ENVIRONMENTAL MANAGEMENT SOLUTIONS
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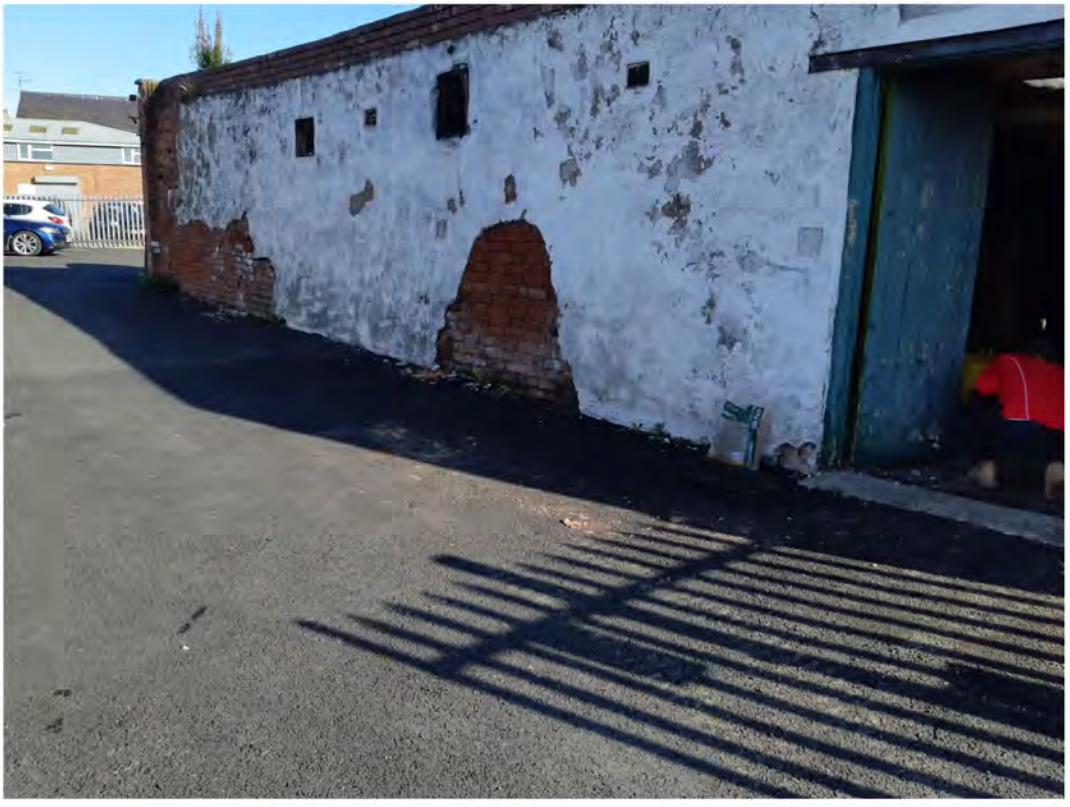
Phase 2 Geo-Environmental Site Investigation Report

Hereford Radiators, 12 Little Berrington Street, Hereford HR4 0BS

Mr James Allan



Environmental Management Solutions – EMS Geotech

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Contents Amendment Record

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Summary Report

SUMMARY REPORT - GENERAL INFORMATION

SUBJECT	COMMENTS
CURRENT USE & DESCRIPTION	Roughly trapezoidal in plan, the site covers approximately 0.03 hectares is relatively flat and comprises the confines of a disused single storey red brick former radiator workshop. The ground is covered with locally cracked and stained concrete hardstanding and slopes gently towards the southeast. The roof includes asbestos cement and corrugated plastic panels. Car parks and commercial businesses surround the site on all sides.
PROPOSED USE	It is proposed to demolish the existing workshop building and replace it with a two-storey structure to house a café and motorbike repair shop.
HISTORICAL SUMMARY	Historical mapping from 1887 onwards indicate that the area north of Little Berrington Street comprised alms houses and / or part of Aubrey's Hospital complex until 1966 when it became a garage. Hereford Radiators operated between 1971 and 2008.
PUBLISHED GEOLOGY	The published geology indicates the site to be underlain by superficial granular Glaciofluvial Sheet deposits overlying clay rich Raglan Mudstone bedrock. Made Ground is also present on-site.
COAL MINING AND MINERAL EXTRACTION	The site is not located within an area likely to have been affected by coal mining or mineral extraction activities.
GROUND STABILITY	There are no ground stability issues recorded for this site.
ACTUAL GROUND CONDITIONS	The encountered ground conditions included Made Ground overlying Glaciofluvial Sheet Deposits. The Raglan Mudstone bedrock was not encountered.
HYDROGEOLOGY	Both the superficial Glaciofluvial Sheet Deposits and Raglan Mudstone bedrock are designated as Secondary – A aquifers. The site is not located within a groundwater Source Protection Zone.
HYDROLOGY	The nearest surface water feature is the River Wye, 257m to the south. The site is designated as Flood Area 1 and it is not considered to be at risk of flooding.

PREVIOUS GROUND REPORTS	The site has previously been subject of a Phase 1 Geo-Environmental Desk Study by EMS, referenced as: 'Phase 1 Geo-Environmental Desk Study Report, 'Hereford Radiators, 12 Little Berrington Street HR4 0BS', EMS, E14130, dated July 2019. A previous archaeological investigation by third parties has been undertaken at the site and the findings summarised in the following report: 12 Little Berrington Street, Hereford – Written Scheme of Investigation (Archaeological Watching Brief)', TigerGeo Limited, Project Code: LBS181, dated May 2019.

SUMMARY REPORT - GEOTECHNICAL

SUBJECT	COMMENTS
EXCAVATIONS	It should be possible to forward excavations employing normal equipment. Specific groundwater control is not likely to be required at this site. The requirements of the Party Wall Act will not apply to the development.
SLOPE STABILITY	It is considered that slope stability is unlikely to be a concern at this site.
SUB-SURFACE CONCRETE	Design Sulphate Class of DS-1 and Aggressive Chemical Environment for Concrete class of AC-1 applies to all on-site soils.
SOAKAWAYS	Not required as part of the scope of works.
PAVEMENT DESIGN	Not required as part of the scope of works.
FOUNDATIONS	
LIKELY FOUNDATION TYPE	The site is considered suitable for adopting traditional trench fill / shallow footings. However, over deepened footings may be required along the northern wall where potentially deeper Made Ground was encountered.
VOLUME CHANGE POTENTIAL	The Glaciofluvial Sheet Deposits are considered to be non-shrinkable soils.
ESTIMATED FOUNDATION DEPTHS	A minimum foundation depth of 1.00m is considered appropriate. However, potentially deeper Made Ground along the northern wall may increase foundation depths.
HEAVE PROTECTION	Will not be required.

SUMMARY REPORT – CONTAMINATION ISSUES

SUBJECT	COMMENTS
SOIL RISKS TO HUMAN HEALTH	No significant contamination has been identified within the Made Ground from these investigation works.
GROUND GAS / HYDROCARBON VAPOURS	No plausible ground gas sources have been identified.
RADON GAS	No radon protection measures are required in the proposed development.
RISKS TO THE WATER ENVIRONMENT	No unacceptable contamination risks in respect of controlled waters have been identified by this investigation.
RISKS TO BUILDING MATERIALS AND SERVICES	No unacceptable contamination risks in respect of building materials and services have been identified by this investigation.
REMEDIATION	No remedial works are considered necessary to facilitate the development at this stage.
ASBESTOS	No suspected asbestos containing materials has been observed within on-site Made Ground. However, corrugated asbestos panels have been used on the roof and there is potential for asbestos to be present elsewhere in the building fabric. Therefore, a full asbestos refurbishment and demolition survey is recommended prior to demolishing the existing workshop.
WASTE SOIL DISPOSAL	Made Ground to be disposed of from the site would be classed as 'inert waste'.

SUMMARY REPORT - KEY RECOMMENDATIONS

RECOMMENDATIONS
It is recommended that this report is submitted to the planning department of the Local Authority, the organization undertaking the Building Control function and warranty providers to confirm that the investigation completed to date is satisfactory. Once the existing workshop building has been demolished and the floor slab removed, it would be prudent to undertake further investigation works along the northern wall. Investigation works adopting trial pits should be sufficient to better assess the depth, extent and nature of Made Ground across the area to aid with foundation design. No further contamination investigation works are recommended at this stage.

1. Introduction

1.1. Contract Information

Environmental Management Solutions Limited (EMS) have been commissioned to undertake a Phase 2 Geo-Environmental Site Investigation for E14130 – Hereford Radiators. The proposed development is located at 12 Little Berrington Street, Hereford, HR40BS. Hereafter, referred to as 'the site'. The works have been commissioned directly by the client.

It is understood that the client is looking to develop the site for commercial use.

The aim of this report is to summarise the findings of recent site investigation works and assess the underlying ground conditions with respect to potential contamination constraints to meet with planning requirements. The report also provides an assessment of likely the geotechnical ground constraints that may impact on foundation design.

A Phase 1 Geo-Environmental Desk Study has been undertaken by EMS, which should be read in conjunction with this report and is referenced as:

- Phase 1 Geo-Environmental Desk Study Report, 'Hereford Radiators 12 Little Berrington Street Hereford HR4 0BS, EMS, E14130, dated July 2019.

1.2. Scope of Work

The agreed scope of works for the Phase 2 intrusive Investigation included:

- Mobilization to site and production of health and safety documentation;
- Undertaking Cable Avoidance Tool (CAT) scans of each exploratory hole position;
- One day of windowless sampling using percussive drilling rig in order to provide 4 No boreholes to a nominal depth of 4m, ground conditions permitting. Including in-situ Standard Penetration Tests (SPTs) at 1m intervals;
- Logging, sampling and undertaking investigation works in general accordance with BS5930:2015 and BS10175:2011 by a supervising EMS Geo-Environmental Engineer;
- Determination of each exploratory hole location using a tape measure or recreational handheld GPS unit;
- Geotechnical testing of soil samples with a budget based on the following testing schedule:
    - 4 No. Moisture content determinations;

- 1 No. Particle Size Distribution Determination (using wet sieve methods); and
- 3 No. BRE SD1 (EMS Suite 3 - pH, water soluble sulphate, total sulphate and total sulphur).

- Chemical analysis of shallow soil samples to prove the absence of on-site contamination with a budget based on the following testing schedule:

  - 4 No. EMS 2 Soil Suite: arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc, speciated Polycyclic Aromatic Hydrocarbons (PAH), TPH CWG (with BTEX and MTBE), total cyanide, total sulphate, water soluble sulphate, total sulphur, pH);
  - 4 No. Asbestos in soils (targeting Made Ground soils);

- Compilation of 1 electronic copy (in pdf format) of a Phase 2 Geo-Environmental site investigation report summarizing available desk study information, details of site works undertaken, and the ground conditions encountered, including exploratory hole records and test results. Providing a revised conceptual Site Model and contamination / ground gas risk assessment. Providing recommendations with respect to excavations, slope stability, pavement design, drainage design, concrete classification and preliminary foundation design, potential remediation works, and further investigation works if necessary.

1.3. Management Limitations

- This report has been prepared under the express instructions and solely for the use of the Client, the Client's agents, and the future purchasers of the site. At the instruction of the Client, EMS will prepare a letter re-assigning the report to the purchaser.

- The findings of this report represent the professional opinion of experienced contaminated land consultants. EMS does not provide legal advice and the advice of legal professionals may also be required.

- All work carried out in preparing this report has utilised and is based upon EMS current professional knowledge and understanding of current relevant UK standards and codes, technology and legislation. Changes in this legislation and guidance may occur at any time in the future and cause any conclusions to become inappropriate or incorrect. EMS does not accept responsibility for advising the Client or other interested parties of the facts or implications of any such changes.

- The report is limited to the boundaries identified by the Client on this site and confirmed within this report.

- This report represents the conditions and findings on the dates of the investigation. Over time, site conditions may alter.

- It is recommended that this report is passed to statutory bodies for their comment as soon as is possible. Such statutory bodies may disagree with the conclusions/recommendations of EMS or provide further information useful to the proposed development.

- The assessment and interpretation of contamination risks is based on the scope of works agreed with the Client together with the budgetary and programme constraints imposed. Further investigation, analysis and assessment of contamination may be required by regulators or other third parties with an interest in the site. An ecological risk assessment of contaminated soils is beyond the scope of this report. This report is concerned with assessing those contamination risks which apply to the future use of the site through the proposed development as part of the planning regime. The assessment does not consider the risk to current site users or continued future use of the site in its current state. If development of the site should occur that differs from that proposed, then the findings of the contamination assessment would need to be re-evaluated.

- At the time of writing, detailed information on the proposed structure, such as detailed layout, loadings and serviceability limits, was not available. Accordingly, where geotechnical design advice is provided it is on the prescriptive basis allowed for by Eurocode 7: employing conventional and conservative design rules. The scope of this investigation excludes a formal slope stability study and any observations made regarding slopes are for information only.

2. Land Use and Site Setting

2.1. Site Location

The site is situated approximately 250m south west of Hereford City Centre at 12 Little Berrington Street, Hereford HR4 0BS.

The National Grid Reference (NGR) for the site is E: 350800, N: 239860.

A Site Location Plan is included in Appendix A.

2.2. Site Description

Roughly trapezoidal in plan, the site covers approximately 0.03 hectares is relatively flat and predominantly comprises the confines of a disused single-storey red brick former workshop. The ground is covered with concrete hardstanding and slopes gently towards the southeast. Formerly used as a radiator workshop the site is delineated on all sides by painted red brick walls.

Beyond the northern boundary is car parking for adjacent businesses that include a window fabricator and shops. To the east is an adjoining two storey office building and associated small open tarmacked area for parking, beyond which is Aubrey Street. Beyond the southern boundary is Little Berrington Street, beyond which is an NCP car park. Beyond the western boundary is car parking, a single storey structure belonging to Sprint Motors – Car & Light Van Servicing and a terrace of black and white houses with associated gardens understood to be former Alms Houses. Beyond is Berrington Street.

Located within an urban conurbation, the site sits at an approximate elevation of between 55m Above Ordnance Datum (m AOD) and 60m AOD approximately 260m north of the River Wye. Local topography is generally low-lying, slopes south towards to the river and rises gently towards Tupsley to the east and Broomy Hill to the west.

A plan showing the existing site layout is included in Appendix A.

2.3. Proposed Development

It is proposed to demolish the existing single storey workshop and replace it with a two-storey structure that will be used as a café and motorcycle repair shop.

A proposed development plan is included in Appendix A.

2.4. Site History

Historical mapping from 1887 onwards indicate that the area north of Little Berrington Street comprised alms houses and / or part of Aubrey's Hospital complex until 1966 when it became a garage. Hereford Radiators operated on-site, as a small scale

business between 1971 and 2008, replacing / repairing car and motor cycle radiators, fuel tanks, heaters, air conditioners and oil coolers.

2.5. Published Geology

Published geological and topographical information shows the site and surrounding area to be situated within low lying ground associated with the bottom of the Wye Valley.

The published geological map, Sheet 198, 'Hereford', shows the site and immediate surrounding area to be directly underlain with superficial Glaciofluvial Sheet Deposits. These deposits are anticipated to be granular (sand and gravel) in nature and were deposited from glacial outwash at the end of the last (Devensian) Ice Age. Although not shown on the geological maps, given the site history and observations made during the walkover it is anticipated that a Made Ground cover is present across the site.

The bedrock geology underlying the superficial deposits is shown as the Raglan Mudstone Formation, which is borderline Silurian / Devonian in age. This stratum is likely to have been derived from cyclic deposition over deltaic mudflats at the mouth of a river with periodic marine inundations. It is generally described by the BGS as 'Sandstones, generally silty or argillaceous, fine- to medium-grained, bright orange-red to dark brick-red, with subordinate siltstone and mudstone; pebbles rare'.

2.6. Mining and Mineral Extraction

The site is not within an area known to have been affected by coal mining and there are no mineral extraction sites within or within 250m.

2.7. Ground Stability

The potential risk from ground stability hazards associated with compressible ground, ground dissolution and shrinking and swelling clays is recorded as 'No Hazard'. The risks associated with collapsible ground, landslides and running sands are recorded as 'Very Low'.

2.8. Radon

The site is situated within an area where radon protection measures are not required.

2.9. Hydrogeology

The site is situated within an area of relatively flat and low-lying ground. Given the local topography and historical borehole information it is anticipated that groundwater will occur at depth and flow in a southerly direction towards the River Wye. However, groundwater is also likely to be susceptible to season fluctuations and the Glaciofluvial Sheet Deposits could contain perched groundwater.

Both the superficial Glaciofluvial Sheet Deposits and the Raglan Mudstone bedrock have been designated by the Environment Agency as Secondary A Aquifers.

The site is not located within a Groundwater Source Protection Zone (SPZ).

There is a single licensed groundwater abstraction entry situated within 250m of the site. The entry is located 208m northwest for food and drink: General Use (Medium Loss) and is recorded as revoked, lapsed or cancelled.

The Secondary Glaciofluvial Sheet Deposits Aquifer is classed as having high vulnerability to leaching, which is to be expected given its anticipated high permeability.

2.10. Hydrology

The site comprises a single-storey building with the ground sloping towards the southeast. Drainage is anticipated to be into existing guttering and down pipes and into the existing drainage network.

The nearest water feature is the River Wye located 257m to the south.

There are no licensed surface water discharges or abstractions within 250m of the site.

The site is situated with Flood Risk Zone Area 1 and it is not considered to be at risk from flooding.

2.11. Soil Chemistry

The site is situated within an area where elevated natural background concentrations of metals have been recorded for chromium (60 – 90 mg/kg) and nickel (15 – 30 mg/kg).

2.12. Landfill

There are no recorded Local Authority landfill sites, areas of potentially infilled land or other licensed waste management facilities within or within 250m of the site.

