Appendix I

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PHASE 2: GROUND INVESTIGATION REPORT

BUCCLEUCH PROPERTY (SHERIFFHALL SOUTH) LTD.

PROPOSED DEVELOPMENT (PHASE I)

SHERIFFHALL SOUTH EAST

GILMERTON ROAD

LASSWADE

MIDLOTHIAN

Project No: 17-115

Prepared By: [redacted]
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Date: 27th June 2017

Approved By: [redacted]
Mark Berriman

Date: 22th June 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

June 2017

As requested by Quattro Consult Limited and Axiom Project Services, on behalf of Buccleuch Property (Sheriffhall South) Limited, a program of intrusive ground investigation works has been completed by Arc Environmental Limited (ARC) on part of a large area of undeveloped farmland off Gilmerton Road, Lasswade, Midlothian, which is currently known as Sheriffhall South East (SHSE). These development works are proposed to be undertaken in three individual phases (I, II & III), with this report focusing solely on the Phase I development works, as shown on the Proposed Development Layout Plan, a copy of which can be seen in Appendix I.

A Phase 1: Desk Top Study (DTS) Report, has been produced for the whole of the site by ARC, dated May 2017 for the three development areas, and reference should be made to the Phase 1: DTS when considering the findings of these investigation reports.

The proposed Phase I development works discussed within this report currently comprise the construction of two separate drive-thru restaurants and a new Petrol Filling Station (PFS) along with the associated access road, areas of hardstanding and some limited areas of soft landscaping. As part of the Phase I development works the foul drainage will exit the north of the Phase I development area, and skirt along the southern and western edges of the existing woodland, in the centre of the main site, and will connect to a new pumping station to be constructed at the north eastern corner of the central area of woodland. In addition, the new surface water drainage will follow the same route before extending further north to a newly constructed SUDS Pond, at the north eastern corner of the main site, before discharging directly into Dean Burn, which runs just to the north of the northern boundary of the main site.

The intrusive investigation works completed on site by ARC comprise 16 no. mechanically excavated trial pits (labelled TP's 01 – 16), 3 no. rotary open hole boreholes (labelled RBH's 01 – 03), 3 no. cable percussive boreholes (labelled CP's 01 – 03) and 5 no. windowless sampling boreholes (labelled BH's 01 – 05, accompanied by the installation of 3 no. combined ground gas and water monitoring wells, installed at the location of BH's 01, 03, & 04. TP's 09 – 16 are located along the proposed route of the new surface and foul drainage, as well as the location of the proposed new SUDS pond, with the rest of the investigation positions covering the Phase I development area and new access roads.

The exploratory locations can be seen on the Borehole & Trial Pit Location Plan, a copy of which can be seen in Appendix II. It should be noted that this plan is for orientating purposes only as the plan is to a non-standard scale.

2.0 Site Details

Table 2.1

Site Name & Address:	Sheriffhall South East, Gilmerton Road, Lasswade, Midlothian, EH18 1BD.
National OS Grid Reference:	334850, 667600 – representative for the central part of the site.
Description of Location:	The site is located to the north of Lasswade just to the south of the Edinburgh bypass (A720) junction with the A7 and A6106. The site lies in a rural setting although commercial developments are located to the east and west, close to the site itself. The proposed Phase I development area is located across the south western portion of the wider site development area.
Site Boundaries:	N = The Phase I development area is bound by cultivated fields with Dean Burn and the A720/A7/A6106 Edinburgh Bypass junction beyond, E = The Phase I development area is bound by cultivated fields (Phase III development area) with Woodland and Melville Gate Road beyond, S = Gilmerton Road (B6392) & W= A7 (unnamed road).

N = North, E = East, S = South, W = West

2.0 Site Details (Cont'd)

Table 2.1 (Cont'd)

Site Shape, Area & General Topography:	The Phase I development area is generally rectangular in shape with an approximate site area of 1.92Ha. The topography gradually decreases from the southern boundary at an approximate site level of 72m, to the northern boundary at 70m AOD. Approximate site levels were obtained from the topographical survey produced by Comprehensive Design Architects (drawing no.: (SK) 11, dated: January 2017).
Additional Comments:	Give the current use of the wider site area there are no existing or historical structures with the exception of two sets of electricity transmission lines, located to the immediate east for the Phase I development area (in the Phase III area). A 15m (each side) buffer zone associated with the power lines was applied during the intrusive investigation as can be seen on the Existing Site Layout Plan and Phasing Diagram in Appendix I. A Phase 1: DTS Report was produced for the wider development area (Phases I, II & II) by ARC, dated: May 2017.

N = North, E = East, S = South, W = West

3.0 Scope of Works

Table 3.1

Client:	Buccleuch Property (Sheriffhall South) Limited.
Consulting Engineers:	Quattro Consult Limited & Axiom Project Services.
Project Type:	Commercial Development.
Site Location Plans:	See Appendix I.
Layout Plan (Existing):	See Appendix I.
Layout Plan (Proposed):	See Appendix I.
Intrusive Investigation Works:	16 no. mechanically excavated trial pits (labelled TP's 01 – 16), 3 no. rotary open hole boreholes (RBH's 01 – 03) and 3 no. cable percussive boreholes (labelled CP's 01 – 03), 5 no. windowless sampling boreholes (labelled BH's 01 – 05), accompanied by the installation of 3 no. combined ground gas & water monitoring wells installed at the location of BH's 01, 03 & 04.
Laboratory Testing:	Geotechnical & Ground Contamination.
CLEA Classification:	Commercial (best fit end use).
Reporting:	Factual & Interpretative.

The information contained in this report is limited to the Phase I development area of the site as indicated on the Existing Site Layout Plan shown in Appendix I, and to those areas accessible during the ground investigation. In addition, a series of mechanically excavated trial pits were carried out along the proposed foul / surface water drainage route and within the vicinity of the associated SUDS Pond in order to confirm the ground conditions along this route and the nature of the ground conditions at the location of the new SUDS pond. 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 general ground and groundwater conditions at the site and potential areas of geotechnical and geo-environmental concern.

The rationale behind the location of each exploratory hole is summarised in Table 4.1 on the following page.

