	units
CE061	Magnesium (2:1 water soluble)	Aqueous extraction, ICP-OES	Dry		1	mg/l Mg
CE049	Chloride (2:1 water soluble)	Aqueous extraction, IC-COND	Dry	U	1	mg/l Cl
CE049	Nitrate (2:1 water soluble)	Aqueous extraction, IC-COND	Dry	U	1	mg/l NO_3
CE061	Sulphate (2:1 water soluble)	Aqueous extraction, ICP-OES	Dry	M	10	mg/l SO_4
CE062	Sulphate (total)	Acid extraction, ICP-OES	Dry	M	100	mg/kg SO_4
CE127	Sulphur (total)	Acid extraction, ICP-MS	Dry		100	mg/kg S
CE077	Cyanide (free)	Extraction, Continuous Flow Colorimetry	Wet		1	mg/kg CN
CE072	Total Organic Carbon (TOC)	Removal of IC by acidification, Carbon Analyser	Dry	M	0.1	% w/w C
CE087	Acenaphthene	Solvent extraction, GC-MS	Wet	M	0.01	mg/kg
CE087	Acenaphthylene	Solvent extraction, GC-MS	Wet	M	0.01	mg/kg
CE087	Anthracene	Solvent extraction, GC-MS	Wet	U	0.02	mg/kg
CE087	Benzo(a)anthracene	Solvent extraction, GC-MS	Wet	U	0.02	mg/kg
CE087	Benzo(a)pyrene	Solvent extraction, GC-MS	Wet	U	0.02	mg/kg
CE087	Benzo(b)fluoranthene	Solvent extraction, GC-MS	Wet	M	0.02	mg/kg
CE087	Benzo(ghi)perylene	Solvent extraction, GC-MS	Wet	M	0.02	mg/kg
CE087	Benzo(k)fluoranthene	Solvent extraction, GC-MS	Wet	M	0.02	mg/kg
CE087	Chrysene	Solvent extraction, GC-MS	Wet	M	0.01	mg/kg
CE087	Dibenz(ah)anthracene	Solvent extraction, GC-MS	Wet	M	0.02	mg/kg
CE087	Fluoranthene	Solvent extraction, GC-MS	Wet	M	0.02	mg/kg
CE087	Fluorene	Solvent extraction, GC-MS	Wet	U	0.01	mg/kg
CE087	Indeno(123cd)pyrene	Solvent extraction, GC-MS	Wet	M	0.02	mg/kg
CE087	Naphthalene	Solvent extraction, GC-MS	Wet	M	0.01	mg/kg
CE087	Phenanthrene	Solvent extraction, GC-MS	Wet	M	0.02	mg/kg
CE087	Pyrene	Solvent extraction, GC-MS	Wet	M	0.02	mg/kg
CE087	PAH (total of USEPA 16)	Solvent extraction, GC-MS	Wet		0.27	mg/kg
CE087	Benzo(j)fluoranthene	Solvent extraction, GC-MS	Wet		0.02	mg/kg
CE087	PAH (total of OIL 8)	Solvent extraction, GC-MS	Wet		0.15	mg/kg
CE067	VPH (>C5-C7)	Headspace GC-FID	Wet		0.1	mg/kg
CE067	VPH (>C7-C8)	Headspace GC-FID	Wet		0.1	mg/kg
CE067	VPH (>C8-C10)	Headspace GC-FID	Wet		0.1	mg/kg
CE033	EPH (>C10-C12)	Solvent extraction, GC-FID	Wet	M	4	mg/kg

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METHOD DETAILS

METHOD	SOILS	METHOD SUMMARY	SAMPLE	STATUS	LOD	UNITS
CE033	EPH (>C12-C16)	Solvent extraction, GC-FID	Wet	M	4	mg/kg
CE033	EPH (>C16-C21)	Solvent extraction, GC-FID	Wet	M	4	mg/kg
CE033	EPH (>C21-C35)	Solvent extraction, GC-FID	Wet	M	6	mg/kg
CE033	EPH (>C35-C44)	Solvent extraction, GC-FID	Wet	M	10	mg/kg
$	Asbestos (qualitative)	HSG 248, Microscopy	Dry	U	-	-

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METHOD DETAILS

METHOD	PREPARED LEACHATES	METHOD SUMMARY	STATUS	LOD	UNITS
CE001	Leachate preparation (EA)	L:S 10:1		-	-
CE128	Arsenic (dissolved)	ICP-MS	U	0.06	µg/l As
CE128	Boron (dissolved)	ICP-MS	U	6	µg/l B
CE128	Cadmium (dissolved)	ICP-MS	U	0.07	µg/l Cd
CE128	Chromium (dissolved)	ICP-MS	U	0.2	µg/l Cr
CE128	Copper (dissolved)	ICP-MS	U	0.4	µg/l Cu
CE128	Lead (dissolved)	ICP-MS	U	0.2	µg/l Pb
CE128	Mercury (dissolved)	ICP-MS	U	0.008	µg/l Hg
CE128	Nickel (dissolved)	ICP-MS	U	0.5	µg/l Ni
CE128	Selenium (dissolved)	ICP-MS	U	0.07	µg/l Se
CE128	Zinc (dissolved)	ICP-MS	U	1	µg/l Zn
CE004	pH	Based on BS 1377, pH Meter	U	-	units
CE049	Sulphate	Ion Chromatography	U	10	mg/l SO_4
CE147	Cyanide (free)	Distillation, Colorimetry		20	µg/l CN
CE051	PAH (speciated)	Solvent extraction, GC-MS		0.1	µg/l
CE051	PAH (total of USEPA 16)	Solvent extraction, GC-MS		1.6	µg/l