2.13. Pollution Incidents

There are no significant historical pollution incidents recorded within 250m of the site that could affect the proposed development.

2.14. Hazardous Substances

There are no recorded hazardous sites within 250m of the site.

2.15. Contemporary Trade Directory and Fuel Station Entries

There are 34 contemporary trade directory entries recorded on or within 250m of the site, of which nine are recorded as active and 25 as inactive.

There are no active fuel station entries within 250m of the site. However, there is a single inactive entry located 216m to the north.

There are four entries for Points of Interest – Commercial Services recorded within 250m of the site. The records relate to two entries each for Sprint Motors and Hereford Radiators located 20m and 21m west.

All associated spills and leaks are likely to be relatively small scale and localised. Given this and their distance from the site, it is considered unlikely that they would pose a risk to the proposed development.

2.16. Ecologically Sensitive Sites

There are no recorded ecological sensitive land uses sites within 250m of the site.

2.17. Unexploded Ordnance

According to the ZeticaUXO website (https://zeticauxo.com) the site is located within an area identified as low risk.

2.18. Previous Investigation Reports

The site has previously been subjected to an archaeological investigation in order to identify any potential heritage assets that could be damaged during the proposed development. The investigation works were undertaken by TigerGeo Limited and are summarized in the following report, which should be read in conjunction with this report:

- 12 Little Berrington Street, Hereford – Written Scheme of Investigation (Archaeological Watching Brief)', TigerGeo Limited, Project Code: LBS181, dated May 2019.

Three test pits (Test Pits 1 to 3), observed during the walkover, were excavated to between 0.80m and 1.00m depth in order to reveal the depth of foundations. All three pits encountered Made Ground, the depth of which wasn't proven. The Made Ground generally comprised grey gravelly sand that included brick, concrete and fragments of metal, pottery, wood, possible ash and burnt wood. No groundwater was encountered.

Test pit locations are shown on the existing site layout plan included in Appendix A.

The site has, also, previously been subject of a Phase 1 Geo-Environmental Desk Study by EMS, referenced as:

- 'Phase 1 Geo-Environmental Desk Study Report, 'Hereford Radiators, 12 Little Berrington Street HR4 0BS', EMS, E14130, dated July 2019.

2.19. Preliminary Contamination Risk Assessment

The preliminary findings from the Phase 1 desk study identified the following potential on-site contamination sources:

- An old motor vehicle inspection pit along the southern site fringe;
- Made Ground beneath the site;
- Asbestos in ceiling panels and potentially elsewhere in the building fabric; and
- A potential for ground gas (carbon dioxide and methane) and hydrocarbon vapours associated with potentially contaminated Made Ground.

The preliminary risk assessment identified:

- A moderate to low risk to human health and controlled waters from heavy metals, hydrocarbons, inorganic compounds and asbestos associated with the inspection pit and Made Ground beneath the site;
- A low risk to buildings, buried structures and services from contaminated Made ground beneath the site; and
- A moderate to low risk to human health and buildings from ground gases and hydrocarbon vapours within the Made Ground.

2.20. Preliminary Geotechnical Risk Assessment

The adoption of traditional shallow / overdeepened trench fill footings may be possible for this site. However, this will depend on factors such as Made Ground, ground disturbance and groundwater depth, which can present construction difficulties and overcomplicate shallow foundation design. Potential variations of soil types, i.e. from granular to clay rich, may also complicate foundation design.

3. Site Investigation and Observations

3.1. Investigation Strategy

The Phase 2 intrusive investigation works were undertaken on 17th October 2019 and comprised 4 No. windowless sample boreholes (WS01 to WS04). Archaeological test pits (FP1 to FP3) were open at the time of the investigation works. Therefore, observations from these pits were also included during these investigation works.

Windowless sample boreholes were selected in order to obtain soil samples at depth for logging purposes and geotechnical testing / chemical analysis. Boreholes also facilitated in-situ strength testing.

The borehole layout included comprised all four windowless samples (WS01 and WS04) within the footprint of the proposed structure. Due to the sloping and low roof height, no boreholes could be undertaken towards the eastern side of the workshop. Therefore, because of access restrictions and for health and safety reasons boreholes WS01 and WS03 were undertaken from the base of test pits FP3 and FP2, respectively.

The investigation layout is presented on the Exploratory Hole Location Plan included in Appendix A.

Based on the proposed end use, the desk study findings and observations from the investigation works the sampling and analysis plan targeted shallow surface soils. These soils being most likely to be available to future site users and where potential contamination is most likely to occur.

Given the site's historical and current usage, EMS scheduled a suite of typically occurring contaminants to check for the presence of contaminated soils at the site.

3.2. Investigation Methodology

The boreholes were sunk using windowless sampling techniques with in-situ Cone Penetration Tests (CPT's) at 1.0m intervals. Soil samples were collected for logging and laboratory purposes during the drilling.

Upon completion, WS01 and WS03 were backfilled with arisings to the depth at which they started in the previously dug inspections pits. WS02 and WS04 were backfilled with arisings to ground level.

All soil arisings were logged in general accordance with British Standard BS5930:2015 by an experienced Geo-Environmental Engineer.

Environmental samples (plastic tub, amber jar and small amber jar) were taken as appropriate by the EMS Geo-Environmental Engineer for follow-on laboratory chemical analysis. Information relating to contamination sample collection,

preservation and transport methodology is included within the supplementary information towards the back of this report.

Details of the soils encountered, and samples are recorded on the exploratory hole logs included in Appendix B.

3.3. Geotechnical Testing – Soils

Samples selected for geotechnical testing were sent to GEO Site and Testing Services Limited (GSTL) for testing at their, Llanelli, Carmarthenshire laboratories. GSTL is UKAS accredited laboratory number 2788. The UKAS accreditation of each individual test method is shown on the laboratory test certificate.

Samples taken for BRE (pH and Sulphate) analysis were forwarded to Envirolab, at their Mottram Road, Hyde laboratory. Envirolab are a UKAS accredited laboratory (UKAS number 1247) and part of the Monitoring Certification Scheme (MCERTS). The UKAS accreditation of each individual test method is shown on the laboratory test certificates.

Laboratory test certificates and results are included in Appendix D.

The geotechnical testing undertaken is outlined in the following table.

Geotechnical Test	Number of Samples Tested
Natural Moisture Content Determinations.	4
Particle Size Distribution (using Wet Sieving methods)	1
pH, total sulphate, water soluble sulphate and total sulphur	3

3.4. Chemical Analysis - Soils

Soil samples for chemical analysis were forwarded to Envirolab, at their Mottram Road, Hyde laboratory. Envirolab are a UKAS accredited laboratory (UKAS number 1247) and part of the Monitoring Certification Scheme (MCERTS). Analysis was undertaken in accordance with in-house test methods. A full list of chemicals analysed along with the UKAS accreditation for each individual testing method are shown on the laboratory test certificates included in Appendix E.

The chemical analysis undertaken is outlined in the table below:

Chemical Analysis	No. of Samples Analysed
EMS Soil Suite 2: arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc, speciated Polycyclic Aromatic Hydrocarbons (PAH), Total Petroleum Hydrocarbons TPH - Banded (with BTEX and MTBE), total cyanide, phenols, organic matter, Chromium (VI), total sulphate, water soluble sulphate, total sulphur & pH.	4
Asbestos in Soil.	4

4. Ground Conditions

4.1. Overview

The ground conditions encountered during the investigation works generally agreed with those anticipated from the published geological information. These generally comprised a Made Ground layer overlying granular glaciofluvial sheet deposits. Bedrock was not encountered during the investigation works.

Details of the various stratigraphic units encountered are presented on the exploratory hole logs, included in Appendix B, and are discussed in the following sections.

4.2. Artificial Ground

Concrete was encountered in all of the borehole locations up to 0.10m.

No buried structures or utilities were identified or encountered within the windowless sample boreholes during the investigation works.

4.3. Topsoil

Topsoil was not encountered during in investigation works.

4.4. Made Ground

Made Ground was encountered in all boreholes and archaeological test pits, typically to between 0.40m and 0.90m depth during the investigation works. This material typically comprised brown sandy gravel that included brick, concrete, coal and mudstone.

However, in borehole WS01 situated on the northern site perimeter material interpreted as Probable Made Ground was encountered between 0.90m and 1.70m depth. This material was generally described as dark brown sandy gravelly clay that also included brick, concrete and coal. However, it should be noted that borehole WS01 was started within the base of archaeological test pit FP3 at 0.82m depth. It is possible that material from the base of the pit was pushed down the borehole during the drilling process, however; this will need to be verified.

4.5. Superficial Soils – Glaciofluvial Sheet Deposits

The encountered Glaciofluvial Sheet Deposits were predominantly granular in nature and recorded in WS02 to WS04, between 0.40m and 2.80m depth, underlying the Made Ground. These deposits were generally described as light reddish brown clayey gravelly sand. In WS02, a Glaciofluvial Sheet Deposit layer described as loose reddish brown sand and gravel was encountered below the base of the Made Ground at between 0.80m and 1.10m depth.

4.6. Bedrock

The Raglan Mudstone Formation bedrock was not encountered during the investigation works.

4.7. Groundwater

Groundwater was not encountered during the investigation works.

5. Geotechnical Properties

5.1. Moisture Content

Natural Moisture Content determinations were undertaken on four granular Glaciofluvial Sheet Deposit samples, between 0.40m (WS04) and 2.00m (WS02) depth. The returned results ranged from 4.9% to 7.6%.

5.2. Partide Size Distribution

A single Particle Size Distribution determination was undertaken on a granular Glaciofluvial Sheet deposit sample at between 2.00m to 2.80m from WS02. The results returned show these deposits generally comprise 12% fines (clay and silt), 32% sand and 56% gravel.

These results are indicative of a well graded clayey silty very sandy gravel.

5.3. Standard Penetration Tests

Cone Penetration Tests (CPTs) were undertaken in all windowless sample boreholes at roughly 1.00m intervals. In WS02 to WS04 CPTs were undertaken in granular Glaciofluvial Sheet Deposits at between 0.80m and 2.60m depth. However, in WS01 CPTs were undertaken within the Probable Made Ground at between 1.00m and 1.70m depth.

In WS02, CPT 'N' values of 5 to 19 were recorded at 1.00m and 1.80m depth within the Glaciofluvial Sheet Deposits indicating a relative density of loose to medium dense for these soils. Boreholes WS02 to WS04 all refused at 0.80m (WS03), 0.90m (WS04) and 2.60m (WS02) with CPT 'N' values in excess of 50 indicating a relative density of very dense.

CPTs undertaken in WS01, between 1.00m and 1.70m depth, in the Probable Made Ground returned CPT 'N' values of 2 and 4. The results indicating a clay soil consistency of very soft.

5.4. pH and Sulphate

The results of BRE pH and sulphate tests on Made Ground and Glaciofluvial Sheet Deposit samples taken between 0.50m to 1.90m depth returned water soluble sulphates of 45mg/l to 458mg/l and pH values of 7.58 to 9.27.

Giving a characteristic sulphate value of 500 mg/l, based on the highest measured concentration rounded to the nearest 100mg/l. The corresponding characteristic pH value is 7.58, based on the lowest measured value, in accordance with BRE SD1 (2005). Total potential sulphate is not applicable as pyrite is unlikely to occur in the samples tested.

6. Geotechnical Assessment

6.1. Introduction

The following advice and recommendations are based on the construction of two-story structure that will include a café and motorcycle maintenance business. A proposed development layout plan is included in Appendix A. From assessment of the nature of the ground conditions and the type of proposed structures, it is considered that the situation falls within EC7 Geotechnical Category 1.

However, should the nature of the development be changed then the results of this investigation would need to be reviewed and reassessed.

6.2. Excavations

Granular soils and potentially deep Made Ground were encountered during the investigation works, which will make excavations prone to sidewall collapse without adequate support to remain open.

Any excavation requiring man entry should be battered back to a safe angle, supported by an appropriate proprietary trench support system or adequately shored to provide safe working conditions. Shoring to any excavation requiring man entry must be designed by a suitably qualified and experienced engineer. Any support system will require regular inspection as detailed in published guidelines to ensure the excavation support is adequate and appropriate for the ground conditions present.

It should be possible to progress excavations with conventional equipment. The removal of sub-surface structures following demolition will require the use of hydraulic breaking equipment.

Groundwater was not encountered during the investigation works and it is anticipated that specific groundwater control will not be required at this site. Limited pumping from sumps or bailing out may be required to deal with slight seepages or surface water ingress during periods of inclement weather. It should be noted that inclement weather will also cause granular soils to become unstable. Therefore, excavations should be left open for as short a time as possible or undertaken during drier periods.

The eastern boundary of the proposed development is part of a larger building also owned by the client, however; there are no other third-party structures within the vicinity of the building. Therefore, it is not anticipated that the Party Wall Act will apply to the proposed development.

6.3. Slope Stability

The site slopes gently towards the southeast with no significant changes in level as part of the proposed development are anticipated. Therefore, it is considered that slope stability is unlikely to be a concern at this site.

There are no significant slopes on-site and any change in levels required should be cut to a slope no greater than one in three (vertical : horizontal) which should provide reasonable long term stability. Alternatively, changes in level should be supported by appropriately designed and constructed retaining walls.

6.4. Subsurface Concrete

The results of pH and sulphate testing indicate that aggressive ground conditions are not present at this site. Therefore, a Design Sulphate Class of DS-1 and Aggressive Chemical Environment for Concrete Class of AC-1 is considered appropriate. The groundwater regime is anticipated to be mobile.

6.5. Soakaways and Soakaway Design Advice

Soakage tests were not required as part of the scope of works.

6.6. Pavement Construction

As the development encompasses the footprint of the existing workshop, pavement construction will not be required as part of the proposed development.

6.7. Preliminary Foundation Recommendations

6.7.1. Introduction

It is proposed to develop the site into a two-storey structure containing a café and motorcycle repair shop.

The investigation works proved a general Made Ground cover across the site to between 0.40m and 0.90m depth. However, potentially deeper Made ground was encountered to 1.70m depth in WS01 on the northern site perimeter. Loose to medium dense, rapidly becoming very dense granular Glaciofluvial Sheet Deposits were recorded underlying the Made Ground to between 0.40m and 2.80m depth.

Due to its variable nature and strength, Made ground is not considered to act as an appropriate bearing stratum. Foundation design should consider taking footings through the Made Ground to found on medium dense granular soils belonging to the Glaciofluvial Sheet Deposits as a minimum.

It is considered that traditional shallow footings should be feasible at the site taken through the Made Ground to the granular Glaciofluvial Sheet Deposits. However, consideration should be given to over deepening foundation along the northern wall where potentially deep Made Ground was encountered. It would be prudent to undertake further investigation using trial pits once the building and existing floor slab have been removed along the northern wall. This will help to better assess the depth and nature of Made Ground present. Consideration should be given to stepping foundations depths from shallow on the southern side of the workshop to over deepened trenches on the northern wall.

6.7.2. Floor Slabs

In consideration of shallow near surface soils, i.e. Made Ground, a fully suspended floor slab designed and constructed in accordance with NHBC Standards is recommended for this development.

With reference to Sections 2.8 and 7.6, it is anticipated that the floor construction will not have to incorporate radon / gas protection measures.

6.7.3. Traditional Footings

The site is suitable for the adoption of shallow strip/trench fill footings taken through the Made Ground to found on the granular medium dense Glaciofluvial Sheet Deposits. A minimum 1.00m footing depth along the southern wall should be considered stepping down to greater depth, below the base of the Made Ground, on the northern wall.

A presumed bearing value of 120kN/m^2 is considered appropriate for foundations up to 1m wide bearing upon the granular soils of the Glaciofluvial Sheet Deposits. Immediate and long term settlement should be within tolerable limits and take place largely during the construction period.

It is understood that the existing workshop walls and foundations will be removed on three sides as part of the proposed development. Where existing structures are to be demolished and foundations removed it is difficult to predict potential footing depths. This is because demolition works and foundation removal are likely to disturb underlying soils and, therefore; locally over deepened footings should be anticipated in areas where former structures have been removed.

During construction, any soft spots found at foundation formation level should be excavated and replaced with lean mix concrete. Foundation excavations should be kept dry and left open for the minimum amount of time possible. Where foundations cannot be completed immediately, a blinding layer of concrete should be placed.

Once the existing workshop has been demolished and removed, the new structure to all intents and purposes can be seen as an extension to original remaining building. Excavations for the proposed structure approaching the existing building risk undermining existing foundations resulting in damaging settlement, or even collapse, of the remaining part of the building. Where it is necessary to excavate up to the remaining building then consideration will have to be given to some form of precautionary measure. Such measures might include stepping–down of new foundations away from the existing or providing the existing foundation with some form of underpinning. The advice of a Structural Engineer and the BRE Good Building Guide, “Foundations for low-rise building extensions” (GBG53, 2002) should be referred to in this regard.

6.8. Recommendations for Further Ground Investigation Works

Once the existing workshop building has been demolished and the floor slab removed, it would be prudent to undertake further investigation works along the northern wall. Investigation works adopting trial pits should be sufficient to better assess the depth, extent and nature of Made Ground across the area to aid with foundation design.

7. Soil Contamination Risk Assessment

7.1. Selection of Generic Assessment Criteria

Information relating to the selection of acceptance criteria for human health, controlled waters and building structures and services is contained within the supplementary information section.

The development of the site for commercial use is proposed. Generic screening values for a commercial land use have therefore been utilized for comparison purposes.

The risk to construction workers from acute (short term) exposure has been initially assessed on a qualitative basis. However, it should be noted that soil contamination considerations and the risks posed to contractors during site works should be covered and included within the construction health and safety documentation.

7.2. Human Health

Four selected Made Ground samples (WS01 at 1.00m, WS03 at 0.20m, WS04 at 0.20m and FP1 at 1.00m) were subjected to chemical analysis. Chemicals analysed for included heavy metals, inorganics (total cyanide, water soluble (2:1) sulphate, total sulphate, total sulphur & pH), phenols, organic matter, polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbons (TPH), and asbestos in soils.

