

SP ASSOCIATES

**PHASE II GEO-ENVIRONMENTAL
ASSESSMENT
PROPOSED INDUSTRIAL DEVELOPMENT
SITE 4
WREXHAM INDUSTRIAL ESTATE**

Client: FI Real Estate Management Ltd

Report Number: S1671- 4

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**PHASE II GEO-ENVIRONMENTAL ASSESSMENT
PROPOSED INDUSTRIAL DEVELOPMENT
SITE 4
WREXHAM INDUSTRIAL ESTATE**

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REPORT No S1671-4

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CONTENTS

1. INTRODUCTION	9
2. THE SITE	10
2.1 LOCATION AND SURFACE CONDITIONS	10
2.2 HISTORY	10
2.3 GEOLOGY AND MINING	10
2.4 HYDROGEOLOGY AND HYDROLOGY	11
2.5 RADON GAS	11
2.6 GROUND STABILITY	11
3 RISK SUMMARY AND CONCEPTUAL SITE MODELS	12
3.1 HUMAN HEALTH RISKS	12
3.2 GROUND GAS	12
3.3 CONTROLLED WATERS	12
3.4 BUILDINGS AND SERVICES	12
3.5 CONCEPTUAL SITE MODELS	12
4 GROUND INVESTIGATION	13
4.1 GENERAL	13
4.2 PRE-INVESTIGATION SURVEY	13
4.3 WINDOW SAMPLER BOREHOLES	13
4.4 STANDPIPES	13

4.5 TRIAL PITS	14
4.6 IN-SITU CBR TESTING	14
4.7 SAMPLING AND LABORATORY TESTING	14
4.8 MONITORING	15
5. GROUND CONDITIONS	16
5.1 MADE GROUND AND BURIED OBSTRUCTIONS	16
5.2 GLACIAL TILL	16
5.3 GROUNDWATER	17
6 GEOTECHNICAL ASSESSMENT	18
6.1 GENERAL	18
6.2 FOUNDATIONS	18
6.3 BURIED OBSTRUCTIONS	18
6.4 GROUND FLOOR SLABS	18
6.5 BELOW GROUND CONCRETE	19
6.6 PAVEMENTS	19
7 ENVIRONMENTAL CONSIDERATIONS	20
7.1 SOIL CONTAMINATION	20
7.1.1 GENERAL APPROACH	20
7.1.2 RISK SCREENING	20
7.1.2.1 EXPLOSIVE RISK	20
7.1.2.2 HUMAN SITE OCCUPIERS AND CONSTRUCTION WORKERS	20
7.1.2.3 STRUCTURES AND INFRASTRUCTURE	20
7.1.3 PROPOSED SOIL REMEDIAL MEASURES	21
7.2 CONTROLLED WATERS	21
7.3 GROUND GAS	21
TABLES	
1. Gas and Groundwater Readings	
2. Human Health Screening Values for a Commercial/Industrial Land Use versus Measured Values – Soils	
3. Groundwater Test Results Compared to UK Drinking Water Standards Maximum Allowable Concentrations	

FIGURES

- 1 Site Location Plan
- 2 Borehole and Trial Pit Location Plan
- 3 CBR Test Location Plan

APPENDICES

- A Preliminary CSMs
- B UXO Threat Assessment
- C Historical Site Features
- D Borehole and Trial Pit Logs
- E Chemical Test Results
- F Geotechnical Test Results
- G CBR Test Results
- H Amended CSM

EXECUTIVE SUMMARY

The Site	The site is located within Wrexham Industrial Estate which is a large industrial area located about 4km to the east of Wrexham town centre. The site's National Grid reference is 337509 349399 (site centre) and its location within the industrial estate is shown on Figure 1. The site is irregularly shaped and occupies an area of about 1.96 hectares. It comprises open land vegetated with rough grasses that slopes gently from about 33m AOD in the north-west to about 31m AOD along its south-eastern boundary. A stream in a cutting of about 0.5m to 2m bounds the site to the south-east, with a bund of about 1m in height defining the site's north-eastern boundary. Mature trees are present within some of the site's boundary areas. An industrial unit and an un-named road bound the site to the north-east with a stream delineating the south-eastern boundary. Clywedog Road North lies to the west with Clywedog Road East to the south.
History	Prior to the late 1930s the site comprised agricultural land. At some point around the end of the 1930s and the beginning of the 1940s the wider area was developed as ROF Wrexham which was created to manufacture Cordite. The site itself is located in an area of the facility that was towards the end of the production cycle and it was occupied by a press house and smaller drying houses. An acetone recovery structure was also present.
Geology	The site is underlain by solid strata of the Salop Formation that comprises sequences of mudstone, sandstone and conglomerate. It is overlain by up to 55m of Devensian Till that typically comprises firm to stiff, sandy, gravelly clay with occasional lenses and beds of sand and gravel with inter-bedded laminated silts. The site lies within a Coal Authority Coal Mining Reporting Area; however, the mineral resources lie beneath a thick cover of Drift deposits (about 55m) and are located at considerable depth beneath rockhead.
Hydrogeology	The Salop Formation is classified as a Secondary A aquifer whilst the overlying Till is classified as a Secondary Undifferentiated Aquifer.
Radon Gas	The site is in a Lower Probability radon area where less than 1% of properties are above the Radon action level. Radon protection will not be required for the proposed development.
Ground Investigation	Boreholes : A total of 5no boreholes were sunk across the site on the 4th March 2020 using a window sampler drilling rig. The boreholes were each located to coincide with the position of proposed development units and were taken to depths of between 3.45m and 4.45m below ground surface. Exceptionally, Borehole 3 refused at 0.5m depth at 3 separate locations around its proposed position due to obstructions within the formation. Standard Penetration Tests were carried out at 1m intervals within each borehole with full depth liner soil samples being recovered for soil description and testing requirements. Trial Pits: A total of 4no trial pits were excavated across the site on the 12th March 2020 using a wheeled excavator with back-actor. The pits were positioned so as to coincide with historic site structures associated with ROF Wrexham including acetone recovery and drying houses, and buried pipework. The pits were each taken to a depth of

	2.1m below ground surface where they were terminated within stiff natural formation. Laboratory Testing: The following list of potential contaminants of concern has been specified for the laboratory testing program on soil samples: Asbestos, phenols, heavy metals, inorganic chemicals, Speciated Petroleum Hydrocarbons, PAHs, acetone and explosives. With regard to geotechnical testing, 4no samples of the cohesive formation taken from the approximate foundation horizon have been tested for Index properties in the laboratories of Socotec. In addition to the soil sampling and testing program, groundwater samples collected from the borehole standpipes have been tested in the laboratory of Chemtest to UK Drinking Water Standards. In_Situ CBR Tests: A total of 5no in-situ CBR tests were carried out at the site on the 2nd February 2020. The tests were carried out in accordance with BS 1377-9, 1990 Method 4.3 using a plunger and 4 x 4 vehicle as kentledge. Standpipe Monitoring: Concentrations of methane, carbon dioxide, oxygen, hydrogen sulphide and carbon monoxide gas have been measured within the three borehole standpipes on four occasions within the period 25th February 2020 to the 29th March 2020. Total gas concentrations were taken using a GA2000 Plus meter with atmospheric pressure meter. The rate of gas flow from the standpipes was measured using a flow meter. Groundwater levels within the standpipes were also measured at each monitoring visit.
Ground Conditions	Made Ground: Made Ground deposits were absent from Borehole 1, 2 and 4 and were present within Borehole 3 and all four trial pits. Made Ground deposits of up to 1.2m in thickness have been encountered within the trial pits which were positioned so as to coincide with historical site structures to include Drying Houses and Acetone Recovery Houses. Boulders of concrete and brick walls and footings have been encountered within the formation which would tend to confirm the site records that suggest the historical structures were demolished down to ground level leaving the below ground sub-structures in place. Dense sandstone fragments were also encountered within the formation in Borehole 3. Glacial Till: The natural formation present beneath the Made Ground and topsoil horizons comprises Glacial Till. The formation was encountered predominantly as a firm to stiff, brown mottled grey clay. The cohesive Till lies within the High Plasticity/Medium Shrinkage potential category. Groundwater: During the monitoring period groundwater was measured at depths of between 0.24m and 0.27m below ground surface within Borehole 1 and at depths of between 0.68m and 0.72m within Borehole 5. The Borehole 4 standpipe remained dry.

	The disparity in groundwater levels within the three standpipes is an illustration of the perched and laterally discontinuous nature of groundwater that often occurs within Till formations.
Foundations	Conventional strip or pad footings should be suitable for the proposed development and such foundations taken through any Made Ground or soft natural soils to found a minimum depth of 900mm below finished grade may be designed using an allowable bearing capacity of 120 kPa. Index test results have categorised the clay formation as being of High Plasticity with Medium shrinkage potential. Consequently, the recommendations of NHBC Standards Chapter 4.2 should be followed where foundations lie within influencing distance of existing, recently planted or recently felled trees. The relationship between Natural Moisture Content and Liquid Limit values indicate that the tested samples are not desiccated.
Ground Floor Slabs	The near surface natural formation comprises high plasticity clay and such materials can display significantly high volume change potential in response to moisture content variations. Such changes in volume post construction can induce undesirable differential movements between the slab and the frame of the structure if slab on untreated grade construction techniques have been adopted. If slab on grade construction is desirable it is recommended that the natural formation beneath the slab is excavated and replaced with well compacted engineering fill to a minimum depth of 900mm below finished grade. This will reduce the impact of potential post construction ground movements on the performance of the slab. As an alternative to the above construction method, a suspended slab could be adopted. Given the high plasticity nature of the natural formation it is recommended that an under-slab void of at least 150mm is maintained. The adoption of a suspended slab may require the construction of internal footings depending upon the dimensions of the required slab and its working load bearing requirements.
Below Ground Obstructions	The trial pits that were excavated within the vicinity of historical site structures have encountered boulders of concrete and buried walls and footings. This would confirm the historical records which state that former buildings associated with ROF Wrexham were demolished to ground level only. It is likely therefore that buried obstructions will be encountered within some of the Made Ground formation and that their removal may result in some degree of overbreak in individual foundation excavations. The locations of historical structures are shown on the aerial photograph contained within Appendix B and any below ground excavations carried out within those areas will likely encounter buried concrete and brick structures. However, it is also possible that such obstructions will also be encountered over other site areas particularly where former pipe runs were located.
Pavements	The in-situ CBR test results range from 0.7% to 3.4%. Some of the CBR values achieved are lower than would be expected for a firm to stiff clay. The CBR value for a given soil depends upon its dry density and its moisture content and the higher the latter value the

	lower the CBR value tends to be. The in-situ testing took place in February during and after a spell of very high rainfall and the near surface soils were very soft. The Plasticity Index range for the clay formation from Index test data is 25% to 35% which, based upon the recommendations of Interim Advice Note 73/06 Revision 1 (2009), equates to a CBR of about 3%. On the grounds that the formation level for the proposed pavements is likely to be somewhat deeper than the test level and that corresponding natural moisture contents will be somewhat lower than those measured, it is recommended that a design CBR value of 2.5% is adopted for a thin layered pavement construction.
Below Ground Concrete	Below ground conditions with respect to concrete specification conform with Class DS-1 as defined in BRE Special Digest 1, 'Concrete in aggressive ground', 2005', with a corresponding ACEC class of AC-1s.
Soil Remedial Measures	Soil remedial measures should not be required at the site.
Groundwater Remedial Measures	No groundwater remediation measures should be required.
Gas Membranes	No gas protection measures should be required for the proposed development.

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1. INTRODUCTION

SP Associates (SPA) has been appointed by F1 Real Estate Management Ltd to carry out a Geo-Environmental Assessment at the site of a proposed industrial development located on a parcel of land located within the Wrexham Industrial Estate known as Site 4. This study is predicated upon the findings of a Phase I, Geo-Environmental Desk Study Assessment carried out by Integra Consulting in September 2018, their reference 3036-15. That report should be referenced for specific historical land use and environmental data; however, for completeness, elements of that study are included within this report.

The scope of the investigation that forms the basis of this Phase II Assessment is as follows:

- Trial pits excavated using a wheeled excavator with back actor;
- Boreholes sunk using a windowless sampler drilling rig;
- Borehole instrumentation comprising gas and groundwater monitoring standpipe;
- Standpipe monitoring for ground gas and groundwater levels;
- In-situ CBR testing;
- Testing of selected soil samples in the laboratory for chemical and geotechnical parameters;
- Testing of groundwater samples for Drinking Water parameters;
- Analysis of data and reporting.

The investigation was implemented in order to assess the geotechnical and geo-environmental conditions at the site and to identify potential geotechnical and geo-environmental issues related to the construction of the proposed industrial development. This report presents the factual data from the investigation and makes recommendations on foundations and ground floor slab design, pavement design and issues associated with soil, ground gas and controlled waters contamination.

2. THE SITE

2.1 LOCATION AND SURFACE CONDITIONS

The site is located within Wrexham Industrial Estate which is a large industrial area located about 4km to the east of Wrexham town centre. The site's National Grid reference is 337509 349399 (site centre) and its location within the industrial estate is shown on Figure 1.

The site is irregularly shaped and occupies an area of about 1.96 hectares. It comprises open land vegetated with rough grasses that slopes gently from about 33m AOD in the north-west to about 31m AOD along its south-eastern boundary. A stream in a cutting of about 0.5m to 2m bounds the site to the south-east, with a bund of about 1m in height defining the site's north-eastern boundary. Mature trees are present within some of the site's boundary areas.

An industrial unit and an un-named road bound the site to the north-east with a stream delineating the south-eastern boundary. Clywedog Road North lies to the west with Clywedog Road East to the south.

2.2 HISTORY

The Phase I Assessment should be accessed for details of the site's history. A summarised version follows.

Prior to the late 1930s the site comprised agricultural land. At some point around the end of the 1930s and the beginning of the 1940s the wider area was developed as ROF Wrexham which was created to manufacture Cordite. The site itself is located in an area of the facility that was towards the end of the production cycle and it was occupied by a press house and smaller drying houses. An acetone recovery structure was also present.

ROF Wrexham ceased to operate in August 1945 shortly after which it was sold for industrial development. Records indicate that remediation works were carried out at this time; however, no specific details of that process remain. At some point in time between the mid-1960s and late 1970s the site had been cleared of all ROF Wrexham related structures with the exception of blast bunds, mounds and cuttings which are recorded as having been removed between the late 1970s and late 1980s. The site has remained undeveloped since then to the present day.

2.3 GEOLOGY AND MINING

Geological records indicate that the site is underlain by solid strata of the Salop Formation that comprises sequences of mudstone, sandstone and conglomerate. It is overlain by up to 55m of Devensian Till that typically comprises firm to stiff, sandy, gravelly clay with occasional lenses and beds of sand and gravel with inter-bedded laminated silts.

It is anticipated that due to the site's historical use as part of ROF Wrexham there may be pockets and areas of Made Ground present along potentially with some buried structures.

The site lies within a Coal Authority Coal Mining Reporting Area; however, the mineral resources lie beneath a thick cover of Drift deposits (about 55m) and are located at considerable depth beneath rockhead. Consequently, the risks posed to the site from mining activities are considered to be very low.

2.4 HYDROGEOLOGY AND HYDROLOGY

The nearest significant surface water feature is the stream that bounds the site to the south-east.

The Salop Formation is classified as a Secondary A aquifer whilst the overlying Till is classified as a Secondary Undifferentiated Aquifer.

The site does not lie within a Source Protection Zone.

There are no groundwater or surface water abstraction licenses within 500m of the site.

2.5 RADON GAS

The site lies in a radon area where between 1% and 3% of homes are estimated to be at or above the action level. No radon protection measures should be required for the proposed new development.

2.6 GROUND STABILITY

The Phase I Assessment indicates that the risks to the site from compressible ground, collapsible ground, ground dissolution, landslides, running sand and shrinking or swelling ground are very low or no hazard.

3 RISK SUMMARY AND CONCEPTUAL SITE MODELS

The following risk summary is predicated upon the findings of the Phase I Assessment.

3.1 HUMAN HEALTH RISKS

The site is considered to pose a low to moderate risk to human health. This risk category has been arrived at on the basis that those ROF activities that were carried out on site and within the immediate surrounding area are considered to have a significantly reduced contaminative potential compared to those activities carried out over other areas of the ROF site.

Construction workers are considered to be the most significant human health receptor and a moderate risk is envisaged as significant harm is possible in the short term. However, this increased risk can be mitigated by ensuring that appropriate work procedures are adhered to and that direct contact with potentially contaminated or explosive material is avoided through the wearing of appropriate PPE.

For future site occupants the majority of pathways between source and receptor are anticipated to be negated or significantly reduced resulting in betterment to the site. Consequently, a low risk is envisaged as it is improbable that significant harm would occur even in the long term.

3.2 GROUND GAS

The site is considered to be at a low level of risk from ground gases due to the very low ground gas generating potential of most of the identified sources; the very low probability of harm occurring to a receptor and the low sensitivity of the proposed development.

3.3 CONTROLLED WATERS

A low risk is considered to be appropriate at this stage for controlled waters. The risk has been assigned on the basis that it is unlikely that any significant harm would occur, even in the very long term, due to the significant thickness of predominantly low permeability superficial deposits that overlie the Secondary A aquifer. It is also unlikely that any significant contamination would migrate to sensitive surface water receptors. In addition, the Secondary Undifferentiated Aquifer is not considered to be overly sensitive.