4.0 Investigation Rationale (Cont'd)

Table 4.1

Potential issue	Position
Geotechnical and geo-environmental consideration with a view to determining a suitable foundation solution for the proposed commercial development in the Phase I area along with access roads and hard standing.	TP's 01 – 08, CP's 01 – 03 & BH's 01 – 05.
Investigation of potential unrecorded coal workings within the underlying White Great Coal seam, as detailed within the Phase 1: DTS Report.	RBH's 01 – 03.
Assessment of potentially hazardous ground gases.	BH's 01, 03 & 04.
Investigate the ground and groundwater conditions along the proposed new drainage route (foul & surface water) and the location of the new SUDS pond.	TP's 09 – 16

5.0 Ground Conditions

For an accurate description of the ground conditions encountered at each investigation position, reference should be made to the Borehole and Trial Pit Record Sheets in Appendix II. It should be noted that there is always the possibility of variation in the ground conditions around and between the investigation locations.

5.1 Soil Profile:-

A summary of the soil profile for this site can be found in Table 5.1 below.

Table 5.1

Type of Strata	Depths Recorded (BGL)	Description & General Comments
TOPSOIL:	From 0.00m up to c.0.20m to c.0.60m	Generally comprising crops overlying dark brown clayey silty SAND.
DRIFT GEOLOGY: (Glaciofluvial Deposits)	From c.0.20m to c.2.50m up to c.1.80m to c.16.00m	Initially comprising medium dense gravelly SAND becoming slightly gravelly and silty with depth across the majority of the Phase I development area. Along the proposed drainage route and SUDS Pond location, these deposits were recorded to be underlain by soft CLAY and SILT, encountered between depths of c.0.20m (TP16) and c.2.80m (TP10). As can be seen from the investigation works these Glaciofluvial Deposits were generally recorded as shallow and thin towards the north east corner of the wider development area.
DRIFT GEOLOGY: (Glacial Till Deposits)	From c.1.80m to c.2.00m up to c.3.00m in TP's 15 & 16 (Base of stratum unproven)	These deposits were recorded locally in TP's 15 & 16 only, underlying the Glaciofluvial Deposits, at the proposed location of the new SUDS Pond. These materials generally comprised of firm becoming stiff silty sandy slightly gravelly CLAY.
SOLID GEOLOGY: (Scottish Lower Coal Measures)	From c.15.00m to c.16.00m up to c.32.00m to c.45.00m	Generally comprising red SANDSTONE. Intact COAL was encountered within rotary borehole RBH02 at a depth of c.30.20m, with a recorded seam thickness of c.0.80m. This intact coal seam is thought to be the Whitehill Great Coal seam.

BGL = Below ground level.

5.0 Ground Conditions (Cont'd)

5.1 Soil Profile (Cont'd):-

The ground conditions encountered during the intrusive ground investigation undertaken across the Phase I development area generally confirm the findings of the Phase 1: DTS undertaken by ARC, dated: May 2017.

5.2 Coal Mining Risk Assessment:-

Following on from the results of the Phase 1: DTS Report, the shallowest seam below this site is considered to be the Whitehill Great Coal (WGC) seam, which was identified as intact within rotary borehole RBH02 only, at a depth of 30.20m below current ground level. The thickness of the WGC seam at this location is c.0.80m, with 14.20m of rock cover above the seam. The WGC seam was not identified within boreholes RBH's 01 & 03 with between c.16m and c.30m of red sandstone noted in both boreholes and no coal seams or evidence of workings, and taking into account the regional dip of the WGC seam confirmed in the Phase 1: DTS report, it can be seen that the WGC seam is at depths of >c.32m below the rest of the site.

Taking into account the results of the Grontmij coal mining investigation and risk assessment undertaken approximately c.200m west of this site (as detailed within the Phase 1: DTS Report), as well as the results of the investigation works undertaken on this development area, it can be seen that there is no evidence of shallow unrecorded coal mine workings being present below this development area. Similarly, if unrecorded extraction of the WGC has taken place below other portions of the site, it can be seen that a minimum rock cover to seam/extraction thickness of at least 20:1 (16.00m:0.80m) is present which is more than adequate to arrest any potential void migration which could cause ground subsidence at the surface. The conventional acceptable minimum "safe" rock cover to seam/extraction thickness ratio is 1:10, in accordance with CIRIA Special Publication 32 – Construction over abandoned mine workings (and draft CIRIA guidance C758 - Abandoned Mine Workings, April 2017) and therefore it can be seen that the Phase I development area is not at risk from shallow coal mining activities below this site and no further investigation or mitigation measures are required.

5.3 Groundwater & Stability:-

No shallow groundwater ingresses were encountered within any of the exploratory holes during and on completion of the works. However, within the cable percussive and windowless sampling boreholes, groundwater ingresses/seepages were noted at depths of between 2.80m and 7.50m bgl, with standing levels of between 3.50m and 4.50m within the cable percussive boreholes after 20 minutes. No final standing levels were recorded in any of the boreholes due to the natural collapse of the boreholes on completion and withdrawal of the casing.

Based on the limited shallow groundwater ingresses observed, wide spread and/or significant shallow groundwater ingress are not considered to be likely on this site, given the nature of the proposed development and likely foundation solutions. However, it would be considered prudent to allow for the introduction of appropriate water control techniques to take care of any potential localised ingresses of water, which may occur within excavations during the construction period, such as those required for any underground fuel storage tanks for the new PFS, particularly during wetter periods of the year.

Collapse of excavations may also occur as a direct result of water ingresses, particularly given the granular nature of the deposits recorded on site. For future site works, adequate lateral trench support will be required for excavations, in order to prevent trench wall collapse or over excavations, as well as to create a safe working environment below a depth of 1.20m, and any excavations on this site should remain open for as short a period as possible, since some of these materials may be susceptible to deterioration, if left open to the natural elements for any significant period of time. Reference to CIRIA Report 97 1992 'Trenching Practice – Second

5.0 Ground Conditions (Cont'd)

5.3 Groundwater & Stability (Cont'd):-

Edition' would be beneficial to establish a suitable means of support or battering of excavation sides during construction.