No significantly elevated concentrations for heavy metals, inorganic compounds, PAH or TPH were recorded above the respective screening criteria in the samples analysed. No asbestos was recorded within the soil samples analysed.

Chemical summary tables are presented in Appendix C and the test certificates are included in Appendix E.

7.3. Controlled Waters

It is not appropriate to consider human health assessment criteria for human health in relation to the risk to the water environment, but currently there are no generic soil assessment criteria in respect of the water environment. In the absence of any groundwater sampling data, the soil results have been assessed on the basis of professional judgement

The contaminant concentrations recorded in the soils at the site are not considered to be at such levels that they would present any significant risk to the underlying water environment.

7.4. Buried Concrete and Underground Services

None of the samples analysed recorded contaminants at concentrations exceeding their respective acceptance criteria and likely to have an impact on buried concrete or services.

7.5. Undiscovered Contamination

Should any hitherto undiscovered contamination be encountered during construction works the Geo-Environmental Engineer should be informed immediately so that appropriate measures can be taken. The potential for the presence of significant undiscovered contamination at this site is considered to be very low.

Corrugated asbestos cement sheeting was observed covering the workshop during the site walkover and the investigation works. It is anticipated that asbestos may occur elsewhere in the workshop's building fabric. Therefore, it is recommended that an asbestos refurbishment and demolition survey is undertaken prior to the existing workshop being demolished.

7.6. Ground Gas

No significant contamination or potential ground gas sources were identified from these investigation works.

Made Ground was encountered on-site. However, no significant chemical concentrations were recorded within the Made Ground samples analysed. Nor was this material found to be particularly organic rich or contain putrescible materials. Therefore, it is anticipated that the risk posed to the site and end-users from potential ground gas or hydrocarbon vapours is very low.

8. Risk Evaluation

8.1. Revised Conceptual Site Model

A revised conceptual site model is presented in Appendix A.

Additional Pollution Linkages

During the investigation works, no additional contamination sources were identified.

Invalid Pollution Linkages

No significant contaminant concentrations were recorded within the Made Ground underlying the workshop from these investigation works. Therefore, it is considered that a low risk is posed to the proposed developers and end-users from contaminated Made Ground on-site.

Limitations and Uncertainties

Height restriction due to the workshop roof meant that no exploratory holes could be undertaken within the north-eastern corner.

8.2. Updated Contamination Risk Assessment

The pollutant linkages identified in the revised conceptual site model are evaluated as to their severity below. A revised conceptual site model is included in Appendix A.

Potential Sources and contaminants	Pathways (Reference from Model)	Receptors	Hazard Severity	Probability of Occurrence	Potential Risk
The former workshop building, Old Inspection Pit and Made Ground associated with	Ingestion Inhalation Direct Contact	Site end-users. and Construction Workers.	Human health effects. [Medium]	No significant contaminant concentrations recorded within Made Ground on-site. [Unlikely]	Low

Potential Sources and contaminants	Pathways (Reference from Model)	Receptors	Hazard Severity	Probability of Occurrence	Potential Risk
the historical use of the site: Heavy metals. Inorganic compounds. Polycyclic Aromatic Hydrocarbons (PAH). Petroleum hydrocarbons. Asbestos.	Horizontal and Vertical migration	Groundwater within the Glaciofluvial Sheet Deposits	Secondary A Aquifer [Medium]	No significant contaminant concentrations recorded within Made Ground on-site. [Unlikely]	Low.
	Direct Contact	Buildings, Buried Structures and Services	Chemical attack of buried structures and tainted water supplies. [Mild]	No significant contaminant concentrations recorded within Made Ground on-site. [Unlikely]	Very low.
Ground gas and hydrocarbon vapours in Made Ground.	Vertical and Horizontal migration, Ingress & Accumulation. Inhalation.	Site End-users.	[Medium]	No significant contaminant concentrations recorded within Made Ground on-site. [Unlikely]	Low.
		Buildings	[Medium]	No significant contaminant concentrations recorded within Made Ground on-site. [Unlikely]	Low.

No significant contamination, ground gas sources or additional pollution linkages have been recorded from the investigation works. Therefore, it is considered that the contamination risk associated with the site is low.

8.3. Risk Management

General

It is recommended that this report is submitted to the planning department of the Local Authority, the organization undertaking the Building Control function and warranty providers to confirm that the investigation completed to date is satisfactory.

Further Investigation

No further site investigation works are considered necessary for contamination purposes.

Outline Remediation Solution

Due to the absence of contamination risks, no remediation is considered necessary.

Waste Classification

It is anticipated that if and where possible all excavated soils will be re-used on-site as part of the proposed works.

Should Made Ground and subsoils be disposed of from the site then it would be classified as 'inert waste'. Where this is the case then the chemical results should be forwarded to the proposed landfill site and the waste classification confirmed prior to disposing of any surplus soils. Waste Acceptance Criteria (WAC) testing of the soils will also be required where the soil is to be disposed of at a landfill permitted to accept inert waste. The waste code from the European Waste Catalogue (EWC) 2002 for the soils would be 17 05 04 'Soil and Stones, not containing dangerous substances'.

References

- British Geological Survey Sheet 198: "Hereford" Solid and Drift edition (1:50,000) published 1989.

- 12 Little Berrington Street, Hereford – Written Scheme of Investigation (Archaeological Watching Brief)', TigerGeo Limited, Project Code: LBS181, dated May 2019.

- 'Phase 1 Geo-Environmental Desk Study Report, 'Hereford Radiators, 12 Little Berrington Street HR4 0BS', EMS, E14130, dated July 2019.

Supplementary Information

GROUND INVESTIGATION

Exploratory holes are logged by an experienced Geo-Environmental Engineer in general accordance with 'Code of practice for site investigations' BS5930:2015. Soil samples are collected at intervals for logging purposes and chemical analysis / geotechnical testing. Soil nature and investigation objectives will dictate the location of soil samples collected.

Where in-situ test information is unavailable, the relative density of granular soils on exploratory hole logs is tentative only. Relative density assessments are based on visual inspections only considering factors such as drilling rates, pit side wall stability, appearance and behaviour under excavation.

Chalk strata is logged and graded in general accordance with CIRIA guidance 'C574 - Engineering in Chalk'. It should be noted that drilling using cable percussive methods in chalk destroys its structure. Therefore, the grading stated on chalk borehole logs is either tentative or absent where it is not possible to assess the grade.

Hand Dug Inspection Pits

Hand dug inspection pits are a cost-effective method of describing and sampling near surface soils using hand tools. They can be used as a quick method for collecting shallow soil samples and to expose building foundations. Depth is a dependant on ground conditions and generally does not exceed 1.2m.

Windowless Sampling Boreholes

Windowless sample boreholes are undertaken using a small tracked dynamic percussion drilling rig that retrieves soil samples as 1.0m length cores contained within a plastic liner, which fit inside the narrow diameter steel sampling tubes. Boreholes typically reach 5m depth, but under exceptional circumstances may reach up to 15m depth. These are the smallest type of rig capable of undertaking Standard Penetration Tests (SPTs). For confined or locations with difficult access a hand-held windowless sample rig may be an option.

Hand-held Window Sampling

Hand-held window sampling is another useful method of drilling narrow diameter boreholes where access is difficult. A percussive hammer is used to drive the sampling tube into the ground and soil samples are collected within the hollow metal sampling tubes. Inspected and logging of soils is done via the open window along one side. Window sample boreholes can reach 3m to 6m depth ground conditions permitting.

Cable Percussive Boreholes

Cable Percussive drilling techniques involve repeatedly dropping a core barrel under its own weight using a tripod support. Samples are obtained from a clay cutter head in fine soils or a bailer for wet granular soils. As cable percussive boreholes progress in-situ strength tests (SPTs) can be undertaken in combination with relatively undisturbed samples (U100s / UT100s). SPTs and U100s / UT100s are typically undertaken at alternative depths at 1.0m intervals for the first 5.0m and at 1.5m intervals thereafter. Cable percussive boreholes can typically reach depths of 15 to 25m or more in soils, however; only thin weak rock layers can be penetrated.

Rotary Boreholes

Rotary coring / open hole techniques are required for drilling into competent rock. Drill rigs vary in size from small tracked units to larger units mounted on four wheel drive trucks. Rotary open hole techniques break the rock into small fragments making sample recovery limited. However, rotary coring retrieves excellent samples. Some rigs also allow windowless sampling to be undertaken through soil layers. Rotary drilling techniques can achieve great depths.

Dynamic Probing

Dynamic probing involves driving a sectional rod with a sacrificial cone into the ground using a constant mass falling over a set distance. The number of blows taken to drive the rod 100mm into the ground is recorded and presented in a graph of N10 values. Dynamic probing is undertaken in accordance with "BS EN ISO 22476-2:2005 Incorporating corrigendum no. 1, Geotechnical investigation and testing — Field testing — Part 2: Dynamic probing" BSi, February 2007.

Dynamic Penetrometer

The Transport Research Laboratory Dynamic Cone Penetrometer (TRL DCP) involves driving a 20mm maximum diameter, 60° cone into the ground using an 8 kg hammer dropping through a height of 575mm. This instrument is typically used for measuring the in-situ strength of flexible road pavements constructed of unbound materials. The depth driven either per blow or per several blows is recorded. The strength of each soil layer encountered is then calculated by converting the penetration rate (mm per blow) into an indicative California Bearing Ratio (CBR) value employing a correlation proposed by TRL.

Gas Monitoring

Gas monitoring is undertaken with a portable gas monitor for oxygen, Methane, Carbon Dioxide, Hydrogen Sulphide and Carbon Monoxide together with recording of atmospheric pressure and any flow rate.

Vapour Monitoring

Headspace tests and monitoring for Volatile Organic Compounds (VOC) or Semi Volatile Organic Compounds (SVOC) is undertaken using a Photo Ionisation Detector (PID). The MiniRAE models used have a 10.6 eV lamp calibrated for isobutylene. The PID is useful tool to indicate the presence of a wide range of volatile compounds, but only provides semi-quantitative data as different compounds provide a different response and thus the reading is not a true reflection of the actual concentration present.

Low PID readings can be recorded in natural uncontaminated organic soils or even as a result of atmospheric pollution. It is generally accepted by consultants and regulators that recorded values in excess 50 parts per million (ppm) represents the presence of organic compound pollutants and in excess of 100 ppm such contamination may be significant.

The headspace test procedure involves the collection of a sample of suspected contaminated soils and placing within a sample bag. A tight seal to the bag is formed with a similar volume of air trapped to that of the soil and the sample is left for fifteen minutes to allow volatilisation of any contaminants. The bag is then pierced by, and sealed around, the sample probe of the PID and a reading taken.

Borehole well monitoring is undertaken by connecting the PID directly to the gas tap on the monitoring well installation.

Groundwater Monitoring

Groundwater levels are recorded using an electronic dip meter that has a detector at the end, which is lowered into a borehole monitoring well. An audible signal is made when water is reached, and the depth recorded from the graduated tape used to lower the detector.

Contamination Sampling

EMS soil contamination sampling methodology determines that samples are taken from the trial pits and placed in glass jars and vials for storage. Jars and vials are stored within a cool box at the first possible opportunity to ensure sample preservation. Containers for volatile analysis were filled so that minimal air space remained prior to sealing. This, in combination with a low storage temperature, reduces the likelihood for volatile compounds, which may have been present within the sample, to volatilise to the headspace prior to analysis.

After brief temporary storage within EMS's sample refrigeration unit samples selected for laboratory analysis are transported in cool boxes via an overnight courier company. On-site inspection for below ground asbestos debris is undertaken as standard at the time of investigation, and soil/debris samples taken if deemed necessary.

Samples were chosen for laboratory analysis based upon visual observations. Disposable nitrile gloves were worn and changed between each sample taken to prevent cross contamination.

Geotechnical Sampling

EMS schedule a range of geotechnical testing as appropriate to the identified ground conditions, available budget and the proposed development. Different types of soil samples are obtained as appropriate to the ground conditions and required testing, including:

- Disturbed Samples (D on exploratory hole logs) – These are small soil samples (of 1kg to 2kg) collected in small plastic bags or tubs;

- Bulk Samples (B on exploratory hole logs) – These are large soil samples (up to about 30 kg) collected in large plastic bags;

- Undisturbed Samples (U on exploratory hole logs) – These are typically 100mm diameter samples, for clay rich firm to stiff consistency soils, using plastic or metal tubing from cable percussive boreholes. Cut plastic sample liners using windowless sampling methods may also represent undisturbed samples. Such samples are recognised as not generally meeting with Eurocode sample quality requirements for the tests commonly employed. However, given the wealth of experience with these sampling methods this continues to be common United Kingdom practice particularly for less sensitive developments where more expensive sampling techniques are not economically justifiable.

- Undisturbed UT Samples – These samples employ the use of a thin walled steel sampler developed by Archway Engineering called a UT100. They were designed in order to attempt to gain better quality samples of soft to firm clay-rich soils when using cable percussive drilling methods.

GEOTECHNICAL PARAMETERS

Soakaway and Percolation Tests

Soakage tests employ excavating a test pit to between 1.50-2.50m below ground level using the back-acting arm of the JCB 3CX or similar mechanical excavator. The test pit is then filled

with clean potable water and the time it takes for the water to drain away recorded. Ground conditions, time and budget permitting, a maximum of up to three tests are undertaken in each test pit. As many repeat tests as possible will be completed in a single day. Percolation tests employ a 300mm x 300mm x 300mm pit at the base of a 1.00m deep trial pit. The smaller pit is filled with water and the time taken for it to drain recorded.

Soakaway tests are undertaken in accordance with 'BRE Digest 365: Soakaway design', Building Research Establishment, 1991 and percolation tests in accordance with BS 6297.

Standard Penetration Tests

Standard Penetration Tests (SPTs) are a method of determining soil resistance, i.e. consistency for clay-rich soils and relative density for granular soils, at the bottom of borehole runs during windowless sample, cable percussive and rotary drilling. The test generally employs the use of a split-spoon sampler to measure the resistance and recover disturbed samples for identification purposes. For granular soils and some soft rocks a solid cone is employed, known as a Cone Penetration Test (CPT).

During the test the sampler or cone is driven into the soil using repetitive blows from a 63.5 kg mass (or hammer) from a height of 760 mm. The number of blows required to drive the sampler or cone to give 300mm penetration is recorded as an SPT N-value. SPTs / CPTs are undertaken in accordance with 'Geotechnical investigation and testing — Field testing — Part 3: Standard penetration test - BS EN ISO 22476-3:2005 Incorporating corrigendum no. 1', BSi, 2007.

Uncorrected SPT N values are recorded on borehole logs together with a record of blows for each 75mm test portion including the seating blows. Where the full test depth cannot be achieved the test refuses on a hard stratum, the blow count and the penetration depth (in mm) is recorded and the N value given as >50.

Due to energy losses associated with the hammer assembly It is necessary to apply a correction to the N values to account for these effects. The correction factor is estimated using the equation: $N_{60} = E_r/60 \; N$, where Er is the energy ratio of the specific test equipment.

For tests in sand, the effects of overburden and rod length modify the equation to $N_{60} = E_r/60 \times \lambda \times C_N \times N$. Where λ is the correction factor for energy losses due to the rod length and CN is the correction factor for vertical stress due to overburden of the soil.

Plasticity Index / Modified Plasticity Index Tests

The shrink / swell behaviour of a clay rich soil is assessed in terms of its volume change potential, in accordance with National House Building Council (NHBC) Standards Chapter 4.2 – Building near trees. To do this, the laboratory measured Plasticity index is convert to a Modified Plasticity Index. A Modified Plasticity Index being defined as the Plasticity Index of the soil multiplied by the percentage of particles with a nominal diameter of less than 425µm. Whilst the NHBC Standards were developed for residential buildings, the advice equally applies to many other low-rise structure types.

Hand Shear Vane

For clay-rich soils, the an in-situ undrained shear strength can be determined using hand shear vane apparatus. Three readings are usually taken at each test depth and uncorrected results recorded on the exploratory hole log. Below 1.2m depth, shear vane readings from trial pits will be undertaken on excavated soils. The results should be corrected in accordance with Eurocode 7 — Geotechnical design — Part 2: Ground investigation and testing EN 1997-2:2007. EMS only employ simple correction methods as the more complex correction methodologies imply undue accuracy to a test that has distinct disadvantages and limitations.

Sulphate

In order to compare the laboratory soil test results with 'Concrete in aggressive ground. BRE Special Digest 1: 2005' (BRE, 2005) laboratory results are converted to SO_4 mg/l. QTS Environmental Ltd results are expressed as SO_4 g/l and so are multiplied by a factor of 1000 to convert to mg/l. Soil Property Testing Ltd laboratory results are expressed as SO_3 g/l and are multiplied by a factor of 1200 to express the results as SO_4 mg/l.

CONTAMINATION ASSESSMENT METHODOLOGY

UK Policy

The UK Government's policy in relation to land affected by historic contamination is based on a 'suitable for use' approach. The approach recognises that the risks presented by any given level of contamination will vary greatly according to the use of the land and a wide range of other factors, such as the underlying geology of the site. Contamination risks therefore need to be assessed on a site-by-site basis. The 'suitable for use' approach limits requirements for remediation to the work necessary to prevent unacceptable risks to human health or the environment in relation to either the current use or future use of the land.

The three main drivers for contamination assessment and remediation are:

- Voluntary action.
- Development as part of the planning regime.
- Regulatory action to mitigate unacceptable risks e.g. Part 2A of the Environmental Protection Act 1990.

Pollutant Linkages

For a contamination risk to exist there must be a 'pollutant linkage' from the contaminant (source) via a pathway (the route from contaminant to receptor) to a receptor (the entity that could be harmed). The absence of a contaminant, pathway or receptor breaks the pollutant linkage and therefore no contamination risk exists.

