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**South Yorkshire Fire &
Rescue**

P18-00555

Barnsley Fire Station

**Phase II
Geo Environmental
Site Assessment**

Report by:

T White

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1. INTRODUCTION

1.1. GENERAL INTRODUCTION

This Report presents the findings of a Phase II Geo-environmental assessment of a site at Barnsley Fire Station, Broadway, S70 6RA (Grid Reference: 433201, 405634) for South Yorkshire Fire & Rescue.

The Intrusive Site Investigation (Phase II) comprised of boreholes and a hand dug pit to establish the sub surface strata and remove samples for contamination and geotechnical testing, and to investigate the foundations of the existing building. The test results combined with the findings of the intrusions will then be used to make recommendations for any remedial works which may be necessary. A site plan including positions of the boreholes and hand dug pit can be found in Appendix I of this report.

1.2. OBJECTIVES

The intrusive investigation was conducted to assess and confirm the immediate sub-surface ground conditions and extract in-situ soil samples for laboratory testing as recommended in Phase I Report dated 9th May 2018 by Met Engineers Ltd, to determine the geotechnical and environmental position of the site.

1.3. SCOPE OF WORKS

Based upon the recommendations of the Desk Study and a visual assessment of the sub-surface materials during the intrusive works, soil samples were taken for laboratory testing. CLEA Guidelines and recommendations given in Land Quality Management General Assessment Criteria have been applied to establish a risk based CLEA Model to assess the likely contamination issues and to comment on potential constraints for development of the site.

Judgement is based strictly on the findings of the specific boreholes, hand dug pit and soil samples tested and therefore may not be representative of the site as a whole. The findings of the intrusive investigation will also be used in conjunction with the findings of the Desk Study to establish parameters which may be used in formulating a foundation design.

1.4. LIMITATIONS OF THE REPORT

South Yorkshire Fire & Rescue (the Client) has requested that a Phase II Site Investigation, CLEA Conceptual Model and Risk Assessment be undertaken in order to assess the suitability of the site for redevelopment. The report is not a comprehensive site characterisation and should not be construed as such.

This report has been prepared for the sole internal use and reliance of South Yorkshire Fire & Rescue. The report shall not be relied upon or transferred to any other parties without the express written authority of Met Engineers Limited. If any unauthorised third party comes into possession of the report, they rely on it at their own risk and Met Engineers Limited owes them no duty of care.

The findings and opinions conveyed via this report are based on information obtained from a variety of sources as detailed within this report and which Met Engineers Limited, believes are reliable. Nevertheless, Met Engineers Limited, cannot and does not guarantee the authenticity or

reliability of the information it has relied upon. The information contained in this report is to the best of our knowledge accurate at the date of issue, however, sub-surface conditions, including ground water levels, may vary, especially with time.

In preparing this report it has been assumed that all past and present occupants and Third Parties have provided accurate information, especially relating to known or potential hazards. This report does not identify deficiencies or mistakes in the information provided by the user/owner, or from any other source, except where obvious in the light of other information.

This report is relevant at the date the report was written and should be read in the light of any subsequent changes in legislation, statutory requirement or industry practices.

The report represents the technical findings and opinions of Met Engineers Limited, and does not constitute any legal advice. As such, the advice of a Solicitor may also be required.

2. SITE HISTORY AND ENVIRONMENTAL SETTING

A detailed review of the published history, hydrological, geological and available environmental information was carried out by Met Engineers in a Phase I Desk Study report dated 9th May 2018. The following is a brief summary of those findings.

The area of land referred to as 'The Site' within this document is indicated in Appendix I.

2.1. SITE DESCRIPTION

Site Name	Barnsley Fire Station, Broadway, Barnsley, S70 6RA
Location	Grid Reference: 433201, 405634
Setting	<p>The site is located approximately 1km south west of Barnsley town centre. The site is rectangular in shape and covers an area of 0.81 hectares (Ha). It is accessed via an open entrance off Broadway (A6133).</p> <p>The centre of the site is covered by buildings and hardstanding parking areas. The south western area and northern corner of the site are covered by grass and occasional large trees. The western boundary is lined with shrubs.</p> <p>The south western boundary is open on to a public footpath, the north western and north eastern boundaries are formed by metal fences and the south eastern boundary is formed by a brick wall topped with wooden fencing.</p> <p>The grass banking in the south of the site slopes north eastwards towards the centre of the site. The centre of the site is generally flat.</p> <p>The adjacent land uses are residential flats to the south east, residential houses, an allotment and a radio pylon to the north east, a warehouse recorded as a co-op distribution centre to the north west and the A6133 (Broadway) to the south west.</p>
Site History	The site comprised undeveloped agricultural land until the existing fire station buildings were developed by 1959. Since 1974, 1No of the buildings in the centre of the site has been labelled as a substation and the layout of the site has remained the same ever since.
Development Proposal	It is proposed to demolish the existing fire station building and re-develop the site with a new fire station building. A proposed layout has not been provided at this stage.

2.2. GEOLOGY & SOILS

Geology	<p>Artificial Ground – None recorded on site. 3Nº areas of Made Ground and 1Nº area of infilled ground are recorded within 250m. The nearest is recorded 79m south east.</p> <p>Superficial Deposits – None recorded.</p> <p>Bedrock Geology – Pennine Middle Coal Measures Formation – Sandstone.</p> <p>Faults – 2Nº faults recorded, 47m south east and 209m south west.</p> <p>Coal Outcrops – 4Nº recorded within 250m. There are located 54m north east, 102m south west, 103m north and 210m west.</p>
Radon	<p>1 – 3 % of properties in the area are above the radon action level. However, radon specific protection measures are not required for new buildings in accordance with BRE publication BR211.</p>
Ground workings	<p>There are 2Nº areas of ground workings shown within 250m of the site. The nearest is an unspecified pit associated with the former sandstone quarry recorded approximately 62m south west. The other is recorded as a refuse heap 137m south.</p>
Mining	<p>The site is within a Coal Mine Reporting Area therefore a Coal Report was obtained from The Coal Authority as part of the Phase I desk study.</p> <p>The Coal Authority confirm that the site is in the zone of influence of workings in 6Nº seams of coal at 140m to 330m depth last worked in 1970. Any movement from these workings should have stopped by now.</p> <p>The site is not affected by any present or planned underground mining however reserves of coal do exist in the area which may be worked at some time in the future.</p> <p>There are no mine entries within 20m of the site.</p> <p>The site is not affected by any past, present or future opencast mining.</p> <p>The Coal Authority have not received a claim for coal mine related subsidence for any property within 50m of the site since 1994.</p> <p>The site is not located within a Development High Risk Area with regards to shallow coal mining, therefore formal Coal Mining Risk Assessment has not been carried out as part of this report.</p>
Natural Ground Subsidence	<p>Shrink-Swell Clay – Very Low Hazard</p> <p>Landslides – Very Low Hazard</p> <p>Soluble Rocks – Negligible Hazard</p> <p>Compressible deposits – Negligible Hazard</p> <p>Collapsible Deposits – Very Low Hazard</p> <p>Running Sands – Negligible Hazard</p> <p>No natural ground subsidence problems are envisaged.</p>

Boreholes	<p>29No BGS borehole records are held for positions located within 250m of the site.</p> <p>The nearest, (ref SE30NW200, located 40m south west of the site) shows topsoil overlain by Made Ground to 1.13mbgl with clay/ shaley clay to 1.83mbgl. Brown sandy mudstone with sandstone bands was encountered from 1.83mbgl to the based of the borehole at 3.05mbgl.</p>
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2.3. ENVIRONMENTAL OVERVIEW

Historical Land Use	There are 9No potentially contaminative historical land uses shown within 250m of the site. The nearest is the fire and ambulance station on site. Others include a fever hospital recorded on site, a warehouse (10m north west), unspecified pit/ sandstone quarry (62m south west), unspecified tank (90m north west), works (105m north west), refuse heap (142m south), unspecified pump (218m south west) and 2No substations (on-site and 44m south west).
Current Land Use	There are 6No potentially contaminative current industrial land uses shown within 250m of the site. The nearest are the current fire station and substation uses on site. Others include a chimney (34m south west), a warehouse (146m north west), an electricity substation (229m south east) and a haulage company (245m north west).
Environmental Permits	There are no environmental permits shown within 250m of the site.
Pollution Incidents	There are no pollution incidents recorded within 250m of the site.
Landfill Sites	There are no current or historical landfills shown within 250m of the site.
Waste Transfer & Processing Stations	There are no waste transfer and processing stations shown within 250m of the site.
Hydrogeology	<p>The bedrock is classed as a Secondary A Aquifer.</p> <p>There are no source protection zones (SPZs) or ground water abstractions within the vicinity of the site.</p>
Hydrology	There are no watercourses shown within 250m of the site.
Flooding	The site is not located within a flood risk area.
Environmental Sensitivity	<p>The site is in a nitrate vulnerable zone.</p> <p>The nearest area of Green Belt land is approximately 236m west.</p>

2.4. PHASE I PRELIMINARY RECOMMENDATIONS

The Phase I report identified a number of potential pollution linkages that may be present within the site, and recommended that representative soil samples were removed from the site and submitted for contamination analysis.

It was also recommended that a number of boreholes and a hand dug pit were undertaken across the site in order to make comment on the foundation solution for the proposed development.