6.0 Insitu Testing

6.1 Insitu Standard Penetration Tests (SPT's):-

Standard penetration tests were carried out within the cable percussive and windowless sampling boreholes with the use of a standard split spoon sampler, to determine the relative density and strength of the deposits encountered below the site. The results are shown as uncorrected 'N' values on the graphic borehole record sheets, adjacent to the appropriate sample level, and are summarised in Table 6.1 below.

Table 6.1

Type of Strata	Range 'N' Value	Result Details
DRIFT GEOLOGY: (Glaciofluvial - sand)	3 – 31	The results are generally indicative of a medium dense stratum, with an average 'N' value of 12 for the upper 3.50m of strata across the Phase I development area. Looser deposits were noted towards the bae of the windowless sampling boreholes corresponding with the depths at which groundwater seepages have been noted.

6.2 Insitu Hand Shear Vane Tests:-

Insitu Hand Shear Vane tests were carried out using portable insitu hand vane testing equipment (upper limit 120kN/m^2) on the natural fine soil (silt and clay) deposits encountered, along the proposed drainage route and SUDS Pond location, in order to determine the undrained shear strength of these materials.

The results can be found on the graphic Trial Pit Record Sheets presented in Appendix II, and are summarised in Table 6.2 below.

Table 6.2

Type of Strata	Range of Undrained Shear Strength Values (kN/m^2)	Description & General Comments
DRIFT GEOLOGY: (Glaciofluvial - silt)	6 – 32	The results are indicative of extremely low, very low and low strength strata.
DRIFT GEOLOGY: (Glacial Till – clay)	58 – 120	Initially recorded as medium strength becoming high strength strata.

6.3 Insitu CBR (MEXE Cone) Tests:-

Insitu tests were carried out within the upper natural deposits encountered in TP's 01, 04 & 05 – 08, using a MEXE Cone Penetrometer. The MEXE Cone Penetrometer is a lightweight apparatus for rapidly measuring in-depth resistance to penetration. The dial indicates in terms of an Equivalent California Bearing Ratio (CBR) value. The instrument is primarily intended for finer grained soils and when used as intended measurements correlate closely with CBR values measured in-situ with conventional equipment. The results of the tests can

6.0 Insitu Testing (Cont'd)

6.3 Insitu CBR (MEXE Cone) Tests (Cont'd):-

be found adjacent to the appropriate sample level, on the graphic trial pit record sheets attached in Appendix II.

Based on the results it can be seen that at approximate formation level (c.0.60m bgl), a range of insitu CBR values ranging from 2.0% to 6.0% have been recorded. Consequently, when considering the use of the upper natural strata as an undisturbed subgrade, a design CBR value of 2% should be taken. It is possible that the natural superficial deposits will also improve with compaction and is it possible that higher insitu CBR values can be achieved from these materials.

6.4 Insitu Gas & Groundwater Monitoring:-

Combined ground gas & groundwater monitoring standpipes were installed at the locations of boreholes BH's 01, 03, & 04 primarily to determine the ground gas regime for the site, however water levels were also observed during each visit.

A standard 50mm diameter HDPE standpipe, with gravel and / or geo-wrap surround, bentonite seal, gas valve cap and security cover, were installed to a maximum depth of c.4.00m below current ground levels, and the ground gas and water levels were allowed to reach equilibrium, prior to the first monitoring visit. Monitoring was undertaken using a Gas Data GFM 435 soil gas analyser, with integral flow meter, and a Geotechnical Instruments electronic dip-meter.

In accordance with CIRIA Report C665, November 2007 and BS8485:2015 Code of practice for the design of protection measures for methane and carbon dioxide ground gas for new buildings, it is felt that an adequate risk assessment for this site can be undertaken based on the following limiting factors:

- The site is considered as a Low sensitivity – based on an end-use of apartments (Commercial).
- The risk associated with the gas generation potential of sources for this particular site is considered as very low, based on the findings of the Phase 1: DTS Report and the Phase 2 investigation. This assessment can be re-evaluated following initial monitoring.
- Therefore, in accordance with CIRIA Report C665 (Assessing risks posed by hazardous ground gases to buildings, 2007), it is deemed appropriate to allow for up to 4 no. monitoring visits to be completed over a minimum period of 1 months. This would be adequate for the nature of the proposed development providing gas readings were obtained during periods of falling and low atmospheric pressures.

A summary of the results for the visits undertaken to date, compared with the 'inert' background gas levels are presented in Table 6.3 below, and copies of the monitoring certificate can be seen attached in Appendix III.

Table 6.3

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)
Background		~	~	**0**	**0**	**0**	**21.0**	**0**
BH01	02/06/2017	1003 (steady)	3.98	0.0	0.0	0.3	20.4	<0.1
BH03			3.86	0.0	0.0	0.2	20.5	<0.1
BH04			2.88	0.0	0.0	0.5	20.3	<0.1
BH01	14/06/2017	1003 - 1004 (rising)	2.02	0.0	0.0	0.3	20.3	<0.1
BH03			3.89	0.0	0.0	0.3	20.1	<0.1
BH04			2.86	0.0	0.0	0.6	19.6	<0.1

6.0 Insitu Testing (Cont'd)

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

There have been no concentrations of Methane (CH_4) recorded within any of the gas monitoring wells at this stage, with relatively low concentrations of Carbon Dioxide (CO_2) ranging from 0.2% v/v up to 0.6% v/v, and associated slightly depleted levels of Oxygen (O_2). Flow rates have been consistently recorded at <0.1 l/hr.

At this stage, the site can be characterised based on the limiting borehole gas volume flow for methane and carbon dioxide known as the Gas Screening Value (GSV) which in turn determines the level of protection required.

In accordance with CIRIA Report C665, the risk to the development from ground gases has been assessed by converting the results in Table 6.3 to a GSV, calculated by multiplying the typical maximum gas concentrations with the recorded maximum positive flow rates (after Wilson & Card). Due to the lack of CH_4 recorded, there is no GSV value for Methane. In order to complete the risk assessment, the maximum GSV for the CO_2 levels recorded has been determined by multiplying the maximum concentration recorded (0.6% v/v) by the maximum flow rate (0.1 l/hr). The GSV can be calculated as follows;

Carbon Dioxide GSV = 0.006 x 0.1 = 0.0006 l/hr

When considering the gas screening value (GSV) for Carbon Dioxide, the GSV of 0.0006 l/hr falls below the lower target concentration of 0.07 l/hr and as such equates to a Characteristic Situation 1 (CS1), in accordance with Table 8.5 in CIRIA C665. Once all the gas monitoring has been completed, a final ground gas risk assessment will be completed.