Contamination is typically present at a site (in the ground and/or in the underlying groundwater) as a result of a historic or current industrial use, usually as a result of leaks, spills or disposal of residues, wastes and excess raw materials from the industrial processes. Contamination may also be present due to:

- The deliberate application of chemicals e.g. the spraying of herbicide/pesticide.
- Migration of pollutants from adjacent land.

Naturally occurring processes e.g. elevated concentrations of particular heavy metals associated with specific geological strata.

Conceptual Site Model

The conceptual site model can be defined as a textual or graphical representation of the identified pollutant linkages for a given site. The model forms the basis for designing the investigation as the aim will be to target all of the potential pollutant linkages to determine, through the subsequent phases of risk assessment, whether or not they pose an actual risk.

It is important that the conceptual site model is updated with new information as the various investigation, risk assessment and remediation works are completed.

Technical Guidance

The technical and legal framework for contamination assessment is complex. The process adopted through this report for assessing contamination risks is in general accordance with the following guidance, as listed below:

- 'Investigation of Potentially Contaminated Sites - Code of Practice - BS 10175: 2011', BSi, 2011.
- 'Model Procedures for the management of Land Contamination - CLR Document No. 11', Environment Agency, 2004.
- 'Guidance for the safe development of housing on land affected by contamination - R&D66: 2008', NHBC/Environment Agency, 2008.

Risk Assessment Methodology

In line with the technical guidance, the contamination risk assessment follows a series of phased stages for each particular site:

PHASE	DESCRIPTION	RISK ASSESSMENT STAGE
PHASE1	Generally limited to desk based research and a site walkover survey to develop an initial conceptual site model and identify what risks, if any, are likely to be presented by the site.	**Hazard Identification and Assessment** A preliminary stage of risk assessment concerned with identifying and characterising the hazards that may be associated with a particular site and identifying potential pollutant linkages.
PHASE 2	This phase is concerned with establishing whether contamination is present, usually through intrusive ground investigation, and then evaluating the degree and magnitude of the associated risks.	**Risk Estimation** A stage concerned with estimating the likelihood that receptors will suffer adverse effects if they come into contact with, or are otherwise affected by, a hazardous substance or agent under defined conditions. **Risk Evaluation** A stage of risk assessment concerned with evaluating the acceptability of estimated risks, taking into account the nature and scale of the risk estimates, any uncertainties associated with the assessment and the broad costs and benefits of taking action to mitigate risks.
PHASE 3	The appraisal and selection of remediation techniques, their implementation and verification.	**Risk Management** The process whereby decisions are made to accept a known or assessed risk and/or the implementation of action to reduce the consequences or probabilities of occurrence.

Risk Classification

The objective of risk assessment is to identify the nature and magnitude of the potential risks and should be based on a consideration of both:

- The likelihood/probability of an event [taking into account both the presence of the hazard and receptor and the integrity of the pathway].
- The severity of the potential consequence [taking into account both the potential severity of the hazard and the sensitivity of the receptor].

There is a need for a logical, transparent and repeatable system in defining the categories of severity of consequence and likelihood as well as for the risk itself and therefore the following risk rating matrix is employed:

		SEVERITY OF CONSEQUENCE			
		SEVERE	**MEDIUM**	**MILD**	**MINOR**
PROBABILITY	**HIGH LIKELIHOOD**	Very High Risk	High Risk	Moderate Risk	Moderate/Low Risk
	LIKELY	High Risk	Moderate Risk	Moderate/Low Risk	Low Risk
	LOW LIKELIHOOD	Moderate Risk	Moderate/Low Risk	Low Risk	Very Low Risk
	UNLIKELY	Moderate/Low Risk	Low Risk	Very Low Risk	Very Low Risk

These risk classifications are defined as follows:

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

This risk assessment matrix and classification system is based on guidance produced by Department for Environment, Food and Rural Affairs (Defra) and the Environment Agency in connection with contaminated land assessment.

RISK ESTIMATION - SOILS

Introduction to Soil Human Health Generic Assessment Criteria (GAC)

The Environment Agency (EA) and Department of Environment Food and Rural Affairs (DEFRA) historically issued revised guidance following consultation about the DEFRA publication "Assessing risks from land contamination – a proportionate approach. Soil Guideline Values: the Way Forward". This resulted in a revised version of the Contaminated Land Exposure Model (CLEA) model (version 1.06) and a few of the previously published Soil Guideline Values (SGVs) were revised.

The main legislative driver for dealing with historical land affected by contamination is Part 2A of the Environmental Protection Act 1990. Revised Statutory Guidance to support Part 2A was published in April 2012. This Guidance introduced a new four-category system for classifying land under Part 2A for cases of a Significant Possibility of Significant Harm to human health,1 where Category 1 includes land where the level of risk is clearly unacceptable and Category 4 includes land where the level of risk posed is acceptably low. The impact assessment for the new Statutory Guidance stated "The new statutory guidance will bring about a situation where the current SGVs/GACs are replaced with more pragmatic (but still strongly precautionary) Category 4 screening levels (C4SLs) which will provide a higher simple test for deciding that land is suitable for use and definitely not contaminated land". The C4SLs are still derived using the CLEA model but adopt a slightly different approach to toxicological assessment and exposure modelling.

In 2014, "SP1010 – Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination - Final Project Report" (CL:AIRE) was published. This document covered C4SLs for four metals (arsenic, cadmium, chromium VI and lead), benzene and benzo(a)pyrene (BaP), which were finalised for use in risk assessment undertaken under the planning regime. As yet no C4SLs for other contaminants have been developed.

Due to the limited number of published C4SL values at this time, the Chartered Institute of Environmental health (CIEH) and Land Quality Management Ltd (LQM) produced Generic Assessment Criteria (GAC) known as Suitable for Use Levels (S4ULs), for use in contaminated land human health risk assessment. These S4ULs (2014) have been derived for 89 substances using the current CLEA model and are therefore consistent with current guidance. They also incorporate the revised exposure parameters as adopted by the C4SL programme, but have not adopted the revised toxicological approach adopted by the C4SLs and so remain a more conservative assessment criteria. The substances for which SGVs were previously published have also been revised as new S4ULs in light of the new exposure parameters proposed by the C4SL programme, and therefore effectively replace the existing SGVs.

EMS have adopted for use the revised 'S4UL' (Suitable for Use Levels), published in 2015 by Land Quality Management (LQM) and the Chartered Institute for Environmental Heath (CIEH) for human health risk assessment. The levels have been based on Health Criteria Values and Tolerable Daily Intakes that represent minimal or tolerable levels of risks to health as described in the Environment Agency's SR2 guidance. In the case of lead, the Department for Environment, Food and Rural Affairs' Category 4 Screening Level (C4SL) has been used for comparison purposes.

In December 2009, other GAC for less common substances were produced by the Environmental Industries Commission (EIC), The Association of Geotechnical and Geoenvironmental Specialists (AGS) and Contaminated Land: Applications in Real Environments (CL:AIRE) using the CLEA model. These are referred to as the EIC/AGS/CLAIRE GAC.

Where C4SL, S4UL or EIC/AGS/CLAIRE GACs are not available, any concentrations exceeding the laboratory limit of detection are identified and discussed in more detail.

The only exception to this approach is the PAH compound benzo(a)pyrene (BaP) where a C4SL guideline value has been produced, whereas BRD has adopted the S4UL value. The C4SL for BaP relates to its use as a surrogate marker compound representing all of the genotoxic PAH compounds as a mixture, rather than this individual compound. BRD has therefore adopted the compound specific S4UL value as the initial screening value, for consistency with the other PAH compounds before then employing the C4SL is necessary.

It should be noted that unless otherwise stated, all the assessment criteria adopted within this report have been derived based on a sandy loam soil at pH 7 and the values quoted are for a conservative soil organic matter content of 1% where applicable (i.e. organic contaminants).

The risk to contractors from acute (short term) exposure has been initially assessed on a qualitative basis. The risk to controlled waters from concentrations of contaminants in soil samples taken as part of this preliminary investigation has also been assessed on a qualitative basis.

Human Health - Soil Generic Assessment Criteria

The results of the soils analysis have been compared to generic assessment criteria for the default exposure scenarios comprising either residential land with plant uptake, residential land without plant uptake, or commercial/industrial land use. The criteria values selected are listed in the table below and full details on the source are referred to above. Where applicable, the results have also been assessed with reference to the required statistical tests presented within CLAIRE document "Guidance on comparing soil contamination data with a critical concentration".

ANALYSIS	GENERIC ASSESSMENT CRITERIA (mg/kg unless stated)			SOURCE
	RESIDENTIAL WITH PLANT UPTAKE	RESIDENTIAL WITHOUT PLANT UPTAKE	COMMERCIAL / INDUSTRIAL	
Arsenic	37	40	640	C4SL
Cadmium	22	150	410	
Chromium (total)[$]	910	910	8,600	S4UL
Chromium VI	21	21	49	C4SL
Lead	200	310	2,330	
Mercury*	11	15	320	S4UL
Selenium	250	430	12,000	
Nickel	180	180	980	
Copper	2400	7,100	68,000	
Zinc	3,700	40,000	730,000	
pH	<5 – 10> units			Professional judgement
Naphthalene	2.3	2.3	190	S4UL
Acenaphthylene	170	2,900	83,000	
Acenaphthene	210	3,000	84,000	
Fluorene	170	2,800	63,000	
Phenanthrene	95	1,300	22,000	
Anthracene	2,400	31,000	520,000	
Fluoranthene	280	1,500	23,000	
Pyrene	620	3,700	54,000	
Benzo(a)anthracene	7.2	11	170	
Chrysene	15	30	350	
Benzo(b)fluoranthene	2.6	3.9	44	
Benzo(k)fluoranthene	77	110	1,200	
Benzo(a)pyrene	2.2	3.2	35	
Indeno(1,2,3-cd)pyrene	27	45	500	

ANALYSIS	GENERIC ASSESSMENT CRITERIA (mg/kg unless stated)			SOURCE
	RESIDENTIAL WITH PLANT UPTAKE	RESIDENTIAL WITHOUT PLANT UPTAKE	COMMERCIAL / INDUSTRIAL	
Dibenzo(a,h)anthracene	0.24	0.31	3.5	S4UL
Benzo(ghi)perylene	320	360	3,900	
TPH Aliphatic C5-C6	42	42	3,200	
TPH Aliphatic C6-C8	100	100	7,800	
TPH Aliphatic C8-C10	27	27	2,000	
TPH Aliphatic C10-C12	130	130	9,700	
TPH Aliphatic C12-C16	1,100	1,100	59,000	
TPH Aliphatic C16-C35	65,000	65,000	1,600,000	
TPH Aliphatic C35-C44	65,000	65,000	1,600,000	
TPH Aromatic C5-C7	70	370	26,000	
TPH Aromatic C7-C8	130	860	56,000	
TPH Aromatic C8-C10	34	47	3,500	
TPH Aromatic C10-C12	74	250	16,000	
TPH Aromatic C12-C16	140	1,800	36,000	
TPH Aromatic C16-C21	260	1,900	28,000	
TPH Aromatic C21-C35	1,100	1,900	28,000	
TPH Aromatic C35-C44	1,100	1,900	28,000	
Benzene	0.87	3.3	98	C4SL
Toluene	130	880	56,000	S4UL
Ethylbenzene	47	83	5,700	
Xylene^	56	79	5,900	
MTBE	49	73	7,900	EIC/AGS/CL:AIRE GAC

Notes:

* The S4UL for methyl mercury has been adopted as the worst case mercury compound as generally there is no desk study evidence to suggest the potential for elemental mercury on the majority of sites.

^ The lowest S4UL of either p-xylene, o-xylene or m-xylene has been adopted for each land use as a conservative measure.

$ S4UL for Chromium III adopted, as in the absence of Chromium VI it is likely that all of the chromium will be in this form as these are the two most common and stable forms of chromium in the soil environment.

Where no GAC is available, any concentrations exceeding the laboratory limit of detection are identified and discussed in more detail.

Water Environment - Soil Generic Assessment Criteria

There are no UK published Generic Assessment Criteria for soil test results in respect of the risk to the water environment. Therefore, risk estimation is based on the professional judgement and experience of EMS to employ values that are a reasonable concentration above which concern for water resources is valid.

The Total PAH GAC employed is the sum of the 16No. priority PAH compounds regularly tested for in contaminated land analysis (i.e. US EPA 16PAHs). EMS employ a soil screening based upon the total PAH limit for 'inert waste' of 100mg/kg. The rationale is based on PAHs are recognised to be generally of low solubility and the risk to the water environment is correspondingly low.

In respect of Total Petroleum Hydrocarbons, EMS employ a value of 500 mg/kg as a screening value in comparison to the sum of the component aliphatic and aromatic TPH carbon bands. The employed soil screening value is based upon:

- In common with some other consultants, the professional judgement and experience of EMS suggests that this value is a reasonable concentration above which concern for water resources is valid. The rationale is based on the fact that lower concentrations of fuel-based contaminants are more likely to naturally degrade than migrate any great distance.

- EMS is aware of regional Environment Agency groundwater and contaminated land teams that employ 500 mg/kg as a screening value for considering whether or not TPH could represent a risk to water resources.

- The value mirrors the mineral oil Waste Acceptance Criteria limits for what is considered 'inert waste'.

Should elevated contaminants that pose a potential risk to the water environment be identified then site specific assessment criteria should be developed.

Building Materials and Services – Soil Generic Assessment Criteria

Some hydrocarbon compounds are known to both attack and permeate through certain plastic pipe materials, with the primary concern being the degradation and tainting of water supplies. The UK Water Industry Research (UKWIR) has therefore produced a document 'Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites' (ref. 10/WM/03/21) that specifies threshold criteria for the adoption of 'standard' polythene (PE) or PVC pipes, protective barrier pipe and ductile iron/steel/copper pipes.

The UKWIR threshold assessment criteria from Table 3.1 of this document for standard PE pipes have been employed. It should be noted that the approach taken by UKWIR is very conservative, and both the document and research are flawed. However, it is these values that are being using to specify water pipe materials and therefore it is appropriate to consider them.

The UKWIR guidance is particularly flawed in respect of the chemical analysis it expects as it seeks a limit of detection that is generally below limits that are reasonable or commonly employed in contaminated land assessment. The UKWIR seeks that where a substance is below the limit of detection it should be taken as being present at half this concentration. For the larger suite of chemicals where the limit is against a sum of compounds, this approach would mean that a sample of virgin sub-soil from a greenfield site with absolutely no contamination would actually fail the criteria for using standard PE pipes. To avoid this situation, EMS have adopted the approach of summing only those compounds detected above their respective limits of detection.

In terms of building materials, the primary concern is in respect of concrete as certain commonly occurring natural ground conditions can adversely impact on buried concrete as discussed in 'Special digest 1:2005 Concrete in aggressive ground', BRE, 2005.

ANALYSIS	GENERIC ASSESSMENT CRITERIA	SOURCE
pH	<5.5	BRE Special Digest 1:2005
Sulphate (w/s)	500 mg/l	BRE Special Digest 1:2005
Sum of any VOC above detection limits	0.5 mg/kg	Relevant compounds adapted from UKWIR Table 3.1
Sum of SVOC + Aliphatic TPH >C5-C10 + Aromatic TPH >C5-C10 above detection limits	2 mg/kg	
Sum of Aliphatic TPH >C10-C21 + Aromatic TPH >C10-C21 above detection limits	10 mg/kg	
Sum of Aliphatic TPH >C21-C34 + Aromatic TPH >C10-C35 above detection limits	500 mg/kg	
Sum of BTEX + MTBE above detection limits	0.1 mg/kg	
Phenols	2 mg/kg	
Cresols and chlorinated phenols	2 mg/kg	
Naphthalene	0.5 mg/kg	
Benzo(a)pyrene	0.5 mg/kg	

RISK ESTIMATION – GROUNDWATER

The initial assessment of the contamination risk to groundwater is by comparing dissolved groundwater concentrations with screening values that are protective of groundwater resources.

The reference source for the target concentrations is generally the EA's Environmental Quality Standards (EQS), the Water Supply (Water Quality) Regulations (WSR) 1989 / 2000 and the DW1/DW2 criteria from the Surface Water (Abstraction for drinking water)(classification) Regulations 1996. The target concentrations are outlined in the table overleaf.

ANALYSIS	GENERIC ASSESSMENT CRITERIA	SOURCE
Arsenic	50 µg/l	EQS
Cadmium	5 µg/l	EQS
Chromium (total)	50 µg/l	DW2
Copper	50 µg/l	DW2
Nickel	20 µg/l	WSR
Lead	50 µg/l	DW2
Mercury	1 µg/l	EQS
Selenium	10 µg/l	WSR
Zinc	5 mg/l	DW2
Cyanide	50 µg/l	WSR
pH	6 to 9 units	EQS
Benzene	30 µg/l	EQS
Toluene	50 µg/l	EQS
Ethylbenzene	30 µg/l	EQS for benzene as a guide
Xylene	30 µg/l	EQS for benzene as a guide
Naphthalene	2.4 µg/l	EQS
Benzo(a)pyrene	0.05 µg/l	EQS
Total PAH	0.2 µg/l	DW1

ANALYSIS	GENERIC ASSESSMENT CRITERIA	SOURCE
TPH (dissolved or emulsified hydrocarbons)	50 µg/l	DW1

There are no available generic assessment criteria for some of the analytical parameters which have been scheduled, for example hexavalent chromium, and individual TPH and PAH and some VOC compounds. These parameters will be assessed based on professional judgement should they exceed the limit of detection.

RISK ESTIMATION - GROUND GAS

Introduction

A variety of potentially hazardous gases occur in naturally in the ground environment. Microbial decay of organic matter under anaerobic conditions and geological processes can lead to the generation of Methane and Carbon Dioxide, but can also include traces gases such as Hydrogen sulphide and Carbon monoxide.