3.4 BUILDINGS AND SERVICES

The Phase I Assessment indicates that the site is at low to moderate risk from aggressive contaminants within soil and groundwater that have the potential to attack building materials and services. A moderate risk is envisaged during construction works due to the explosive risk to building materials and services.

3.5 CONCEPTUAL SITE MODELS

The development of Conceptual Models for the site involves the determination of potential pollutant linkages through the identification of likely sources of contamination from previous and current site uses and the identification of potential receptors such as site users and controlled waters. Conceptual Site Models developed by the Phase I Assessment for Human Health, Geotechnical Issues, Ground Gas and Controlled Waters are enclosed within Appendix A.

4 GROUND INVESTIGATION

4.1 GENERAL

The fieldwork was carried out generally where relevant in accordance with BS5930 (1999) 'Code of Practice for Site Investigations', BS10175 Investigation of Potentially Contaminated Sites, and the Association of Geotechnical and Geoenvironmental Specialist Guidelines for Good Practice in Site Investigations (1998).

The locations of the exploratory boreholes and trial pits were chosen so as to provide specific coverage relative to the proposed development layout and to the recorded locations of historical structures.

4.2 PRE-INVESTIGATION SURVEY

The site, being operational during the second world war and being a facility that manufactured explosives for the war effort, was an obvious potential target for bombardment by enemy aircraft. Under those circumstances, UXO Threat Assessment reports have been obtained copies of which are enclosed within Appendix B.

Those reports indicate that there are no specific records of unexploded ordnance within the site boundaries. Despite this, precautions were taken by site operatives during the intrusive investigative work and this commenced with a metal detector scan at each borehole and trial pit location. Subsequent to this, hand dug trial pits were excavated at each borehole and trial pit location prior to the employment of mechanical equipment. No objects that could be considered to represent UXO were encountered.

Explosive residues within the site soils were also considered to be a potential risk to site operatives and also subsequently to laboratory staff. In order to mitigate the risk a program of in-situ screening tests was carried out on those soil samples selected for laboratory testing. All in-situ tests returned a negative result for explosive residues.

4.3 WINDOW SAMPLER BOREHOLES

A total of 5no boreholes were sunk across the site on the 4th March 2020 using a window sampler drilling rig. The boreholes were each located to coincide with the position of proposed development units and were taken to depths of between 3.45m and 4.45m below ground surface. Exceptionally, Borehole 3 refused at 0.5m depth at 3 separate locations around its proposed position due to obstructions within the formation. Standard Penetration Tests were carried out at 1m intervals within each borehole with full depth liner soil samples being recovered for soil description and testing requirements.

Borehole locations are shown on Figure 2 whilst borehole logs are enclosed within Appendix D.

4.4 STANDPIPES

Groundwater and gas monitoring standpipe were installed into augered boreholes on the 24th February 2020 some weeks prior to the sinking of the window sampler boreholes. At the time of their installation the auger rig was able to handle the very wet ground conditions better than the window sampler and a decision was made to use that rig to ensure that the standpipes were correctly installed. They were sunk at the proposed locations of Boreholes 1, 4 and 5. Standpipe details are summarised below:

Borehole	Depth to Base (m)	Response Zone (m bgl)	Pipe Diameter (mm)	Gas Valve/Lockable Cover
1	4.0	1.0 – 4.0 (firm to stiff clay)	50	Yes
4	3.0	1.0 – 3.0 (firm to stiff clay)	50	Yes
5	3.0	1.0 – 3.0 (firm to stiff clay)	50	Yes

4.5 TRIAL PITS

A total of 4no trial pits were excavated across the site on the 12th March 2020 using a wheeled excavator with back-actor. The pits were positioned so as to coincide with historic site structures associated with ROF Wrexham including acetone recovery and drying houses, and buried pipework. The pits were each taken to a depth of 2.1m below ground surface where they were terminated within stiff natural formation.

Trial pit locations are shown on Figure 2 with trial pit logs enclosed within Appendix D.

4.6 IN-SITU CBR TESTING

A total of 5no in-situ CBR tests were carried out at the site on the 2nd February 2020 in the locations shown on Figure 3. The tests were carried out in accordance with BS 1377-9, 1990 Method 4.3 using a plunger and 4 x 4 vehicle as kentledge.

Test results are enclosed within Appendix G.

4.7 SAMPLING AND LABORATORY TESTING

Soil samples was carried out in the knowledge that they could contain explosive contaminants with particular attention to the following:

- Samples were taken using non-sparking implements;
- They were placed in amber glass jars with PTFE liners and a sealing lid suitable for use with primary explosives;
- Samples to be tested for explosive contamination were tested prior to transportation on the public roads;
- All sample packaging complied with the Packaging of Explosives for Carriage Regulations and the Classification and Labelling of Explosives Regulations.

The Phase I environmental database has indicated that the site has historically comprised part of ROF Wrexham and was occupied by drying houses and an acetone recovery house. Consequently, the following list of potential contaminants of concern has been specified for the laboratory testing program:

Asbestos, phenols, heavy metals, inorganic chemicals, Speciated Petroleum Hydrocarbons, PAHs, acetone and explosives.

Selected soil samples from the borehole and trial pit investigation have been tested in the laboratories of Chemtest for the above range of chemical determinants.

With regard to geotechnical testing, 4no samples of cohesive formation taken from the approximate foundation horizon have been tested for Index properties in the laboratories of Socotec.

In addition to the soil sampling and testing program, groundwater samples collected from the borehole standpipes have been tested in the laboratory of Chemtest for UK Drinking Water parameters.

Chemical test results are enclosed within Appendix E, with geotechnical test results enclosed within Appendix F.

4.8 MONITORING

Concentrations of methane, carbon dioxide, oxygen, hydrogen sulphide and carbon monoxide gas have been measured within the three borehole standpipes on four occasions within the period 29th February 2020 to the 27th March 2020. Total gas concentrations were taken using a GA2000 Plus meter with atmospheric pressure meter. The rate of gas flow from the standpipes was measured using a flow meter.

Groundwater levels within the standpipes were also measured at each monitoring visit.

The results obtained from the monitoring exercise are summarised on Table 1.

5. GROUND CONDITIONS

The site investigation has confirmed the expected natural geological formation of Glacial Till. Made Ground deposits were present overlying the Glacial Till within some of the exploratory boreholes and trial pits.

5.1 MADE GROUND AND BURIED OBSTRUCTIONS

Made Ground deposits were absent from Borehole 1, 2 and 4. Made Ground deposits as encountered within the trial pits and within Borehole 3 are summarised below:

BH/TP	Depth below Ground Surface (m)	Description
BH3	GL – 0.5	Brown, gravelly CLAY with dense Sandstone fragments
TP1	GL – 1.6	Soft CLAY with brick, concrete and shale fragments
TP2	GL – 0.9	Soft CLAY with fine to coarse gravel and boulders of concrete with occasional brick and shale fragments
	0.9 – 1.2	BRICK wall and footing trending east/west
TP3	GL – 0.4	Soft CLAY with brick fragments
	0.4 – 0.7	Soft CLAY with boulders of concrete, brick fragments and occasional shale and wood fragments
	0.7 – 0.9	Loose GRAVEL in a sandy clay matrix
TP4	GL – 1.2	Soft to firm, brown CLAY with some boulders of concrete and occasional brick and fine coal fragments

As the above summary table illustrates Made Ground deposits of up to 1.2m in thickness have been encountered within the trial pits which were all positioned so as to coincide with historical site structures to include Drying Houses and Acetone Recovery Houses (see Appendix B). Boulders of concrete and brick walls and footings have been encountered within the formation which would tend to confirm the site records that suggest historical structures were demolished down to ground level leaving the below ground sub-structures in place.

Dense sandstone fragments were encountered within the formation in Borehole 3.

5.2 GLACIAL TILL

The natural formation present beneath the Made Ground and topsoil horizons comprises Glacial Till. The formation was encountered predominantly as a firm to stiff, brown mottled grey clay.

SPT N values achieved within the formation are summarised below:

Depth Below Ground Surface (m)	SPT 'N' Values
1	14, 17, 20, 23
2	18, 25, 28, 38
3	30, 39, 41, 43
4	34

The results of Index test carried out on 4no samples of the cohesive Till formation have resulted in the following Liquid Limit and Plasticity Index values:

Liquid Limit Range (%): 48 – 59

Plasticity Index Range (%): 25 – 35

The above values place the cohesive Till within the High Plasticity/Medium Shrinkage potential category.

The relationship between natural moisture content and Liquid Limit suggests that the tested soils are not desiccated.

5.3 GROUNDWATER

All of the boreholes and trial pits remained dry during the drilling and excavation program.

During the monitoring period groundwater was measured at depths of between 0.24m and 0.27m below ground surface within Borehole 1 and at depths of between 0.68m and 0.72m within Borehole 5. The Borehole 4 standpipe remained dry.

The disparity in groundwater levels within the three standpipes is an illustration of the perched and laterally discontinuous nature of groundwater that often occurs within Till formations.

6 GEOTECHNICAL ASSESSMENT

6.1 GENERAL

It is understood that the proposed development will consist of 11no industrial units, 10 of which are linked, as shown on Figure 2. No precise details are available at the time of writing with respect to foundation loads; however, we understand that such loads will be within the light to medium category.

6.2 FOUNDATIONS

The predominantly stiff natural clay that underlies the superficial Made Ground and topsoil horizons should be capable of supporting light to medium structural loads whilst maintaining total and differential settlements within accepted tolerances. Conventional strip or pad footings should therefore be suitable for the proposed development and such foundations taken through any Made Ground or soft natural soils to found a minimum depth of 900mm below finished grade may be designed using an allowable bearing capacity of 120 kPa.

Index test results have categorised the clay formation as being of High Plasticity with Medium shrinkage potential. Consequently, the recommendations of NHBC Standards Chapter 4.2 should be followed where foundations lie within influencing distance of existing, recently planted or recently felled trees.

The relationship between Natural Moisture Content and Liquid Limit values indicate that the tested samples are not desiccated.

6.3 BURIED OBSTRUCTIONS

The trial pits that were excavated within the vicinity of historical site structures have encountered boulders of concrete and buried walls and footings. This would confirm the historical records which state that former buildings associated with ROF Wrexham were demolished to ground level only. It is likely therefore that buried obstructions will be encountered within some of the Made Ground formation and that their removal may result in some degree of overbreak in individual foundation excavations. The locations of historical structures are shown on the aerial photograph contained within Appendix B and any below ground excavations carried out within those areas will likely encounter buried concrete and brick structures. However, it is also possible that such obstructions will also be encountered over other site areas particularly where former pipe runs were located.

6.4 GROUND FLOOR SLABS

The near surface natural formation comprises high plasticity clay and such materials can display significantly high volume change potential in response to moisture content variations. Such changes in volume post construction can induce undesirable differential movements between the slab and the frame of the structure if slab on untreated grade construction techniques have been adopted.

If slab on grade construction is desirable it is recommended that the natural formation beneath the slab is excavated and replaced with well compacted engineering fill to a minimum depth of 900mm below finished grade. This will reduce the impact of potential post construction ground movements on the performance of the slab.

As an alternative to the above construction method, a suspended slab could be adopted. Given the high plasticity nature of the natural formation it is recommended that an under-

slab void of at least 150mm is maintained. The adoption of a suspended slab may require the construction of internal footings depending upon the dimensions of the slab and its working load bearing requirements.

6.5 BELOW GROUND CONCRETE

The results of Soluble Sulphate and pH tests carried out on samples of the formation are summarised below:

No. of Tested Samples	Range of Water Soluble Sulphate Values (g/l)	Range of pH Values
6	<0.010	8.2 – 8.6

The results fall within concrete Class DS-1 as defined in BRE Special Digest 1, 'Concrete in aggressive ground', 2005', with a corresponding ACEC class of AC-1s.

6.6 PAVEMENTS

The in-situ CBR test results enclosed within Appendix G are summarised below:

CBR Test No	CBR Value (%)	Moisture Content (%)
1	1.0	43
2	0.7	35
3	1.6	30
4	3.4	25
5	2.2	30

Some of the CBR values achieved are lower than would be expected for a firm to stiff clay. The CBR value for a give soil depends upon its dry density and its moisture content and the higher the latter value the lower the CBR value tends to be as illustrated in the above summary table. The in-situ testing took place in February during and after a spell of very high rainfall and the near surface soils were very soft as demonstrated by the fact that the four wheel drive test vehicle had to be winched off the site as it was 'bogging down'.

The Plasticity Index range for the clay formation based upon Index test data is 25% to 35% which, based upon the recommendations of Interim Advice Note 73/06 Revision 1 (2009), equates to a CBR of about 3%. On the grounds that the formation level for the proposed pavements is likely to be somewhat deeper than the test level and that corresponding natural moisture contents will be somewhat lower than those listed above, it is recommended that a design CBR value of 2.5% is adopted for a thin layered pavement construction.

7 ENVIRONMENTAL CONSIDERATIONS

7.1 SOIL CONTAMINATION

7.1.1 GENERAL APPROACH

The UK approach to the assessment of contaminated land is based upon the principles of risk assessment. This is founded upon the 'source – pathway – target' model to establish the presence or potential presence of a pollutant linkage. The overall methodology is based upon a tiered approach to determine risk based remedial targets for soil involving site specific data collection.

Should the adopted criteria be exceeded, then two courses of action are available. Firstly, the pollutant link could be broken by undertaking remedial work such as providing clean soil cover. Alternatively, a more detailed risk assessment can be carried out to determine whether a statistically relevant pollutant link actually exists.

The proposed development is industrial in nature and for the purposes of risk assessment an industrial/commercial use has been adopted as the default land use category.

7.1.2 RISK SCREENING

7.1.2.1 EXPLOSIVE RISK

Both the screening exercise that took place on soil samples on site and the testing that took place on samples in the laboratory have returned values lower than detection limits for explosives. This would tend to reinforce the historical evidence that this site was only used for drying purposes and for acetone recovery. The risk to human site occupiers and construction workers from explosives within the near surface soils at the site can be considered to be low based upon the available test results.

7.1.2.2 HUMAN SITE OCCUPIERS AND CONSTRUCTION WORKERS

In terms of risk to human health, the results of the chemical testing data enclosed within Appendix E have been compared to the Tier 1 final chemical screening criteria for an industrial/commercial land use. A summary of the risk screening exercise is shown on Table 2. Reference to that table shows that none of the potential contaminants of concern that constitute the test suite are present within the tested samples at concentrations that exceed their chemical acceptance criteria values. Acetone values were all below detection limits.

The risk to human health at the site resulting from the potential presence of contaminants of concern within the near surface soils is considered to be low.

7.1.2.3 STRUCTURES AND INFRASTRUCTURE

The range of measured water soluble sulphate values within the near surface soil samples are all less than 0.010g/l whilst pH values are in the range 8.2 – 8.6. These represent very benign conditions with respect to sulphate and acid attack on buried concrete and based upon the measured values the risk to buried structures at the site is considered to be very low.

None- barrier buried potable water supply pipework can be attacked by acids and they can be penetrated by hydrocarbons and other substances such as phenols which can

have the effect of tainting water supplies. The concentrations of such substances at this site are such that the risk to non-barrier pipework is considered to be low.

7.1.3 PROPOSED SOIL REMEDIAL MEASURES

The risk screening exercise has shown that the risk to human health at the site from explosives and potential contaminants of concern within the soil is low and consequently no specific soil remedial measures are proposed.

However, as was the case with all brownfield sites it is recommended that if any areas of potentially contaminated ground become apparent during the construction phase then they should be brought to the attention of the Engineer for further consideration.

Although the site and laboratory testing program has failed to detect explosives within the soil it is recommended at the groundworks stage of the project that suitable screening measures are put in place and that such a program forms part of the H & S file.

7.2 CONTROLLED WATERS

Selected groundwater samples taken from the standpipes have been tested in the laboratory for those determinants that comprise the UK Drinking Water Standards. Table 3 summarises those results and compares them to the Maximum Allowable Concentrations as defined by the above standards.

Reference to Table 3 shows that the following determinants are present within the tested samples at concentrations that exceed the defined maximum allowable concentration for drinking water:

Determinant	Maximum Allowable Concentration (MAC)	Range of Measured Values	No. of Values > MAC	Mean Value
Chloride	250mg/l	93 - 360	1	244
Sulphate	250mg/l	120 - 390	2	260
Manganese	50ug/l	5.4 - 1200	2	715

The mean values for chloride and sulphate lie very close to or are slightly lower than their MAC value and such concentrations are considered to represent a low risk to human health. The maximum concentration of manganese is significantly in excess of its MAC value as is the mean value for that metal. However, elevated concentrations of manganese within groundwater are not uncommon in strata that contain metals such as iron and, due to the significant thickness of predominantly low permeability superficial deposits that overlie the Secondary A aquifer, the risk to that aquifer from manganese is considered to be low. It is also unlikely that any significant contamination would migrate to sensitive surface water receptors through the Glacial Till formation that contains significant horizons of low permeability cohesive soils. In addition, the Secondary Undifferentiated Aquifer is not considered to be overly sensitive.

The results of the groundwater analyses are such that a quantified controlled waters risk assessment is considered to be unnecessary.

7.3 GROUND GAS

Table 1 shows that methane gas was effectively absent from the borehole standpipes. Carbon dioxide concentrations were measured within Borehole 1 at a maximum concentration of 2.8%, within Borehole 4 at a maximum concentration of 0.4% and within

Borehole 5 at a maximum concentration of 0.7%. Very low gas pressures were detected, whilst flow rates were less than 0.1l/hr.