3. INTRUSIVE INVESTIGATION

3.1. FIELDWORK

The intrusive investigation consisted of 5 No windowless sampler boreholes and 1 No hand dug pit. The intrusive investigations were carried out on 15.05.18; the locations of which can be found within Appendix I. The intrusions were spread evenly across the site to give a good overview of the underlying strata. The weather was sunny.

The boreholes found Made Ground to depths of between 1mbgl (WS02 and WS05) and 1.5mbgl (WS01). The Made Ground comprised firm light brown sandy gravelly clay with gravels of fine to coarse of brick, ash, clinker, porcelain, glass, sandstone and mudstone.

Superficial deposits comprising firm to stiff orangish brown mottled grey clay with occasional mudstone and sandstone gravels were identified under the entire site from top depths of between 1.0mbgl and 1.5mbgl with typical thicknesses ranging between 0.3m (WS02) and 1.7m (WS04).

Bedrock was deepest in the eastern area of the site and was encountered at between 1.3mbgl (WS02) and 2.9mbgl (WS04). Bedrock comprised weak to strong light grey mottled greyish brown mudstone, apart from WS02 where bedrock comprised strong fine orangish brown sandstone.

Logs of the Boreholes and Hand Dug Pit can be found in Appendix II and III of this report respectively.

Soil samples were removed for laboratory analysis from the 5 No windowless sampler borehole locations.

3.2. GROUNDWATER

Groundwater was not found during this site investigation.

3.3. GAS MONITORING

Gas and groundwater monitoring equipment was installed in 3 No borehole positions (WS01, WS02 and WS03). Response zones were set from 0.5mbgl to the base of each borehole in order to evaluate the combined gas risk from both the Made Ground at the surface as well as natural venting from the aquifer.

Monitoring was undertaken using a Geotech GA5000 portable gas analyser which is calibrated on a 6 monthly basis. UKAS calibration certificates can be provided on request. Monitoring is currently ongoing. The results of this monitoring will be presented as an amendment to this report.

3.4. LABORATORY TESTING

The desk study recommended a regime of contamination testing on soil samples recovered from the intrusive investigation. Samples were obtained during the site investigation and tested at a UKAS accredited laboratory for contaminants including:

- *Heavy Metals*
- *Polycyclic Aromatic Hydrocarbons*
- *Total Petroleum Hydrocarbons*
- *Asbestos*

Geotechnical testing was also carried out on the soils. The samples were tested for:

- *pH*
- *Water Soluble Sulphate (2:1)*
- *Atterberg limits*

4. CONTAMINATION ASSESSMENT

4.1. GENERAL

Current Environmental Legislation, in particular Part IIA of the Environmental Protection Act 1990, adopts a risk-based approach to the evaluation of contaminated sites, based on the proposed end use of the site. The commonly accepted approach is to adopt a Source-Pathway-Receptor model where the Source of the contaminant is examined in relation to potential Receptors (i.e. humans, controlled waters etc.) to determine if there is a Pathway (i.e. contaminant linkage) connecting them. If any of these elements (i.e. contaminant, pathway or receptor) are absent or removed, then there is no risk.

The Department of the Environment, Food and Rural Affairs (DEFRA) have published a series of guidelines in connection with Risk Assessment. In addition The Environment Agency has produced the Contaminated Land Exposure Model (CLEA) which models guideline values for those elements which pose the greatest risk to human health.¹ Using values derived from CLEA, a site specific, conceptual model has been used to determine any significant contaminant linkages and identify suitable risk management proposals on which remediation design (if any required) can be based. The conceptual model is summarised at the end of this section in tabular form.

By considering the Source-Pathway-Receptors Model, an assessment can be made as to whether the source contamination can reach a receptor. The degree and significance of any resulting risk is then determined. The categorisation of the risk is based on consideration of both:

- The likelihood or probability of an event (taking into account both the presence of the Source and the Receptor, and the integrity of the Pathway).
- The severity of the potential consequence (taking into account both the potential severity of the Source and the sensitivity of the Receptor).

The following categorisation of risk has been adopted in this report:

Very High	There is a high probability that severe harm could arise to a designated receptor from an identified hazard at the site without appropriate remedial action.
High	Harm is likely to arise to a designated receptor from an identified hazard without appropriate remedial action.
Moderate	It is possible that, without appropriate remedial action, harm could arise to a designated receptor, but it is relatively unlikely that any such harm would be severe and, if harm were to occur, it is more likely that such harm would be relatively mild.
Low	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that, at worst, this harm, if realised, would normally be mild.
Negligible	The presence of an identified hazard does not give rise to the potential to cause any significant harm to a designated receptor on this site.

¹ Updated technical background to the CLEA model, Science Report SC050021/SR3, The Environment Agency, 2009

4.2. PRELIMINARY CONCEPTUAL SITE MODEL

The following table provides a list of the potential Sources, Pathways and Receptors that have potential to exist on this site as determined within the Phase I desk study.

Potential Source	Contaminants	Receptor	Pathway	Severity	Likelihood	Potential Risk
Soil based Contaminants (Solid)	Heavy Metals PAH TPH PCBs	Construction Workers Maintenance Workers End user	Direct contact with soil Ingestion of soils Inhalation of soil dust Inhalation of vapours (PAH/TPH only)	Moderate	Moderate	Moderate
		Off-site resident	Inhalation of soil dust Inhalation of vapours (PAH/TPH only)	Moderate	Very Low	Low
		Flora & Fauna	Plant uptake	Very Low	Very Low	Very Low
		Buildings & Infrastructure	Direct Contact with soil	Very Low	Very Low	Very Low
Soil based Contaminants (as Leachate)	Heavy Metals PAH TPH PCBs	Flora & Fauna	Plant uptake	Very Low	Very Low	Very Low
Asbestos within building fabric	Asbestos Fibres	Construction Workers	Inhalation of asbestos fibres	High	High	High
Asbestos within Made Ground	Asbestos Fibres	Construction Workers Maintenance Workers End user	Inhalation of asbestos fibres	High	Low	Moderate
Land Gas		Construction Workers Maintenance Workers End user	Inhalation of gases	High	Low	Moderate

Based on the above conceptual site model, the following sources of contamination have been investigated;

- Soils
 - Heavy Metals
 - Poly Aromatic Hydrocarbons
 - Total Petroleum Hydrocarbons
 - Asbestos
- Land Gas

4.3. CONTAMINATION CRITERIA FOR SOIL TESTING

Suitable 4 Use Levels (S4ULs) published by Land Quality Management, have been used to assess risk.² Where there are no S4ULs, Defra Category 4 Screening Levels (C4SLs) have been used as intervention values to assess risk.³

It is proposed that the site will be developed with a new fire station, therefore the proposed land use can be classified as 'Commercial' in accordance with the CLEA Guidelines.

Soils were taken from site and tested for % Soil Organic Matter (SOM).

Location	WS01	WS02	WS03	WS04	WS05
Depth (m)	0.2	0.4	0.4	0.6	0.5
Strata	Topsoil	Made Ground	Made Ground	Made Ground	Made Ground
SOM (%)	9	6.8	6.5	1.1	2.6

Taking the lowest SOM recorded as the worst case scenario, the results of the chemical analysis on the soil samples are compared against the S4ULs for Commercial developments with 1% SOM (where there are published S4ULs) and C4SLs where there are no published S4ULs. These values are then used as Intervention Values (IV) to assess the risk.

4.4. RESULTS OF CONTAMINATION TESTING

The following tables are summaries of the laboratory test results. Please see the key below for the origin of each intervention value.

Intervention Value Key

Author	Type	Land Use
Land Quality Management	S4UL	Commercial
DEFRA	C4SL	Commercial

Heavy Metals

Location	WS01	WS02	WS03	WS04	WS05		
Depth (m)	0.2	0.4	0.4	0.6	0.5		
Strata	Topsoil	Made Ground	Made Ground	Made Ground	Made Ground		
Contaminant (mg/kg)						IV	Number Exceeding
Arsenic	20	12	16	6	5	640	0
Cadmium	1.3	1.1	5.4	0.9	0.6	190	0
Copper	41	28	39	14	13	68000	0
Chromium	23	32	21	15	30	8900	0
Lead	88	78	111	36	22	23000	0
Mercury	<0.17	<0.17	0.31	<0.17	0.37	58	0

² The LQM/CIEH S4ULs for Human Health Risk Assessment, Land Quality Press, Nathanail et. al, 2015.