Methane is a colourless and odourless gas that has the hazardous properties of being flammable and, at certain air/Methane mixtures, explosive. Methane has a low toxicity, but can be a simple asphyxiant due to the displacement of oxygen.

Carbon Dioxide is a colourless, odourless and non-combustible gas that has the hazardous property of being a highly toxic chemical. At concentrations of 3% by volume, shortness of breath and headaches will occur becoming acute by 6%. At levels of above 10% by volume headache, visual distortion, tremors and rapid loss of consciousness occur. Concentrations of Carbon Dioxide above 22% by volume are likely to be fatal. The effects of Carbon Dioxide poisoning are made more severe if there is accompanying reduction in oxygen concentrations.

Hydrogen sulphide is a colourless and flammable gas that has an odour of rotten eggs. It is important to that the sense of smell is over powered at higher concentrations. The gas is toxic and can be an asphyxiant.

Carbon monoxide is a colourless, odourless and explosive gas in air mixtures that has the hazardous property of being a highly toxic chemical.

Radon is a naturally occurring colourless and odourless gas that is radioactive. It is formed by the radioactive decay of radium which in turn is derived from the radioactive decay of uranium, both of which are minerals that can be found in many soil types. Whilst it is recognised that the air inside every house contains radon, some houses built in certain defined areas of the country might have unacceptably high concentrations and require special precautions to be taken. The maps contained within BRE211:2007 'Radon: guidance on protective measures for new buildings' identify areas where no radon protection measures are necessary or where higher concentrations are present that either basic or full radon protection measures are required to be fitted to all new dwellings.

Basis of Gas Assessment

In order to classify the level of risk and need, if any, for gas protection measures at a site with the potential for a gas problem, consideration of each of the following is necessary:

- The source of the gas.

- The generation potential of the gas.
- The location of the source and the geological setting.
- Boreholes flow rate and estimated surface emission rate.
- The nature of the proposed development.
- Confidence in the knowledge of the gas regime.

The gas assessment is made with reference to 'C665 - Assessing risks posed by hazardous ground gases to buildings', Construction Industry Research and Information Association (CIRIA), 2007.

Gas Screening Value

The method within CIRIA C665 uses both the gas concentrations and borehole flow rates to define a characteristic situation for a site based on the limiting borehole gas volume flow for Methane and Carbon Dioxide. This limiting borehole gas volume flow is called the Gas Screening Value (GSV) and is expressed below:

Gas Screening Value (l /hr) = borehole flow rate (l/hr) x gas concentration (fraction)

The calculation of GSV is completed for both Methane and Carbon Dioxide and then the 'worse case' maximum values are used in the assessment. The assessment is to determine the gas regime at the site is dependent upon the nature of the development.

Situation A – All development types except low rise housing with gardens.

The characteristic situation for many sites is determined from evaluation of the Gas Screening Value derived against the criteria in the following table.

Characteristic situation	Risk classification	Gas Screening Value (CH_4 or CO_2 l/hr)	Additional factors	Typical sources of generation
1	Very low risk	<0.07	Typically Methane ≤1% and/or Carbon Dioxide ≤5%. Otherwise consider an increase to characteristic situation 2.	Natural soils with low organic matter content and 'typical' made ground.
2	Low risk	<0.7	Borehole air flow rate not to exceed 70 l/hr. Otherwise consider an increase to characteristic situation 3.	Natural soil with high organic peat/organic content and 'typical' made ground.
3	Moderate risk	<3.5		Old landfill, inert waste and flooded mine working.
4	Moderate to high risk	<15	Quantitative risk assessment required to evaluate scope of protection measures.	Mine working susceptible to flooding and landfill completed to WMP 26B criteria.
5	High risk	<70		Mine working unflooded inactive with shallow workings near surface.
6	Very high risk	>70		Recent landfill site.

Situation B – Low rise housing with gardens – NHBC 'Traffic Lights'

The NHBC model for low rise housing development considered a typical residential house with a ground floor area of 64m^2, suspended floor and ventilated sub-floor void of height 150mm. Where the proposed development of a site is consistent with this model, the NHBC traffic light situation of the site is determined from evaluation of the Gas Screening Value against the criteria in the following table.

Traffic Lights	Methane		Carbon Dioxide	
	Typical maximum concentrations (%)	Gas Screening Value (l/hr)	Typical maximum concentrations (%)	Gas Screening Value (l/hr)
Green	≤1	≤0.16	≤5	≤0.78
Amber 1	1> to ≤5	>0.16 to ≤0.63	>5 to ≤10	>0.78 to ≤1.56
Amber 2	5> to ≤20	>0.63 to ≤1.56	>10 to ≤30	>1.56 to ≤3.13
Red	>20	>1.56	>30	>3.13

Appendices

A. Site Plans

B. Exploratory Hole Logs

C. Chemical Analysis Summary Tables

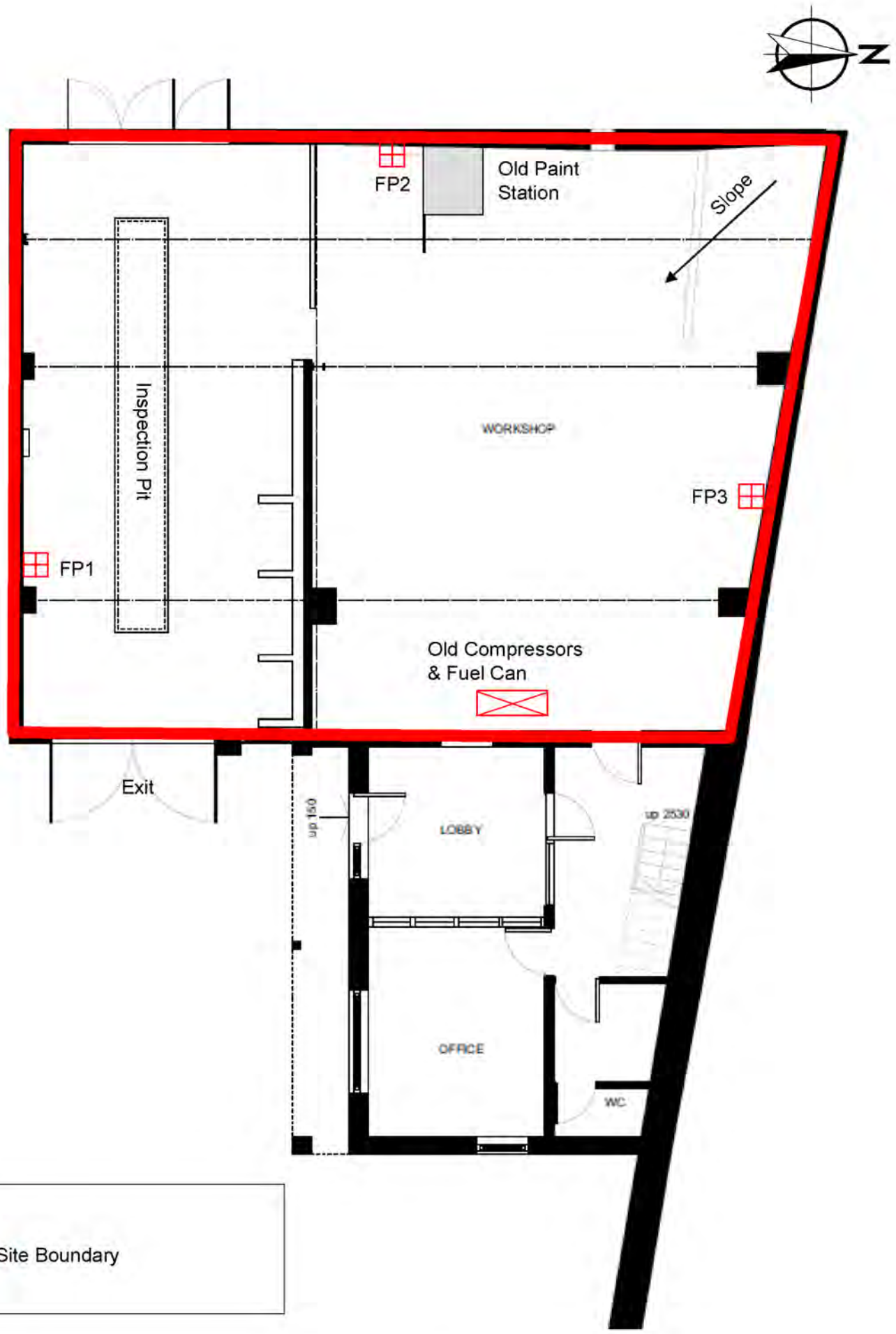
D. Laboratory Results – Geotechnical Testing

E. Laboratory Results – Chemical Analysis

Appendix A – Site Plans

Drawing taken from RRA Architects Drawing Ref: Site Location and Site Plans

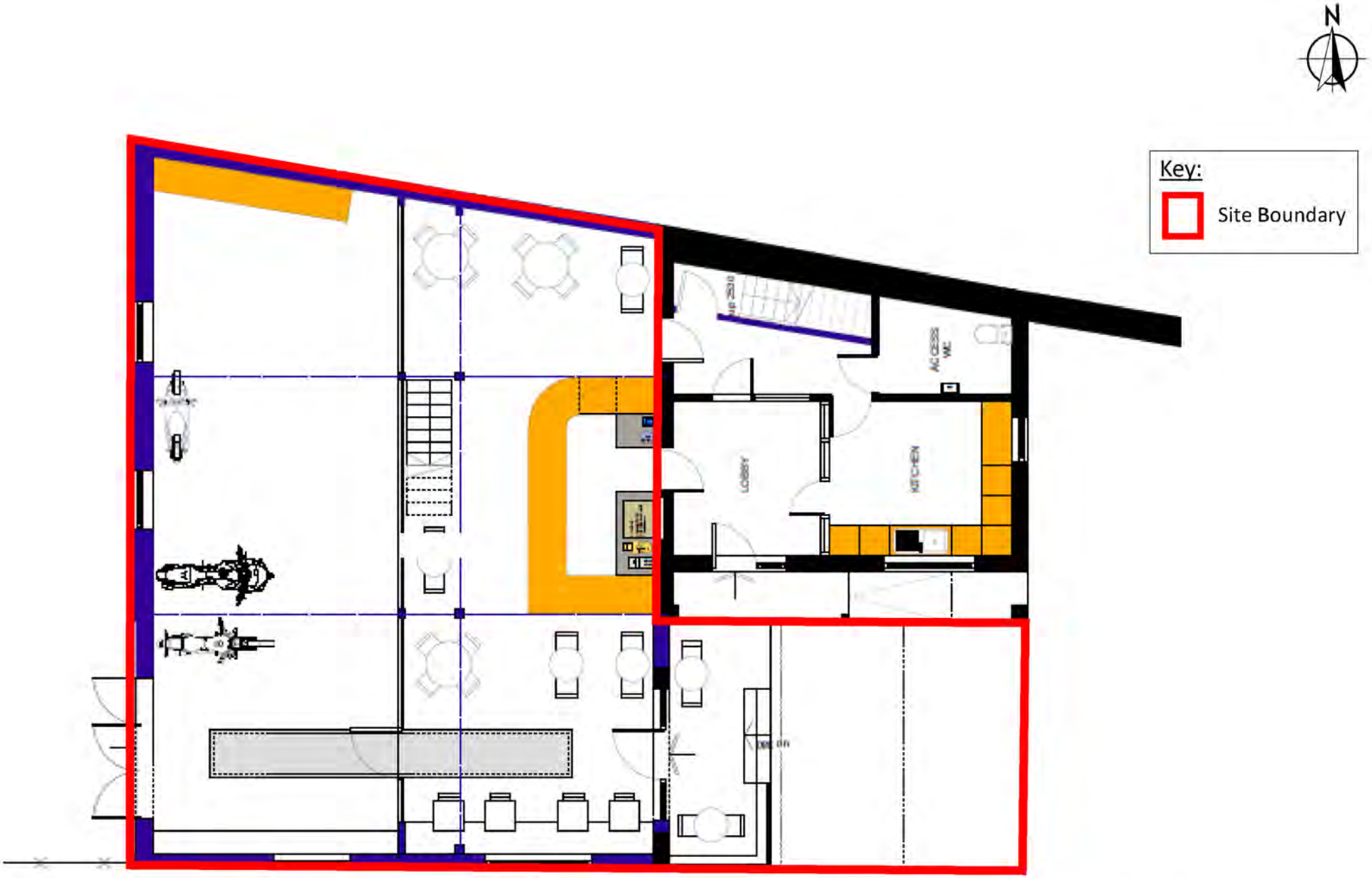
ENVIRONMENTAL MANAGEMENT SOLUTIONS EMSasbestos EMSgeotech EMSwater	Project Number:	E14130
	Site:	Hereford Radiators, 12 Little Berrington Street, Hereford HR4 0BS
	Drawing Title:	Site Location Plan



Key:

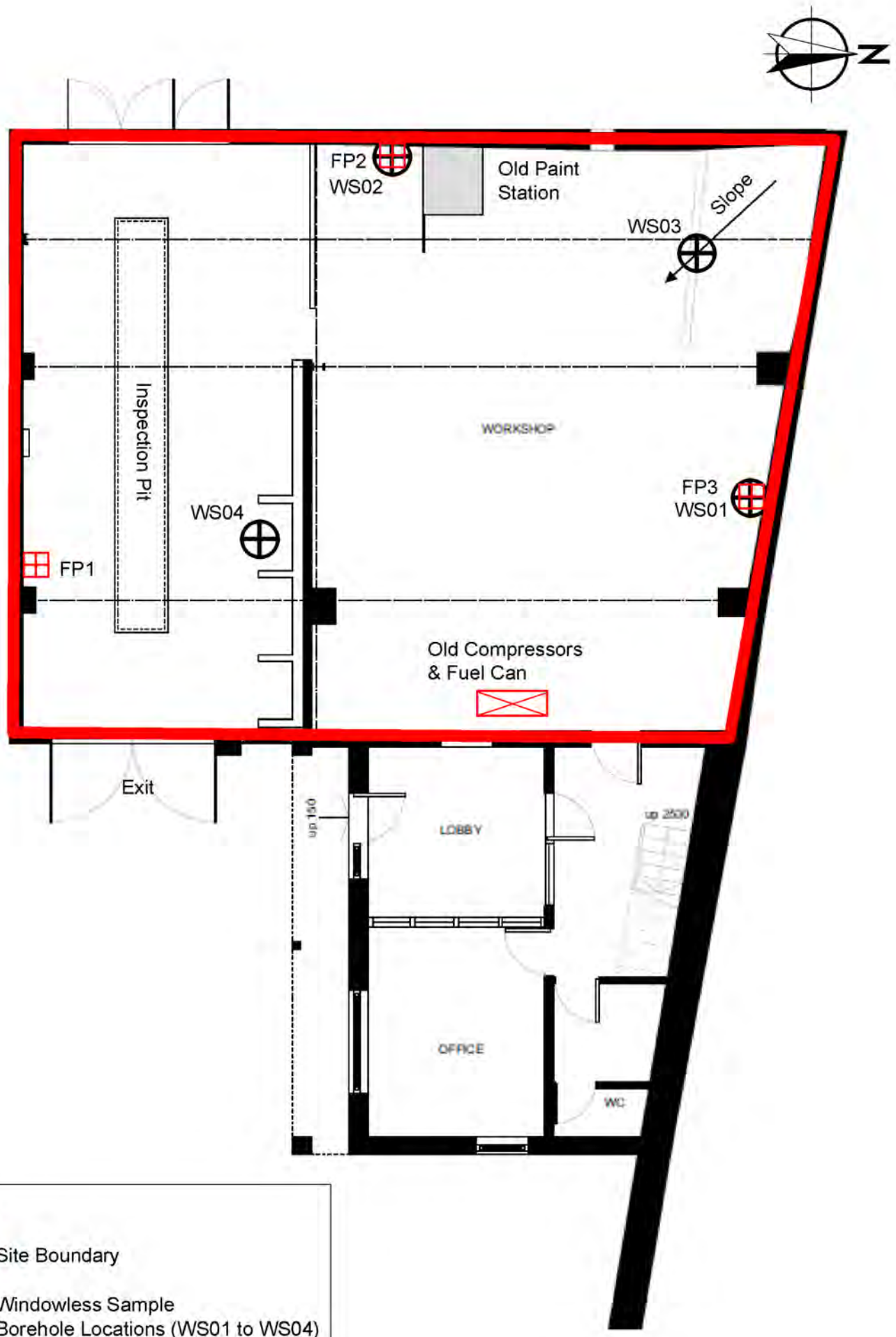
Site Boundary

ENVIRONMENTAL MANAGEMENT SOLUTIONS EMSasbestos EMSgeotech EMSwater	Project Number:	E14130
	Site:	Hereford Radiators, 12 Little Berrington Street, Hereford HR4 0BS
	Drawing Title:	Existing Site Layout Plan



Extract taken from RRA Architects Drawing No 2663 P(0) 004, dated March 2018.