The ground gas situation has been assessed using the methodology outlined in CIRIA Publication C665 'Assessing risks posed by hazardous ground gases to buildings'. Under that methodology, the site has been assessed as falling within the Characteristic Situation 1 category, where no special precautions are required with respect to carbon dioxide and methane in the ground. For these gases, the installation of a gas resistant membrane within the new industrial units should not be required.

The units will not require a radon membrane.

TABLES

Table 1
Wrexham Industrial Estate – Site 4
Gas and Groundwater Readings

Gas Readings

Date: 25/02/2020 Atmospheric Pressure: 998mb

BH	Gas Flow (l/hr)	Borehole Pressure (mb)	Methane (%vol)		Methane (%LEL)		Carbon Dioxide (%vol)		Oxygen (%vol)		Other Gases (ppm)	
			Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	H ₂ s	CO
1	<0.1	0.02	0.2	0.2	<2	<2	2.8	2.8	18.0	18.0	<1	<1
4	<0.1	0.03	0.2	0.2	<2	<2	0.2	0.2	20.1	20.1	<1	<1
5	<0.1	0.02	0.2	0.2	<2	<2	0.6	0.6	19.8	19.8	<1	<1

Date: 02/03/2020 Atmospheric Pressure: 990mb

BH	Gas Flow (l/hr)	Borehole Pressure (mb)	Methane (%vol)		Methane (%LEL)		Carbon Dioxide (%vol)		Oxygen (%vol)		Other Gases (ppm)	
			Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	H ₂ s	CO
1	<0.1	0.06	0.2	0.2	<2	<2	2.5	2.5	18.1	18.1	<1	<1
4	<0.1	0.04	0.2	0.2	<2	<2	0.3	0.3	19.9	19.9	<1	<1
5	<0.1	0.03	0.2	0.2	<2	<2	0.7	0.7	19.8	19.8	<1	<1

Date: 13/03/2020 Atmospheric Pressure: 1016mb

BH	Gas Flow (l/hr)	Borehole Pressure (mb)	Methane (%vol)		Methane (%LEL)		Carbon Dioxide (%vol)		Oxygen (%vol)		Other Gases (ppm)	
			Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	H ₂ s	CO
1	<0.1	0.03	0.2	0.2	<2	<2	2.5	2.5	18.2	18.2	<1	<1
4	<0.1	0.07	0.2	0.2	<2	<2	0.3	0.3	19.9	19.9	<1	<1
5	<0.1	0.04	0.2	0.2	<2	<2	0.5	0.5	19.9	19.9	<1	<1

Date: 27/03/2020 Atmospheric Pressure: 1001mb

BH	Gas Flow (l/hr)	Borehole Pressure (mb)	Methane (%vol)		Methane (%LEL)		Carbon Dioxide (%vol)		Oxygen (%vol)		Other Gases (ppm)	
			Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	H ₂ s	CO
1	<0.1	0.04	0.2	0.2	<2	<2	2.3	2.3	18.4	18.4	<1	<1
4	<0.1	0.06	0.2	0.2	<2	<2	0.4	0.4	19.8	19.8	<1	<1
5	<0.1	0.05	0.2	0.2	<2	<2	0.4	0.4	20.0	20.0	<1	<1

Groundwater Readings (mbgl)

BH	23/02/2019	02/03/2020	13/03/2020
1	dry	dry	Dry
4	0.24	0.24	0.25
5	0.68	0.71	0.72

BH	27/03/2020		
1	dry		
4	0.27		
5	0.72		

Gas and groundwater monitoring undertaken by: P. Cosgrove
Equipment used: GA2000 plus Flow pod S/N 419

Table 2
Proposed Industrial Development, Wrexham Industrial Estate – Site 4
Human Health Screening Values for a Commercial/Industrial Land Use versus Measured Values - Soils

Determinant	Final screening chemical acceptance criteria mg/kg	Derivation Tool	Range of Measured Values	No. of Values > acceptance criteria (location)
Asbestos	Presence		None Detected	0
Phenols	1500	LQM/CIEH:S4UL	<0.3	0
US EPA Priority PAHs				
Acenaphthene	97000	LQM/CIEH:S4UL	<0.1	0
Acenaphthylene	97000	LQM/CIEH:S4UL	<0.1	0
Anthracene	54000	LQM/CIEH:S4UL	<0.1 – 0.32	0
Benzo(a)Anthracene	170	LQM/CIEH:S4UL	<0.1 – 0.48	0
Benzo (a)pyrene	77	DEFRA:C4SL	<0.1	0
Benzo (b)fluoranthene	44	LQM/CIEH:S4UL	<0.1	0
Benzo(k)fluoranthene	1200	LQM/CIEH:S4UL	<0.1	0
Benzo(g,h,i) perylene	4000	LQM/CIEH:S4UL	<0.1	0
Chrysene	350	LQM/CIEH:S4UL	<0.1 – 0.66	0
Di-benzo(a,h)anthracene	3.6	LQM/CIEH:S4UL	<0.1	0
Indeno(1,2,3-cd)pyrene	510	LQM/CIEH:S4UL	<0.1	0
Fluoranthene	23000	LQM/CIEH:S4UL	<0.1 – 0.95	0
Flourene	68000	LQM/CIEH:S4UL	<0.1	0
Napthalene	400	LQM/CIEH:S4UL	<0.1	0
Phenanthrene	22000	LQM/CIEH:S4UL	<0.1 – 0.93	0
Pyrene	64000	LQM/CIEH:S4UL	<0.1 – 1.1	0
Heavy Metals/ Metalloids				
Arsenic	640	DEFRA C4SL	7.6 - 11	0
Cadmium	420	DEFRA C4SL	0.38 – 1.5	0
Chromium	86000	LQM/CIEH:S4UL	25 - 45	0
Copper	68000	LQM/CIEH:S4UL	12 - 31	0
Lead	1100	DEFRA C4SL	22 - 94	0
Mercury	1100	LQM/CIEH:S4UL	<0.10	0
Nickel	980	LQM/CIEH:S4UL	25 - 54	0
Selenium	12000	LQM/CIEH:S4UL	<0.2 – 0.23	0
Zinc	730000	LQM/CIEH:S4UL	68 - 300	0

Petroleum Hydrocarbons				
TPH Aliphatic C5-6	5900	LQM/CIEH:S4UL	<0.1	0
C6-8	7800	LQM/CIEH:S4UL	<0.1	0
C8-10	4800	LQM/CIEH:S4UL	<0.1	0
C10-12	23000	LQM/CIEH:S4UL	<1	0
C12-16	82000	LQM/CIEH:S4UL	<1	0
C16-21	1700000	LQM/CIEH:S4UL	<1	0
C21-35	170000	LQM/CIEH:S4UL	<1	0
C35-44	1700000	LQM/CIEH:S4UL	<1	0
TPH Aromatic C5-7	46000	LQM/CIEH:S4UL	<0.1	0
C7-8	110000	LQM/CIEH:S4UL	<0.1	0
C8-10	8100	LQM/CIEH:S4UL	<0.1	0
C10-12	28000	LQM/CIEH:S4UL	<1	0
C12-16	37000	LQM/CIEH:S4UL	<1	0
C16-21	28000	LQM/CIEH:S4UL	<1	0
C21-35	28000	LQM/CIEH:S4UL	<1	0
C35-44	28000	LQM/CIEH:S4UL	<1	0
Acetone			*	
Explosives Suite	Presence		*	

1% SOM adopted for SGV calculation

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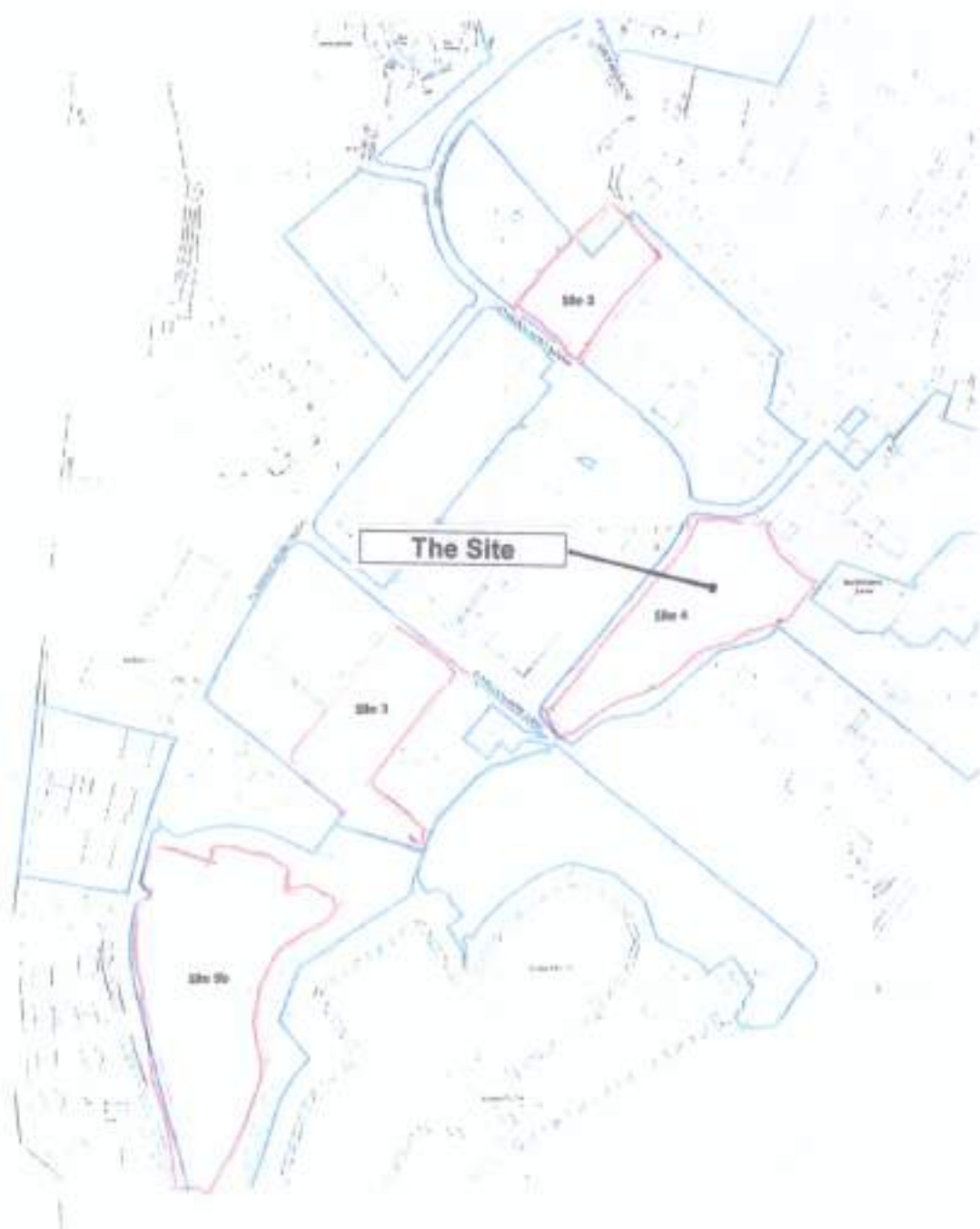
*Below Detection Limit

Table 3
Wrexham Industrial Estate – Site 4
Groundwater Test Results Compared to UK Drinking Water
Standards Maximum Allowable Concentrations

Determinant	Maximum Allowable Concentration (MAC)	Range of Measured Values	No. of Values > MAC
Conductivity	2500 (us/cm)	1800 - 2400	0
Chloride	250mg/l	93 - 360	1
Flouride	1.5mg/l	0.15 - 0.25	0
Ammonium	0.5mg/l	<0.05 - 0.092	0
Nitrite	0.5mg/l	<0.020	0
Nitrate	50mg/l	<0.50	0
Sulphate	250mg/l	120 - 390	2
Cyanide	50ug/l	<0.050	0
Sodium	200mg/l	150 - 160	0
Aluminium	200ug/l	<10 - 110	0
Arsenic	10ug/l	<1.0 - 2.2	0
Boron	1000ug/l	95 - 900	0
Cadmium	5ug/l	<0.080 - 0.15	0
Chromium	50ug/l	<1.0 - 7	0
Copper	2000ug/l	3.5 - 5.8	0
Iron	200ug/l	190 - 550	0
Mercury	1ug/l	<0.50	0
Manganese	50ug/l	5.4 - 1200	2
Nickel	20ug/l	1.3 - 5.4	0
Lead	25ug/l	<1.0	0
Antimony	5ug/l	<1.0	0
Selenium	10ug/l	1.6 - 3.7	0
Zinc	5000ug/l	5.3 - 30	0
Mineral Oil	10ug/l	<10	0
Total PAHs	0.1ug/l	<2	0
Solvents and Organics	*	*	0

*Below Detection Limit

FIGURES



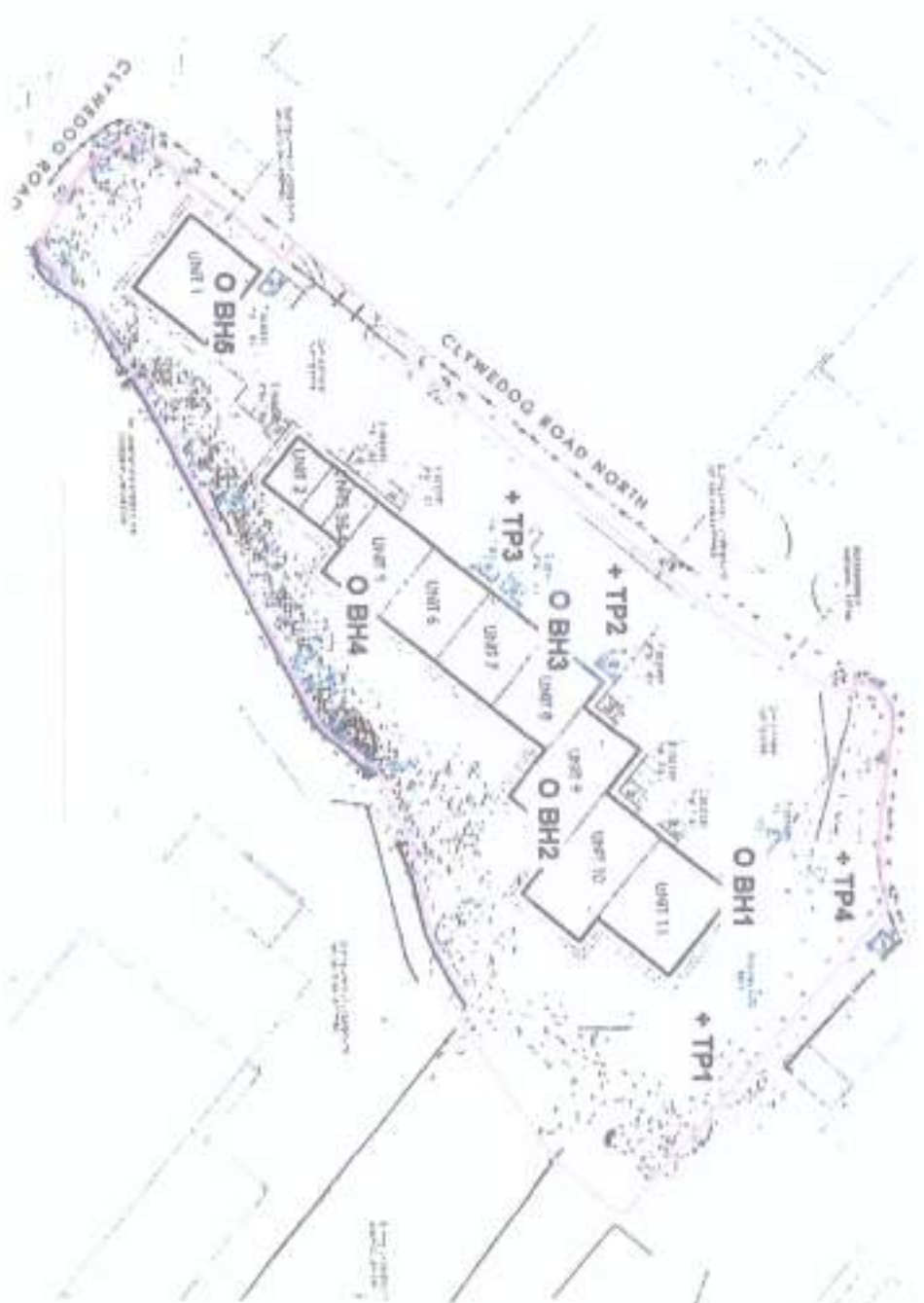
Site Location Plan

**SP
ASSOCIATES**

Report:
S1671-4

Site:
Wrexham Industrial Estate, Site 4

Figure:
1



Borehole and Trial Pit Location Plan

**SP
ASSOCIATES**

**Report No.
S1671 - 4**

**Project:
Wrexham Industrial Estate, Site 4**

**Figure:
2**



In-situ CBR Test Location Plan

SP ASSOCIATES	Report No. S1671 - 4	Project: Wrexham Industrial Estate, Site 4	Figure: 3
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APPENDIX A