In addition, water was recorded within all monitoring well at depths ranging between c.2.02m and c.3.98m below current ground level, which is considered to represent seepage/perched water at the base of the monitoring wells, and correlates with the ingress/seepage/standing levels noted in the cable percussive and windowless sampling boreholes during the field works.

7.0 Laboratory Testing

All geotechnical testing was carried out in accordance with BS1377:1990:Parts 1-9 unless otherwise stated, at a UKAS accredited laboratory. Ground contamination screening was undertaken by a suitably experienced and qualified laboratory (UKAS and MCERTS accredited, unless otherwise stated).

7.1 Determination of Particle Size Distribution (PSD):-

Representative samples of the natural deposits were tested in order to determine their particle size distribution, so the materials might be classified. The results can be seen in Table 7.1 below and on the following page, and are also contained in the PSL Analytical Report, reference no. PSL17/2335, a copy of which can be seen attached in Appendix IV.

Table 7.1

Position	Depth (m)	Clay Fraction (%)	Silt Fraction (%)	Sand Fraction (%)	Gravel Fraction (%)	Cobble Fraction (%)	Description of Soil
BH01	0.45-1.00	16		83	1	0	Poorly graded (uniform) silty slightly gravelly fine to medium SAND
BH02	0.68-1.00	4		73	23	0	Poorly graded slightly silty very gravelly SAND

7.0 Laboratory Testing (Cont'd)

7.1 Determination of Particle Size Distribution (PSD) (Cont'd):-

Table 7.1 (Cont'd)

Position	Depth (m)	Clay Fraction (%)	Silt Fraction (%)	Sand Fraction (%)	Gravel Fraction (%)	Cobble Fraction (%)	Description of Soil
BH01	0.45-1.00	16		83	1	0	Poorly graded (uniform) silty slightly gravelly fine to medium SAND
BH02	0.68-1.00	4		73	23	0	Poorly graded slightly silty very gravelly SAND
BH05	0.78-1.00	4		64	32	0	Poorly graded slightly silty very gravelly SAND
TP06	1.60	10		81	9	0	Poorly graded (uniform) silty gravelly fine to medium SAND
TP07	0.60	3		66	31	0	Poorly graded slightly silty very gravelly SAND
TP10	3.00	4	41	55	0	0	Well graded slightly clayey very silty SAND
TP11	1.00-1.20	28		66	6	0	Poorly graded (uniform) very silty slightly gravelly fine SAND
TP12	1.50-2.00	5	46	49	0	0	Well graded slightly clayey very silty SAND
TP15	2.00-2.10	17	18	29	36	0	Poorly graded clayey silty very sandy GRAVEL
TP16	0.80-1.00	40	46	13	1	0	Slightly gravelly sandy very clayey SILT
CP01	6.50-7.00	29		70	1	0	Poorly graded (uniform) very silty slightly gravelly fine SAND
CP02	11.00-12.00	6	35	57	2	0	Well graded clayey very silty slightly gravelly SAND
CP03	14.00-15.00	86		13	1	0	Slightly gravelly sandy SILT

As can be seen from these results, the materials tested range from well graded clayey silty gravelly sands through to poorly graded (sometimes uniform) silty gravelly sands with some silt and occasional gravel deposits also recorded. The variability in these results and the particle size distributions recorded reflect the heterogenous nature of the depositional environment in which these Glaciofluvial materials have been laid down and generally concur with the field descriptions recorded during the field works and given on the borehole and trial pit logs.

7.2 Determination of Liquid & Plastic Limits:-

A representative sample of the natural clayey materials, encountered in TP15 at a shallow depth, was tested in order to determine the, liquid and plastic limits, so that the material might be classified. A summary of the results are presented within Table 7.2 below and is also contained within the PSL Analytical Report reference no.: PSL17/2335, a copy of which is presented in Appendix IV.

Table 7.2

Position	Depth(m)	M/C (%)	LL	PL	PI	Class	% Passing 425µm sieve
TP15	0.60 – 0.80	20	33	20	13	CL	93

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

7.0 Laboratory Testing (Cont'd)

7.2 Determination of Liquid & Plastic Limits:-

From the results, it can be seen that the sample tested is of an inorganic nature and when plotted on the plasticity chart, falls within the low plasticity range. From the resulting plasticity indices, the recorded clay has a low volume change potential, when taking in to account the amount passing the 425µm sieve. Therefore, it can be seen that the clay tested is unlikely to undergo significant changes in volume, if large changes in the natural moisture content were to occur due to seasonal variations or the like, and if new foundations were to be based within these materials, they would need to be taken down to a minimum depth of 0.75m below finished ground levels.

An increase in founding depth may be required if the proposed development is within close proximity to existing or envisaged vegetation. 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 and Construction".

7.3 Determination of Dry Density / Moisture Content Relationship:-

Representative bulk samples of the upper natural strata were combined and prepared in order to determine the Maximum Dry Density and Optimum Moisture Content (OMC) values for these materials for potential earthworks. For each combined sample, the initial moisture content has been determined and the dry density calculated for a range of moisture contents in order to establish the OMC value. Th results are summarised in Table 7.3 below and are also contained in the PSL Analytical Report, reference no. PSL17/2686, a copy of which can be seen attached in Appendix IV.