³ SP1010, Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination, DEFRA 2014

Location	WS01	WS02	WS03	WS04	WS05		
Depth (m)	0.2	0.4	0.4	0.6	0.5		
Strata	Topsoil	Made Ground	Made Ground	Made Ground	Made Ground		
Contaminant (mg/kg)						IV	Number Exceeding
Nickel	20	20	23	14	15	980	0
Selenium	<1	1	2	1	1	12000	0
Zinc	113	116	147	71	32	730000	0

Polycyclic Aromatic Hydrocarbons

Location	WS01	WS02	WS03	WS04	WS05		
Depth (m)	0.2	0.4	0.4	0.6	0.5		
Strata	Topsoil	Made Ground	Made Ground	Made Ground	Made Ground		
Contaminant (mg/kg)						IV	Number Exceeding
Acenaphthene	<0.01	<0.01	0.02	<0.01	0.51	84000	0
Acenaphthylene	0.02	<0.01	0.06	<0.01	0.13	83000	0
Anthracene	0.05	<0.02	0.26	<0.02	1.89	520000	0
Benzo(a)anthracene	0.27	0.06	1.24	<0.04	8.11	170	0
Benzo(a)pyrene	0.27	0.06	0.88	<0.04	8.77	35	0
Benzo(b)fluoranthene	0.35	0.07	1.11	<0.05	8.77	44	0
Benzo(ghi)perylene	0.16	<0.05	0.44	<0.05	4.58	3900	0
Benzo(k)fluoranthene	0.13	<0.07	0.45	<0.07	3.52	1200	0
Chrysene	0.36	0.08	1.32	<0.06	8.62	350	0
Dibenzo(ah)anthracene	<0.04	<0.04	0.12	<0.04	1.07	3.5	0
Fluoranthene	0.55	0.13	2.53	<0.08	15.7	23000	0
Fluorene	<0.01	<0.01	0.03	<0.01	0.26	63000	0
Indeno(123-cd)pyrene	0.19	0.04	0.54	<0.03	5.45	500	0
Naphthalene	<0.03	<0.03	<0.03	<0.03	0.07	190	0
Phenanthrene	0.19	0.04	0.96	<0.03	5.76	22000	0
Pyrene	0.49	0.12	2.03	<0.07	16.6	54000	0
Total PAH	3.03	0.59	12	<0.08	89.9		0

Total Petroleum Hydrocarbons

Location	WS01	WS01		
Depth (m)	0.2	0.2		
Strata	Topsoil	Topsoil		
Contaminant (mg/kg)			IV	Number Exceeding
Ali >C5-C6	<0.01	<0.01	3200	0
Ali >C6-C8	<0.01	<0.01	7800	0
Ali >C8-C10	<0.01	<0.01	2000	0
Ali >C10-C12	<0.1	<0.1	9700	0
Ali >C12-C16	<0.1	<0.1	59000	0
Ali >C16-C21	<0.1	<0.1	1600000	0
Ali >C21-C35	<0.1	<0.1	1600000	0
Total Aliphatics	<0.1	<0.1	-	-
Aro >C5-C7	<0.01	<0.01	26000	0
Aro >C7-C8	<0.01	<0.01	56000	0
Aro >C8-C9	<0.01	<0.01	3500	0

Location	WS01	WS01		
Depth (m)	0.2	0.2		
Strata	Topsoil	Topsoil		
Contaminant (mg/kg)			IV	Number Exceeding
Aro >C9-C10	<0.01	<0.01	3500	0
Aro >C10-C12	<0.1	<0.1	16000	0
Aro >C12-C16	<0.1	<0.1	36000	0
Aro >C16-C21	<0.1	1.2	28000	0
Aro >C21-C35	<0.1	1.2	28000	0
Total Aromatics	<0.1	2.5	-	-
TPH (Ali & Aro)	<0.1	2.5	-	-
BTEX - Benzene	<0.01	<0.01	27	0
BTEX - Toluene	<0.01	<0.01	56000	0
BTEX - Ethyl Benzene	<0.01	<0.01	5700	0
BTEX - m & p Xylene	<0.01	<0.01	6200	0
BTEX - o Xylene	<0.01	<0.01	6600	0
MTBE	<0.01	<0.01	-	0

Asbestos

Location	WS01	WS02	WS03	WS04	WS05	
Depth (m)	0.2	0.4	0.4	0.6	0.5	
Strata	Topsoil	Made Ground	Made Ground	Made Ground	Made Ground	
Contaminant	WS01	WS02	WS03	WS04	WS05	Number Exceeding
Asbestos in Soil	NAD	NAD	NAD	NAD	NAD	0

The full test certificates are included in Appendix IV of this report.

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4.5. RADON AND LAND GAS

1 – 3 % of properties in the area are above the radon action level. However radon specific protection measures are not required for new buildings in accordance with BRE publication BR211.

Gas and water monitoring equipment was installed in 3No positions across the site. Response zones were set from 0.5m to the base of each borehole so as to assess the risk from Made Ground towards the surface, as well as any natural venting from the aquifer below. The monitoring is currently ongoing and the results will be presented as an amendment to this report.

Results

Date	BH Number	CH ₄ (%)	CO ₂ (%)	O ₂ (%)	Atmos. Pres.(mb)	Pres. Trend (24hrs)	Flow (l/h)	Water (mbgl)	Depth to Bottom (m)
29.05.18	01	0.1	4.1	17.4	1005	↓	0.1	Dry	2.47
	02	0.1	2.3	19.7	1004	↓	0.1	Dry	1.50
	03	0.1	1.9	20.2	1006	↓	0.1	2.42	2.64

Analysis

Instead of monitoring on predetermined dates to a set schedule, it is best practice to gas monitor on occasions where the worst case scenario is likely to occur. Generally this is determined to be when sharp falls of atmospheric pressure occur or when low atmospheric pressures are recorded, (below 1000mb). Thus the remaining gas results will be collected in periods of high to low falling pressure as well as low pressure.

One round of monitoring has been undertaken to date. Five further rounds of monitoring are proposed.

The monitoring will be undertaken over a period of three months.

During the first round of monitoring, Methane levels were 0.1%. Carbon dioxide levels varied between 1.9 and 4.1% across the boreholes. The maximum flow recorded was 0.1/h.

The gas monitoring results have been evaluated in conjunction with BS8485:2015⁴ and the characteristic situations defined in CIRIA C665⁵.

The maximum concentrations of CH₄ and CO₂ recorded were 0.1 and 4.1% respectively. The maximum flow rate recorded across the site was 0.1/h. Therefore the gas screening values (GSVs) for both methane and carbon dioxide are 0.0001/h and 0.0041/h respectively.

In accordance with the BS8485:2015, since the GSVs are <0.07 and as the maximum CO₂ concentration is below 5% the site is classified as characteristic situation 1.

In accordance with the BS8485:2015, the site is classed as characteristic situation 1 and the proposed future buildings on the site will be Type C, therefore it is deemed that gas protection measures are not necessary for the proposed development.

It should be noted that monitoring is still on-going and the above recommendations are to be considered as **PRELIMINARY**, to be confirmed on completion of the monitoring.

4.6. CONTAMINATION SOURCES

No elevated concentrations have been detected on site for the contaminants tested, for a proposed commercial development.

4.7. PATHWAYS

Based on the proposed land use, the possible pathways that exist on site for any possible source of contamination are as follows;

Pathway	Pathway Present	Comments
Direct Contact with soil/ water	Yes	Potential for contact with soil/ water during future development and landscaping works
Incidental ingestion	Yes	Potential for ingestion of soils/ water during future development and landscaping works
Inhalation of soil dust/ asbestos fibres	Yes	Potential for inhalation of soil dust/ asbestos during future development, landscaping works and ground disturbance

⁴ Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings (BS 8485:2015) BSI, 2015

⁵ Assessing Risks Posed by Hazardous Ground Gases to Buildings (C665), CIRIA, Wilson et al., 2007

Pathway	Pathway Present	Comments
Leaching/ migration of liquids	Yes	Potential for leaching to aquifer as the site is to remain with some soft landscaped areas.
Surface water run-off	No	Site will be covered with buildings, tarmac car park and drive, and soft landscaped areas. So risk of surface runoff reduced.
Migration/ emission/accumulation inhalation of land gas/ vapours	Yes	Migration and emission of land gas/ vapours possible, and potential for accumulation within the propose building.
Plant uptake/ plant uptake followed by ingestion	No	Site is to have area of soft landscaping, however there are to be no plants grown for consumption.

4.8. RECEPTORS

Based on the identified sources of contamination, and the present pathways, the potential receptors for the development are:-

Receptor	Receptor Present	Comments
Site worker	Yes	Contractors carrying out development, ground works and landscaping
Maintenance staff	Yes	Future gardeners/ landscaping staff
Long term site user/ future resident	Yes	It is assumed future users including staff will only be on site for short periods of time
Off-site resident	No	No residential buildings anticipated to be affected by the development works.
Flora & Fauna	Yes	Flora on landscaped areas
Aquifer	No	Bedrock is a Secondary A Aquifer, however there are no groundwater abstractions or source protection zones in the vicinity of the site
Surface water	No	No surface watercourses in the vicinity of the site
Buildings & Infrastructure	Yes	Services and infrastructure of the proposed building(s).