Preliminary CSMs

Potential Hazard	Description / Outline of Hazard	Pertinent Site-Specific Details	General Recommendations / Considerations	Risk
Expansive Soils (Shrink / Swell)	Some types of ground (e.g. clay soils) can change volume due to changes in moisture content induced by weather variations (e.g. drought), vegetation (e.g. growth or removal of trees) or man-made activities (e.g. changes to local drainage or leakage from water pipes). This shrink / swell behaviour typically causes significant ground movement to a depth of approx. 3m (although depths of 6m bgl have been reached in London Clay) potentially damaging building foundations, external pipes or services by differential movements.	- The natural Devensian Till within the Wrexham area is recorded to have a low to intermediate, sometimes high plasticity and is typically of low to intermediate shrinkage potential. However, Laminated Clay Till is recorded to be well developed around the Wrexham Industrial Estate and these clays are more susceptible to shrink / swell (typically of intermediate plasticity and of medium shrinkage potential). - Previous site investigation works in the surrounding area have revealed that the cohesive natural Glacial Till deposits are of intermediate to high plasticity and of medium shrinkage potential. As indicated by the above this is more typical of Laminated Clay Till, which is also indicated by nearby BGS Borehole logs. However, limited testing was undertaken. - The site is densely vegetated with a thickset of mature trees within its north-eastern section which thins moving south westerwards along the site south eastern boundary. Mature trees are also scattered across the remainder of the site. - Desiccation may have occurred around trees potentially leading to swelling following an increase in soil moisture content (e.g. removal of trees). - Low moisture contents recorded within the top 5m of the laminated clay tills indicate that in the area these deposits may be desiccated down to at least 5m. Consequently, they could be susceptible to swelling with increases in moisture content. - The plasticity and shrinkage / volume change potential of the Landscaped Ground that is recorded beneath the site is unknown and could vary widely. However, if they comprise reworked natural deposits then values could be like that for the Devensian and Laminated Tills.	- Shrink / swell tests may be required to assess the volume change potential of the soils at the site. - Local deepening of shallow foundations near to trees may be required. - Consideration may need to be given to external areas and services, especially if trees are to be planted. Soil stabilisation and / or water control methods may be required to avoid differential movements if expansive soils cannot be avoided or removed. Alternatively, a design for low strength and regular maintenance may be required. - Do not plant trees with high soil moisture demands near to buildings.	Moderate
Compressible Soils	Some types of soft superficial deposits may undergo volume reduction over time if loaded or if the groundwater level changes. This compression is due to water expulsion (primary consolidation) followed by restructuring (secondary consolidation) that may result in excessive settlement of the ground and damage to overlying buildings, external pipes or services by differential settlement.	- The natural Devensian Till within the Wrexham area is recorded to have a low to high compressibility. However, if laminated clay till is present, as indicated by previous site investigation works and BGS Boreholes, then these deposits are typically recorded to be of medium compressibility. - The compressibility of the Landscaped Ground is unknown and could vary widely. However, if they comprise reworked natural deposits then values could be like that for the Devensian and Laminated Tills. - If the natural Tills are desiccated at the surface then this may reduce compressibility somewhat due to low moisture contents. - Compressible soils may be present at the location of the possible infilled ponds that are located on-site.	- Specialist consolidation / settlement tests using laboratory and field methods may be required to estimate the degree and rate of settlement, especially if high foundation loads are envisaged. - Consideration may need to be given to external areas and services if the natural superficial deposits are found to be compressible. Soil stabilisation, ground improvement, geosynthetics or lightweight fill may be required to avoid settlement. - If the natural superficial deposits are found to be compressible then large differential loadings of the ground should be avoided.	Moderate

Potential Hazard	Description / Outline of Hazard	Pertinent Site-Specific Details	General Recommendations / Considerations	Risk
Groundwater	Nearly all geotechnical hazards are linked in some way with water or groundwater (e.g. increased pore water pressure may cause slope failure and decreased pore water pressure may cause subsidence in clays). However, groundwater is the potential for water ingress into open excavations that may result in instability and collapse. Capillary rise in embankments may also cause instability problems.	- Previous SI works within the surrounding area have recorded perched water within permeable Made Ground deposits. These perched waters may be present on-site in areas that have been backfilled (e.g. cuttings, former structures and infilled ponds). - Several of the BGS Boreholes reviewed also encountered numerous perched groundwater tables within the natural superficial deposits, predominantly wherever granular layers of sufficient thickness and extent were encountered. These ground water tables were typically encountered at depths below 5.00m bgl. - Within the BGS Boreholes artesian conditions were also noted and this coincides with the springs noted on the historical maps and the artesian conditions recorded within the sands and gravels beneath the Wrexham Industrial Estate. - Due to the recorded depth of the artesian groundwater and within the natural Devensian Till it is unlikely to be encountered within any shallow excavations that are undertaken on-site. However, if present it may pose an issue for deeper excavations. - Deeper groundwater within the underlying solid geology was not encountered within any of the boreholes reviewed and is anticipated to be located at a significant depth beneath the site (>55m). - Due to seasonal variations groundwater may be encountered at shallower depth due to prolonged periods of rainfall. However, this would be dependent on the extent and interconnected nature of any permeable layers within the natural Glacial Till.	- There may be a requirement for localised temporary works in the form of construction dewatering / exclusion techniques (e.g. cut-off walls) during excavation of any service trenches, mass excavations or excavations for foundations (depending on the foundation type selected). - Monitoring wells should be installed within boreholes with subsequent groundwater monitoring to further quantify the risk. - Artesian groundwater may cause problems for intrusive investigations (e.g. boreholes) and / or any piling works.	Low to moderate
Running Sand	Some types of ground (e.g. loose sand) can become fluidized by water flowing through them. This occurs when the pressure of the water filling the spaces between the sand grains reduces the contact between the grains and they are carried along by the flow. These conditions typically occur where excavations in loose sand go below the water table, where springs occur at the base of a sand outcrop, around leaking drains or near water supply pipes or if sand is vibrated (e.g. liquefaction). Such sands can 'run', removing support from overlying buildings, externalis and services causing potential damage.	- The silts and sands of the natural Devensian Till within the Wrexham area are usually water bearing and are known to develop running conditions, particularly along spring lines where they are underlain by impermeable materials. Springs are recorded in the area on historical maps. - Considerable thicknesses of loose, water bearing, fine to medium sands and silts are recorded from nearby BGS Borehole logs and running conditions have been noted in several borings. However, significant deposits are typically encountered at depth but lenses / pockets are indicated at shallower depth. - Artesian pressures are also indicated on the BGS Borehole Logs and this constant upward velocity of flow is likely to provide the necessary fluidisation to allow running sand conditions to occur. However, artesian groundwater is usually encountered at depths below 5.00m. - The BGS borehole logs indicate that these water bearing sands and silts also contain layers of clay / silt. This difference in permeability between the layers can also contribute to running sand conditions. - Leaking drains or water mains may be present beneath or within the vicinity of the site that may provide the necessary flow to induce running sand conditions.	- Support may be required in open excavations. - Avoid large amounts of water entering the ground through pipe leakage or soakaways. - Do not dig deep holes in saturated sands without technical advice. - Where running sand deposits are significant ground improvement techniques may be required for foundations and externalis / services. - Flexible foundations and super structures may be applicable for smaller, lower cost structures.	Low to moderate

Potential Hazard	Description / Outline of Hazard	Relevant Site-Specific Details	General Recommendations / Considerations	Risk
Made Ground	Made Ground may settle variably, have poor bearing capacity and may suffer significant movements due to causes other than imposed loading (e.g. self-weight settlement) that may be problematic for foundations, external and infrastructure elements. Other problems associated with some Made Ground include contamination, spontaneous combustion and the emission of gas.	- Due to the historical development on-site, a significant thicknesses of Landscaped Ground may be present at the site, particularly at the location of backfilled below ground structures. - Previous site investigation works within the surrounding area recorded a significant thickness (<2.0m) of Made Ground at the location of former backfilled structures. However, the area on-site covered by former structures is limited (e.g. confined to the boundaries). - It is unknown to what extent the Landscaped Ground was engineered, if any, and therefore it should be treated as suspect until proved otherwise.	- Important to further determine the nature and thickness of any Landscaped Ground and / or Made Ground as this would determine the type of foundation solution. Excavations within non-engineered Made Ground may be unstable, and support may be required. - If significant Made Ground is present and it is selected as a founding strata ground improvement may be required to improve the load carrying characteristics. - Piled foundations and / or suspended floors may be required for structures that are sensitive to small movements if significant Made Ground Deposits are present.	Low to moderate
Aggressive Ground	Acidic ground and sulphate may attack the concrete and steel used in foundations and react with aggregates. Sulfur is widespread in rocks and occurs in two principal forms, an oxidised state as sulphate (e.g. gypsum) or in a reduced state as sulphide (e.g. pyrite). Other forms can occur in special circumstances. The oxidation of pyrite and other sulphides can also occur due to biotechnical activities. This can lead to the generation of high concentrations of sulphate and low pH that attacks construction materials and may lead to the precipitation of gypsum resulting in the heave of foundations and floor slabs.	- Previous site investigation works encountered elevated pH and sulphate in soils and elevated concentrations of sulphate in shallow groundwater. However, these elevated concentrations may be associated with historic site uses that were not recorded on-site (e.g. Firestone Factory). - Those identified potentially contaminative activities at ROF Wrexham involved mineral acids and processes that produced acid effluents. However, the site is suspected to be remote from any processing areas but unrecorded on-site disposal may have occurred or leaking pipes may have been present beneath the site. - The natural superficial deposits beneath the site are not anticipated to contain significant concentrations of pyrite, although high concentrations can occur within overconsolidated Glacial Till, especially if they are derived from pyrite rich strata. However, this is not anticipated to be the case on-site. - Significant contents of pyrite are not anticipated for the Landscaped Ground that may be present on-site as they are anticipated to be derived from natural superficial strata. However, cillory soil from the nearby coalfield may have been utilised in places and this could be pyrite rich.	- Assessment of sulphate / sulphide contents and pH of the soil and groundwater should be undertaken to further clarify the risk. - If aggressive contaminants are identified then concrete may need to be designed to withstand aggressive ground. - Specialist testing may be required to ascertain the heave potential of any soils / stabilised soils or the degradation potential of any fill materials. - Potentially aggressive ground exceeding the limiting values for backfill to structural metallic elements may not be permitted as backfill to reinforced soil, anchored earth or corrugated steel banded structures (excluding manholes and drain covers). - Pyrite oxidation can be triggered by mixing susceptible materials with lime or cement resulting in high pH that can lead to the expansion of some sulfates that cause heave of stabilised soils.	Low to moderate

Potential Hazard	Description / Outline of Hazard	Pertinent Site-Specific Details	General Recommendations / Considerations	Risk
Obstructions	Man-made obstructions in the form of buried structures or parts of structures are commonly encountered on brownfield sites and these can be particularly hazardous if they contain voids. Obstructions may delay site investigation works and affect subsequent design and construction by creating obstructions to excavations and / or the chosen foundation solution, by acting as 'hard spots' in the ground and increasing variability within the ground. Obstructions can be solid or contain space filled by other solids, liquids or gases. Damage to a buried structure may create hazards by instigating collapse or by releasing these liquids or gases leading to other issues.	Due to the historical development that is recorded to have occurred on-site (e.g. ROF Wrexham) there is a possibility that significant obstructions may be present beneath the site, particularly at the location of the former ROF structures, infrastructure and areas of backfill. Previous site investigations within the area have recorded obstructions pertaining to former ROF buildings and infrastructure and there are indications that following the demolition of ROF Wrexham the buildings were only demolished to ground level and that subterranean features (e.g. basements) were either left in-situ or backfilled. Consequently, numerous subterranean features may be present beneath the site and this could include concrete slabs / walls / foundations, potential basements, drains and other services, underground tunnels, roadways and railway tracks.	Important to determine if obstructions are present and to what extent as hand digging and / or breasting out may be required, which could impede site investigation works or slow down an earthworks exercise, if not factored into the timings. Probing works, geophysical works and / or intrusive site investigation works can provide an indication as to the presence and extent of any obstructions. Easements may be required for obstructions that are still in use (e.g. major sewers, tunnels or pipelines) but no significant infrastructure is envisaged.	Low to moderate
Slope	A relatively rapid outward and downward movement of a mass of rock or soil on a slope due to the force of gravity. Typically slope instability is caused by either a decrease in soil strength or an increase in shear stress. Numerous factors are involved but usually loading on or at the crest of the slope, increasing the amount of water entering the slope or cutting at the toe of the slope cause failure. Damage by landside can occur through the removal of supporting ground from under structures, external or services or by the movement of material onto property. Large landslides can be catastrophic.	Most of the site is relatively flat but steep slopes are present in places leading down to the stream / drain that is located along the south eastern boundary of the site. However, the slopes are of relatively limited extent but are up to 2m in places. An upwelling / spring was noted located in one of the sloping areas towards the central eastern section of the site. Numerous demolition materials and some relict structural features were noted within the slope indicating that it may comprise landscaped / reworked ground meaning that the materials within the slope could be variable. The slope is heavily vegetated with mature trees and shrubs which may be having a stabilising effect on the slope. On features of instability were noted but some areas could not be accessed due to dense vegetation.	No special ground investigation or construction methods are envisaged. Avoid loading the crest of the slope. If construction is to occur next to the slope then preliminary checks should be undertaken to ensure that the slope will remain stable. If a problem is indicated then a slope stability analysis and / or slope stabilisation may be required (e.g. profile modification, drainage, mass support, ground improvement and ground anchors).	Low to moderate

Potential Hazard	Description / Outline of Hazard	Pertinent Risk-Specific Details	General Recommendations / Considerations	Risk
Collapsible Soils	Some types of ground (e.g. fine grained, organic soil) can collapse due to increased loads (induced by buildings or road traffic) and / or more commonly the addition of water (e.g. leaking pipes, poor drainage and groundwater recharge) causing the soils to become saturated for the first time. The volume reduction associated with this collapse may be up to 15% of the soil thickness. This is followed by a rapid reduction in volume of the ground which may cause damage to overlying buildings, external pipes or services by sudden or differential settlement.	- Natural soils susceptible to collapse are unlikely to be present beneath the site due to the processes that have resulted in their deposition (i.e. created by the action of ice and meltwater) and resulting lack of an open metastable structure. - Some of the Glacial silts noted on the BGS Borehole logs may be more susceptible to collapse but again due to the style of deposition, depth, thickness and the presence of perched water tables within the Till, this is considered unlikely. - Landscaped Ground and / or Made Ground may be susceptible to collapse but this is dependent on the thickness, grading and level of compaction / engineering employed. - Local collapses may occur if voids from infrastructure or previous site use (e.g. ROF Wharfedale) are present beneath the site.	- No special ground investigation or construction methods are envisaged. - Probing works, geophysical works and / or intrusive site investigation works can provide an indication as to the presence and extent of any voids are present beneath the site.	Low
Slope	A relatively rapid outward and downward movement of a mass of rock or soil on a slope due to the force of gravity. Typically slope instability is caused by either a decrease in soil strength or an increase in shear stress. Numerous factors are involved but usually loading on or at the crest of the slope, increasing the amount of water entering the slope or cutting at the toe of the slope cause failure. Damage by landslide can occur through the removal of supporting ground from under structures, external services or by the movement of material onto property. Large landslides can be catastrophic.	- Most of the site is relatively flat but steep slopes are present in places leading down to the stream / drain that is located along the southern eastern boundary of the site. However, the slopes are of relatively limited extent but are up to 20m in places. - An upwelling / spring was noted located in one of the sloping areas towards the central eastern section of the site. - Numerous demolition materials and some relict structural features were noted within the slope indicating that it may comprise landscaped / reworked ground meaning that the materials within the slope could be variable. - The slope is heavily vegetated with mature trees and shrubs which may be having a stabilising effect on the slope. - On features of instability were noted but some areas could not be accessed due to dense vegetation.	- No special ground investigation or construction methods are envisaged. - Avoid loading the crest of the slope. - If construction is to occur next to the slope then preliminary checks should be undertaken to ensure that the slope will remain stable. - If a problem is indicated then a slope stability analysis and / or slope stabilisation may be required (e.g. profile modification, drainage, mass support, ground improvement and ground anchors).	Low