Table 7.3

Position	Depth (m)	M/C (%)	Optimum Moisture Content (%)	Moisture Content Range (%) to Achieve ≥95% compaction and ≤5% air voids	Does the Natural Moisture Content fall within moisture content range?	95% of the Maximum Dry Density (Mg/m^3)
TP01/2/3	0.50-1.00	8.7	13	c.12.3 to c.16.6	No (too dry)	1.69
TP04/5/8	0.50-1.00	11	15	c.14.1 to c.18.6	No (too dry)	1.67

As can be seen from these results, OMC values of between 13% and 15% have been recorded giving maximum dry density values of 1.76Mg/m^3 to 1.78Mg/m^3. Assuming the compaction criteria of any future earthworks will require ≥95% maximum dry density and ≤5% air voids it can be seen that compaction moisture contents of 12.3% to 16.6% and 14.1% to 18.6% will be required. Taking into account the as received moisture content values for these materials, it can be seen that in their present condition the upper natural strata is too 'dry' to achieve the anticipated compaction specification.

7.4 Determination of pH & SO_4:-

Representative samples of the variable soil deposits encountered within the boreholes and trial pits were tested in order to determine their acidic (pH) and soluble sulphate (SO_4) levels. The results are summarised in Table 7.4 below and on the following page and are also contained within the Chemtech Environmental Limited Analytical Report, reference no. 64936, a copy of which can be seen in Appendix IV.

Table 7.4

Position	Depth (m)	pH	SO_4(mg/l)	Design SO_4 Class	ACEC Class
BH01	1.20 – 1.80	7.9	11	AC-1	DS-1

7.0 Laboratory Testing (Cont'd)

7.4 Determination of pH & SO_4 (Cont'd):-

Table 7.4 (Cont'd)

Position	Depth (m)	pH	SO_4(mg/l)	Design SO_4 Class	ACEC Class
BH01	1.20 – 1.80	7.9	11	AC-1	DS-1
BH02	0.00 – 0.50	7.8	<10	AC-1	DS-1
BH03	0.00 – 0.30	7.6	11	AC-1	DS-1
BH04	0.00 – 0.58	7.7	10	AC-1	DS-1
BH04	0.80 – 1.00	7.3	<10	AC-1	DS-1
BH05	5.00	8.1	17	AC-1	DS-1
CP01	11.00 – 12.00	7.9	34	AC-1	DS-1
TP01	0.10	7.6	11	AC-1	DS-1
TP01	0.30	7.4	<10	AC-1	DS-1
TP03	0.70	7.6	<10	AC-1	DS-1
TP04	1.20	7.4	10	AC-1	DS-1
TP05	0.20	7.5	24	AC-1	DS-1
TP12	1.50	7.4	14	AC-1	DS-1
TP13	1.80 – 2.00	7.4	67	AC-1	DS-1
TP14	1.20 – 1.40	7.5	37	AC-1	DS-1

ACEC = Aggressive Chemical Environment for Concrete site classification.

The test results obtained within the natural deposits encountered across the development area reveal pH values ranging from 7.3 up to 8.1 and the amount of water soluble sulphate present ranges from between <10mg/l up to 67 mg/l.

In accordance with BRE Special Digest 1: 2005 (3rd Edition), Characteristic values have been derived for the pH & SO_4. This assessment has been based on the mean of the highest 20% of the results obtained, since the sample population is greater than 10 samples. The site can be given a classification of Class DS-1 and when considering the nature of the materials tested and assuming mobile groundwater, the assessment of the Aggressive Chemical Environment for Concrete (ACEC), is AC-1.

7.5 Contamination Screening:-

5 no. representative samples of the natural topsoil deposits recovered from across the Phase I development area were passed onto Chemtech Environmental of Stanley, Co. Durham, so that contamination screening could be carried out, in order to assess the potential for the re-use of these materials on site. Given the lack of potential sources of ground contamination on this site, no other contamination screening or further risk assessment was considered necessary, with the Phase I Development area considered to be 'greenfield'.

The representative samples of topsoil materials were screened using standard generic contamination suites as given in the YALPAG Verification Requirements for Cover Systems, Version 3.3, December 2016 guidance which typically comprises screening for a mixture of metals, non-organics, speciated PAH's, speciated TPH's and asbestos (presence).

The catalogue of testing results can be found in the Chemtech Analytical Report reference no. 64936, a copy of which can be seen attached in Appendix IV. The total analysis carried out is summarised below:

- 5 no. soil samples screened using a Generic soils suite, comprising; Arsenic, Cadmium, Chromium III, Chromium VI, Copper, Lead, Mercury, Nickel, Selenium, Zinc & Cyanide.
- 5 no. soil samples screened for Speciated Polycyclic Aromatic Hydrocarbons (PAH's) – based on the current USEPA 16 PAH's + Benzo(j)fluoranthene.

7.0 Laboratory Testing (Cont'd)

7.5 Contamination Screening (Cont'd):-

- 5 no. soil samples screened for Speciated Total Petroleum Hydrocarbons (8 band).
- 5 no. soil samples screened for asbestos fibres and Asbestos Containing Materials (ACM's).

The results of the screening for each of the samples have been assessed against appropriate assessment criteria based on a commercial end use and these are summarised in Table 7.5 below.

Table 7.5

Analyte	Critical Conc. (C_C) mg/kg	No. of samples Screened	Max. Conc. (C_M) recorded mg/kg	Has C_M exceeded C_C	No. of Samples > C_C
Generic Metals					
Arsenic	640(1)	5	7.5	NO	0
Cadmium	190(1)	5	0.4	NO	0
Chromium III	8600(1)	5	98	NO	0
Chromium VI	33(1)	5	<1.0	NO	0
Copper	68000(1)	5	32	NO	0
Lead	2330(2)	5	75	NO	0
Mercury	1100(1)	5	0.7	NO	0
Nickel	980(1)	5	28	NO	0
Selenium	12000(1)	5	0.9	NO	0
Zinc	730000(1)	5	139	NO	0
Cyanide	34(3)	5	<1.0	NO	0
Speciated PAH's					
Acenaphthene	97000(1)	5	<0.01	NO	0
Acenaphthylene	97000(1)	5	0.02	NO	0
Anthracene	540000(1)	5	0.03	NO	0
Benzo(a)anthracene	170(1)	5	0.23	NO	0
Benzo(a)pyrene	35(1)	5	0.29	NO	0
Benzo(b)fluoranthene	44(1)	5	0.37	NO	0
Benzo(ghi)perylene	4000(1)	5	0.20	NO	0
Benzo(k)fluoranthene	1200(1)	5	0.16	NO	0
Chrysene	350(1)	5	0.25	NO	0
Dibenz(ah)anthracene	3.6(1)	5	0.04	NO	0
Fluoranthene	23000(1)	5	0.42	NO	0
Fluorene	68000(1)	5	<0.01	NO	0
Indeno(123cd)pyrene	510(1)	5	0.19	NO	0
Naphthalene	460(1)	5	<0.01	NO	0
Phenanthrene	22000(1)	5	0.11	NO	0
Pyrene	54000(1)	5	0.39	NO	0
Speciated TPH's					
VPH C5-C7	5900(4)	5	<0.1	NO	0
VPH C7-C8	17000(4)	5	<0.1	NO	0
VPH C8-C10	4800(4)	5	<0.1	NO	0
EPH C10-C12	23000(4)	5	<4	NO	0
EPH C12-C16	37000(4)	5	<4	NO	0
EPH C16-C21	28000(4)	5	9	NO	0
EPH C21-C35	28000(4)	5	63	NO	0
EPH C35-C44	28000(4)	5	22	NO	0
Asbestos	Presence	5	NAD	NO	0