ENVIRONMENTAL MANAGEMENT SOLUTIONS EMSasbestos EMSpollution EMSwater	Project Number:	E14130
	Site:	Hereford Radiators, 12 Little Berrington Street, Hereford HR4 0BS
	Drawing Title:	Proposed Site Layout Plan

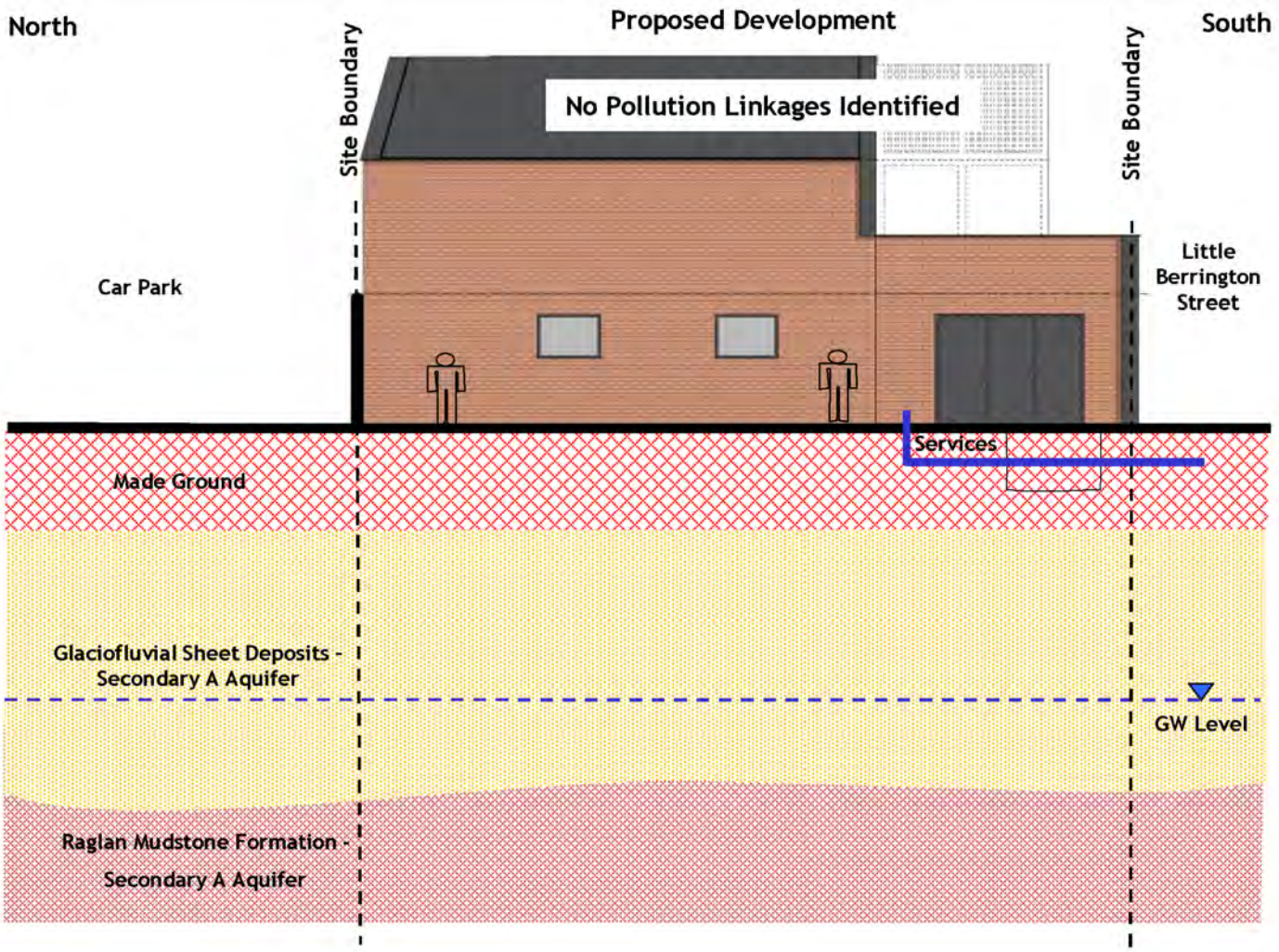


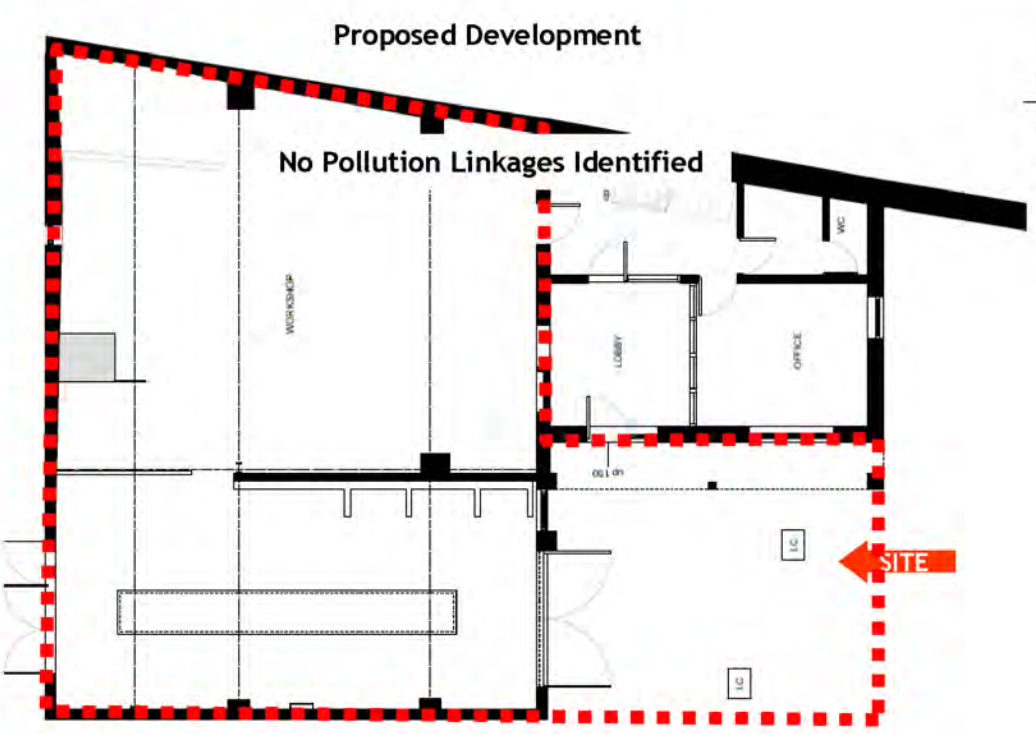
Key:

Site Boundary

Windowless Sample Borehole Locations (WS01 to WS04)

ENVIRONMENTAL MANAGEMENT SOLUTIONS EMSasbestos EMSgeotech EMSwater	Project Number:	E14130
	Site:	Hereford Radiators, 12 Little Berrington Street, Hereford HR4 0BS
	Drawing Title:	Exploratory Hole Layout Plan





Job Title:	Hereford Radiators, 12 Little Berrington Street, Hereford HR4 0BS
Job Number:	E14130
Drawing Title:	Revised Conceptual Site Model

ENVIRONMENTAL MANAGEMENT SOLUTIONS
EMSasbestos EMSgeotech EMSwater

Appendix B – Exploratory Hole Logs

ENVIRONMENTAL MANAGEMENT SOLUTIONS

EMS Geotech
Sigeric Business Park, Holme Lacy Road
Hereford, HR2 6BQ
Telephone: 01432 263333

EXPLORATORY HOLE LOG

Project				HOLE No
Hereford Radiators				WS01
Job No	Date	Ground Level (m)	Co-Ordinates ()	
E14130	17-10-19 17-10-19	61.00	E 350,810.0 N 239,904.0	
Contractor				Sheet
Geo Site Surveys				1 of 1

SAMPLES & TESTS		Water	STRATA				Geology	Instrument/ Backfill
Depth	Sample No.		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION		
			61.00		0.10	MADE GROUND: Concrete.		
			61.00		0.20	MADE GROUND: Brown sandy gravel. Sand is coarse. Gravel sized fragements of angular to subrounded coarse bricks and concrete.		
					(0.70)	MADE GROUND: Dark brown sand and gravel. Sand is fine to coarse. Gravel sized fragments of angular fine to coarse of brick, concrete and coal.		
			61.00		0.90			
1.00-1.20 1.00	ES1 N4				(0.80)	MADE GROUND: Very soft dark brown slightly sandy gravelly clay. Sand is fine to coarse. Gravel sized fragements of angular to subrounded fine to coarse of brick, concrete, quartzite and mudstone.		
			61.00		1.70			
1.70	N2							

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	
											Windowless sample started from 0.82m in a previously dug foundation inspection pit (FP3). No groundwater encountered. Abandoned at 1.70m due to lack of head room.

All dimensions in metres Scale 1:17.5	Client Mr James Allan	Method/ Plant Used Windowless Sample Rig	Logged By OFB

EXPLORATORY HOLE LOG E14130 HEREFORD RADIATORS.GPJ GINT STD AGS 3_1.GDT 2/12/19

ENVIRONMENTAL MANAGEMENT SOLUTIONS

EMS Geotech
Sigeric Business Park, Holme Lacy Road
Hereford, HR2 6BQ
Telephone: 01432 263333

EXPLORATORY HOLE LOG

Project				HOLE No
Hereford Radiators				WS02
Job No	Date	Ground Level (m)	Co-Ordinates ()	
E14130	17-10-19 17-10-19	61.00	E 350,807.0 N 239,898.0	
Contractor				Sheet
Geo Site Surveys				1 of 1

SAMPLES & TESTS		Water	STRATA				Geology	Instrument/ Backfill
Depth	Sample No.		Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION		
			61.00		0.08	MADE GROUND: Concrete.		
			61.00		0.15	MADE GROUND: Brown sandy gravel. Sand is coarse. Gravel sized fragements of angular to subrounded coarse bricks and concrete.		
					(0.45)	MADE GROUND: Dark brown sand and gravel. Sand is fine to coarse. Gravel sized fragments of angular fine to coarse of brick, concrete and coal.		
			61.00		0.60			
					(0.20)	MADE GROUND: Brown mottled yellowish brown sandy gravelly clay. Sand is fine to coarse. Gravel sized fragments of angular to subrounded fine to coarse concrete, brick and mudstone.		
			61.00		0.80	0.60 - 0.70 2 No angular coarse gravel sized fragments of metal		
					(0.30)	Loose light reddish brown SAND and GRAVEL. Sand is fine to coarse. Gravel is subangular and subrounded fine to coarse quartzite, mudstone, siltstone and sandstone. Occasional light green speckling. (GLACIOFLUVIAL SHEET DEPOSITS)		
1.00	N5		61.00		1.10			
						Medium becoming very dense light brown mottled grey very gravelly fine to coarse SAND. Gravel is angular to rounded fine to coarse quartzite, mudstone, siltstone and sandstone. (GLACIOFLUVIAL SHEET DEPOSITS)		
1.80-1.90 D1 1.80 N19 1.90-2.00 D3 2.00-2.80 B2					(1.70)	1.80 - 2.80 Medium dense		
2.60	N50/ 175 mm							
			61.00		2.80			

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	
											Windowless sample start 0.20m in a previously dug foundation inspection pit (FP2) Windowless sample refused at 2.80m. No groundwater encountered.

All dimensions in metres Scale 1:17.5	Client Mr James Allan	Method/ Plant Used Windowless Sample Rig	Logged By OFB

EXPLORATORY HOLE LOG E14130 HEREFORD RADIATORS.GPJ GINT STD AGS 3_1.GDT 2/12/19

ENVIRONMENTAL MANAGEMENT SOLUTIONS

EMS Geotech
Sigeric Business Park, Holme Lacy Road
Hereford, HR2 6BQ
Telephone: 01432 263333

EXPLORATORY HOLE LOG

Project				HOLE No
Hereford Radiators				WS03
Job No	Date	Ground Level (m)	Co-Ordinates ()	
E14130	17-10-19 17-10-19	61.00	E 350,807.0 N 239,903.0	
Contractor				Sheet
Geo Site Surveys				1 of 1

SAMPLES & TESTS			STRATA							
Depth	Sample No.	Water	Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION			Geology	Instrument/ Backfill
			61.00		0.05	MADE GROUND: Concrete.				
			61.00		0.10	MADE GROUND: Brown sandy gravel. Sand is fine to coarse. Gravel sized fragments of angular coarse of brick and concrete.				
0.20-0.30	ES1		61.00		(0.15) 0.25	MADE GROUND: Dark brown to black sandy gravelly clay. Sand is fine to coarse. Gravel sized fragements of angular to subrounded fine to coarse of brick, concrete and cement.				
			61.00		(0.25) 0.50	MADE GROUND: Brown sandy gravel. Sand is fine to coarse. Gravel sized fragments of angular fine to coarse of brick.				
0.70-0.80 0.70-0.80 0.80	D2 D3 N50/ 140 mm		61.00		(0.30) 0.80	Very dense light brown mottled grey very gravelly fine to coarse SAND. Gravel is angular to rounded fine to coarse quartzite, mudstone, siltstone and sandstone. (GLACIOFLUVIAL SHEET DEPOSITS)				

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	
											Windowless sample refused at 0.80m. No groundwater encountered.

All dimensions in metres Scale 1:17.5	Client Mr James Allan	Method/ Plant Used Windowless Sample Rig	Logged By OFB

ENVIRONMENTAL MANAGEMENT SOLUTIONS

EMS Geotech
Sigeric Business Park, Holme Lacy Road
Hereford, HR2 6BQ
Telephone: 01432 263333

EXPLORATORY HOLE LOG

Project				HOLE No
Hereford Radiators				**WS04**
Job No	Date	Ground Level (m)	Co-Ordinates ()	
E14130	17-10-19 17-10-19	61.00	E 350,812.0 N 239,899.0	
Contractor				Sheet
Geo Site Surveys				1 of 1

SAMPLES & TESTS			STRATA						
Depth	Sample No.	Water	Reduced Level	Legend	Depth (Thick-ness)	DESCRIPTION	Geology	Instrument/ Backfill
			61.00		0.10	MADE GROUND: Concrete.		
			61.00		0.20	MADE GROUND: Brown sandy gravel. Sand is fine to coarse. Gravel sized fragments of angular to subrounded fine to coarse of brick and concrete.		
0.20-0.30	ES1		61.00		(0.20) 0.40	MADE GROUND: Dark brown sandy gravelly clay. Sand is fine to coarse. Gravel sized fragments of angular to subrounded fine to coarse of coal, brick, mudstone and concrete.		
0.40-0.50	D2					Very dense light brown mottled grey very gravelly fine to coarse SAND. Gravel is angular to rounded fine to coarse quartzite, mudstone, siltstone and sandstone. (GLACIOFLUVIAL SHEET DEPOSITS)		
0.50-0.60	D3				(0.50)			
			61.00		0.90			
0.90	N50/ 90 mm							

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Casing Depth	Casing Dia. mm	Water Dpt	From	To	Hours	From	To	
											Windowless sample refused at 0.90m. No groundwater encountered.

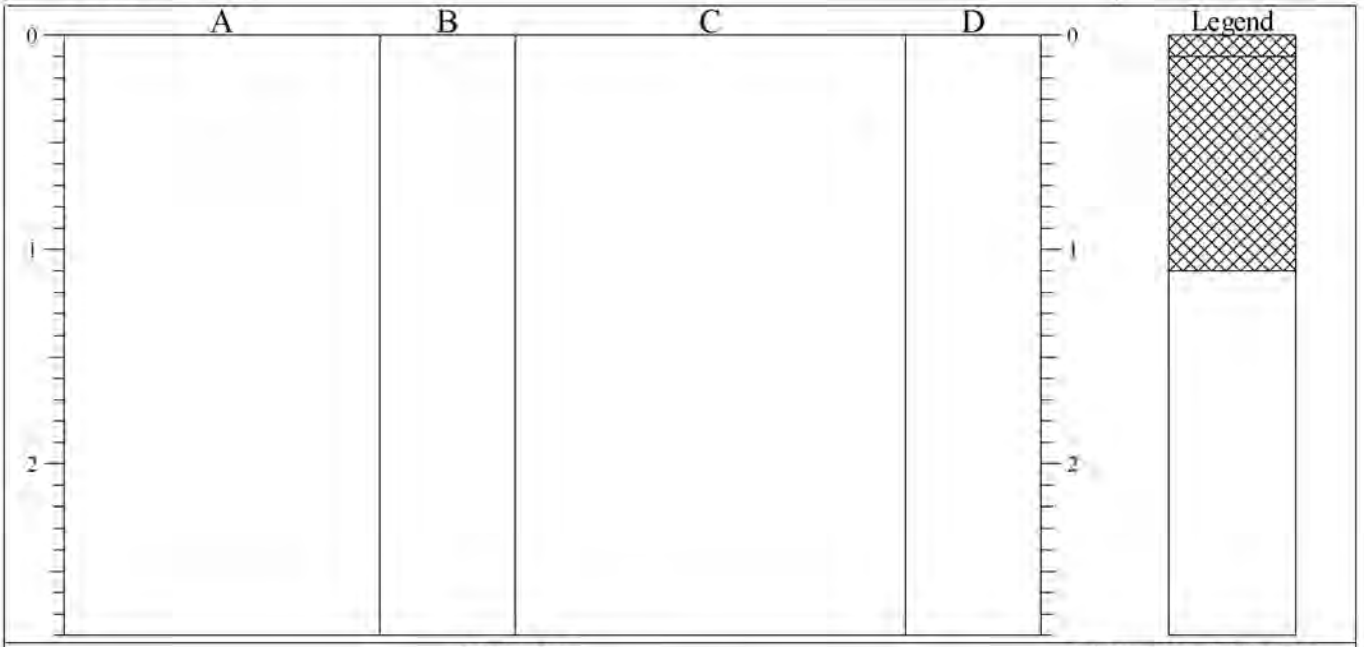
All dimensions in metres Scale 1:17.5	Client Mr James Allan	Method/ Plant Used Windowless Sample Rig	Logged By OFB

EXPLORATORY HOLE LOG E14130 HEREFORD RADIATORS.GPJ GINT STD AGS 3_1.GDT 2/12/19

EMS Geotech
Sigeric Business Par
Hereford, HR2 6BQ
Telephone: 01432 2

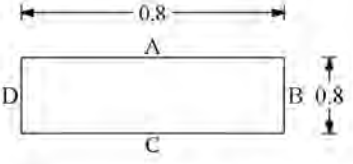
TRIAL PIT LOG

Project				TRIAL PIT No
Hereford Radiators				FP1
Job No	Date	Ground Level (m)	Co-Ordinates ()	
E14130	15-03-19 15-03-19	61.00	E 350,806.0 N 239,898.0	
Contractor				Sheet
Geo Site Surveys				1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.10		MADE GROUND: Concrete.			
0.10-1.10		MADE GROUND: Grey gravelly find to coarse sand. Gravel sized fragments of angular to rounded fine to coarse metal, brick, concrete, pottery and wood.			
			1.00-1.10	ES1	