4.9. SITE SPECIFIC MODEL

Source	Contaminant	Receptor	Pathway	Risk
Soil based contaminants (Solid)	<i>Heavy Metals²</i>	A – Construction Workers ¹ B – Maintenance Worker ¹ C – Future End user ¹ E – Flora & Fauna ¹	a – Direct contact with soil/ water ¹ b – Incidental ingestion ¹ c – Inhalation of soil dust/ asbestos fibres ¹ d – Leaching/ migration ¹ e – Surface water run off ¹ g – Plant uptake/ plant uptake followed by ingestion ¹	Negligible
	<i>Polycyclic Aromatic Hydrocarbons²</i>	A – Construction Workers ¹ B – Maintenance Worker ¹ C – Future End user ¹ D – Off-Site Resident ¹ E – Flora & Fauna ¹	a – Direct contact with soil/ water ¹ b – Incidental ingestion ¹ c – Inhalation of soil dust/ asbestos fibres ¹ d – Leaching/ migration ¹ e – Surface water run off ¹ f – Migration/ emission/ inhalation of land gas/ vapours ¹ g – Plant uptake/ plant uptake followed by ingestion ²	Negligible
	<i>Total Petroleum Hydrocarbons²</i>	A – Construction Workers ¹ B – Maintenance Worker ¹ C – Future End user ¹ D – Off-Site Resident ¹ E – Flora & Fauna ¹	a – Direct contact with soil/ water ¹ b – Incidental ingestion ¹ c – Inhalation of soil dust/ asbestos fibres ¹ d – Leaching/ migration ¹ e – Surface water run off ¹ f – Migration/ emission/ inhalation of land gas/ vapours ¹ g – Plant uptake/ plant uptake followed by ingestion ¹	Negligible
Asbestos in Made Ground	<i>Asbestos fibres²</i>	A – Construction Workers ¹ B – Maintenance Worker ¹ C – Future End user ¹ D – Off-Site Resident ¹	c – Inhalation of soil dust/ asbestos fibres ¹	Negligible
<i>Land Gas and Radon²</i>		B – Future End user ¹	f – Inhalation of gases ¹	Negligible

¹ Source/ Pathway/ Receptor PRESENT on site

² Source/ Pathway/ Receptor NOT PRESENT on site

4.10. CONTAMINATION ISSUES

Based upon the conceptual site model, there are no contamination linkages present for the sources tested for.

4.11. ASSESSED RISKS AND MANAGEMENT

Appropriate personal protective equipment should be worn, accompanied with employing good personal hygiene standards (especially before eating) in order to minimise the risk to construction workers on site.

All ground works should be monitored by a suitably qualified person and significant deviation from the findings of this document is to be reported to the Engineer immediately prior to commencing any further works.

4.12. ENVIRONMENTAL SUMMARY

A site induction and appropriate PPE should mitigate any residual risk towards construction workers.

All ground works should be monitored by a suitably qualified person and any significant deviation from the findings of this document is to be reported to the Engineer immediately prior to commencing any further works.

5. GEOTECHNICAL ASSESSMENT

5.1. GENERAL

The site investigation was required to make recommendations as to a suitable foundation solution for the development. 5NØ boreholes and 1NØ hand dug pit were undertaken in order to achieve this aim.

5.2. GEOLOGICAL ASSESSMENT

Artificial Deposits

Made Ground comprising firm light brown sandy gravelly clay with gravels of fine to coarse brick, ash, clinker, porcelain, glass, sandstone and mudstone was found to depth of between 1mbgl and 1.5mbgl.

Superficial Deposits

Superficial deposits comprising firm to stiff orangish brown mottled grey clay with occasional mudstone gravels were identified under the entire site from depths of between 1mbgl and 1.5mbgl with typical thicknesses ranging between 0.3m and 1.7m.

Bedrock

Bedrock comprising weak to strong light grey mottled greyish brown mudstone was found at depths of between 2.2mbgl and 2.9mbgl in 4NØ of the boreholes. In WS02 fine orangish brown sandstone was found at 1.3mbgl.

5.3. MINING

No evidence of mining was uncovered during the site investigation and no further consideration to this matter is necessary.

5.4. FOUNDATIONS AND SUBSTRUCTURES

1NØ hand dug pit was undertaken against the southern wall of the existing building to investigate the foundations of the existing building. The hand dug pit found made ground to 0.2mbgl on top of firm clay. The existing foundations are 250mm thick at the edge and extend 60mm beyond the building. The Foundations are raft foundations and are onto the firm clays found beneath the site.

The following foundation recommendations are based on a low rise masonry construction. Should this not be the final form of the development, alternative foundation recommendations will be required.

Based on the geological conditions found below the site, trench filled foundations are suitable for the proposed development dependent on final levels and the form of the construction. An allowable bearing pressure of 80kN/m² should be assumed.

Foundations should be onto the stiff clays encountered beneath the site at depths of between 1.2mbgl (WS04) and 1.8mbgl (WS05) dependant on final levels and form of construction.

5.5. GEOTECHNICAL TEST RESULTS

Soil samples were taken from site and submitted for the following geotechnical testing.

Location	WS01	WS02	WS03
Depth (m)	1.7	1.3	1.2
pH	6.2	7.33	7.22
SO ₄ (2:1)	0.05	0.07	0.02
Plasticity Index	31	20	27
% <425µm	100	100	100
Modified Plasticity	31	20	27

Based on the soil sulphate concentrations and pH levels, AC-1s conditions exist for buried concrete in accordance with BRE Special Digest 1:2005 – Concrete in Aggressive Ground.⁶

The Plasticity Index for the soils tested, have been modified as per chapter 4.2 of NHBC guidelines. The results show medium volume change soils exist on site. As trees already exist towards the south west and north east of the site, foundations should be designed in accordance with chapter 4.2 of NHBC guidelines.⁷

5.6. GROUND FLOOR CONSTRUCTION

Based on the assumed low rise masonry construction, suspended ground floors are suitable for the building development. Any internal garage slabs should be ground bearing with underlying Made Ground removed and replaced by imported stone.

5.7. GEOTECHNICAL SUMMARY

Based on a proposed low rise masonry construction trench fill foundations are suitable for the proposed development dependent on final levels and the form of the construction. The foundations should be onto the stiff clay encountered from depths of between 1/2m and 1.8mbgl. An allowable bearing pressure of 80kN/m² should be assumed.

Suspended ground floors are suitable for a proposed low rise masonry development. Any internal garages should be on to a ground bearing floor slab with all Made Ground removed and replaced by imported stone in these areas.

Based on the soluble sulphate levels found, AC-1s conditions exist on site in accordance with BRE Special Digest 1:2005 – Concrete in Aggressive Ground.

Medium volume change soils exist below the site. Foundations should be designed in accordance with chapter 4.2 of NHBC guidelines.

All ground works should be monitored by a suitably qualified person and any significant deviation from the findings of this document is to be reported to the Engineer immediately prior to commencing any further.

⁶ BRE Special Digest 1, Concrete in Aggressive Ground, BRE Press, 2005

⁷ NHBC Standards, Chapter 4.2 Building Near Trees, NHBC, 2014

6. CONCLUSIONS AND RECOMMENDATIONS

In conclusion:

- No contamination linkages are deemed exist on the site.
- Based on preliminary gas monitoring results, gas protection measures are not required for the proposed development.
- The site is underlain by Made Ground to depths of between 1m and 1.5mbgl above various strata of the Pennine Middle Coal Measures Formation.
- Trench filled foundations are deemed suitable for the proposed development dependent on final levels and the form of the proposed construction. These should be onto the stiff clay underlying the site with an allowable bearing pressure of 80kN/m².
- It is recommended that additional boreholes/trial pits are carried out beneath the existing building following the demolition works, to confirm ground conditions are the same in this area.

APPENDIX I

Site Investigation Plan

APPENDIX II

Windowless Sampler Logs



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Windowless Sampler Borehole Log

Borehole No.

WS01

Sheet 1 of 1

Project Name: Barnsley Fire Station

Project No.
P18-00555

Co-ords: 433200E - 405588N

Hole Type
WS

Location: Barnsley, S70 6RA

Level: 149.70

Scale
1:25

Client: South Yorkshire Fire & Rescue

Dates: 15/05/2018

Logged By
TAW

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.60	149.10		Soft dark brown sandy CLAY with fragments of brick. Sand is fine. (TOPSOIL)	1
		1.00	SPT	N=16 (2,3/3,4,4,5)				MADE GROUND. Very firm dark brown sandy gravelly CLAY. Sand is fine, gravels are fine and rounded of sandstone, some ash/clinker present.	
					1.50	148.20		Stiff light orangish brown mottled grey CLAY with with occasional fine and rounded sandstone gravels.	2
		2.00	SPT	N=18 (1,2/3,4,4,7)				Medium strong light grey mottled greyish brown MUSDTONE.	
		2.60	SPT	40 (0 for 0mm/40 for 150mm)	2.40	147.30			3
					2.70	147.00		End of Borehole at 2.70m	
									4
									5

Remarks



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Windowless Sampler Borehole Log

Borehole No.

WS02

Sheet 1 of 1

Project Name: Barnsley Fire Station

Project No.
P18-00555

Co-ords: 433160E - 405627N

Hole Type
WS

Location: Barnsley, S70 6RA

Level: 150.00

Scale
1:25

Client: South Yorkshire Fire & Rescue

Dates: 15/05/2018

Logged By
TAW

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		1.00	SPT	N=15 (2,3/3,4,4,4)	0.35	149.65		Soft brown sandy slightly gravelly CLAY. Sand is fine and gravels are fine of sandstone. Rootlets noted in top 100mm. (TOPSOIL)	1
					1.00	149.00		MADE GROUND. Firm light brown gravelly CLAY. Gravels are fine to coarse of brick and sandstone. Fragments of glass and clinker/ash noted.	
								Firm yellowish light brown gravelly CLAY. Gravels are fine and angular of sandstone. Occasional angular cobbles of sandstone noted.	
									
		1.55	SPT	50 (0 for 0mm/50 for 0mm)	1.55	148.45		End of Borehole at 1.55m	
									2
									3
									4
									5

Remarks



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Windowless Sampler Borehole Log

Borehole No.