(1) = LQM CIEH Suitable 4 Use Levels - S4UL Nov 2014 (Revised August 2015) – *Commercial 2.5% SOM*, (2) = C4SL Values (*Commercial*), (3) = ATRISK^{SOIL} SSV, (4) = lower of aliphatic/aromatic assessment criteria for carbon banding (LQM CIEH Suitable 4 Use Levels - S4UL Nov 2014 (Revised August 2015)) – *Commercial 2.5% SOM*, **Bold** = result exceeds critical concentration, NAD = no asbestos detected Note = All units are mg/kg.

7.0 Laboratory Testing (Cont'd)

7.5 Contamination Screening (Cont'd):-

The results have identified the following:

- The analysis has shown that no recorded results have elevated levels of contamination above the assessment criteria. Therefore, it can be seen that the natural topsoil deposits can be reused on this site for any new areas of soft landscaping.

8.0 Conclusions & Recommendations

In total, 16 no. mechanically excavated trial pits, 3 no. rotary open hole boreholes, 3 no. cable percussive boreholes and 5 no. windowless sampling borehole, accompanied by the installation of 3 no. combined ground gas and water monitoring wells, have been completed on the Phase I development area, as well as the route of the new drainage runs, by ARC.

8.1 Ground Conditions:-

The intrusive investigation identified the initial ground conditions to comprise natural topsoil deposits with a recorded thickness ranging between c.0.20m and c.0.60m. These materials are directly underlain by Glaciofluvial Deposits, generally comprising medium dense gravelly sand, to a maximum recorded depth of between c.15.00m and c.16.00m. Trial pits excavated along the proposed drainage route and SUDS Pond location, recorded these deposits as thinning and in turn were underlain by soft clay and silt, encountered between depths of c.0.20m and c.2.80m. In addition, local deposits of Glacial Till, generally comprising stiff and very stiff (high strength) slightly sandy slightly gravelly clay, were noted in the area of the proposed SUDS Pond (TP's 15 & 16) location from depth of c.1.80m and c.2.00m.

The solid geology below the site generally comprises red sandstone and was encountered between depths of c.15.00m & c.16.00m bgl, with the rotary boreholes extending into the solid deposits to depths of between c.32.00m and c.45.00m bgl.

Intact coal, which is anticipated to be the WGC (Whitehill Great Coal) seam, was only encountered within borehole RBH02, between a depth of c.30.20m and c.31.00m (c.0.80m thick), with the seam dipping below the rest of the site at depths below the base of boreholes RBH's 01 & 03 and this concurs with the findings of the Phase 1: DTS Report produced by ARC for the development area as well as the Grontmij coal mining risk assessment undertaken for an adjacent site to the west. No workings, broken ground or voiding was identified within the WGC coal seam, and given the thickness of competent rock above the seam/extraction thickness, even if unrecorded workings are present within this seam, the is more than enough rock cover to meet the standard 'safe' ratio of 10:1 (rock cover:seam/extraction thickness). As such, there is not considered to be a significant risk to the Phase I development area form historical coal mining activities.

8.2 Groundwater & Stability:-

No significant shallow groundwater ingresses were encountered during the excavation of the trial pits, with some limited ingresses and seepages noted in the cable percussive and windowless sampling boreholes during the field works. Similarly, some seepage/trapped water was noted during the monitoring of the gas and water monitoring standpipes undertaken to date, at depths of between c.2.02m and c.3.98m bgl. Based on the limited water observations noted during the intrusive investigation works, heavy and widespread shallow groundwater ingress is unlikely to occur within future standard construction related excavations.

8.0 Conclusions & Recommendations (Cont'd)

8.2 Groundwater & Stability (Cont'd):-

However, part of the development will comprise a new petrol filling station which is likely to include underground fuel storage tanks and therefore will include deeper excavation works compared to the other elements of the Phase I development. Bearing this in mind, it is recommended that appropriate groundwater controlled measures are introduced in order to take care of groundwater ingresses where excavations extend to depths below which groundwater has been recorded during these investigation works. In addition, it would be considered prudent to allow for the possible introduction of temporary groundwater control techniques for shallower excavations, in order to take care of any localised unrecorded ingresses of water, which may occur within excavations during the construction period, particularly during the wetter periods of the year.

Collapse of excavations may also occur as a direct result of heavy water ingresses, particularly given the granular nature of the deposits recorded on site. For future site works, adequate lateral trench support will be required for excavations, in order to prevent trench wall collapse or over excavations, as well as to create a safe working environment below a depth of 1.20m, and any excavations on this site should remain open for as short a period as possible, since some of these materials may be susceptible to deterioration, if left open to the natural elements for any significant period of time. Reference to CIRIA Report 97 1992 'Trenching Practice – Second Edition' would be beneficial to establish a suitable means of support or battering of excavation sides during construction.

8.3 Foundation Options:-

Based on the findings of the intrusive investigation at the Phase I development area, it can be seen that the topsoil deposits are not suitable as a founding medium, compared to the natural drift deposits below, which should be capable of supporting conventional shallow foundations.