Source	Potential Pollutants	Pathways	Receptors	Hazard Severity	Liability/Impact	Discussion	Risk
Former on and off-site ROF Wretham	Metals: Zn; PAH; SVOC; VOCs, PCBs BTEX; Pesticides; Explosive Compounds; Explosive Devices; Asbestos; Sulphur; Acids; Alkalies; Molten Metals; Chlorides; Ammonium; Cyanide and other contaminants outlined in sections 7.4.1 & 7.4.2	Migration of water through ground (vertical and lateral)	Groundwater within Secondary A Aquifer (Sako Formation)	Effects to controlled waters Medium	Current Development Unlikely	Receptor Sensitivity: Not an overly sensitive receptor but an SPZ lies approximately 404m to the north west of the site. 10 No. groundwater abstraction licenses are recorded within 2km of the site. Hazard Severity / Presence: - General potentially contaminative sources identified with the highest risk pertaining to ROF Wretham, which may have resulted in explosive contamination being present at the site (see Section 7.4.1). However, these ROF activities undertaken at the site and within the surrounding area have a low to moderate contaminative potential compared to other sections of ROF Wretham. - These activities associated with ROF Wretham with a higher contaminative potential are generally located downgradient of the site and any contamination is likely to have migrated away from the site. However, unrecorded and unaccounted disposal of contamination from other parts of ROF Wretham may have occurred at the site (e.g. unrecorded burning grounds or wastes being dumped into ponds). - Site investigations undertaken immediately to the north of the site recorded low concentrations of contaminants but only shallow testing was undertaken and explosive contaminants were not tested for. - Site investigations undertaken at the former Friesone site approximately 520m to the south east of the site recorded 'contaminated' and 'highly contaminated' soils that included identified metals, hydrocarbons, sulphate, titanium extractable material, pH, plant and PAHs but these may be associated with the Friesone Factory itself. Testing indicated that shallow perched waters within Made Ground are being impacted by arsenic, ammoniacal nitrogen and sulphate but these levels were undetectable at shallow depth and following the remediation of the site. - Due to the landscaping that is recorded to have occurred the soils are likely to have been removed and this could have resulted in localised contamination from an on and off-site sources being spread over a much larger area. Consequently, low concentrations of contamination may be present within the uppermost layers but contamination could be more widespread. - During landscaping, many of the more volatile contaminants are likely to have been lost to atmosphere. - High concentrations of contaminants may still be present in areas below the level of remaining (e.g. at the location of backfilled structures / excavations and within historic drainage). Receptor Presence: Groundwater depth unknown but is anticipated to be present at depths <55m. Pathway Integrity: While the Sako Formation is recorded to have a high leaching potential it is bounded by approximately 50m of predominantly low permeability superficial drift. While fissures and sand beds / lenses are present that could provide pathways to bedrock, it is unlikely that these are vertically interconnected and / or extend to bedrock. Even if pathways were present, due to the thickness of these deposits it is likely that significant dilution and attenuation would occur before the deeper groundwater of the Secondary A Aquifer are reached.	Low
On-site Landscaped Ground							
Existing and Abandoned On-Site Drainage / Infrastructure							
On-site Historic Infilled Ponds							
Current on- site electrical substation							
Current and Historic Off- Site Sources					Post Development Site Unlikely	Receptor Sensitivity: As above for current development. Hazard Severity / Presence: As above for current development. Receptor Presence: As above for current development. Pathway Integrity: As above for current development. However, if a piled foundation solution is required then pathways may be created but piled foundations to bedrock are considered unlikely. An increase in landscaping is also envisaged reducing infiltration and vertical migration.	Low

Source	Potential Pollutants	Pathways	Receptors	Hazard Severity ¹	Likelihood ²	Discussion	Risk
Former on and off-site ROF Wreham	Metals: TPH, PAH, SVOCs, VOCs, PCBs, BTEX, Phenols, Explosives, Concoquants, Explosive, Dioxins, Asbestos, Sulphur, Acids, Alkalis, Metals, Alkalis, Chlorides, Ammonium, Cyanide and other contaminants outlined in sections 7.4.1 & 7.4.2	Migration of water through ground (vertical and lateral)	Groundwater within Secondary Unconfined Aquifer (Devonian Till)	Effects to controlled waters: Mild	Current Development: Low Likelihood	Receptor Sensitivity: The receptor is not overly sensitive but is recorded to be an important source of groundwater within the district. 10 No. groundwater abstraction boreholes recorded within 2km of the site. Hazard Severity / Presence: As above for Groundwater within Secondary A Aquifer. Receptor Presence: Shallow perched waters and deeper perched waters have been recorded in the area at depths of between 5 – 7m bgl between 11 – 15m bgl between 18 – 22m bgl and between 25 – 27m bgl indicating that several perched water tables may be present. These perched water levels could vary seasonally but there is a low likelihood of interconnectivity. Pathway Integrity: Predominantly low permeability superficial deposits are envisaged but backfilled areas (e.g. backfilled structures) may have higher permeability or select foundations could provide pathways to deeper water bearing layers. Fractures and sand channels / lenses are present within the Devonian Till that could increase and have high permeability, respectively. Water bearing sand channels / lenses are unlikely to be interconnected at shallow depth but may be more continuous beneath the uppermost Devonian Till. However, vertical interconnectivity is considered unlikely.	Low
On-site Landscaped Ground	Metals: TPH, PAH, SVOCs, VOCs, PCBs, BTEX, Phenols, Explosives, Concoquants, Explosive, Dioxins, Asbestos, Sulphur, Acids, Alkalis, Metals, Alkalis, Chlorides, Ammonium, Cyanide and other contaminants outlined in sections 7.4.1 & 7.4.2	Migration of water through ground (vertical and lateral)	Surface water receptors (Wreham Drain, Radwether Brook)	Effects to controlled waters: Medium	Current Site: Unlikely	Receptor Sensitivity: As above for current development. Hazard Severity / Presence: As above for current development. Receptor Presence: As above for current development. Pathway Integrity: As above for current development. Potential for mobilisation of any contaminants during rainwater that may expose high permeability and water bearing layers. If a piled foundation solution is required then additional pathways may be present. However, an increase in landscaping is also envisaged reducing infiltration and vertical migration.	Low
Existing and Abandoned On-Site Drainage / Infrastructure	Metals: TPH, PAH, SVOCs, VOCs, PCBs, BTEX, Phenols, Explosives, Concoquants, Explosive, Dioxins, Asbestos, Sulphur, Acids, Alkalis, Metals, Alkalis, Chlorides, Ammonium, Cyanide and other contaminants outlined in sections 7.4.1 & 7.4.2	Migration of water through ground (vertical and lateral)	Surface water receptors (Wreham Drain, Radwether Brook)	Effects to controlled waters: Medium	Current Site: Unlikely	Receptor Sensitivity: The small stream / drain along the sites south eastern boundary and within the immediately surrounding area (including Radwether Brook) are not considered to be overly sensitive. The River Clywedog is considered a sensitive receptor. Hazard Severity / Presence: As above for Groundwater within Secondary A Aquifer. Receptor Presence: Hardest surface water receptor is located along the sites south eastern boundary. Pathway Integrity: Any significant contamination or contaminated waters are likely to be trapped on-site at the location of backfilled structures / excavations where they will be perched on low permeability Devonian Till. Vertical migration may occur where permeable backfill is present. That interconnectivity between layers within the natural Devonian Till, if these permeable layers are underlain by low permeability deposits lateral migration to receptors could occur if continuity exists but this is dependent on the orientation of any sand areas / channels and their lateral interconnectivity. Due to the predominantly low permeability of the underlying soils it is likely that any near surface water run-off will migrate downgradient to the stream along the sites south eastern boundary but there is limited potential for any leachable contaminants to be entrained within surface waters due to the anticipated low concentrations of contaminants at the surface. There is a limited distance between the source and the immediately receptor, but significant dilution and attenuation is likely to have occurred before any potentially contaminated waters reach the most sensitive receptor (River Clywedog).	Low
Current on-site electrical substation	Metals: TPH, PAH, SVOCs, VOCs, PCBs, BTEX, Phenols, Explosives, Concoquants, Explosive, Dioxins, Asbestos, Sulphur, Acids, Alkalis, Metals, Alkalis, Chlorides, Ammonium, Cyanide and other contaminants outlined in sections 7.4.1 & 7.4.2	Migration of water through ground (vertical and lateral)	Surface water receptors (Wreham Drain, Radwether Brook)	Effects to controlled waters: Medium	Current Site: Unlikely	Receptor Sensitivity: As above for current development. Hazard Severity / Presence: As above for current development. Receptor Presence: As above for current development. Pathway Integrity: As above for current development. Potential for mobilisation of any buried contaminants or contaminated waters during earthworks that may expose high permeability and water bearing layers or result in surface water run-off to drains. However, due to the distance from the site to the most sensitive receptor significant attenuation and dilution is likely to occur. Due to an increase in landscaping surface water run-off to drainage is considered a more viable pathway and any vertical migration will be largely regulated.	Low

¹ Considers both the potentially severity of the hazard and the sensitivity of the receptor. The most sensitive receptor / hazard has been used for the overall assessment.

² Considers both the presence of the hazard and the integrity of the pathway. The most likely hazard / pathway has been used for the overall assessment.

Source	Potential Contaminants	Pathways	Receptors	Hazard Severity	Likelihood	Discussion	Risk
Former on and off-site ROF Warehouse	Metals, Acids, Alkali, PCB's, Fuel oil, Organic solvents, Organic compounds, Inorganic compounds, Asbestos, Explosive compounds, Carbonates, Lubricants, Detergents, Solids, Ash, Organic acids, Hydraulic oil, Total Petroleum Hydrocarbons, Polycyclic Aromatic Hydrocarbons, Sulphates and Explosive Devices	Ingestion through the mouth of airborne dust and soil (indoor and outdoor), Inhalation through the nose and mouth of airborne dusts and vapours (indoor and outdoor), Absorption through the skin due to dermal contact with dust and soil	Current site users (unarmoured)	Effect on human health: Medium	Low likelihood	Receptor Presence: The site is easily accessible but any current site users are unlikely to spend a significant amount of time on-site and the frequency of visits are anticipated to be low as the site has no apparent use. Pathway Integrity: It is unlikely that current site users will come into contact with contaminated soils in the near surface during their visits. However, as potentially contaminated soils are present at the surface, dermal pathways are considered to be viable but ingestion and ingestion pathways are considered less likely due to the open nature of the site.	Low to moderate
On-site Landscaped Ground						Receptor Sensitivity: Sensitive receptors in this instance would be an adult likely using personal protective equipment. Hazard Severity / Presence: As above for Current Site Users. Receptor Presence: Groundworkers likely to spend moderate periods of time on-site (typically an 8-hour work day) with a high frequency of visits until the work is complete. However, construction works are relatively short term in the grand scheme of things. Pathway Integrity: Adults in contact with soil and materials during ground works, enabling works, construction of foundations etc. so most pathways are feasible. Any asbestos fibres that are present could be released from the soil during earthwork and construction activities. Any potential significant contamination or explosive devices that are located at depth or within areas that have been backfilled (e.g. former buildings) may be encountered during excavations. Hazards: Infrastructure possibly containing residual explosive compounds or contamination are most likely to be encountered or broken up during construction works.	Moderate
Existing and Abandoned On-Site Drainage / Infrastructure			Ground & Construction Workers	Effect on human health: Medium	Likely	Receptor Sensitivity: Surrounding commercial / industrial land use. The most sensitive receptor is likely to be an adult working indoors. Hazard Severity / Presence: As above for Current Site Users. Receptor Presence: Adjacent site users likely to spend moderate periods of time off-site (typically an 8-hour work day) with a high frequency of visits. However, indoor working is envisaged. Pathway Integrity: As Landscaped Ground is present at the surface, soil-derived dust may be windblown to off-site receptors but this is considered unlikely due to the predominantly clayey nature of the soils. In the short-term, problems with soil derived dust are more likely during development of the site unless appropriate health and safety measures are undertaken (e.g. spraying down dust). Following development most pathways (except for vapour) are anticipated to be negligibly reduced due to an increase in landscaping areas. Potential pathways may remain for any areas of POB or soil landscaping. During construction works there could be risk to off-site users from an explosive incident.	Low
On-site Historic Infilled Ponds			Adjacent site users and general public	Effect on human health: Medium	Unlikely	Receptor Sensitivity: Industrial / Commercial land use so the most sensitive receptor would be an adult. Hazard Severity / Presence: As above for adjacent site users. Receptor Presence: Future site users likely to spend moderate periods of time on-site (typically an 8-hour work day) with a high frequency of visits. However, indoor working is envisaged. Pathway Integrity: Following development of the site there is expected to be an increase in landscaping and indoor working areas. Consequently, most pathways (except for vapour) are anticipated to be negligibly reduced. Potential pathways may be present for any areas of POB or soil landscaping.	Low
Current on-site electrical substation							
Current and Historic Off-Site Sources			Future site users	Effect on human health: Medium	Unlikely		

*1 Considers both the potential severity of the hazard and the sensitivity of the receptor. The most sensitive receptor / hazard has been used for the overall assessment.

*2 Considers both the presence of the hazard and receptor and the integrity of the pathway. The most likely hazard / pathways have been used for the overall assessment.

Source	Potential Ground Gases	Pathways	Receptors	Hazard Severity ¹	Likelihood ²	Discussion	Risk
Off-site Landfills	Methane / Carbon dioxide / Hydrogen Sulfide / Trace Gases	Migration Ingress and accumulation Inhalation	Current & future human occupants Ground and construction workers Building and structures	Effect on human health / Damage to Buildings Medium	Unlikely	Receptor Sensitivity: For commercial / industrial buildings with large well-ventilated open spaces the consequences of gas migration (e.g. explosion) are significantly reduced due to the lack of confined spaces. Increased severity for construction workers who may be working in confined trenches. Hazard Severity / Presence: Comprises a number of relatively small landfills that are located approximately 420m to the north-east of the site. Recorded to have received industrial and liquid sludge wastes between December 1953 and December 1983. Ground gas generation potential largely unknown due to the presence of industrial wastes but sludge wastes may have a moderate gas generation potential. May be past its primary methanogenic phase due to the age of the landfill. Receptor Presence: Buildings and structures are permanent whereas human receptors are only likely to spend moderate periods of time on-site (typically an 8-hour work day) with a high frequency of visits, the exception being current site users where limited presence is anticipated. Pathway Integrity: These landfills are located approximately 420m to the east and downgradient of the site. Possible driving force for gas migration due to possible moderate ground gas generation potential. Predominantly low permeability of the natural superficial deposits will likely inhibit any lateral or vertical migration to the site. However, sand beds / lenses and fissures may provide pathways but limited interconnectivity is envisaged over such a distance. Groundwater flow is towards the south east and away from the site so any gas migration via groundwater is also considered unlikely.	Low
On-site Landfilled Ground / Made Ground Deposits	Methane / Carbon dioxide	Migration Ingress and accumulation Inhalation	Current & future human occupants Ground and construction workers Building and structures Off-site buildings and structures	Effect on human health / Damage to Buildings Medium	Unlikely	Receptor Sensitivity: For commercial / industrial buildings with large well-ventilated open spaces the consequences of gas migration are significantly reduced due to the lack of confined spaces. Increased severity for construction workers who may be working in confined trenches. Hazard Severity / Presence: The source is anticipated to be widespread but limited thickness envisaged and no degradable materials were noted during the previous SI works with low total organic carbon (0.7 and 1.7%) recorded. However, thicker deposits may be present in areas of filled excavations or backfilled structures and unrecorded degradable materials may be present. Ground gas generation is anticipated to be very low with a lack of driving force for gas migration. Receptor Presence: Buildings and structures are permanent whereas human receptors are only likely to spend moderate periods of time on and off-site (typically an 8-hour work day) with a high frequency of visits, the exception being current site users where limited presence is anticipated. Pathway Integrity: The source is anticipated to be widespread and located at the surface with no overlying low permeability soils so most pathways are viable, although ingress and accumulation is not considered a viable pathway for current site users.	Low
Historic On-site Filled Ponds	Methane / Carbon dioxide	Migration Ingress and accumulation Inhalation	Off-site buildings and structures	Effect on human health / Damage to Buildings Medium	Unlikely	Receptor Sensitivity: For commercial / industrial buildings with large well-ventilated open spaces the consequences of gas migration are significantly reduced due to the lack of confined spaces. Increased severity for construction workers who may be working in confined trenches. Hazard Severity / Presence: Unknown thickness and constituents of filled material but anticipated to be associated with historic RCV Wastewater. Limited volume of fill is envisaged due to the size of the ponds. Any fill is at least 60 years old so a low ground gas generation potential is envisaged unless any degradable materials have remained dry. Ground gas generation is anticipated to be very low with a lack of driving force for gas migration. Receptor Presence: Buildings and structures are permanent whereas human receptors are only likely to spend moderate periods of time on and off-site (typically an 8-hour work day) with a high frequency of visits, the exception being current site users where limited presence is anticipated. Pathway Integrity: Overlying and surrounding low permeability soils anticipated to be present and likely inhibiting any lateral or vertical migration. Lack of driving force for gas migration anticipated due to low ground gas generation potential. However, pathways may be present during construction works and following development due to future foundations penetrating low permeability strata.	Low