Shoring/Support: None
Stability: Stable



GENERAL REMARKS

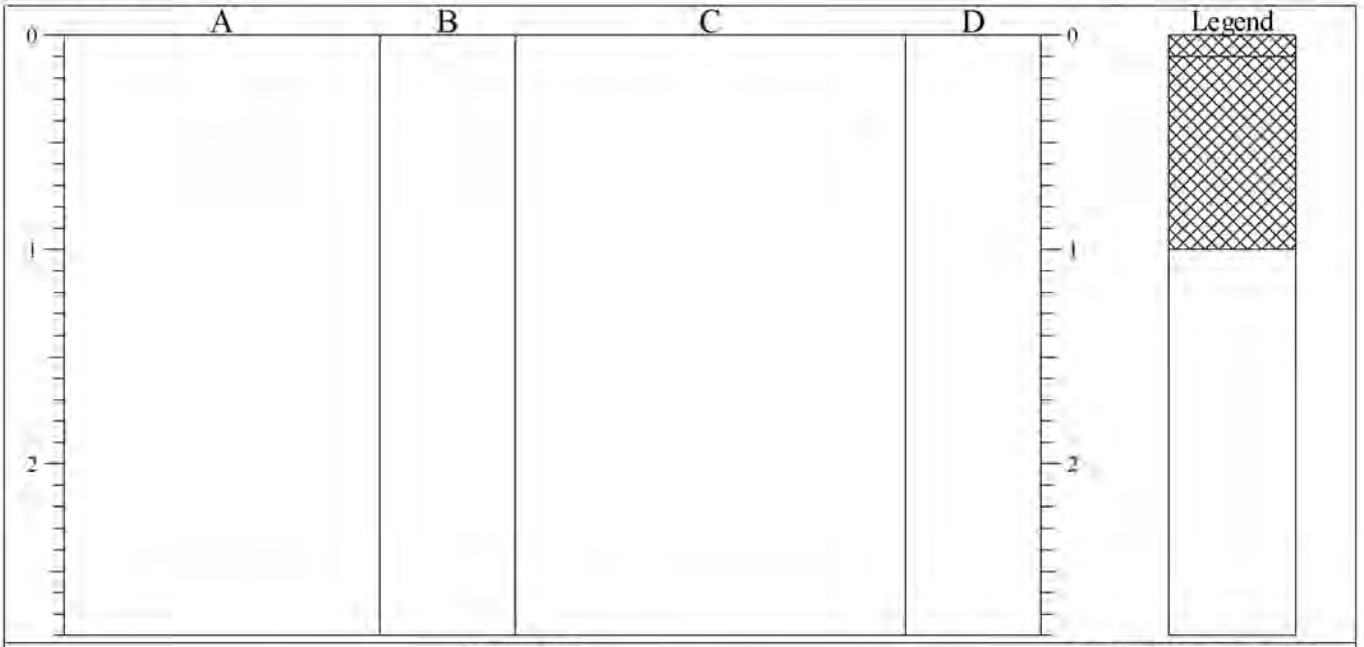
Previously dug foundation inspection pit.

All dimensions in metres Scale 1:35	Client Mr James Allan	Method/ Plant Used Hand pit	Logged By DB

EMS Geotech
Sigeric Business Par
Hereford, HR2 6BQ
Telephone: 01432 2

TRIAL PIT LOG

Project				TRIAL PIT No
Hereford Radiators				FP2
Job No	Date	Ground Level (m)	Co-Ordinates ()	
E14130	15-03-19 15-03-19	61.00	E 350,807.0 N 239,898.0	
Contractor				Sheet
Geo Site Surveys				1 of 1



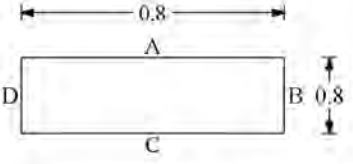
STRATA

Depth	No	DESCRIPTION
0.00-0.10		Made Ground: Concrete.
0.10-1.00		MADE GROUND: Grey gravelly find to coarse sand. Gravel sized fragments of angular to rounded fine to coarse brick, concrete and wood.

SAMPLES & TESTS

Depth	No	Remarks/Tests

Shoring/Support: None
Stability: Stable



GENERAL REMARKS

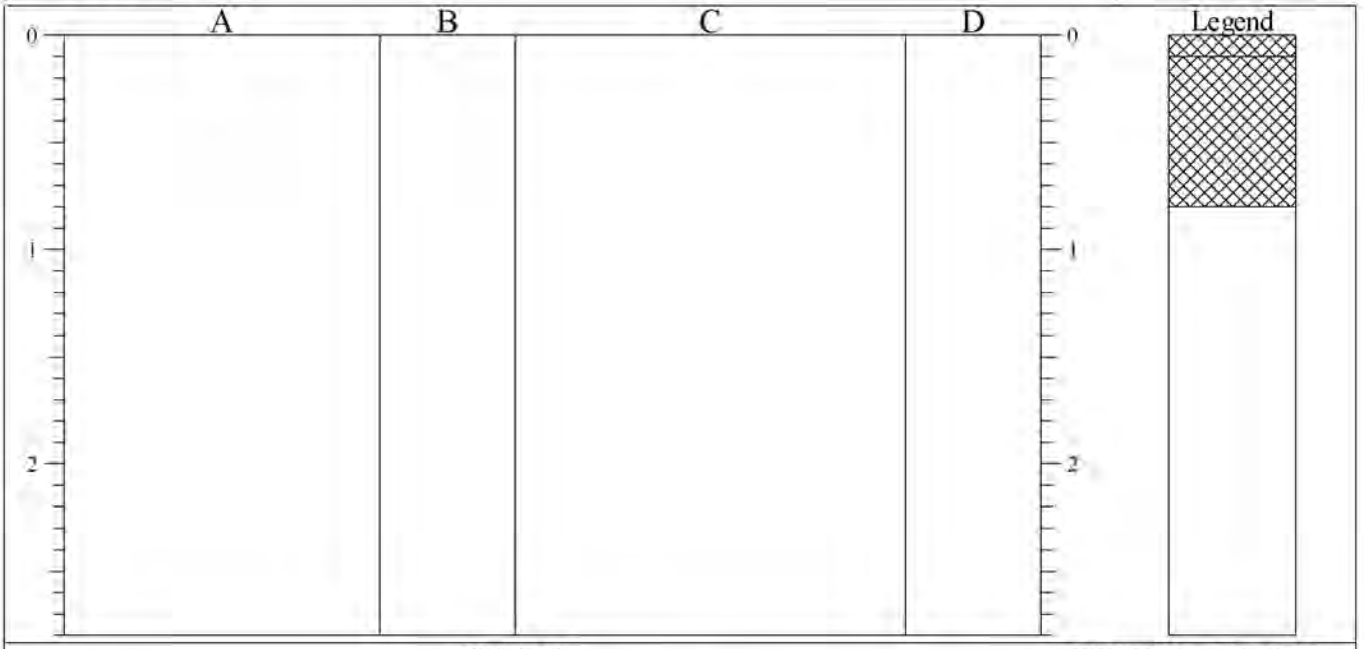
Previously dug foundation inspection pit.

All dimensions in metres Scale 1:35	Client Mr James Allan	Method/ Plant Used Hand pit	Logged By DB

EMS Geotech
Sigeric Business Par
Hereford, HR2 6BQ
Telephone: 01432 2

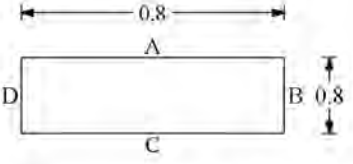
TRIAL PIT LOG

Project				TRIAL PIT No
Hereford Radiators				FP3
Job No	Date	Ground Level (m)	Co-Ordinates ()	
E14130	15-03-19 15-03-19	61.00	E 350,810.0 N 239,904.0	
Contractor				Sheet
Geo Site Surveys				1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.10		MADE GROUND: Concrete.			
0.10-0.80		MADE GROUND: Grey gravelly find to coarse sand. Gravel sized fragments of angular to rounded fine to coarse brick, concrete and wood.			

Shoring/Support: None
Stability: Stable



GENERAL REMARKS

Previously dug foundation inspection pit.

All dimensions in metres Scale 1:35	Client Mr James Allan	Method/ Plant Used Hand pit	Logged By DB

Appendix C – Chemical Analysis Summary Tables

CHEMICAL SUMMARY - METALS & INORGANICS (SOILS)

Client Sample No	Units	Limit of Detecti on (LoD)	GAC*	S1	S1	S1	S1	D3	D3	D3
Client Sample ID				WS01	WS03	WS04	FP1	WS02	WS03	WS04
Depth to Top				1.00	0.20	0.20	1.00	1.90	0.70	0.50
Soil Type				MG	MG	MG	MG	GFSF	GFSD	GFSD
% Stones >10mm	% w/w	0.1	-	5.20	13.00	28.60	25.70	47.4	33.7	13.5
pH BRE	pH	0.01	5 - 10	7.58	7.98	8.50	9.27	8.37	8.45	8.52
Sulphate BRE (water sol 2:1)	mg/l	10	-	94.00	458.00	61.00	50.00	190	104	45
Sulphate BRE (acid sol)	% w/w	0.02	-	0.07	0.13	0.02	<0.02	0.05	0.03	<0.02
Sulphur BRE (total)	% w/w	0.01	-	0.03	0.06	<0.01	<0.01	0.02	0.01	<0.01
Cyanide (total)	mg/kg	1	-	<1	<1	<1	<1			
Phenols - Total by HPLC	mg/kg	0.2	-	<0.2	<0.2	<0.2	<0.2			
Organic matter	% w/w	0.1	-	2.40	4.70	0.90	0.40			
Arsenic	mg/kg	1	340	<1	4.00	<1	<1			
Cadmium	mg/kg	0.5	410	1.30	1.30	0.90	0.50			
Copper	mg/kg	1	68000	52.00	43.00	10.00	4.00			
Chromium	mg/kg	1	8600	20.00	20.00	13.00	11.00			
Chromium (hexavalent)	mg/kg	1	49	<1	<1	<1	<1			
Lead	mg/kg	1	2330	217.00	93.00	35.00	7.00			
Mercury	mg/kg	0.17	320	0.81	0.56	<0.17	0.20			
Nickel	mg/kg	1	980	25.00	25.00	15.00	13.00			
Selenium	mg/kg	1	12000	<1	<1	<1	<1			
Zinc	mg/kg	5	730000	111.00	89.00	31.00	22.00			
Asbestos in Soil (inc. matrix) ^										
Asbestos in soil			LoD	NAD	NAD	NAD	NAD			

* GACs - Commercial and Industrial Use

Concentrations in excess of the GAC

Elevated Concentrations close to but not exceeding the GAC

CHEMICAL SUMMARY - POLYCYCLIC AROMATIC HYDROCARBONS (PAHs) (SOILS)

Client Sample No	Units	Limit of Detection (LoD)	GAC*	S1	S1	S1	S1
Client Sample ID				WS01	WS03	WS04	FP1
Depth to Top				1.00	0.20	0.20	1.00
Soil Type				MG	MG	MG	MG
PAH-16MS							
Acenaphthene	mg/kg	0.01	83000	<0.01	<0.01	<0.01	<0.01
Acenaphthylene	mg/kg	0.01	84000	<0.01	<0.01	<0.01	<0.01
Anthracene	mg/kg	0.02	520000	<0.02	<0.02	<0.02	<0.02
Benzo(a)anthracene	mg/kg	0.04	170	0.05	<0.04	0.04	<0.04
Benzo(a)pyrene	mg/kg	0.04	35	0.06	<0.04	0.04	<0.04
Benzo(b)fluoranthene	mg/kg	0.05	44	0.07	<0.05	0.06	<0.05
Benzo(ghi)perylene	mg/kg	0.05	3900	<0.05	<0.05	<0.05	<0.05
Benzo(k)fluoranthene	mg/kg	0.07	1200	<0.07	<0.07	<0.07	<0.07
Chrysene	mg/kg	0.06	350	<0.06	<0.06	<0.06	<0.06
Dibenzo(ah)anthracene	mg/kg	0.04	3.5	<0.04	<0.04	<0.04	<0.04
Fluoranthene	mg/kg	0.08	23000	<0.08	<0.08	<0.08	<0.08
Fluorene	mg/kg	0.01	63000	<0.01	<0.01	<0.01	<0.01
Indeno(123-cd)pyrene	mg/kg	0.03	500	0.04	<0.03	0.03	<0.03
Naphthalene	mg/kg	0.03	190	<0.03	<0.03	<0.03	<0.03
Phenanthrene	mg/kg	0.03	22000	<0.03	<0.03	<0.03	<0.03
Pyrene	mg/kg	0.07	54000	<0.07	<0.07	0.07	<0.07
Total PAH-16MS	mg/kg	0.01	-	0.22	<0.08	0.24	<0.08

* GACs - Commercial and Industrial Use

Concentrations in excess of the GAC

Elevated Concentrations close to but not exceeding the GAC

CHEMICAL SUMMARY - TOTAL PETROLEUM HYDROCARBONS (TPH) (SOILS)

Client Sample No	Units	Limit of Detection (LoD)	GAC*	S1	S1	S1	S1
Client Sample ID				WS01	WS03	WS04	FP1
Depth to Top				1.00	0.20	0.20	1.00
Soil Type				MG	MG	MG	MG
TPH CWG							
Ali >C5-C6	mg/kg	0.01	3200	<0.01	<0.01	<0.01	<0.01
Ali >C6-C8	mg/kg	0.01	7800	<0.01	<0.01	<0.01	<0.01
Ali >C8-C10	mg/kg	1	2000	<1	<1	<1	<1
Ali >C10-C12	mg/kg	1	9700	<1	<1	<1	<1
Ali >C12-C16	mg/kg	1	59000	<1	<1	<1	<1
Ali >C16-C21	mg/kg	1	1600000	<1	<1	2	<1
Ali >C21-C35	mg/kg	1	1600000	<1	<1	24	<1
Total Aliphatics	mg/kg	1	-	<1	<1	26	<1
Aro >C5-C7	mg/kg	0.01	26000	<0.01	<0.01	<0.01	<0.01
Aro >C7-C8	mg/kg	0.01	56000	<0.01	<0.01	<0.01	<0.01
Aro >C8-C10	mg/kg	1	3500	<1	<1	<1	<1
Aro >C10-C12	mg/kg	1	16000	<1	<1	<1	<1
Aro >C12-C16	mg/kg	1	36000	<1	<1	<1	<1
Aro >C16-C21	mg/kg	1	28000	<1	<1	2	<1
Aro >C21-C35	mg/kg	1	28000	2	<1	6	<1
Total Aromatics	mg/kg	1	-	2	<1	7	<1
TPH (Ali & Aro >C5-C35)	mg/kg	1	-	2	<1	33	<1
BTEX - Benzene	mg/kg	0.01	98	<0.01	<0.01	<0.01	<0.01
BTEX - Toluene	mg/kg	0.01	56000	<0.01	<0.01	<0.01	<0.01
BTEX - Ethyl Benzene	mg/kg	0.01	5700	<0.01	<0.01	<0.01	<0.01
BTEX - m & p Xylene	mg/kg	0.01	5900	<0.01	<0.01	<0.01	<0.01
BTEX - o Xylene	mg/kg	0.01	5900	<0.01	<0.01	<0.01	<0.01
MTBE	mg/kg	0.01	7900	<0.01	<0.01	<0.01	<0.01

* GACs - Commercial and Industrial Use

Concentrations in excess of the GAC

Elevated Concentrations close to but not exceeding the GAC

Appendix D – Laboratory Results – Geotechnical Testing

Laboratory Report

2788

GSTL
GEO Site & Testing Services Ltd

Contract Number: 46230

Client Ref: **E14130**
Client PO: **724**

Report Date: **08-11-2019**

Client **Environmental Management Solutions Ltd (EMS)**
Sigeric Business Park
Holme Lacy Road
Rotherwas
Hereford
HR2 6BQ

Contract Title: **Hereford Radiators**
For the attention of: **Olivia Benbow**

Date Received: **21-10-2019**
Date Completed: **08-11-2019**

Test Description	Qty
Moisture Content BS 1377:1990 - Part 2 : 3.2 - * UKAS	4
PSD Wet Sieve method BS 1377:1990 - Part 2 : 9.2 - * UKAS	1
Disposal of samples for job	1

Notes: **Observations and Interpretations are outside the UKAS Accreditation**
*** - denotes test included in laboratory scope of accreditation**
 # - denotes test carried out by approved contractor
@ - denotes non accredited tests

Approved Signatories:
Emma Sharp (Office Manager) - Paul Evans (Quality/Technical Manager) - Richard John (Advanced Testing Manager)
Sean Penn (Administrative/Accounts Assistant) - Shaun Jones (Laboratory manager) - Wayne Honey (Administrative/Quality Assistant)

GEO Site & Testing Services Ltd
Unit 3-4, Heol Aur, Dafen Ind Estate, Dafen, Llanelli, Carmarthenshire SA14 8QN
Tel: 01554 784040 Fax: 01554 784041 info@gstl.co.uk gstl.co.uk

GSTL

Natural Moisture Content
(BS 1377:1990 - Part 2 : 3.2)
DESCRIPTIONS

Contract Number	46230
Site Name	Hereford Radiators
Date Tested	06/11/2019

Sample/Hole Reference	Sample Number	Sample Type	Depth (m)			Descriptions
WS02	1	D	1.80	-	1.90	
WS03	2	D	0.70	-	0.80	
WS04	2	D	0.40	-	0.50	