The most viable foundation solution for the proposed commercial structures will be strip and pad foundations, taken down through any of the topsoil materials and based within the underlying natural medium dense Glaciofluvial deposits at a minimum depth of 0.75m below finished ground levels. complimented with strip footings. In this case, these foundations can be designed to a maximum allowable bearing pressure not to exceed 150kN/m^2 in order to ensure that all normal settlements are within acceptable limits and the risk of excessive differential settlements occurring is negligible, provided strip footings do not exceed 1m in width and pad foundations do not exceed 2m in length and/or width. However, this should be more than adequate for the size and type of structures envisaged.

In accordance with BRE Special Digest 1: 2005 (3rd edition), the site can be given a classification of Class DS-1 and assuming mobile groundwater, the assessment of the Aggressive Chemical Environment for Concrete (ACEC), is AC-1.

8.4 Hazardous Ground Gas Risk Assessment:-

When considering the gas monitoring completed to date, and if similar concentrations are recorded during the remaining gas monitoring visits, based on the screening value (GSV) for Carbon Dioxide of 0.0006 l/hr, it can be seen that this value falls well below the lower target concentration of 0.07 l/hr and as such equates to a Characteristic Situation 1 (CS1), in accordance with Table 8.5 in CIRIA C665, i.e. no gas protection measures will be required for the Phase I development area.

A minimum of 2 no. additional gas monitoring visits are required to complete the full monitoring programme, and once these have been completed a final ground gas risk assessment will be undertaken and the results issued as an addendum letter to this report.

8.0 Conclusions & Recommendations (Cont'd)

8.5 Contamination Screening – Reuse of Topsoil:-

As can be seen from the results of the contamination screening undertaken on the 5 no. representative samples of topsoil from across the Phase I development area, it can be seen that none of the assessment criteria for a commercial end use have been exceeded (based on the guidance given in the YALPAG Verification Requirements for Cover Systems, Version 3.3, December 2016). Therefore, it is felt that the natural topsoil deposits can remain on site without representing a significant risk towards the future end-users and will be suitable for re-use in any new areas of soft landscaping. Due to the nature of the natural superficial deposits (i.e. natural ground) encountered below the whole of the site, there are no significant contamination risks associated with this site and no significant risks to the Water Environment, from the proposed Phase I development works. Consequently, no additional soil, leachate nor groundwater contamination screening is considered necessary for this site.

8.6 General Comments:-

When considering the risks to the construction workforce, adequate PPE will be required to provide protection against the levels of 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.

If during future development 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.

For any future site works, adequate lateral trench support will be required for excavations, in order to prevent trench wall collapse or over excavations, as well as to create a safe working environment below a depth of 1.20m, and any excavations on this site should remain open for as short a period as possible, since some of these materials may be susceptible to deterioration, if left open to the natural elements for any significant period of time. It is also recommended for any future redevelopment works, 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 the existing surface drainage system is disrupted or damaged.

For deeper excavations, drainage, service runs or the like that may pass close to or beneath any existing or proposed foundations, these should also 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. Furthermore, trench support is likely to be required in the southern site area due to unstable drift materials within open excavation walls.

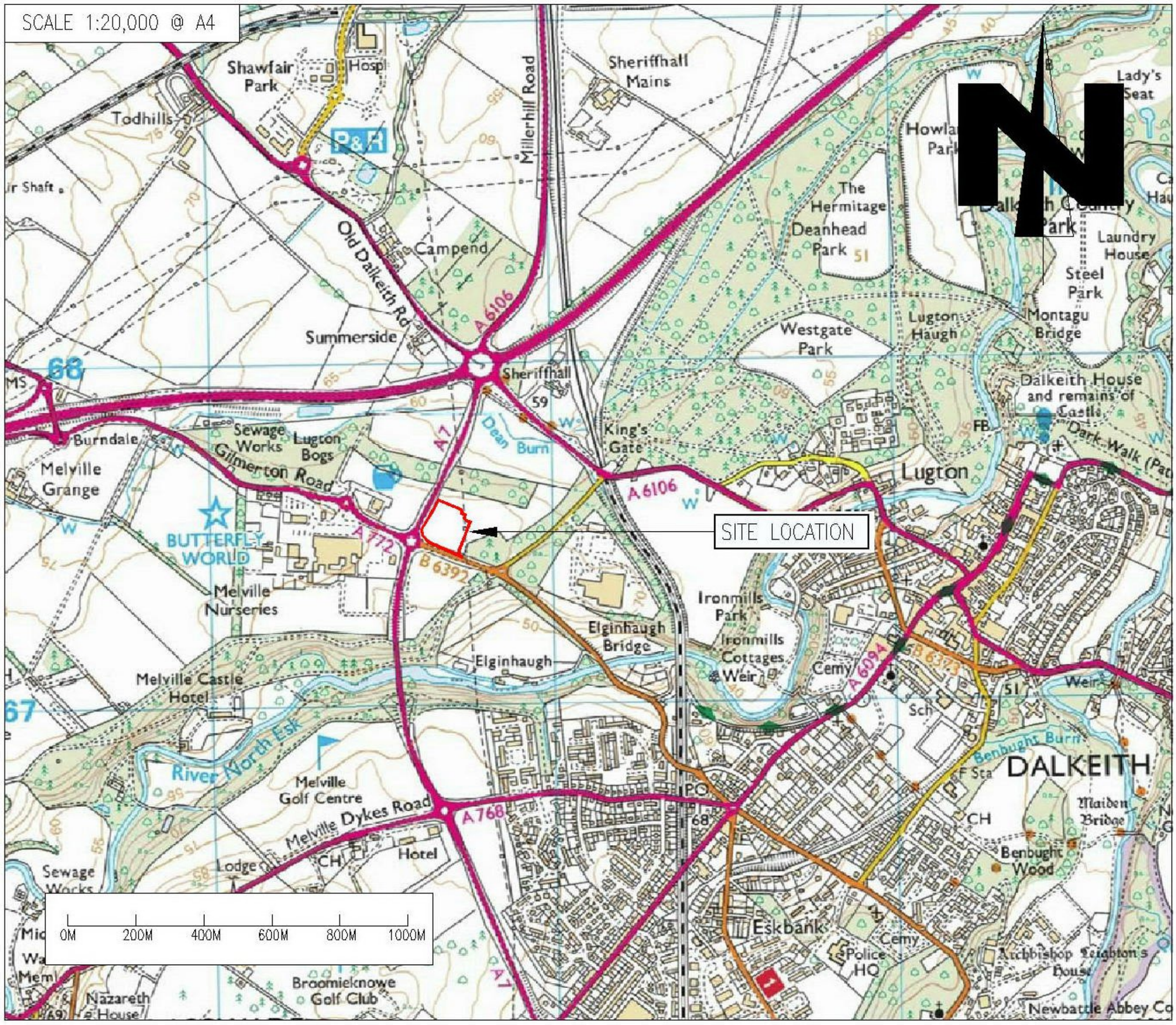
An "observational technique" can be applied to future design and construction works on this site, and where ground conditions seem to vary from that indicated from the conceptual ground model derived from works to date, then advice from a suitably qualified Engineering Geologist/Geotechnical Engineer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