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DEVIATING SAMPLE INFORMATION

Comments
Sample deviation is determined in accordance with the UKAS note "Guidance on Deviating Samples" and based on reference standards and laboratory trials.
For samples identified as deviating, test result(s) may be compromised and may not be representative of the sample at the time of sampling.
Chemtech Environmental Ltd cannot be held responsible for the integrity of sample(s) received if Chemtech Environmental Ltd did not undertake the sampling. Such samples may be deviating.

Key

N	No (not deviating sample)
Y	Yes (deviating sample)
NSD	Sampling date not provided
NST	Sampling time not provided (waters only)
EHT	Sample exceeded holding time(s)
IC	Sample not received in appropriate containers
HP	Headspace present in sample container
NCF	Sample not chemically fixed (where appropriate)
IT	Sample not cooled
OR	Other (specify)

Lab ref	Sample id	Depth (m)	Deviating	Tests (Reason for deviation)
66115-1	BH03	1.50-2.00	N	
66115-2	HP01	0.00-0.40	N	
66115-3	HP03	0.00-0.70	N	
66115-4	TP03	0.25	N	
66115-5	TP04	1.20	N	
66115-6	TP05	0.10	N	
66115-7	TP08	1.40	N	
66115-8	TP10	0.10	N	
66115-9	TP11	0.40	N	

APPENDIX V

Ground Contamination Risk Assessment Data: Methodology

Revised Conceptual Site Model

Ground Contamination Risk Assessment

Assessment Framework:-

Ground contamination risk assessments are undertaken to identify potential risks from historical and recent land contamination on a given site and enable appropriate risk management actions to be undertaken in accordance with the regulatory context of the site and any future development. There are a range of technical approaches to the assessment of chemical contaminants in the UK, all of which broadly fit within a tiered/phased approach and the current UK approach is set out in the Defra and Environment Agency Publication: CLR 11: Model Procedures for the Management of Land Contamination (*Defra/EA 2004*).

ARC's approach to undertaking ground contamination risk assessments is based on the tiered/phased framework in accordance with CLR11, and for Human Health, the recently updated CLEA (Contaminated Land Exposure Assessment) framework and model for assessing potentially contaminated land in the UK. This framework and model is based primarily on the following publications and software: Science Reports SC050021/SR2 (EA 2008b Human Health toxicological assessment of contaminants in soil) and SC050021/SR3 (Updated technical background to CLEA model – replaces the previous guidance documents CLR9, CLR10 and Briefing notes 1 – 4); Science Report SC050021/SR4 (CLEA Software (version 1.06 beta) handbook) and the new CLEA software (replaces Science Report SC050021/H CLEA UK Handbook (draft) and the CLEA UK Software version 1.0 beta), along with the publication of a review of body weight and height data used within the Contaminated Land Exposure Assessment model (CLEA), Project no. SC050021/Technical Review 1.

All SGV's (Soil Guidance Values) published as part of the CLEA UK Handbook (draft) and software (version 1.0 beta), have been withdrawn along with guidance documents CLR7 and CLR8, and replacement of the SGV values to provide new Generic Assessment Criteria values (GAC's), using the updated model and software (version 1.06) has been derived by a combination of regulatory and non-governmental organisations (Defra, CL:AIRE and LQM). The newly published GAC's are known as Category 4 Screening Levels (C4SL's) and Suitable 4 Use Levels (S4UL's), and where assessment values for certain contaminants are not available the most appropriate alternative values from other sources will be utilised.

When considering ground contamination risk assessments for Controlled Waters (groundwater and surface waters), ARC follows the EA guidance on Remedial Targets Methodology, Hydrogeological Risk Assessment for Land Contamination, 2006.

Methodology:-

ARC consider that the most appropriate methodology for completing a ground contamination risk assessment for soils on this site is to utilise the recently published GAC values (C4SL's – Arsenic, Cadmium, Chromium VI, Lead, Benzo(a)pyrene & Benzene, S4UL's – Chromium III, Copper, Mercury, Nickel, Selenium, Zinc, Toluene, Ethylbenzene, Xylenes, Phenol, speciated PAH's, speciated TPH's and other organic compounds), combined with other published and recognised GAC's (generic assessment criteria) for the remaining analytes. It is widely recognised by ground contamination risk assessment practitioners that the new CLEA model will generally result in higher SGV and GAC (generic assessment criteria) values for the standard end uses, and consequently continued use of the former CLEA model will result in a slightly more conservative assessment.