WS03

Sheet 1 of 1

Project Name: Barnsley Fire Station

Project No.
P18-00555

Co-ords: 433211E - 405693N

Hole Type
WS

Location: Barnsley, S70 6RA

Level: 146.50

Scale
1:25

Client: South Yorkshire Fire & Rescue

Dates: 15/05/2018

Logged By
TAW

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		1.00	SPT	N=19 (2,2/3,4,6,6)	0.30	146.20		Soft dark brown sandy CLAY with fragments of brick and porcelain, sand is fine. Rootlets noted in top 100mm. (TOPSOIL)	1
					0.65	145.85		MADE GROUND. Soft dark brown sandy gravelly CLAY. Gravels are sub angular and fine to coarse, sand is fine. Occasional sub angular sandstone cobbles noted.	
					0.90	145.60		MADE GROUND. Loose light grey sandy GRAVEL. Sand is coarse, gravels are fine to coarse of sandstone.	
					1.10	145.40		MADE GROUND. Firm dark brown CLAY with clinker/ash.	
								Firm to stiff yellowish brown mottled grey CLAY with occasional fine angular mudstone gravels. Becomes stiff at 1.6mbgl.	
		2.00	SPT	N=16 (2,2/2,4,5,5)	2.00	144.50		Stiff light greyish brown CLAY with occasional fine mudstone gravels.	2
					2.50	144.00		Weak to medium strong silty MUDSTONE. Becomes strong at 2.9mbgl.	
					2.95	143.55		End of Borehole at 2.95m	
		2.80	SPT	50 (0 for 0mm/50 for 0mm)					3
									4
									5

Remarks



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Windowless Sampler Borehole Log

Borehole No.

WS04

Sheet 1 of 1

Project Name: Barnsley Fire Station

Project No.
P18-00555

Co-ords: 433234E - 405643N

Hole Type
WS

Location: Barnsley, S70 6RA

Level: 147.20

Scale
1:25

Client: South Yorkshire Fire & Rescue

Dates: 15/05/2018

Logged By
TAW

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.10	147.10		Dark grey TARMAC	
					0.25	146.95		MADE GROUND. Light grey sandy GRAVEL. Sand is coarse, gravels are sub angular fine to coarse of sandstone.	
								MADE GROUND. Firm light brown sandy gravelly CLAY. Sand is fine, gravels are sub angular fine to coarse of sandstone, mudstone and brick. Clinker and ash also noted.	
		1.00	SPT	N=16 (2,2/3,4,4,5)	1.20	146.00		Stiff orangish brown mottled grey CLAY.	1
		2.00	SPT	N=19 (2,2/3,4,6,6)					2
		2.90	SPT	0 (50 for 0mm/0 for 0mm)	2.90	144.30		Weak to strong greyish brown MUDSTONE. Becomes strong at 3mbgl.	3
					3.00	144.20		End of Borehole at 3.00m	
									4
									5

Remarks



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Windowless Sampler Borehole Log

Borehole No.

WS05

Sheet 1 of 1

Project Name: Barnsley Fire Station

Project No.
P18-00555

Co-ords: 433234E - 405643N

Hole Type
WS

Location: Barnsley, S70 6RA

Level: 146.90

Scale
1:25

Client: South Yorkshire Fire & Rescue

Dates: 15/05/2018

Logged By
TAW

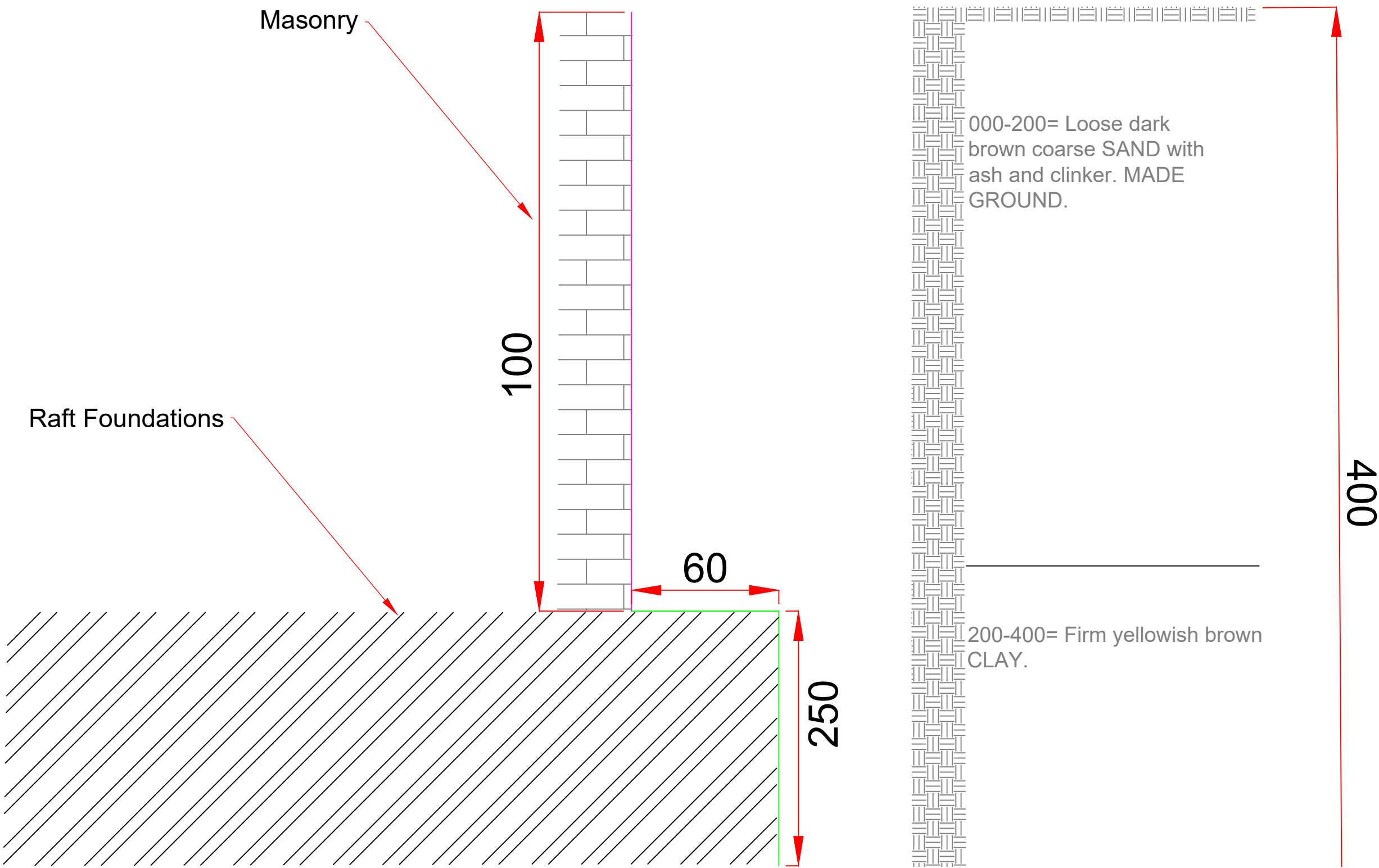
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.10	146.80		Dark grey TARMAC.	
					0.35	146.55		MADE GROUND. Light grey sandy GRAVEL. Sand is coarse, gravels are sub angular fine to coarse of sandstone. becomes slightly clayey at 0.2mbgl.	
					0.80	146.10		MADE GROUND. Slightly sandy GRAVEL. Sand is coarse, gravels are medium to coarse of sandstone, brick and conglomerate. Some ash/clinker present.	
		1.00	SPT	N=8 (2,2/2,2,2,2)	1.00	145.90		MADE GROUND. Firm yellowish brown cobbly CLAY. Cobbles are angular of brick.	1
								Firm orangish brown mottled grey CLAY with occasional fine rounded sandstone and mudstone gravels.	
		2.00	SPT	N=98 (8,10/20,24,25,29)	1.80	145.10		Stiff orangish brown mottled grey CLAY with occasional fine rounded sandstone and mudstone gravels.	2
					2.20	144.70		End of Borehole at 2.20m	
									3
									4
									5

Remarks

APPENDIX III

Hand Dug Pit Log

Hand Dug Pit 01



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1. Do not scale dimensions from this drawing in either paper or electronic format.
2. To be read in conjunction with all relevant Engineer's, Architect's and Other drawings and specifications.
3. All building products to be used in strict accordance with the manufacturer's recommendations.
4. Any discrepancies are to be reported to the Engineer immediately.
5. Main Contractor to provide a detailed method statement for all works prior to commencement on site.