Source	Potential Ground Gases	Pathways	Receptors	Hazard Severity ⁴⁵	Likelihood ⁴⁶	Discussion	Risk
Residual hydrocarbon and VOC vapours associated with current and historic on-site activities	Hydrocarbons / VOC's / SVOC's	Migration Ingress and accumulation Inhalation	Current & future human occupants Ground and construction workers Building and structures Off-site buildings and structures	Effect on human health / Damage to Buildings Medium	Unlikely	Receptor Sensitivity: For commercial / industrial buildings with large well-ventilated open spaces the consequences of gas migration are significantly reduced due to the lack of confined spaces. Increased severity for construction workers who may be working in confined trenches. Hazard Severity / Presence: Historic on-site activities may have resulted in hydrocarbon or VOC contamination (e.g. press machinery, heating for drying houses and acetone recovery). However, most contamination is now >70 years old and due to the inherent mobility / volatility of most hydrocarbons / VOCs, the potential presence of pathways via permeable strata and the remaining soils that likely occurred during landscaping, significant sources of vapours are unlikely to remain. However, sources of vapours may be present at the locations of backfilled structures / refilled excavations. No significant hydrocarbon or VOC concentrations noted for these SI works undertaken within the surrounding area. Receptor Presence: Buildings and structures are permanent whereas human receptors are only likely to spend moderate periods of time on and off-site (typically up to 8-hour work day) with a high frequency of visits, the exception being current site users where limited presence is anticipated. Pathway Integrity: Any remaining source of vapours are likely to be overlain and surrounded by low permeability soils likely inhibiting any lateral or vertical migration. However, pathways may be present during construction works and following development due to future foundations penetrating low permeability strata.	Low
Historic On-Site Refilled Ponds	Methane / Carbon dioxide	Migration Ingress and accumulation Inhalation	Current & future human occupants Ground and construction workers Building and structures	Effect on human health / Damage to Buildings Medium	Unlikely	Receptor Sensitivity: For commercial / industrial buildings with large well-ventilated open spaces the consequences of gas migration are significantly reduced due to the lack of confined spaces. Increased severity for construction workers who may be working in confined trenches. Hazard Severity / Presence: Numerous ponds located between 10 – 250m of the site. Underlain by boulders and constituents of refilled material but anticipated to be associated with historic (POF) Wharfedale. Limited volumes of refilled material are envisaged due to the size of the ponds. Any refill is at least 65 years old so a low ground gas generation potential is envisaged unless any degradable materials have remained dry. Ground gas generation is anticipated to be very low. Receptor Presence: Buildings and structures are permanent whereas human receptors are only likely to spend moderate periods of time on-site (typically an 8-hour work day) with a high frequency of visits, the exception being current site users where limited presence is anticipated. Pathway Integrity: While some of these ponds are located downgradient of the site the predominantly low permeability of the natural superficial deposits will likely inhibit any lateral or vertical migration to the site. However, sand beds / lenses and fissures may provide pathways but limited interconnectedness is envisaged at shallow depths. Lack of driving force for gas migration anticipated due to low ground gas generation potential.	Low
Residual hydrocarbon vapours associated with historic and current off-site activities	Hydrocarbons / VOC's / SVOC's	Inhalation	Building and structures	Effect on human health / Damage to Buildings Medium	Unlikely	Receptor Sensitivity: For commercial / industrial buildings with large well-ventilated open spaces the consequences of gas migration are significantly reduced due to the lack of confined spaces. Increased severity for construction workers who may be working in confined trenches. Hazard Severity / Presence: Historic off-site activities may have resulted in hydrocarbon or VOC contamination. No significant hydrocarbon or VOC concentrations noted for these SI works undertaken within the surrounding area. Most contamination now <70 years old and due to the inherent mobility / volatility of most hydrocarbons / VOCs, the potential presence of pathways via permeable strata and the remaining soils that likely occurred during landscaping, significant sources of vapours are unlikely to remain. However, sources of vapours may be present at the locations of backfilled structures / infrastructure. More recent VOC contamination may be present from current and historic off-site sources that post-date landscaping. Receptor Presence: Buildings and structures are permanent whereas human receptors are only likely to spend moderate periods of time on-site (typically an 8-hour work day) with a high frequency of visits, the exception being current site users where limited presence is anticipated.	Low

Source	Potential Ground Gases	Pathways	Receptors	Hazard Severity ¹⁾	Likelihood ²⁾	Discussion	Risk
(Continued) Residual hydrocarbon, and VOC vapours associated with historic and current off-site activities	Hydrocarbons / VOC's / SVOC's	Migration Ingress and accumulation Inhalation	Current & future human occupants Ground and construction workers Building and structures	Effect on human health / Damage to buildings: Medium	Unlikely	Pathway Integrity: The presence of any potential plumes and vapour migration beneath the site is considered unlikely as most sources are / were located downgradient of the site so the migration of contaminants would be away from the site and towards the south east provided that sand beds / lenses are laterally interconnected. Limited contaminative potential for those current off-site sources due to modern working practices and the presence of extensive hardstanding and drains.	Low
Solid Geology	Radon	Inhalation	Current & future human occupants Ground and construction workers	Effect on human health: Medium	Unlikely	Receptor Sensitivity: For commercial / industrial buildings with large well-ventilated open spaces the consequences of gas migration are significantly reduced due to the lack of confined spaces. Increased severity for construction workers who may be working in confined benches. Hazard Severity / Presence: The site lies within a Radon Affected Area where less than 1 – 2% of properties are above the action level. Receptor Presence: Buildings and structures are permanent whereas human receptors are only likely to spend moderate periods of time on-site (typically an 8-hour work day) with a high frequency of visits, the exception being current site users where airborn presence is anticipated. Pathway Integrity: Predominantly low permeability soils will likely inhibit any migration of radon gas from any concentrated radon sources located at depth (i.e. bedrock). However, soils may also constitute a radon source but again the low permeability of the soils will inhibit the migration of radon gas.	Low

¹⁾ Considers both the potential severity of the hazard and the sensitivity of the receptor. The most sensitive receptor / hazard has been used for the overall assessment.

²⁾ Considers both the presence of the hazard and receptor and the integrity of the pathway. The most likely hazard / pathway has been used for the overall assessment.

APPENDIX B

UXO Threat Assessment

PRELIMINARY UNEXPLODED ORDNANCE (UXO) THREAT ASSESSMENT

Meeting the requirements of CIRIA C681 'Unexploded Ordnance (UXO) – A guide for the Construction Industry' Risk Management Framework



6 ALPHA PROJECT NUMBER	8004	ORIGINATOR	D. Barrett
LANDMARK ORDER NUMBER	234719387_1	REVIEWED BY	S. Barratt (18 th February 2020)
CLIENT REFERENCE	S1671-2	RELEASED BY	J. Cole (18 th February 2020)
STUDY SITE	Tritech, Unit 69, Clywedog Road East, Wrexham Industrial Estate, Wrexham, LL13 9XE		
RECOMMENDATION	This Study Site requires a Detailed UXO Threat and Risk Assessment		

STUDY SITE

The Study Site is described as "Tritech, Unit 69, Clywedog Road East, Wrexham Industrial Estate, Wrexham, LL13 9XE", and it is centred on National Grid Reference 337470, 349490.

THREAT POTENTIAL AND RECOMMENDATIONS

The potential for UXO hazard to occur, and more specifically, the potential for unexploded WWI and WWII ordnance to exist at this site is assessed as being **LIKELY** (Figure 2).

In accordance with CIRIA C688 Chapter 5 on managing UXO risks, 6 Alpha recommends that the risk management framework is:

DETAILED UXO THREAT & RISK ASSESSMENT

(We would be pleased to provide this service, please contact Envirocheck for further details.)



REPORT SUMMARY

During WWII, the Study Site was situated within *Wrexham Rural District*, which recorded one High Explosive (HE) bomb strike per 100 hectares; a very low level of bombing.

Luftwaffe aerial reconnaissance photography associated with the Study Site identified an ammunition dump (on-site) as a primary bombing target. This ammunition dump however was actually *Royal Ordnance Factory (ROF) Wrexham*, which manufactured cordite, an explosive propellant used in shells during WWII.

Air Raid Precaution (ARP) records associated with the Study Site were not available. In addition, further research did not identify any bomb strikes on-site or within 1,000m of the Study Site boundary.

Official bomb damage mapping associated with the Study Site was not available. In addition, neither an analysis of post-WWII mapping or further research did not identify any areas of potential bomb damage on-site or within 1,000m. However, as *Royal Ordnance Factory (ROF) Wrexham* was located on-site during WWII, it is likely that bomb strike and bomb damage records would have been recorded privately and not released to the public domain as a matter of national security.

Given that *ROF Wrexham* was identified on-site during WWII; it would suggest that further action is warranted to address the potential for UXO encounter.

USING THIS REPORT

This Preliminary Assessment is designed to inform environmental and construction professionals of the potential threat of military related explosives and/or ordnance on, or in, the vicinity of the Study Site.

This assessment is designed to be employed as a site-screening tool to meet with the requirement of Phase One of the *CIRIA UXO Risk Management Framework*; there are two broad prospective outcomes; either the threat level requires a detailed threat & risk assessment; or no further action is required. In the former instance we can provide a report within 10 working days (or more quickly upon application).

Two figures accompany the report, the *Second World War (WWII)* High Explosive (HE) Bomb Density and the final Probability of UXO Encounter. The purpose of this approach is to demonstrate that whilst bomb density statistics give an indication for WWII bombing, they should not be relied upon exclusively to generate a holistic assessment.

For further information, please contact *Envirocheck*:

Telephone: +44 (0)844 844 9952

Website: <http://www.envirocheck.co.uk>

Email: customerservice@envirocheck.co.uk

DATA FINDINGS

Threat Source (within 1,000m)		Identified	Detail Comments
	Airfields/Military Facilities	✗	None recorded within 1,000m.
	Ordnance Manufacture/Storage	✓	ROF Wrexham (on-site).
	WWII Decoy Bombing Sites	✗	None recorded within 1,000m.
	WWII Defensive Features	✓	Three pillboxes (935m south-east, 995m east-south-east, 995m south-east)
	WWII Luftwaffe Designated Bombing Targets	✓	Luftwaffe aerial photography identified an ammunition dump (on-site) as a primary bombing target.
	WWII Bomb Strikes Within Study Site Boundary	✗	ARP records were not available.
	WWII Bomb Strikes Near Study Site Boundary	✗	ARP records were not available.
	WWII Bomb Damage	✗	Official bomb damage mapping was not available.
	Abandoned Bomb Register	✗	The official abandoned bomb list did not identify any abandoned bombs on-site or within 1,000m of the Study Site boundary.
	Potential Threat Sources	✓	The most probable UXO threat is posed by AXO/LSA/SAA, whilst HE bombs, IBs and British AAA projectiles pose a residual threat.
	WWII Bombing Density Per 100 Hectares	✓	The Study Site was located within Wrexham Rural District, which recorded one HE bomb strike per 100 hectares.

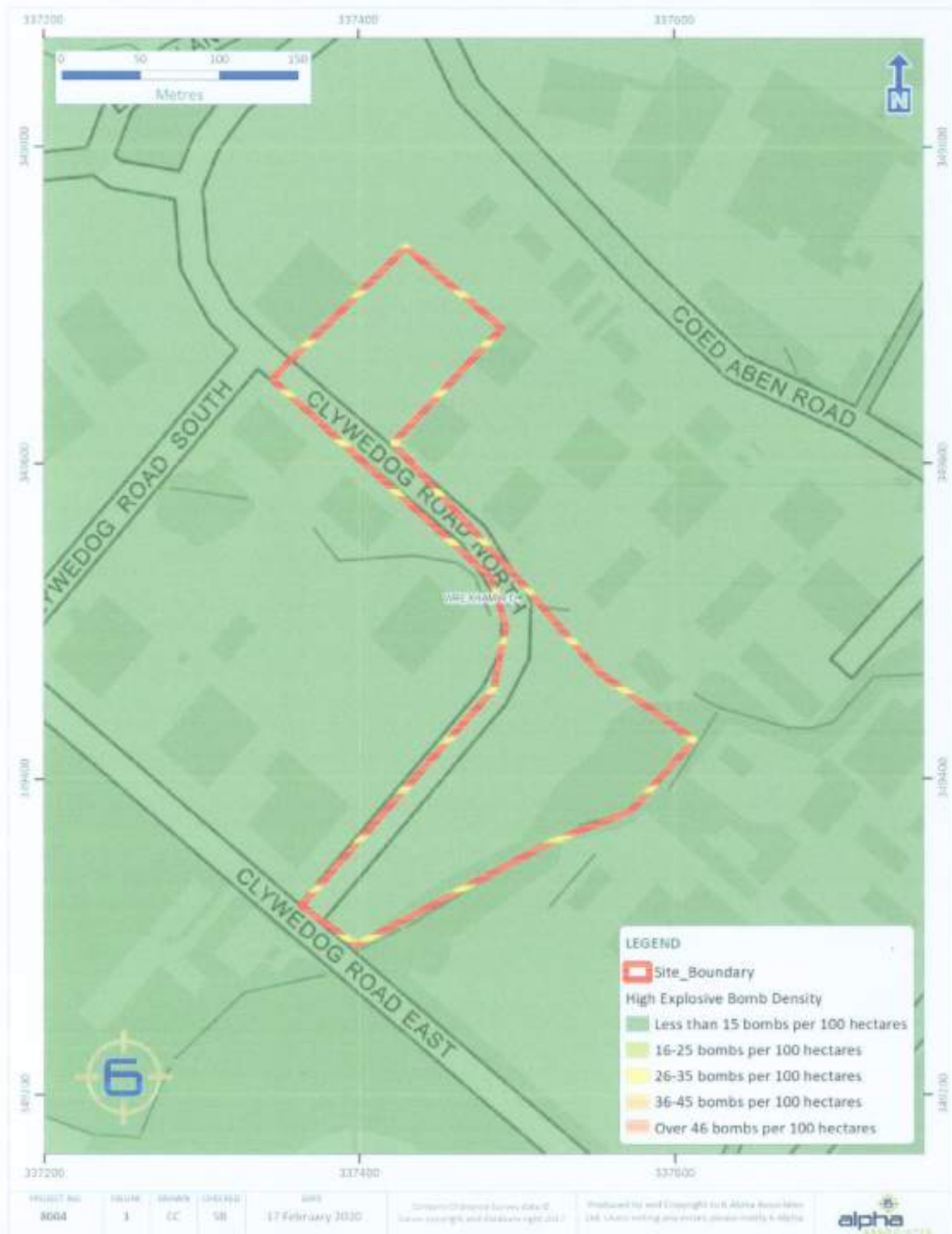
IMPORTANT NOTES

1. The term 'Preliminary UXO Threat Assessment' has been used to describe this report, to fall in line with the CIRIA C681 guidelines. Whilst the term 'Risk' can be justifiably used at this stage, the reader should note that the 'Consequence' function of 'Risk' is not considered. Should it be required, this would be addressed in the 'Detailed UXO Threat & Risk Assessment' (Stages 2 and 3).
2. This report is accurate and up to date at the time of writing.
3. The assessment levels have been generated from historical data and third party sources. Where possible 6 Alpha have sought to verify the accuracy of such data, but cannot be held accountable for inherent errors that may be in third party data sets (e.g. National Archives or library sources).
4. 6 Alpha have exercised all reasonable care, skill and due diligence in producing this service.
5. Whilst every effort has been used to identify all potential UXO/explosive threats, there were a number of private facilities, which may not have released privately recorded information concerning UXO/explosive threats into the public domain. It is therefore possible that some of the aforementioned sites may not be included within the database.



TRITECH, UNIT 69, CLYWEDOG ROAD EAST,
WREXHAM INDUSTRIAL ESTATE, WREXHAM, LL13 9XE

WWII High Explosive Bomb Density



TRITECH, UNIT 69, CLYWEDOG ROAD EAST,
WREXHAM INDUSTRIAL ESTATE, WREXHAM, LL13 9XE

Probability of UXO Encounter



PROJECT NO.

0004

FIGURE

2

DATE

CC

UNCLASSIFIED

SB

DATE

17 February 2020

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SEARCH

APPENDIX C

Historical Site Features

APPENDIX D

Borehole and Trial Pit Logs

AFTER DRILLING —

Bottom of borehole at 4.45 meters.

BORING NUMBER BH2

PAGE 1 OF 1

SP Associates

CLIENT F1 Real Estate Management PROJECT NAME Wrexham Industrial Estate - Site 4
 PROJECT NUMBER S1671-4 PROJECT LOCATION Wrexham
 DATE STARTED 4/3/20 COMPLETED 4/3/20 GROUND ELEVATION _____ HOLE SIZE _____
 DRILLING CONTRACTOR _____ GROUND WATER LEVELS:
 DRILLING METHOD Window Sampler AT TIME OF DRILLING _____
 LOGGED BY PVC CHECKED BY SMP AT END OF DRILLING _____
 NOTES Borehole remained dry. AFTER DRILLING _____

DEPTH (m)	SAMPLE TYPE NUMBER	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0.00				Soft, dark brown CLAY with roots (Topsoil)
0.20				Firm to stiff, brown and grey mottled CLAY (Glacial Till)
1.00	UD 1			
2.00	UD 2	SPT N @ 1m = 20		
3.00	UD 3	SPT N @ 2m = 28		
3.45	SPT 4	SPT N @ 3m = 41		

Bottom of borehole at 3.45 meters.

CLIENT F1 Real Estate Management PROJECT NAME Wrexham Industrial Estate - Site 4
PROJECT NUMBER 51671-4 PROJECT LOCATION Wrexham
DATE STARTED 4/3/20 COMPLETED 4/3/20 GROUND ELEVATION _____ HOLE SIZE _____
DRILLING CONTRACTOR _____ GROUND WATER LEVELS:
DRILLING METHOD Window Sampler AT TIME OF DRILLING —
LOGGED BY PVC CHECKED BY SMP AT END OF DRILLING —
NOTES Borehole refused at 3 locations AFTER DRILLING —

DEPTH (m)	SAMPLE TYPE NUMBER	GRAPHIC LOG	MATERIAL DESCRIPTION
0.20			Soft, dark brown CLAY with occasional fine gravel and roots (Made Ground)
0.40			Firm to stiff, brown CLAY (Made Ground)
0.50			Dense, brown SANDSTONE fragments (Made Ground)
Bottom of borehole at 0.50 meters.			

BORING NUMBER BH4

PAGE 1 OF 1

SP Associates

CLIENT F1 Real Estate Management PROJECT NAME Wrexham Industrial Estate - Site 4
 PROJECT NUMBER S1671-4 PROJECT LOCATION Wrexham
 DATE STARTED 4/3/20 COMPLETED 4/3/20 GROUND ELEVATION _____ HOLE SIZE _____
 DRILLING CONTRACTOR _____ GROUND WATER LEVELS:
 DRILLING METHOD Window Sampler AT TIME OF DRILLING _____
 LOGGED BY PVC CHECKED BY SMP AT END OF DRILLING _____
 NOTES Standpipe installed to 3m, 1m plain, 2m slotted. AFTER DRILLING _____

DEPTH (m)	SAMPLE TYPE NUMBER	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
			0.00	Soft, dark brown CLAY with occasional roots (Topsoil)
	UD 1		0.40	Firm to stiff, brown and grey mottled CLAY (Glacial Till)
1			1.00	Firm, becoming stiff, brown and grey mottled CLAY (Glacial Till)
	UD 2	SPT N @ 1m = 20		
2				
	UD 3	SPT N @ 2m = 26		
3				
	SPT 4	SPT N @ 3m = 39	3.45	
Bottom of borehole at 3.45 meters.				