Operators	Checked	08/11/2019	Wayne Honey (Administrative/Quality Assistant)
Sam Hammond	Approved	08/11/2019	Paul Evans (Quality/Technical Manager)

UKAS TESTING 2788

GSTL

Natural Moisture Content
(BS 1377:1990 - Part 2 : 3.2)

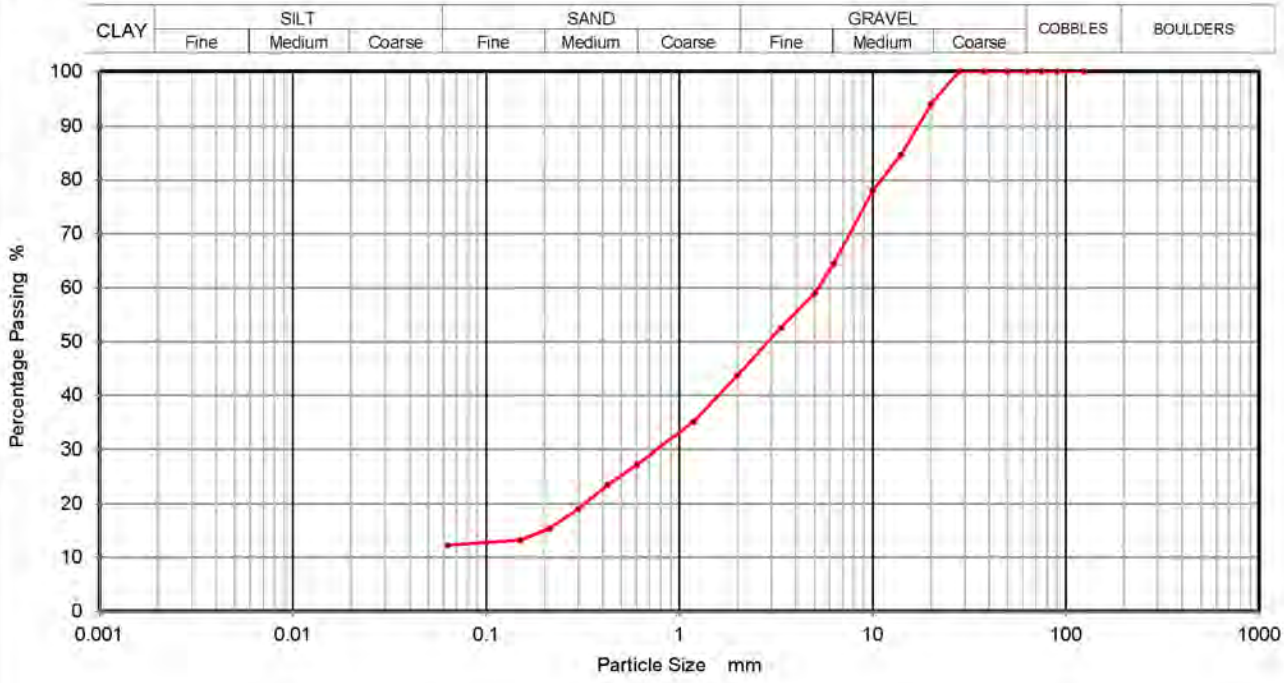
Contract Number	46230
Site Name	Hereford Radiators
Date Tested	06/11/2019

Sample/Hole Reference	Sample Number	Sample Type	Depth (m)			Moisture Content %	Remarks
WS02	1	D	1.80	-	1.90	4.9	
WS02	2	B	2.00	-	2.80	5.1	
WS03	2	D	0.70	-	0.80	7.6	
WS04	2	D	0.40	-	0.50	6.5	

Operators	Checked	08/11/2019	Wayne Honey (Administrative/Quality Assistant)
Sam Hammond	Approved	08/11/2019	Paul Evans (Quality/Technical Manager)

UKAS TESTING
2788

GSTL	PARTICLE SIZE DISTRIBUTION BS 1377 Part 2:1990 Wet Sieve, Clause 9.2	Contract Number	46230
		Borehole/Pit No.	WS02
Site Name	Hereford Radiators	Sample No.	
Soil Description		Depth Top	2.00
		Depth Base	2.80
Date Tested	07/11/2019	Sample Type	B



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	94		
14	85		
10	78		
6.3	64		
5	59		
3.35	53		
2	44		
1.18	35		
0.6	27		
0.425	24		
0.3	19		
0.212	15		
0.15	13		
0.063	12		

Sample Proportions	% dry mass
Cobbles	0
Gravel	56
Sand	32
Silt and Clay	12

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operators	Checked	07/11/2019	Wayne Honey	[redacted]
RO/MH	Approved	08/11/2019	Paul Evans	

UKAS TESTING 2788

Appendix E – Laboratory Results – Chemical Analysis

envirolab
Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 19/09896
Issue Number: 1 **Date:** 01 November, 2019

Client: Environmental Management Solutions Ltd
Sigeric Business Park
Holme Lacy Road
Rotherwas
Hereford
UK
HR2 6BQ

Project Manager: Andrew Harrison
Project Name: Hereford Radiators
Project Ref: E14130
Order No: 723
Date Samples Received: 21/10/19
Date Instructions Received: 21/10/19
Date Analysis Completed: 01/11/19

[redacted]

Melanie Marshall
Laboratory Coordinator

Iain Haslock
Analytical Consultant

mCERTS
UKAS TESTING
1247

Envirolab Job Number: 19/09896

Client Project Name: Hereford Radiators

Client Project Ref: E14130

Lab Sample ID	19/09896/1	19/09896/2	19/09896/3	19/09896/4	19/09896/5	19/09896/6	19/09896/7	Units	Limit of Detection	Method ref
Client Sample No	1	1	1	1	3	3	3			
Client Sample ID	WS01	WS03	WS04	FP1	WS02	WS03	WS04			
Depth to Top	1.00	0.20	0.20	1.00	1.90	0.70	0.50			
Depth To Bottom	1.20	0.30	0.30	1.10	2.00	0.80	0.60			
Date Sampled	17-Oct-19	17-Oct-19	17-Oct-19	17-Oct-19	17-Oct-19	17-Oct-19	17-Oct-19			
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES			
Sample Matrix Code	5AB	5AB	5ABE	4A	4A	4A	4A			
% Stones >10mm$_A$	5.2	13.0	28.6	25.7	47.4	33.7	13.5	% w/w	0.1	A-T-044
pH BRE$_D$[M#]	7.58	7.98	8.50	9.27	8.37	8.45	8.52	pH	0.01	A-T-031s
Sulphate BRE (water sol 2:1)$_D$[M#]	94	458	61	50	190	104	45	mg/l	10	A-T-026s
Sulphate BRE (acid sol)$_D$[M#]	0.07	0.13	0.02	<0.02	0.05	0.03	<0.02	% w/w	0.02	A-T-029s
Sulphur BRE (total)$_D$	0.03	0.06	<0.01	<0.01	0.02	0.01	<0.01	% w/w	0.01	A-T-034s
Cyanide (total)$_A$[M#]	<1	<1	<1	<1	-	-	-	mg/kg	1	A-T-042sTCN
Phenols - Total by HPLC$_A$	<0.2	<0.2	<0.2	<0.2	-	-	-	mg/kg	0.2	A-T-050s
Organic matter$_D$[M#]	2.4	4.7	0.9	0.4	-	-	-	% w/w	0.1	A-T-032:OM
Arsenic$_D$[M#]	<1	4	<1	<1	-	-	-	mg/kg	1	A-T-024s
Cadmium$_D$[M#]	1.3	1.3	0.9	0.5	-	-	-	mg/kg	0.5	A-T-024s
Copper$_D$[M#]	52	43	10	4	-	-	-	mg/kg	1	A-T-024s
Chromium$_D$[M#]	20	20	13	11	-	-	-	mg/kg	1	A-T-024s
Chromium (hexavalent)$_D$	<1	<1	<1	<1	-	-	-	mg/kg	1	A-T-040s
Lead$_D$[M#]	217	93	35	7	-	-	-	mg/kg	1	A-T-024s
Mercury$_D$	0.81	0.56	<0.17	0.20	-	-	-	mg/kg	0.17	A-T-024s
Nickel$_D$[M#]	25	25	15	13	-	-	-	mg/kg	1	A-T-024s
Selenium$_D$[M#]	<1	<1	<1	<1	-	-	-	mg/kg	1	A-T-024s
Zinc$_D$[M#]	111	89	31	22	-	-	-	mg/kg	5	A-T-024s

Envirolab Job Number: 19/09896

Client Project Name: Hereford Radiators

Client Project Ref: E14130

Lab Sample ID	19/09896/1	19/09896/2	19/09896/3	19/09896/4	19/09896/5	19/09896/6	19/09896/7	Units	Limit of Detection	Method ref
Client Sample No	1	1	1	1	3	3	3			
Client Sample ID	WS01	WS03	WS04	FP1	WS02	WS03	WS04			
Depth to Top	1.00	0.20	0.20	1.00	1.90	0.70	0.50			
Depth To Bottom	1.20	0.30	0.30	1.10	2.00	0.80	0.60			
Date Sampled	17-Oct-19	17-Oct-19	17-Oct-19	17-Oct-19	17-Oct-19	17-Oct-19	17-Oct-19			
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES			
Sample Matrix Code	5AB	5AB	5ABE	4A	4A	4A	4A			
Asbestos in Soil (inc. matrix) ^										
Asbestos in soil[D]*	NAD	NAD	NAD	NAD	-	-	-			A-T-045
Asbestos ACM - Suitable for Water Absorption Test?[D]	N/A	N/A	N/A	N/A	-	-	-			A-T-045

Envirolab Job Number: 19/09896

Client Project Name: Hereford Radiators

Client Project Ref: E14130

Lab Sample ID	19/09896/1	19/09896/2	19/09896/3	19/09896/4	19/09896/5	19/09896/6	19/09896/7	Units	Limit of Detection	Method ref
Client Sample No	1	1	1	1	3	3	3			
Client Sample ID	WS01	WS03	WS04	FP1	WS02	WS03	WS04			
Depth to Top	1.00	0.20	0.20	1.00	1.90	0.70	0.50			
Depth To Bottom	1.20	0.30	0.30	1.10	2.00	0.80	0.60			
Date Sampled	17-Oct-19	17-Oct-19	17-Oct-19	17-Oct-19	17-Oct-19	17-Oct-19	17-Oct-19			
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES			
Sample Matrix Code	5AB	5AB	5ABE	4A	4A	4A	4A			
PAH-16MS										
Acenaphthene$_A^{M\#}$	<0.01	<0.01	<0.01	<0.01	-	-	-	mg/kg	0.01	A-T-019s
Acenaphthylene$_A^{M\#}$	<0.01	<0.01	<0.01	<0.01	-	-	-	mg/kg	0.01	A-T-019s
Anthracene$_A^{M\#}$	<0.02	<0.02	<0.02	<0.02	-	-	-	mg/kg	0.02	A-T-019s
Benzo(a)anthracene$_A^{M\#}$	0.05	<0.04	0.04	<0.04	-	-	-	mg/kg	0.04	A-T-019s
Benzo(a)pyrene$_A^{M\#}$	0.06	<0.04	0.04	<0.04	-	-	-	mg/kg	0.04	A-T-019s
Benzo(b)fluoranthene$_A^{M\#}$	0.07	<0.05	0.06	<0.05	-	-	-	mg/kg	0.05	A-T-019s
Benzo(ghi)perylene$_A^{M\#}$	<0.05	<0.05	<0.05	<0.05	-	-	-	mg/kg	0.05	A-T-019s
Benzo(k)fluoranthene$_A^{M\#}$	<0.07	<0.07	<0.07	<0.07	-	-	-	mg/kg	0.07	A-T-019s
Chrysene$_A^{M\#}$	<0.06	<0.06	<0.06	<0.06	-	-	-	mg/kg	0.06	A-T-019s
Dibenzo(ah)anthracene$_A^{M\#}$	<0.04	<0.04	<0.04	<0.04	-	-	-	mg/kg	0.04	A-T-019s
Fluoranthene$_A^{M\#}$	<0.08	<0.08	<0.08	<0.08	-	-	-	mg/kg	0.08	A-T-019s
Fluorene$_A^{M\#}$	<0.01	<0.01	<0.01	<0.01	-	-	-	mg/kg	0.01	A-T-019s
Indeno(123-cd)pyrene$_A^{M\#}$	0.04	<0.03	0.03	<0.03	-	-	-	mg/kg	0.03	A-T-019s
Naphthalene $_A^{M\#}$	<0.03	<0.03	<0.03	<0.03	-	-	-	mg/kg	0.03	A-T-019s
Phenanthrene$_A^{M\#}$	<0.03	<0.03	<0.03	<0.03	-	-	-	mg/kg	0.03	A-T-019s
Pyrene$_A^{M\#}$	<0.07	<0.07	0.07	<0.07	-	-	-	mg/kg	0.07	A-T-019s
Total PAH-16MS$_A^{M\#}$	0.22	<0.08	0.24	<0.08	-	-	-	mg/kg	0.01	A-T-019s

Envirolab Job Number: 19/09896

Client Project Name: Hereford Radiators

Client Project Ref: E14130

Lab Sample ID	19/09896/1	19/09896/2	19/09896/3	19/09896/4	19/09896/5	19/09896/6	19/09896/7	Units	Limit of Detection	Method ref
Client Sample No	1	1	1	1	3	3	3			
Client Sample ID	WS01	WS03	WS04	FP1	WS02	WS03	WS04			
Depth to Top	1.00	0.20	0.20	1.00	1.90	0.70	0.50			
Depth To Bottom	1.20	0.30	0.30	1.10	2.00	0.80	0.60			
Date Sampled	17-Oct-19	17-Oct-19	17-Oct-19	17-Oct-19	17-Oct-19	17-Oct-19	17-Oct-19			
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES			
Sample Matrix Code	5AB	5AB	5ABE	4A	4A	4A	4A			
TPH CWG										
Ali >C5-C6$_A^{\#}$	<0.01	<0.01	<0.01	<0.01	-	-	-	mg/kg	0.01	A-T-022s
Ali >C6-C8$_A^{\#}$	<0.01	<0.01	<0.01	<0.01	-	-	-	mg/kg	0.01	A-T-022s
Ali >C8-C10$_A$	<1	<1	<1	<1	-	-	-	mg/kg	1	A-T-055s
Ali >C10-C12$_A^{M\#}$	<1	<1	<1	<1	-	-	-	mg/kg	1	A-T-055s
Ali >C12-C16$_A^{M\#}$	<1	<1	<1	<1	-	-	-	mg/kg	1	A-T-055s
Ali >C16-C21$_A^{M\#}$	<1	<1	2	<1	-	-	-	mg/kg	1	A-T-055s
Ali >C21-C35$_A$	<1	<1	24	<1	-	-	-	mg/kg	1	A-T-055s
Total Aliphatics$_A$	<1	<1	26	<1	-	-	-	mg/kg	1	A-T-055s
Aro >C5-C7$_A^{\#}$	<0.01	<0.01	<0.01	<0.01	-	-	-	mg/kg	0.01	A-T-022s
Aro >C7-C8$_A^{\#}$	<0.01	<0.01	<0.01	<0.01	-	-	-	mg/kg	0.01	A-T-022s
Aro >C8-C10$_A$	<1	<1	<1	<1	-	-	-	mg/kg	1	A-T-055s
Aro >C10-C12$_A^{M\#}$	<1	<1	<1	<1	-	-	-	mg/kg	1	A-T-055s
Aro >C12-C16$_A$	<1	<1	<1	<1	-	-	-	mg/kg	1	A-T-055s
Aro >C16-C21$_A^{M\#}$	<1	<1	2	<1	-	-	-	mg/kg	1	A-T-055s
Aro >C21-C35$_A^{M\#}$	2	<1	6	<1	-	-	-	mg/kg	1	A-T-055s
Total Aromatics$_A$	2	<1	7	<1	-	-	-	mg/kg	1	A-T-055s
TPH (Ali & Aro >C5-C35)$_A$	2	<1	33	<1	-	-	-	mg/kg	1	A-T-055s
BTEX - Benzene$_A^{\#}$	<0.01	<0.01	<0.01	<0.01	-	-	-	mg/kg	0.01	A-T-022s
BTEX - Toluene$_A^{\#}$	<0.01	<0.01	<0.01	<0.01	-	-	-	mg/kg	0.01	A-T-022s
BTEX - Ethyl Benzene$_A^{\#}$	<0.01	<0.01	<0.01	<0.01	-	-	-	mg/kg	0.01	A-T-022s
BTEX - m & p Xylene$_A^{\#}$	<0.01	<0.01	<0.01	<0.01	-	-	-	mg/kg	0.01	A-T-022s
BTEX - o Xylene$_A^{\#}$	<0.01	<0.01	<0.01	<0.01	-	-	-	mg/kg	0.01	A-T-022s
MTBE$_A^{\#}$	<0.01	<0.01	<0.01	<0.01	-	-	-	mg/kg	0.01	A-T-022s

REPORT NOTES

General
This report shall not be reproduced, except in full, without written approval from Envirolab.
The results reported herein relate only to the material supplied to the laboratory.
The residue of any samples contained within this report, and any received with the same delivery, will be disposed of six weeks after initial scheduling. For samples tested for Asbestos we will retain a portion of the dried sample for a minimum of six months after the initial Asbestos testing is completed.
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, 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.
The Client Sample No, Client Sample ID, Depth to Top, Depth to Bottom and Date Sampled were all provided by the client.

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.

Envirolab Deviating Samples Report

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Client: Environmental Management Solutions Ltd, Sigeric Business Park, Holme Lacy Road, Rotherwas, Hereford, UK, HR2 6BQ

Project: Hereford Radiators

Clients Project No: E14130

Project No: 19/09896

Date Received: 21/10/2019 (am)

Cool Box Temperatures (°C): 9.9

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.

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