-	27.02.18	--	--	--	--
Rev	Date	Drawn	Description	Chk'd	



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Client
Barnsley Fire Station

Project
Barnsley Fire Station
P18-00555

Title
Hand Dug Foundation Pit Log

Drawn	TAW	Checked		Scale	NTS
Date	11.06.18	Date		Original Size	A3
Status					Rev
Drawing No					

APPENDIX IV

Soil Test Results

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 18/03816
Issue Number: 1

Date: 04 June, 2018

Client: MET Engineers Ltd
Southgate House
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Leeds
LS10 1SW

Project Manager: Ami Cooper/Thomas White
Project Name: Barnsley Fire Station
Project Ref: P18-00555
Order No: PO-01406
Date Samples Received: 16/05/18
Date Instructions Received: 17/05/18
Date Analysis Completed: 04/06/18

Prepared by:



Gill Walker
Director/Laboratory Manager

Approved by:



Richard Wong
Client Manager

Envirolab Job Number: 18/03816

Client Project Name: Barnsley Fire Station

Client Project Ref: P18-00555

Lab Sample ID	18/03816/1	18/03816/2	18/03816/3	18/03816/4	18/03816/5	18/03816/6	18/03816/7	18/03816/8	Units	Method ref
Client Sample No	1	1b	2	2b	3	3b	4	5		
Client Sample ID	WS01	WS01	WS02	WS02	WS03	WS03b	WS04	WS05		
Depth to Top	0.20	1.70	0.40	1.30	0.40	1.20	0.60	0.50		
Depth To Bottom										
Date Sampled	15-May-18	15-May-18	15-May-18	15-May-18	15-May-18	15-May-18	15-May-18	15-May-18		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Solid		
Sample Matrix Code	4AE	6	4E	3	6EA	3	6	7		
% Stones >10mm _A	2.2	<0.1	<0.1	<0.1	6.2	<0.1	<0.1	<0.1	% w/w	A-T-044
pH _D ^{M#}	-	6.20	-	7.33	-	7.22	-	-	pH	A-T-031s
Sulphate (water sol 2:1) _D ^{M#}	-	0.05	-	0.07	-	0.02	-	-	g/l	A-T-026s
Sulphate (acid soluble) _D ^{M#}	-	360	-	<200	-	<200	-	-	mg/kg	A-T-028s
Organic matter _D ^{M#}	9.0	-	6.8	-	6.5	-	1.1	2.6	% w/w	A-T-032 OM
Arsenic _D ^{M#}	20	-	12	-	16	-	6	5	mg/kg	A-T-024s
Cadmium _D ^{M#}	1.3	-	1.1	-	5.4	-	0.9	0.6	mg/kg	A-T-024s
Copper _D ^{M#}	41	-	28	-	39	-	14	13	mg/kg	A-T-024s
Chromium _D ^{M#}	23	-	32	-	21	-	15	30	mg/kg	A-T-024s
Chromium (hexavalent) _D	<1	-	<1	-	<1	-	<1	<1	mg/kg	A-T-040s
Lead _D ^{M#}	88	-	78	-	111	-	36	22	mg/kg	A-T-024s
Mercury _D	<0.17	-	<0.17	-	0.31	-	<0.17	0.37	mg/kg	A-T-024s
Nickel _D ^{M#}	20	-	20	-	23	-	14	15	mg/kg	A-T-024s
Selenium _D ^{M#}	<1	-	1	-	2	-	1	1	mg/kg	A-T-024s
Zinc _D ^{M#}	113	-	116	-	147	-	71	32	mg/kg	A-T-024s
1.02 Atterburg 4Pt BS1377 1990 pt2 cl4.4,5.3+5.4 _A [#]	-	Appended	-	Appended	-	Appended	-	-		Subcon SS
1.01 % Moisture BS1377 1990 pt2 cl3.2 _A [#]	-	Appended	-	Appended	-	Appended	-	-		Subcon SS

Envirolab Job Number: 18/03816

Client Project Name: Barnsley Fire Station

Client Project Ref: P18-00555

Lab Sample ID	18/03816/1	18/03816/2	18/03816/3	18/03816/4	18/03816/5	18/03816/6	18/03816/7	18/03816/8	Units	Method ref
Client Sample No	1	1b	2	2b	3	3b	4	5		
Client Sample ID	WS01	WS01	WS02	WS02	WS03	WS03b	WS04	WS05		
Depth to Top	0.20	1.70	0.40	1.30	0.40	1.20	0.60	0.50		
Depth To Bottom										
Date Sampled	15-May-18	15-May-18	15-May-18	15-May-18	15-May-18	15-May-18	15-May-18	15-May-18		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Solid		
Sample Matrix Code	4AE	6	4E	3	6EA	3	6	7		
Asbestos in Soil (inc. matrix)										
Asbestos in soil [#]	NAD	-	NAD	-	NAD	-	NAD	NAD		A-T-045
Asbestos ACM - Suitable for Water Absorption Test?	N/A	-	N/A	-	N/A	-	N/A	N/A		

Envirolab Job Number: 18/03816

Client Project Name: Barnsley Fire Station

Client Project Ref: P18-00555

Lab Sample ID	18/03816/1	18/03816/2	18/03816/3	18/03816/4	18/03816/5	18/03816/6	18/03816/7	18/03816/8	Units	Method ref
Client Sample No	1	1b	2	2b	3	3b	4	5		
Client Sample ID	WS01	WS01	WS02	WS02	WS03	WS03b	WS04	WS05		
Depth to Top	0.20	1.70	0.40	1.30	0.40	1.20	0.60	0.50		
Depth To Bottom										
Date Sampled	15-May-18	15-May-18	15-May-18	15-May-18	15-May-18	15-May-18	15-May-18	15-May-18		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Solid		
Sample Matrix Code	4AE	6	4E	3	6EA	3	6	7		
PAH-16MS										
Acenaphthene _A ^{M#}	<0.01	-	<0.01	-	0.02	-	<0.01	0.51	mg/kg	A-T-019s
Acenaphthylene _A ^{M#}	0.02	-	<0.01	-	0.06	-	<0.01	0.13	mg/kg	A-T-019s
Anthracene _A ^{M#}	0.05	-	<0.02	-	0.26	-	<0.02	1.89	mg/kg	A-T-019s
Benzo(a)anthracene _A ^{M#}	0.27	-	0.06	-	1.24	-	<0.04	8.11	mg/kg	A-T-019s
Benzo(a)pyrene _A ^{M#}	0.27	-	0.06	-	0.88	-	<0.04	8.77	mg/kg	A-T-019s
Benzo(b)fluoranthene _A ^{M#}	0.35	-	0.07	-	1.11	-	<0.05	8.77	mg/kg	A-T-019s
Benzo(ghi)perylene _A ^{M#}	0.16	-	<0.05	-	0.44	-	<0.05	4.58	mg/kg	A-T-019s
Benzo(k)fluoranthene _A ^{M#}	0.13	-	<0.07	-	0.45	-	<0.07	3.52	mg/kg	A-T-019s
Chrysene _A ^{M#}	0.36	-	0.08	-	1.32	-	<0.06	8.62	mg/kg	A-T-019s
Dibenzo(ah)anthracene _A ^{M#}	<0.04	-	<0.04	-	0.12	-	<0.04	1.07	mg/kg	A-T-019s
Fluoranthene _A ^{M#}	0.55	-	0.13	-	2.53	-	<0.08	15.7	mg/kg	A-T-019s
Fluorene _A ^{M#}	<0.01	-	<0.01	-	0.03	-	<0.01	0.26	mg/kg	A-T-019s
Indeno(123-cd)pyrene _A ^{M#}	0.19	-	0.04	-	0.54	-	<0.03	5.45	mg/kg	A-T-019s
Naphthalene _A ^{M#}	<0.03	-	<0.03	-	<0.03	-	<0.03	0.07	mg/kg	A-T-019s
Phenanthrene _A ^{M#}	0.19	-	0.04	-	0.96	-	<0.03	5.76	mg/kg	A-T-019s
Pyrene _A ^{M#}	0.49	-	0.12	-	2.03	-	<0.07	16.6	mg/kg	A-T-019s
PAH (total 16) _A ^{M#}	3.03	-	0.59	-	12	-	<0.08	89.9	mg/kg	A-T-019s
Total PAH-16MS _A ^{M#}	6.06	-	1.19	-	24	-	<0.08	180	mg/kg	A-T-019s

Envirolab Job Number: 18/03816

Client Project Name: Barnsley Fire Station

Client Project Ref: P18-00555

Lab Sample ID	18/03816/1	18/03816/2	18/03816/3	18/03816/4	18/03816/5	18/03816/6	18/03816/7	18/03816/8	Units	Method ref
Client Sample No	1	1b	2	2b	3	3b	4	5		
Client Sample ID	WS01	WS01	WS02	WS02	WS03	WS03b	WS04	WS05		
Depth to Top	0.20	1.70	0.40	1.30	0.40	1.20	0.60	0.50		
Depth To Bottom										
Date Sampled	15-May-18	15-May-18	15-May-18	15-May-18	15-May-18	15-May-18	15-May-18	15-May-18		
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Solid		
Sample Matrix Code	4AE	6	4E	3	6EA	3	6	7		
TPH CWG										
Ali >C5-C6 _A [#]	<0.01	-	-	-	<0.01	-	-	-	mg/kg	A-T-022s
Ali >C6-C8 _A [#]	<0.01	-	-	-	<0.01	-	-	-	mg/kg	A-T-022s
Ali >C8-C10 _A [#]	<0.01	-	-	-	<0.01	-	-	-	mg/kg	A-T-022s
Ali >C10-C12 _A [#]	<0.1	-	-	-	<0.1	-	-	-	mg/kg	A-T-023s
Ali >C12-C16 _A [#]	<0.1	-	-	-	<0.1	-	-	-	mg/kg	A-T-023s
Ali >C16-C21 _A [#]	<0.1	-	-	-	<0.1	-	-	-	mg/kg	A-T-023s
Ali >C21-C35 _A [#]	<0.1	-	-	-	<0.1	-	-	-	mg/kg	A-T-023s
Total Aliphatics _A	<0.1	-	-	-	<0.1	-	-	-	mg/kg	A-T-023s
Aro >C5-C7 _A [#]	<0.01	-	-	-	<0.01	-	-	-	mg/kg	A-T-022s
Aro >C7-C8 _A [#]	<0.01	-	-	-	<0.01	-	-	-	mg/kg	A-T-022s
Aro >C8-C9 _A [#]	<0.01	-	-	-	<0.01	-	-	-	mg/kg	A-T-022s
Aro >C9-C10 _A [#]	<0.01	-	-	-	<0.01	-	-	-	mg/kg	A-T-022s
Aro >C10-C12 _A [#]	<0.1	-	-	-	<0.1	-	-	-	mg/kg	A-T-023s
Aro >C12-C16 _A [#]	<0.1	-	-	-	<0.1	-	-	-	mg/kg	A-T-023s
Aro >C16-C21 _A [#]	<0.1	-	-	-	1.2	-	-	-	mg/kg	A-T-023s
Aro >C21-C35 _A [#]	<0.1	-	-	-	1.2	-	-	-	mg/kg	A-T-023s
Total Aromatics _A	<0.1	-	-	-	2.5	-	-	-	mg/kg	A-T-023s
TPH (Ali & Aro) _A	<0.1	-	-	-	2.5	-	-	-	mg/kg	A-T-023s
BTEX - Benzene _A [#]	<0.01	-	-	-	<0.01	-	-	-	mg/kg	A-T-022s
BTEX - Toluene _A [#]	<0.01	-	-	-	<0.01	-	-	-	mg/kg	A-T-022s
BTEX - Ethyl Benzene _A [#]	<0.01	-	-	-	<0.01	-	-	-	mg/kg	A-T-022s
BTEX - m & p Xylene _A [#]	<0.01	-	-	-	<0.01	-	-	-	mg/kg	A-T-022s
BTEX - o Xylene _A [#]	<0.01	-	-	-	<0.01	-	-	-	mg/kg	A-T-022s
MTBE _A [#]	<0.01	-	-	-	<0.01	-	-	-	mg/kg	A-T-022s