BORING NUMBER BH5

PAGE 1 OF 1

SP Associates

CLIENT F1 Real Estate Management PROJECT NAME Wrexham Industrial Estate - Site 4
 PROJECT NUMBER 51671-4 PROJECT LOCATION Wrexham
 DATE STARTED 4/3/20 COMPLETED 4/3/20 GROUND ELEVATION _____ HOLE SIZE _____
 DRILLING CONTRACTOR _____ GROUND WATER LEVELS:
 DRILLING METHOD Window Sampler AT TIME OF DRILLING _____
 LOGGED BY PVC CHECKED BY SMP AT END OF DRILLING _____
 NOTES Borehole remained dry. AFTER DRILLING _____

DEPTH (m)	SAMPLE TYPE NUMBER	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0.20	UD 1			Soft, dark brown CLAY with roots (Topsoil)
1.00	UD 2	SPT N @ 1m = 17		Soft to firm, brown and grey mottled CLAY (Glacial Till)
2.00	UD 3	SPT N @ 2m = 38		Firm, becoming stiff, brown and grey mottled CLAY (Glacial Till)
3.45	SPT 4	SPT N @ 3m = 43		Bottom of borehole at 3.45 meters.

TEST PIT NUMBER TP1

PAGE 1 OF 1

SP Associates

CLIENT F1 Real Estate Management PROJECT NAME Wrexham Industrial Estate - Site 4
 PROJECT NUMBER S1671-4 PROJECT LOCATION Wrexham
 DATE STARTED 12/3/20 COMPLETED 12/3/20 GROUND ELEVATION _____ TEST PIT SIZE _____
 EXCAVATION CONTRACTOR _____ GROUND WATER LEVELS:
 EXCAVATION METHOD Trial Pit AT TIME OF EXCAVATION _____
 LOGGED BY PVC CHECKED BY SMP AT END OF EXCAVATION _____
 NOTES Trial Pit remained dry. AFTER EXCAVATION _____

DEPTH (m)	SAMPLE TYPE NUMBER	GRAPHIC LOG	MATERIAL DESCRIPTION
1	GS		Soft brown CLAY with some brick, concrete and shale fragments and occasional roots (Made Ground)
2			Firm to stiff, brown mottled grey CLAY (Glacial Till)

Bottom of test pit at 2.10 meters.

TEST PIT NUMBER TP2

PAGE 1 OF 1

SP Associates

CLIENT F1 Real Estate Management PROJECT NAME Wrexham Industrial Estate - Site 4
 PROJECT NUMBER S1671-4 PROJECT LOCATION Wrexham
 DATE STARTED 12/3/20 COMPLETED 12/3/20 GROUND ELEVATION _____ TEST PIT SIZE _____
 EXCAVATION CONTRACTOR _____ GROUND WATER LEVELS:
 EXCAVATION METHOD Trial Pit AT TIME OF EXCAVATION ---
 LOGGED BY PVC CHECKED BY SMP AT END OF EXCAVATION ---
 NOTES Trial Pit remained dry. AFTER EXCAVATION ---

DEPTH (m)	SAMPLE TYPE NUMBER	GRAPHIC LOG	MATERIAL DESCRIPTION
			0.10 Soft, dark brown CLAY with occasional roots (Made Ground)
			Soft brown CLAY with occasional fine to coarse gravel and boulders of concrete and occasional brick and shale fragments (Made Ground)
			0.90
			Brick Wall and Footing running east to west (Made Ground)
			1.20
			Firm to stiff, brown and grey mottled CLAY (Glacial Till)
2			2.10

Bottom of test pit at 2.10 meters.

TEST PIT NUMBER TP3

PAGE 1 OF 1

SP Associates

CLIENT F1 Real Estate Management PROJECT NAME Wrexham Industrial Estate - Site 4
 PROJECT NUMBER S1671-4 PROJECT LOCATION Wrexham
 DATE STARTED 12/3/20 COMPLETED 12/3/20 GROUND ELEVATION _____ TEST PIT SIZE _____
 EXCAVATION CONTRACTOR _____ GROUND WATER LEVELS:
 EXCAVATION METHOD Trial Pit AT TIME OF EXCAVATION ---
 LOGGED BY PVC CHECKED BY SMP AT END OF EXCAVATION ---
 NOTES Trial Pit remained dry. AFTER EXCAVATION ---

DEPTH (m)	SAMPLE TYPE NUMBER	GRAPHIC LOG	MATERIAL DESCRIPTION
			Soft, dark brown CLAY with occasional roots and occasional brick fragments (Made Ground)
		0.40	Soft to firm, brown CLAY with some boulders of concrete, some brick fragments and occasional shale and wood fragments (Made Ground)
		0.70	Loose, fine to coarse GRAVEL within a matrix of brown, sandy clay (Made Ground)
		0.80	Firm to stiff, brown and grey mottled CLAY (Glacial Till)
1			
2			
		2.10	

Bottom of test pit at 2.10 meters.

CLIENT F1 Real Estate Management PROJECT NAME Wrexham Industrial Estate - Site 4
 PROJECT NUMBER S1671-4 PROJECT LOCATION Wrexham
 DATE STARTED 12/3/20 COMPLETED 12/3/20 GROUND ELEVATION _____ TEST PIT SIZE _____
 EXCAVATION CONTRACTOR _____ GROUND WATER LEVELS:
 EXCAVATION METHOD Trial Pit AT TIME OF EXCAVATION _____
 LOGGED BY PVC CHECKED BY SMP AT END OF EXCAVATION _____
 NOTES Trial Pit remained dry. AFTER EXCAVATION _____

DEPTH (m)	SAMPLE TYPE NUMBER	GRAPHIC LOG	MATERIAL DESCRIPTION
0.10			Soft, dark brown CLAY with occasional fine to coarse gravel and occasional roots (Made Ground)
			Soft to firm, brown CLAY with some boulders of concrete and occasional brick and fine coal fragments (Made Ground)
1	GB 1		
1.20			Firm to stiff, brown and grey mottled CLAY (Glacial Till)
	GB 2		
2			
2.10			Bottom of test pit at 2.10 meters.

APPENDIX E

Chemical Test Results



2183



The right chemistry to deliver results

Chemtest Ltd.

Depot Road

Newmarket

CB8 0AL

Tel: 01638 606070

Email: info@chemtest.com

Final Report

Report No.: 20-06877-1
Initial Date of Issue: 19-Mar-2020
Client: SP Associates Ltd
Client Address: 1 Market Place
Warwick
Warwickshire
CV34 4SA
Contact(s): Steven Peters
Project: Wrexham Industrial Estate, Wrexham

Quotation No.:	Q20-19849	Date Received:	04-Mar-2020
Order No.:		Date Instructed:	11-Mar-2020
No. of Samples:	6		
Turnaround (Wkdays):	5	Results Due:	17-Mar-2020
Date Approved:	17-Mar-2020		

Approved By:

Details: Darrell Hall, Director

Results - Water

The right chemistry to deliver results

Project: Wrotham Industrial Estate, Wrotham

Client: SP Associates Ltd	Chemtest Job No.:	20-06877	20-06877	20-06877	20-06877	20-06877	20-06877
Quotation No.: Q20-19849	Chemtest Sample ID:	990040	990041	990042	990043	990044	990045
Order No.:	Client Sample Ref.:	BH1	BH2	BH3	BH4	BH5	BH6
	Sample Location:	Site 2	Site 3	Site 3	Site 4	Site 5	Site 6
	Sample Type:	WATER	WATER	WATER	WATER	WATER	WATER
	Date Sampled:	02-Mar-2020	02-Mar-2020	02-Mar-2020	02-Mar-2020	02-Mar-2020	02-Mar-2020
Determinand	Accred.	SOP	Units	LOG			
pH	U	1010	ppm	8.2	8.4	8.4	8.1
Electrical Conductivity	U	1020	µS/cm	5200	1100	880	1500
Chloride	U	1220	mg/l	1.0	380	33	85
Fluoride	U	1220	mg/l	0.050	0.18	0.27	0.29
Ammonium	U	1220	mg/l	0.050	0.70	0.067	0.063
Nitrite	U	1220	mg/l	0.020	< 0.020	< 0.020	< 0.020
Nitrate	U	1220	mg/l	0.50	< 0.50	1.5	< 0.50
Sulphate	U	1220	mg/l	1.0	3000	64	110
Cyanide (Total)	U	1300	mg/l	0.050	< 0.050	< 0.050	< 0.050
Sodium	U	1415	mg/l	0.50	380	48	140
Aluminium (Dissolved)	N	1450	µg/l	10	210	12	330
Arsenic (Dissolved)	U	1450	µg/l	1.0	1.1	< 1.0	< 1.0
Boron (Dissolved)	U	1450	µg/l	20	270	65	38
Cadmium (Dissolved)	U	1450	µg/l	0.080	0.15	< 0.080	< 0.080
Chromium (Dissolved)	U	1450	µg/l	1.0	2.4	< 1.0	< 1.0
Copper (Dissolved)	U	1450	µg/l	1.0	4.2	5.4	5.8
Iron (Dissolved)	N	1450	µg/l	20	520	210	430
Mercury (Dissolved)	U	1450	µg/l	0.50	< 0.50	< 0.50	< 0.50
Manganese (Dissolved)	U	1450	µg/l	1.0	63	3.0	62
Nickel (Dissolved)	U	1450	µg/l	1.0	3.5	< 1.0	2.0
Lead (Dissolved)	U	1450	µg/l	1.0	< 1.0	< 1.0	< 1.0
Antimony (Dissolved)	U	1450	µg/l	1.0	< 1.0	< 1.0	< 1.0
Selenium (Dissolved)	U	1450	µg/l	1.0	4.4	3.7	1.4
Zinc (Dissolved)	U	1450	µg/l	1.0	140	11	13
Total TPH >C6-C40	U	1670	µg/l	10	< 10	< 10	< 10
Naphthalene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Acenaphthylene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Acenaphthene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Fluorene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Phenanthrene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Anthracene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Fluoranthene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Pyrene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Benz[a]anthracene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Chrysene	N	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Benzofluoranthene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Benzofluoranthene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Benzofluoranthene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Indeno[1,2,3-cd]Pyrene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10
Dibenz[a,h]Anthracene	U	1700	µg/l	0.10	< 0.10	< 0.10	< 0.10

Results - Water

Client: SP Associates Ltd	Chemtest Job No:	20-06877	20-06877	20-06877	20-06877	20-06877	20-06877
Quotation No.: Q00-19649	Chemtest Sample ID:	980040	980041	980042	980043	980044	980045
Order No.:	Client Sample Ref:	BH1	BH3	BH1	BH4	BH1	BH3
	Sample Location	Site 2	Site 2	Site 3	Site 4	Site 5B	Site 5B
	Sample Type	WATER	WATER	WATER	WATER	WATER	WATER
	Date Sampled	02-Mar-2020	02-Mar-2020	02-Mar-2020	02-Mar-2020	02-Mar-2020	02-Mar-2020
Determinand	Accred.	LOD	Units	LOD	Units	LOD	Units
Arsenic	U	1750	µg/l	0.10	< 0.10	< 0.10	< 0.10
Benzene	U	1750	µg/l	0.10	< 0.10	< 0.10	< 0.10
Total Of 16 PAHs	N	1750	µg/l	0.10	< 0.10	< 0.10	< 0.10
Dichlorodifluoromethane	U	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
Chloromethane	U	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
Vinyl Chloride	N	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
Bromomethane	U	1750	µg/l	0.5	< 0.5	< 0.5	< 0.5
Chloroethane	U	1750	µg/l	0.5	< 0.5	< 0.5	< 0.5
Trichlorofluoromethane	U	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloroethane	U	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
Trans 1,2-Dichloroethane	U	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
1,1,1-Trichloroethane	U	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
cis 1,2-Dichloroethane	U	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
Bromochloromethane	U	1750	µg/l	0.5	< 0.5	< 0.5	< 0.5
Trichloromethane	U	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
1,1,1-Trichloroethane	U	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
Tetrachloromethane	U	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
1,1-Dichloropropane	U	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
Benzene	U	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloroethane	U	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
Trichloroethane	N	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
1,2-Dichloropropane	U	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
Dibromomethane	U	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
Bromodichloromethane	U	1750	µg/l	0.5	< 0.5	< 0.5	< 0.5
cis 1,2-Dichloropropane	N	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
Toluene	U	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
Trans 1,2-Dichloropropane	N	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
1,1,2-Trichloroethane	U	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
Tetrachloroethane	U	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
1,3-Dichloropropane	U	1750	µg/l	2.0	< 2.0	< 2.0	< 2.0
Dibromochloromethane	U	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
1,2-Dibromomethane	U	1750	µg/l	0.5	< 0.5	< 0.5	< 0.5
Chlorobenzene	N	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
1,1,1,2-Tetrachloroethane	U	1750	µg/l	2.0	< 2.0	< 2.0	< 2.0
Rhuthene	U	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
m & p-Xylene	U	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
o-Xylene	U	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
Styrene	U	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
Tetramethane	U	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
Isopropylbenzene	U	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0
Bromobenzene	U	1750	µg/l	1.0	< 1.0	< 1.0	< 1.0

Results - Water

Client: SP Associates Ltd	Chemtest Job No.:	20-06877	20-06877	20-06877	20-06877	20-06877	20-06877
Quotation No.: Q20-18849	Chemtest Sample ID:	980040	980041	980042	980043	980044	980045
Order No.:	Client Sample Ref:	BH1	BH3	BH1	BH4	BH1	BH2
	Sample Location	Site 2	Site 2	Site 2	Site 4	Site 2B	Site 2B
	Sample Type	WATER	WATER	WATER	WATER	WATER	WATER
	Date Sampled	02-Mar-2020	02-Mar-2020	02-Mar-2020	02-Mar-2020	02-Mar-2020	02-Mar-2020
Determinand	Accred.	LOP	Units	LOD			
1,2,3-Trichlorobenzene	N	1760	µg/l	50	< 50	< 50	< 50
n-Propylbenzene	U	1760	µg/l	1.0	< 1.0	< 1.0	< 1.0
2-Chlorotoluene	U	1760	µg/l	1.0	< 1.0	< 1.0	< 1.0
1,3,5-Trimethylbenzene	U	1760	µg/l	1.0	< 1.0	< 1.0	< 1.0
4-Chlorotoluene	U	1760	µg/l	1.0	< 1.0	< 1.0	< 1.0
Tert-Butylbenzene	U	1760	µg/l	1.0	< 1.0	< 1.0	< 1.0
1,2,4-Trimethylbenzene	U	1760	µg/l	1.0	< 1.0	< 1.0	< 1.0
Sec-Butylbenzene	U	1760	µg/l	1.0	< 1.0	< 1.0	< 1.0
1,3-Dichlorobenzene	N	1760	µg/l	1.0	< 1.0	< 1.0	< 1.0
4-Isopropyltoluene	U	1760	µg/l	1.0	< 1.0	< 1.0	< 1.0
1,4-Dichlorobenzene	U	1760	µg/l	1.0	< 1.0	< 1.0	< 1.0
n-Butylbenzene	U	1760	µg/l	1.0	< 1.0	< 1.0	< 1.0
1,2-Dichlorobenzene	U	1760	µg/l	1.0	< 1.0	< 1.0	< 1.0
1,2-Dinitro-3-Chlorobenzene	U	1760	µg/l	50	< 50	< 50	< 50
1,2,4-Trichlorobenzene	U	1760	µg/l	1.0	< 1.0	< 1.0	< 1.0
Hexachlorobenzene	U	1760	µg/l	1.0	< 1.0	< 1.0	< 1.0
1,2,3-Trichlorobenzene	U	1760	µg/l	2.0	< 2.0	< 2.0	< 2.0
Methyl Tert-Butyl Ether	N	1760	µg/l	1.0	< 1.0	< 1.0	< 1.0
Epichlorohydrin	N	1760	µg/l	10	< 10	< 10	< 10
Acrylonitrile	N	1760	mg/l	0.50	< 0.50	< 0.50	< 0.50
Total Phenols	U	1920	mg/l	0.030	[R] < 0.030	[R] < 0.030	[R] < 0.030

Deviations

In accordance with UKAS Policy on Deviating Samples TPS 63, Chemtest have a procedure to ensure upon receipt of each sample a competent laboratory shall assess whether the sample is suitable with regard to the requested test(s). This policy and the respective holding times applied, can be supplied upon request. The reason a sample is declared as deviating is detailed below. Where applicable the analysis remains UKAS/MCERs accredited but the results may be compromised.