END OF REPORT

APPENDIX I

Location Plan, Aerial Photograph, Existing Site Layout Plan
&
Phase I Proposed Development Layout Plan

SCALE 1:20,000 @ A4



Client:	
	BUCCLEUCH PROPERTY (SHERRIFFHALL SOUTH) LTD

Project Title:	Drawing Title:
Proposed Development (Phase I) Sherriffhall South East, Gilmerton Rd., Lasswade, Midlothian	Location Plan

Job Reference:	Drawing Number:	Revision:
17–115	–	–

Drawn by:	Date:	Scale at A4:
P.D	23.06.17	As Shown

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

rev.	date	amendments	drawn	chckd

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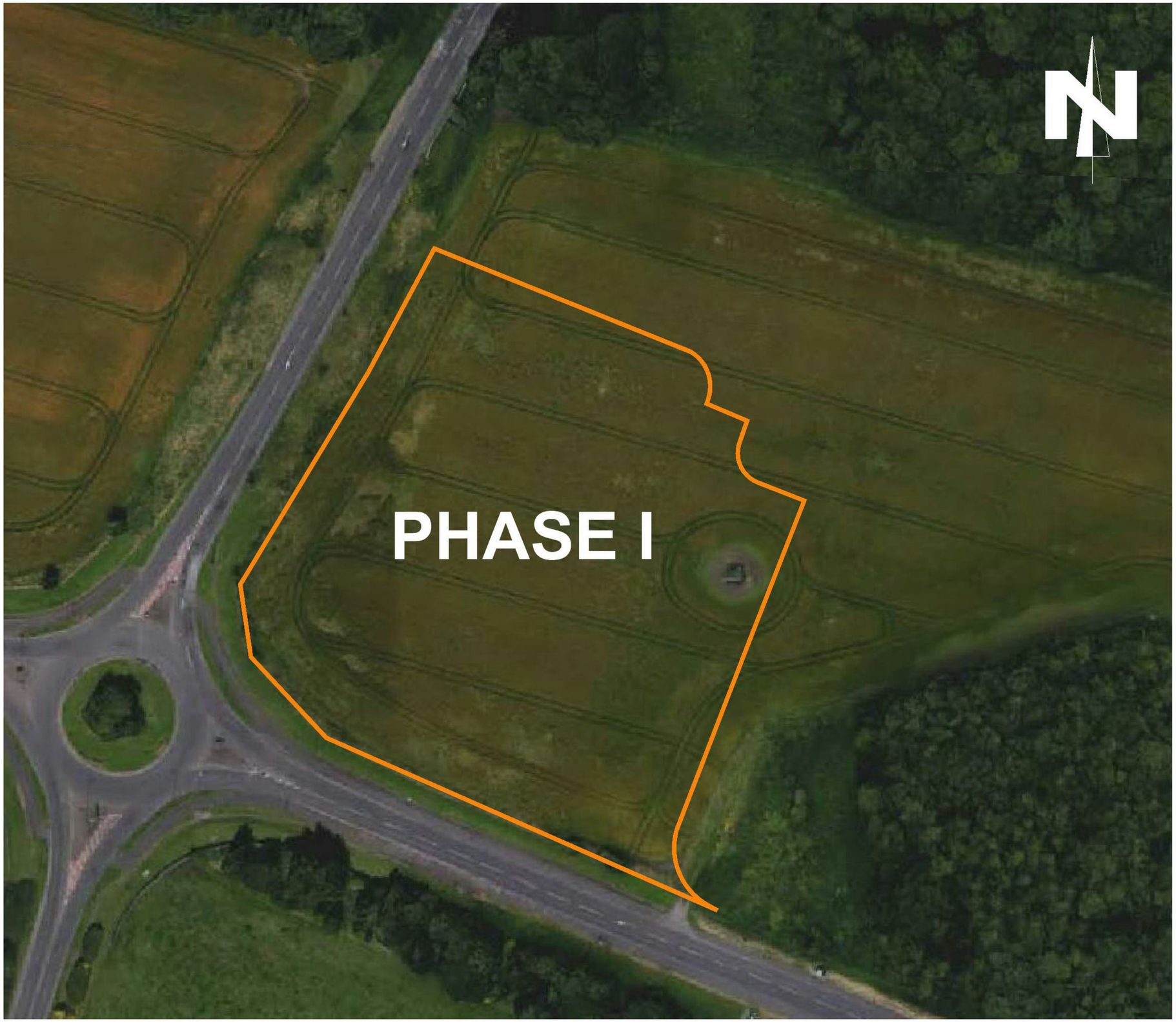

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LEGEND	
	APPROXIMATE PHASE I BOUNDARY

rev.	date	amendments	drawn	chckd

Client:
BUCCLEUCH PROPERTY (SHERRIFFHALL SOUTH) LTD

Project Title:
Proposed Development (Phase I)
Sherriffhall South East, Gilmerton Road
Lasswade, Midlothian

Drawing Title:
Aerial Photograph

Scale at A3:	Date:	Drawn by:	Approved by:
1:1000 @ A3	23.06.17	P.D	M.R.B

Job Ref:	Drg no:	Rev:
17-115	–	–