REPORT NOTES

General:

This report shall not be reproduced, except in full, without written approval from Envirolab.

All samples contained within this report, and any received with the same delivery, will be disposed of one month after the date of this report.

Analytical results reflect the quality of the sample at the time of analysis only.

Opinions and interpretations expressed are outside the scope of our accreditation.

If results are in italic font they are associated with an AQC failure and there is insufficient sample to repeat the analysis. These are not accredited and are unreliable.

A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

Soil chemical analysis:

All results are reported as dry weight (<40°C).

For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.

For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any "A" subscripts

All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:

Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:

Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:

Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.

Stones etc. are not removed from the sample prior to analysis.

Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:

1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.

Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.

Secondary Matrix Codes:

A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal,

E = contains roots/twigs.

Key:

IS indicates Insufficient Sample for analysis.

US indicates Unsuitable Sample for analysis.

NDP indicates No Determination Possible.

NAD indicates No Asbestos Detected.

N/A indicates Not Applicable.

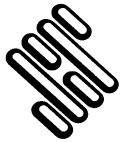
Superscript # indicates method accredited to ISO 17025.

Superscript "M" indicates method accredited to MCERTS.

Subscript "A" indicates analysis performed on the sample as received.

Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.



STRUCTURAL SOILS LTD
TEST REPORT



Report No. 783163 R1

Date 31-May-2018 Contract 18/03816

Client Envirolab Ltd
Address Units 7 & 8 Sandpits Business Park
Mottram Road
Hyde
SK14 3AR

For the Attention of Iain Haslock

Samples submitted by client 18/05/2018
Testing Started 19/05/2018
Testing Completed 31/05/2018

Client Reference 18/03816
Client Order No. P0738113
Instruction Type Written

Tests marked 'Not UKAS Accredited' in this report are not included in the UKAS Accreditation Schedule for our Laboratory.

UKAS Accredited Tests Undertaken

Moisture Content (oven drying method) BS1377:Part 2:1990,clause 3.2 (superseded)**
Liquid Limit (definitive method) BS1377:Part 2:1990,clause 4.3
Plastic Limit BS1377:Part 2:1990,clause 5.3
Plasticity Index Derivation BS1377:Part 2:1990,clause 5.4

* This clause of BS1377 is no longer the most up to date method due to the publication of ISO17892

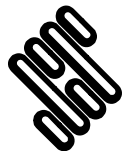
Please Note: Remaining samples will be retained for a period of one month from today and will then be disposed of.
Test were undertaken on samples 'as received' unless otherwise stated.
Opinions and interpretations expressed in this report are outside the scope of accreditation for this laboratory.

Structural Soils Ltd, The Potteries, Pottery Street, Castleford, WF10 1NJ Tel.01977 552255. E-mail mark.athorne@soils.co.uk

SUMMARY OF SOIL CLASSIFICATION TESTS

In accordance with clauses 3.2,4.3,4.4,5.3,5.4,7.2,8.2,8.3 of BS1377:Part 2:1990

Exploratory Position ID	Sample Ref	Sample Type	Depth (m)	Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity Index	% <425um	Description of Sample
WS01	18/03816/2	D	1.70	23	55	24	31	100	Light grey brown slightly sandy CLAY
WS02	18/03816/4	D	1.30	21	43	23	20	100	Light brown slightly sandy CLAY
WS03b	18/03816/6	D	1.20	22	50	23	27	100	Light brown grey CLAY



STRUCTURAL
SOILS LTD

Contract:

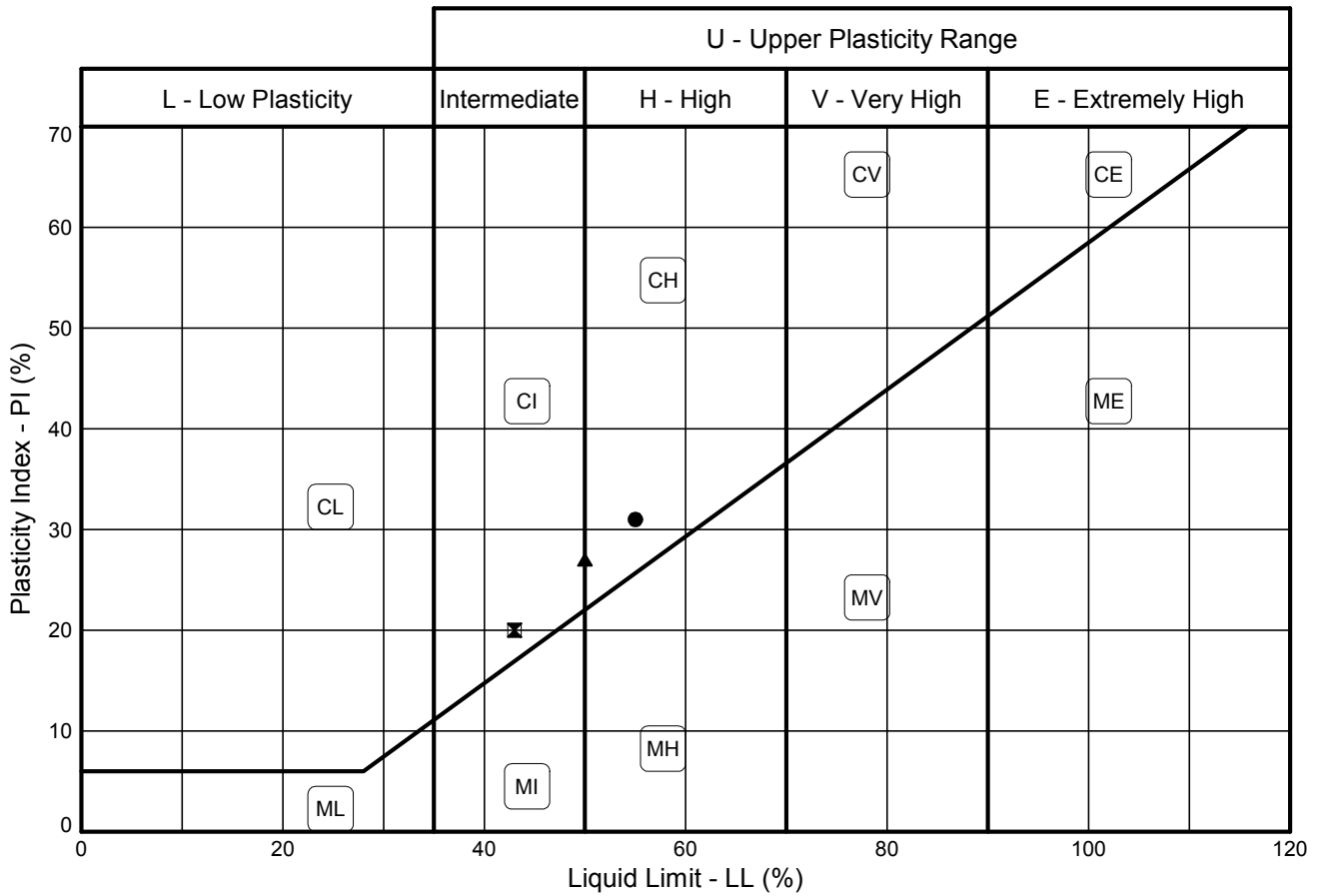
18/03816

Contract Ref:

783163



In accordance with BS5930:2015
Testing in accordance with BS1377-2:1990

[illegible]

Tested in accordance with the following clauses of BS1377-2:1990.