For general soil surface contamination, the new S4UL value for inorganic Mercury can be compared with chemical analysis for total mercury content, as the concentrations of elemental and methylmercury compounds are likely to be very low, in accordance with Science Report SC050021 / Mercury SGV. In addition, the updated C4SL values are based upon a Soil Organic Matter (SOM) content of 6%, in line with the most recent Defra and EA guidance. Once all the relevant data is available, a reassessment of the ground contamination present on this site can be carried out, if felt necessary, as this may result in a reduction in the scope of remediation works (if required). It should be noted that guidance document CLR11: Model Procedures for the Management of Land Contamination has not been withdrawn.

Ground Contamination Risk Assessment (Cont'd)

Methodology (Cont'd):-

ARC ground contamination risk assessments, in accordance with CLR11, are based on the established *source-pathway-receptor* pollutant linkage methodology and 'suitable for use' approach (Part IIA, EPA 1990 - inserted through Section 57 EA 1995), and adopts the tiered/phased approach beginning with a preliminary assessment (also referred to a desk top study). If potential pollutant linkages are identified from the preliminary assessment, for both Human Health and/or The Water Environment, then Level 1 Quantitative Risk Assessments are appropriate guideline values. For soils these typically comprise Generic Assessment Criteria values (GAC's) or site specific assessment criteria (SSAC) and for The Water Environment, Environmental Quality Standards (EQS) or UK Drinking Water Standards.

Where any Level 1 criteria have been exceeded, various courses of action are available for recommendation, in order to try and 'break' the pollutant linkage by designing into the proposed development works and/or by recommending appropriate remediation works, i.e. removal of source, treatment of contaminants, installation of permanent barriers, etc. and/or by carrying out more detailed site specific quantitative risk assessment (DQRA, i.e. Level 2 or above). Completing further DQRA for any contaminants present, can take into account factors such as the introduction of physical barrier and the actual availability of plausible contaminant migration pathways, as well as site specific data such as the type, properties and characteristics (permeability, porosity, density, etc.) of the soil present on site, groundwater depth and flow, site specific exposure criteria and values, and contaminant retardation, attenuation, dilution and degradation. Similarly, when considering potential risks to off-site receptors, these are considered by assessing the potential risks to on-site receptors, as well as the potential mobility of any contaminants present within either the soils or water/groundwater below this site.

For the purpose of this report, the preliminary and level 1 risk assessments considers two main categories of receptor, and these are as follows:

- On site Human Health – (CLEA Model).
- Controlled Waters – (groundwater) – (EA Remedial Targets Methodology).

When considering the risk to construction workforce, the results of the screening can be used by the Main Contractor/Project Coordinator, when devising an adequate Site Health & Safety Plan, in accordance with current CDM Regulations, and when assessing the level of PPE required on site. Similarly, when considering the risks to building materials, again the results of the contamination screening can be used to determine the level of protection that may be required, and reference should be made to the utilities suppliers for their comments.

Level 1 - Human Health:-

Level 1 human health related assessments are based upon the current CLEA Model, with site values assessed against published Generic Assessment Criteria Values (GAC's – C4SL's & S4UL's), and where these values are not available against the published CIEM (Chartered Institute of Environmental Health)/LQM Generic Assessment Criteria (GAC), CL:AIRE, Atkins ATRISKsoil© SSV values and USEPA Region 9 Screening Values (2009). For statistical analysis, the site is assessed to delineate any potentially differing areas of contamination (averaging areas), based on the results of the preliminary investigation as well as the result of any visual, olfactory or analytical evidence following completion of the intrusive investigation works. Following this geographical delineation of the site, where generic or pervasive contaminants are anticipated, for each 'averaging area' under consideration, the results are assessed using the established methods of statistical analysis given in the CL:AIRE Guidance on Comparing Soil Contamination Data with a Critical Concentration (C_C), May 2008. In this case, the results of the sample population are assessed to determine whether they represent a normal or non-normal distribution and the statistical upper confidence limit is (95% percentile – $UCL_{0.95}$) is calculated and then compared with the chosen Level 1 Critical Concentration (C_C) value for the site (i.e. the appropriate GAC or SSV).

In addition, further statistical analysis is undertaken to determine whether the maximum concentration(s) recorded represent statistical outliers, i.e. potential 'hot spots', and where necessary these are removed from the sampling populations and a reassessment of the averaging areas/potential hot spot areas identified.

Ground Contamination Risk Assessment (Cont'd)

Methodology (Cont'd):-

Level 1 - Human Health (Cont'd):-

Where targeted screening is undertaken for suspected organic contamination, etc., the maximum site values recorded (C_M) at each location have been compared to the chosen Level 1 Critical Concentration (C_C), with no requirement for statistical analysis to be undertaken for these samples.

Level 1 – Controlled Waters:-

The Level 1 Controlled Waters risk assessment has been carried out (in accordance with the guidance; Remedial Targets Methodology, Hydrogeological Risk Assessment for Land Contamination, Environment Agency, 2006) by comparing leachate and groundwater samples, with the chosen Level 1 Target Concentration (C_T) value, based on an appropriate water quality standard (EQS, UK Drinking Water, etc.).