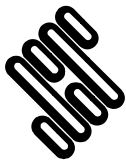
- 3.2 - Moisture Content
- 4.3 - Cone Penetrometer Method
- 4.4 - One Point Cone Penetrometer Method
- 4.6 - One Point Casagrande Method
- 5.3 - Plastic Limit Method
- 5.4 - Plasticity Index

+ Tested in accordance with the following clauses of BS1377-2:1990.

- 4.2.3 - Natural State
4.2.4 - Wet Sieved

Key: * = Non-standard test, NP = Non plastic.

Lab location: B = Bristol (BS3 4AG), C = Castleford (WF10 1NJ), H = Hemel Hempstead (HP3 9RT), T = Tonbridge (TN11 9HU)



STRUCTURAL SOILS
The Potteries
Pottery Street
Castleford
W. Yorkshire WF10 1NJ

Compiled By

Date _____

M. Fisher

MAUREEN FISHER

31/05/18

Contract

Contract Ref:

18/03816

783163



TESTING VERIFICATION CERTIFICATE



1774

The test results included in this report are certified as:-

ISSUE STATUS: **FINAL**

In accordance with the Structural Soils Ltd Laboratory Quality Management System, results sheets and summaries of results issued by the laboratory are checked by an approved signatory. The integrity of the test data and results are ensured by control of the computer system employed by the laboratory as part of the Software Verification Program as detailed in the Laboratory Quality Manual.

This testing verification certificate covers all testing compiled on or before the following datetime: **31/05/2018 17:04:58**.

Testing reported after this date is not covered by this Verification Certificate.

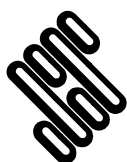
Approved Signatory
Mark Athorne (Laboratory Manager)

(Head Office)
Bristol Laboratory
Unit 1A, Princess Street
Bedminster
Bristol
BS3 4AG

Castleford Laboratory
The Potteries, Pottery Street
Castleford
West Yorkshire
WF10 1NJ

Hemel Laboratory
18 Frogmore Road
Hemel Hempstead
Hertfordshire
HP3 9RT

Tonbridge Laboratory
Anerley Court, Half Moon Lane
Hildenborough
Tonbridge
TN11 9HU



**STRUCTURAL
SOILS LTD**

Contract:

18/03816

Job No:

783163



Envirolab Deviating Samples Report

Units 7&8 Sandpits Business Park, Mottram Road, Hyde, SK14 3AR
Tel. 0161 368 4921 email. ask@envlab.co.uk

Client: MET Engineers Ltd, Southgate House, Pontefract Road, Leeds, LS10 1SW

Project No: 18/03816

Project: Barnsley Fire Station

Date Instructions Received: 17/05/2018 (am)

Clients Project No: P18-00555

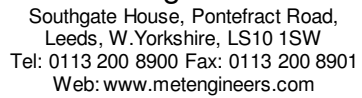
Cool Box Temperatures (°C): 16.6

NO DEVIATIONS IDENTIFIED

If, at any point before reaching the laboratory, the temperature of the samples has breached those set in published standards, e.g. BS-EN 5667-3, ISO 18400-102:2017, then the concentration of any affected analytes may differ from that at the time of sampling.

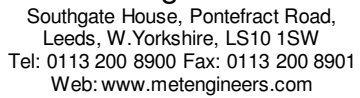
APPENDIX V

Gas Monitoring Results and Gas Monitor Calibration Certificate



Client	South Yorkshire Fire & Rescue
Project No.	P18-00555
Project Title:	Barnsley Fire Station
Borehole No:	BH01
Response Zone:	0.5-2.47m
Grid Reference:	433200, 405588
Equipment:	Geo Tech GA5000

[illegible]



Client	South Yorkshire Fire & Rescue
Project No.	P18-00555
Project Title:	Barnsley Fire Station
Borehole No:	BH02
Response Zone:	0.5-1.5m
Grid Reference:	433160, 405627
Equipment:	Geo Tech GA5000

[illegible]

Southgate House, Pontefract Road,
Leeds, W. Yorkshire, LS10 1SW
Tel: 0113 200 8900 Fax: 0113 200 8901
Web: www.metengineers.com

Gas Monitoring Record

Client	South Yorkshire Fire & Rescue
Project No.	P18-00555
Project Title:	Barnsley Fire Station
Borehole No:	BH03
Response Zone:	0.5-2.64m
Grid Reference:	433211, 405693
Equipment:	Geo Tech GA5000

[illegible]

Date Of Calibration: 13-Apr-2018

Certificate Number: G500155_1/20438

ISSUED BY: GEOTECHNICAL INSTRUMENTS (UK) LTD

Customer: Met Engineers

Southgate House Pontefract Road LEEDS
LS10 1SW UNITED KINGDOM

Description: Gas Analyser

Model: GA5000

Serial Number: G500155

UKAS Accredited results:

Results after adjustment :

Methane (CH ₄)		
Certified Gas (%)	Instrument Reading (%)	Uncertainty (%)
5.0	4.9	0.41
15.0	15.0	0.64
50.0	49.4	0.94

Carbon Dioxide (CO ₂)		
Certified Gas (%)	Instrument Reading (%)	Uncertainty (%)
5.0	4.9	0.43
15.0	14.8	0.70
50.0	49.9	1.1

Oxygen (O ₂)		
Certified Gas (%)	Instrument Reading (%)	Uncertainty (%)
21.1	21.2	0.31

The inwards assessment was carried out 04-Apr-2018.

The maximum adjustment was less than the inwards assessment uncertainty.

Inwards assessment data is available if requested.

All concentrations are molar.

CH₄, CO₂ readings recorded at : 30.7 °C ± 2.5 °CO₂ readings recorded at : 20.9 °C ± 2.5 °C

Barometric Pressure : 0998 mbar ± 4 mbar

Method of Test : The analyser is calibrated in a temperature controlled chamber using a series of reference gases, in compliance with procedure LP004.

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

Calibration Instance: 97 IGC Instance: 97

Page 1 of 2 | LP015GIUKAS-2.4

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor of $k=2$, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

Calibrations marked 'Non-UKAS Accredited results' on this certificate have been included for completeness.

Non-UKAS accredited results after adjustment:

Barometer (mbar)		
Reference	Instrument Reading	
998	998	

Additional Gas Cells		
Gas	Certified Gas (ppm)	Instrument Reading (ppm)
H ₂ S	252	252.1
CO	492	492.4

Internal Flow	
Applied (l/hr)	Instrument Reading (l/hr)
5	5.2
10	10.1

Date of Issue : 17-Apr-2018

Approved by Signatory

Dawn Hemings

Laboratory Inspection



This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

Calibration Instance: 97 IGC Instance: 97

Page 2 of 2 | LP015GIUKAS-2.4

SERVICE REPORT



ISSUED BY: GEOTECHNICAL INSTRUMENTS (UK) LTD

Customer Name: Met Engineers

Model: GA5000

Part Number: GA5KA0F0-101

Serial Number: G500155

Date of Service: 17-Apr-2018

Service Engineer: Ricky Cottrill

Calibration Engineer: Suk Balrey

Verification / Approved By: Dawn Hemings

Signature:

Reason for Return (inc. Customer Comments):

Returned for full service and calibration

Service Comments/Feedback:

Thank you for returning your gas analyser to the Geotech Service Centre for full service and calibration. We are pleased to inform you that the analyser was received and fully assessed by one of our experienced Service Engineers and no significant faults or issues were observed during the assessment. Our extensive service was carried out, and any necessary components replaced. The analyser has successfully passed all of our rigorous testing and quality checks and has been calibrated using our bespoke, state of the art calibration facility. The CO & H2S electrochemical sensor has been replaced due to it being over 2 years old in accordance with the manufacturer's recommendations, and also as a proactive measure based on our experience of the typical lifetime of this type of sensor. We are pleased to inform you that we have installed the latest version of firmware on your gas analyser, so you will be able to benefit from the latest features and improvements. For further information about how to get the best use from your instrument please visit our YouTube channel <http://www.youtube.com/GeotechTV> and on our Website <http://www.geotechuk.com>

If you require any further assistance with your instrument please email our Technical Support Team at technical@geotech.co.uk or call us on +44 1926 338111 (Monday to Thursday 08.30 - 17.00 & Friday 08.30 - 15.30) UK time zone.

Next Service Due: 13-Oct-2018

LP022-1 | Page 1 of 1

17025

Our ISO accreditation for our customised auto-calibration facility

5

Number of days we aim to complete your service within

50

Number of checks instruments are subject to when serviced

65

Number of countries from which we service instruments/accessories each year

7,384

Number of calibrations completed in last 12 months

340

Minimum number of service instruments we process each month

25

Cost (in £) of fully insured analyser collection for our UK customers



SERVICE REPORT



ISSUED BY: GEOTECHNICAL INSTRUMENTS (UK) LTD

17025

Our ISO
accreditation for
our customised
auto-calibration
facilities

5

Number of
days we aim to
complete your
service within

50

Number of checks
instruments are
subject to when
serviced

65

Number of countries
from which we
service instruments/
accessories
each year

7,384

Number of
calibrations
completed in
last 12 months

340

Minimum number
of service
instruments
we process
each month

25

Cost (in £) of fully
insured analyser
collection for our
UK customers

Geotechnical Instruments (UK) Ltd

Sovereign House, Queensway, Leamington Spa, Warwickshire, CV31 3JR



geotechuk.com



service@geotech.co.uk



+44 (0)1926 338111