Sample:	Sample Ref:	Sample ID:	Sample Location:	Sampled Date:	Deviation Code(s):	Containers Received:
980040	BH1		Site 2	02-Mar-2020	B	Coloured Winchester 1000ml
980040	BH1		Site 2	02-Mar-2020	B	EPA Vial 40ml
980040	BH1		Site 2	02-Mar-2020	B	Plastic Bottle 1000ml
980041	BH3		Site 2	02-Mar-2020	B	Coloured Winchester 1000ml
980041	BH3		Site 2	02-Mar-2020	B	EPA Vial 40ml
980041	BH3		Site 2	02-Mar-2020	B	Plastic Bottle 1000ml
980042	BH1		Site 3	02-Mar-2020	B	Coloured Winchester 1000ml
980042	BH1		Site 3	02-Mar-2020	B	EPA Vial 40ml
980042	BH1		Site 3	02-Mar-2020	B	Plastic Bottle 1000ml
980043	BH4		Site 4	02-Mar-2020	B	Coloured Winchester 1000ml
980043	BH4		Site 4	02-Mar-2020	B	EPA Vial 40ml
980043	BH4		Site 4	02-Mar-2020	B	Plastic Bottle 1000ml
980044	BH1		Site 5B	02-Mar-2020	B	Coloured Winchester 1000ml
980044	BH1		Site 5B	02-Mar-2020	B	EPA Vial 40ml
980044	BH1		Site 5B	02-Mar-2020	B	Plastic Bottle 1000ml
980045	BH3		Site 5B	02-Mar-2020	B	Coloured Winchester 1000ml
980045	BH3		Site 5B	02-Mar-2020	B	EPA Vial 40ml
980045	BH3		Site 5B	02-Mar-2020	B	Plastic Bottle 1000ml

SOP	Title	Parameters included	Method summary
1010	pH Value of Waters	pH	pH Meter
1020	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Conductivity Meter
1220	Anions, Alkalinity & Ammonium in Waters	Fluoride; Chloride; Nitrite; Nitrate; Total; Oxidisable Nitrogen (TON); Sulfate; Phosphate; Alkalinity; Ammonium	Automated colorimetric analysis using 'Aquakem 600' Discrete Analyser.
1300	Cyanides & Thiocyanate in Waters	Free (or easily liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Continuous Flow Analysis.
1415	Cations in Waters by ICP-MS	Sodium; Potassium; Calcium; Magnesium	Direct determination by inductively coupled plasma - mass spectrometry (ICP-MS).
1450	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).
1670	Total Petroleum Hydrocarbons (TPH) in Waters by GC-FID	TPH (C6-C40); optional carbon banding, e.g. 3-band - GRO, DRO & LRO	Pentane extraction / GC FID detection
1700	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Waters by GC-FID	Acenaphthene; Acenaphthylene; Anthracene; Benzo(a)Anthracene; Benzo(a)Pyrene; Benzo(b)Fluoranthene; Benzo(ghi)Perylene; Benzo(k)Fluoranthene; Chrysene; Dibenz(ah)Anthracene; Fluoranthene; Fluorene; Indeno(123cd)Pyrene; Naphthalene; Phenanthrene; Pyrene	Dichloromethane extraction / GC-FID (GC-FID detection is non-selective and can be subject to interference from co-eluting compounds)
1760	Volatile Organic Compounds (VOCs) in Waters by Headspace GC-MS	Volatile organic compounds, including BTEX and halogenated Aliphatic/Aromatics. (cf. USEPA Method 8260)	Automated headspace gas chromatographic (GC) analysis of water samples with mass spectrometric (MS) detection of volatile organic compounds.
1790	Semi-Volatile Organic Compounds (SVOCs) in Waters by GC-MS	Semi-volatile organic compounds	Solvent extraction / GCMS detection
1920	Phenols in Waters by HPLC	Phenolic compounds including: Phenol, Cresols, Xylenols, Trimethylphenols Note: Chlorophenols are excluded.	Determination by High Performance Liquid Chromatography (HPLC) using electrochemical detection.

Report Information

Key

- U UKAS accredited
- M MCERTS and UKAS accredited
- N Unaccredited
- S This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
- SN This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
- T This analysis has been subcontracted to an unaccredited laboratory
- I/S Insufficient Sample
- U/S Unsuitable Sample
- N/E not evaluated
- < "less than"
- > "greater than"

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis

All Asbestos testing is performed at the indicated laboratory

Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

- A - Date of sampling not supplied
- B - Sample age exceeds stability time (sampling to extraction)
- C - Sample not received in appropriate containers
- D - Broken Container
- E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 45 days from the date of receipt

All water samples will be retained for 14 days from the date of receipt

Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:

customerservices@chemtest.com



Final Report

Report No.: 20-08553-1

Initial Date of Issue: 24-Mar-2020

Client SP Associates Ltd

Client Address: 1 Market Place
Warwick
Warwickshire
CV34 4SA

Contact(s): Steven Peters

Project Water Analysis

Quotation No.: Q20-19849

Date Received: 18-Mar-2020

Order No.:

Date Instructed: 18-Mar-2020

No. of Samples: 6

Turnaround (Wkdays): 5

Results Due: 24-Mar-2020

Date Approved: 24-Mar-2020

Approved By:

Details: Glynn Harvey, Technical Manager

Results - Water

Project: Water Analysis

Client: SP Associates Ltd		Chemtest Job No.		20-06053	20-06053	20-06053	20-06053	20-06053	20-06053
Quotation No.: Q20-19943		Chemtest Sample ID:		987614	987615	987616	987617	987618	987619
		Client Sample ID:		SH4	SH4	SH5	SH1	SH5	SH5
		Sample Location:		Site 2	Site 2	Site 3	Site 4	Site 4	Site 5
		Sample Type:		WATER	WATER	WATER	WATER	WATER	WATER
Determinand	Accred.	SOP	Units	LOD					
pH	U	1010	N/A	[A] 6.4	[A] 6.5	[A] 6.4	[A] 6.1	[A] 6.4	[A] 6.5
Electrical Conductivity	U	1020	µS/cm	1.0	[A] 3000	[A] 993	[A] 1000	[A] 2200	[A] 1696
Chloride	U	1220	mg/l	1.0	[A] 130	[A] 23	[A] 54	[A] 280	[A] 83
Fluoride	U	1220	mg/l	0.050	[A] 0.19	[A] 0.15	[A] 0.20	[A] 0.15	[A] 0.19
Ammonium	U	1220	mg/l	0.050	[A] 0.080	[A] 0.052	[A] 0.11	[A] 0.090	[A] 0.051
Nitrite	U	1220	mg/l	0.030	[A] 0.020	[A] 0.020	[A] 0.020	[A] 0.020	[A] 0.020
Nitrate	U	1220	mg/l	0.50	[A] 0.50	[A] 0.50	[A] 0.50	[A] 0.50	[A] 0.50
Sulphate	U	1220	mg/l	1.0	[A] 870	[A] 58	[A] 86	[A] 270	[A] 120
Cyanide (Total)	U	1300	mg/l	0.050	[A] 0.050	[A] 0.050	[A] 0.050	[A] 0.050	[A] 0.050
Sodium	U	1415	mg/l	0.80	[A] 140	[A] 24	[A] 66	[A] 150	[A] 190
Aluminium (Dissolved)	N	1450	µg/l	10	[A] 1.0	[A] 200	[A] 1.0	[A] 110	[A] 1.0
Arsenic (Dissolved)	U	1450	µg/l	1.0	[A] 1.7	[A] 1.3	[A] 1.0	[A] 2.2	[A] 1.0
Boron (Dissolved)	U	1450	µg/l	25	[A] 1400	[A] 200	[A] 330	[A] 600	[A] 110
Cadmium (Dissolved)	U	1450	µg/l	0.003	[A] 0.11	[A] 0.31	[A] 0.080	[A] 0.15	[A] 0.060
Chromium (Dissolved)	U	1450	µg/l	1.0	[A] 0.1	[A] 1.0	[A] 1.0	[A] 3.1	[A] 7.0
Copper (Dissolved)	U	1450	µg/l	1.0	[A] 10	[A] 7.4	[A] 3.6	[A] 6.9	[A] 5.5
Iron (Dissolved)	N	1450	µg/l	20	370	420	340	510	190
Mercury (Dissolved)	U	1450	µg/l	0.50	[A] 0.50	[A] 0.50	[A] 0.50	[A] 0.50	[A] 0.50
Manganese (Dissolved)	U	1450	µg/l	1.0	[A] 1.8	[A] 370	[A] 1.5	[A] 640	[A] 5.4
Nickel (Dissolved)	U	1450	µg/l	1.0	[A] 3.7	[A] 5.3	[A] 1.4	[A] 5.4	[A] 1.3
Lead (Dissolved)	U	1450	µg/l	1.0	[A] 1.8	[A] 1.0	[A] 1.0	[A] 1.0	[A] 1.0
Antimony (Dissolved)	U	1450	µg/l	1.0	[A] 1.0	[A] 1.0	[A] 1.0	[A] 1.0	[A] 1.0
Selenium (Dissolved)	U	1450	µg/l	1.0	[A] 3.3	[A] 1.4	[A] 2.6	[A] 3.2	[A] 1.6
Zinc (Dissolved)	U	1450	µg/l	1.0	[A] 32	[A] 14	[A] 5.7	[A] 19	[A] 6.3
Mineral Oil	N	1670	µg/l	10	< 10	< 10	< 10	< 10	< 10
Total TPH >C8-C40	U	1670	µg/l	10	[A] 10	[A] 10	[A] 10	[A] 10	[A] 10
Polycyclic Aromatic Hydrocarbons	U	1700	µg/l	0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10
Acenaphthylene	U	1700	µg/l	0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10
Acenaphthene	U	1700	µg/l	0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10
Fluorene	U	1700	µg/l	0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10
Phenanthrene	U	1700	µg/l	0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10
Anthracene	U	1700	µg/l	0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10
Fluoranthene	U	1700	µg/l	0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10
Pyrene	U	1700	µg/l	0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10
Benzo[a]fluoranthene	U	1700	µg/l	0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10
Chrysene	N	1700	µg/l	0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10
Benzo[b]fluoranthene	U	1700	µg/l	0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10
Benzo[k]fluoranthene	U	1700	µg/l	0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10
Benzo[a]pyrene	U	1700	µg/l	0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10
Indeno[1,2,3-c,d]pyrene	U	1700	µg/l	0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10
Dibenz[a,h]anthracene	U	1700	µg/l	0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10	[A] 0.10

Project: Water Analysis

Client: SP Associates Ltd	Chemist Job No.	20-08553	20-08553	20-08553	20-08553	20-08553	20-08553
Question No: Q20-19849	Chemist Sample ID:	887514	887515	887516	887517	887518	887519
	Client Sample ID:	SH-5	SH-6	SH-6	BH-1	BH-5	SH-6
	Sample Location	Site 1	Site 2	Site 2	Site 4	Site 4	Site 5b
	Sample Type	WATER	WATER	WATER	WATER	WATER	WATER
Detected	Accred.	SDP	Units	LOD			
Benzodibenzene	U	1790	µg/l	0.10	[A] < 0.10	[A] < 0.10	[A] < 0.10
Total Of 16 PFAs	N	1790	µg/l	2.0	[A] < 2.0	[A] < 2.0	[A] < 2.0
Dichlorodifluoromethane	U	1790	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
Chloromethane	U	1790	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
Vinyl Chloride	N	1790	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
Bromomethane	U	1790	µg/l	5.0	[A] < 5.0	[A] < 5.0	[A] < 5.0
Chloroethane	U	1790	µg/l	2.0	[A] < 2.0	[A] < 2.0	[A] < 2.0
Trichlorofluoromethane	U	1790	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
1,1-Dichloroethane	U	1790	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
Trans 1,2-Dichloroethane	U	1790	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
1,1-Dichloroethane	U	1790	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
cis 1,2-Dichloroethane	U	1790	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
Bromochloromethane	U	1790	µg/l	5.0	[A] < 5.0	[A] < 5.0	[A] < 5.0
Trichloromethane	U	1790	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
1,1,1-Trichloroethane	U	1790	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
Tetrachloromethane	U	1790	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
1,1-Dichloropropene	U	1790	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
Benzene	U	1790	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
1,2-Dichloroethane	U	1790	µg/l	2.0	[A] < 2.0	[A] < 2.0	[A] < 2.0
Trichloroethane	N	1790	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
1,2-Dichloropropene	U	1790	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
Oxybenzene	U	1790	µg/l	10	[A] < 10	[A] < 10	[A] < 10
Bromodichloromethane	U	1790	µg/l	5.0	[A] < 5.0	[A] < 5.0	[A] < 5.0
cis-1,3-Dichloropropene	N	1790	µg/l	10	[A] < 10	[A] < 10	[A] < 10
toluene	U	1790	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
Trans-1,3-Dichloropropene	N	1790	µg/l	10	[A] < 10	[A] < 10	[A] < 10
1,1,3-Trichloroethane	U	1790	µg/l	10	[A] < 10	[A] < 10	[A] < 10
Trichloroethane	U	1790	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
1,3-Dichloropropene	U	1790	µg/l	2.0	[A] < 2.0	[A] < 2.0	[A] < 2.0
Dibromochloromethane	U	1790	µg/l	10	[A] < 10	[A] < 10	[A] < 10
1,2-Dibromomethane	U	1790	µg/l	5.0	[A] < 5.0	[A] < 5.0	[A] < 5.0
Chlorobenzene	N	1790	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
1,1,1,2-Tetrachloroethane	U	1790	µg/l	2.0	[A] < 2.0	[A] < 2.0	[A] < 2.0
Ethylbenzene	U	1790	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
m & p-Xylene	U	1790	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
o-Xylene	U	1790	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
Styrene	U	1790	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
Trichloromethane	U	1790	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
Isopropylbenzene	U	1790	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
Bromobenzene	U	1790	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
1,2,3-Trichloropropene	N	1790	µg/l	50	[A] < 50	[A] < 50	[A] < 50

Project: Water Analysis

Client: SP Associates Ltd	Chemtest Job No.:	20-00053	20-00053	20-00053	20-00053	20-00053	20-00053
Quotation No.: Q20-19848	Chemtest Sample ID:	887614	887615	887616	887617	887618	887619
	Client Sample ID:	8845	8846	8846	8847	8848	8849
	Sample Location:	Site 2	Site 3	Site 3	Site 4	Site 4	Site 5
	Sample Type:	WATER	WATER	WATER	WATER	WATER	WATER
Determinand	Accred.	SOP	Units	LOD			
N-Propylbenzene	U	1760	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
2-Chlorotoluene	U	1760	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
1,3,5-Trimethylbenzene	U	1760	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
4-Chlorotoluene	U	1760	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
Tert-Butylbenzene	U	1760	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
1,2,4-Trimethylbenzene	U	1760	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
Sec-Butylbenzene	U	1760	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
1,3-Dichlorobenzene	N	1760	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
4-Isopropyltoluene	U	1760	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
1,4-Dichlorobenzene	U	1760	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
N-Butylbenzene	U	1760	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
1,3-Dichlorobenzene	U	1760	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
1,2-Dichloro-3-Chloropropane	U	1760	µg/l	50	[A] < 50	[A] < 50	[A] < 50
1,2,4-Trichlorobenzene	U	1760	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
Hexachlorocyclopentadiene	U	1760	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
1,2,3-Trichlorobenzene	U	1760	µg/l	2.0	[A] < 2.0	[A] < 2.0	[A] < 2.0
Methyl Tert-Butyl Ether	N	1760	µg/l	1.0	[A] < 1.0	[A] < 1.0	[A] < 1.0
Epichlorohydrin	N	1760	µg/l	10	< 10	< 10	< 10
Acrylonitrile	N	1760	µg/l	0.50	< 0.50	< 0.50	< 0.50
Total Phenols	U	1620	mg/l	0.030	[A] < 0.030	[A] < 0.030	[A] < 0.030

Deviations

In accordance with UKAS Policy on Deviating Samples TPS 63, Chemtest have a procedure to ensure 'upon receipt of each sample a competent laboratory shall assess whether the sample is suitable with regard to the requested test(s)'. This policy and the respective holding times applied, can be supplied upon request. The reason a sample is declared as deviating is detailed below. Where applicable the analysis remains UKAS/MCERTs accredited but the results may be compromised.

Sample:	Sample Ref:	Sample ID:	Sample Location:	Sampled Date:	Deviation Code(s):	Containers Received:
987614		BH5	Site 2		A	Coloured Winchester 1000ml
987614		BH5	Site 2		A	EPA Vial 40ml
987614		BH5	Site 2		A	Plastic Bottle 1000ml
987615		BH4	Site 3		A	Coloured Winchester 1000ml
987615		BH4	Site 3		A	EPA Vial 40ml
987615		BH4	Site 3		A	Plastic Bottle 1000ml
987616		BH5	Site 3		A	Coloured Winchester 1000ml
987616		BH5	Site 3		A	EPA Vial 40ml
987616		BH5	Site 3		A	Plastic Bottle 1000ml
987617		BH1	Site 4		A	Coloured Winchester 1000ml
987617		BH1	Site 4		A	EPA Vial 40ml
987617		BH1	Site 4		A	Plastic Bottle 1000ml
987618		BH5	Site 4		A	Coloured Winchester 1000ml
987618		BH5	Site 4		A	EPA Vial 40ml
987619		BH6	Site 5b		A	Coloured Winchester 1000ml
987619		BH6	Site 5b		A	EPA Vial 40ml
987619		BH6	Site 5b		A	Plastic Bottle 1000ml

SOP	Title	Parameters included	Method summary
1010	pH Value of Waters	pH	pH Meter
1020	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Conductivity Meter
1220	Anions, Alkalinity & Ammonium in Waters	Fluoride; Chloride; Nitrite; Nitrate; Total Oxidisable Nitrogen (TON); Sulfate; Phosphate; Alkalinity; Ammonium	Automated colorimetric analysis using 'Aquakem 600' Discrete Analyser.
1300	Cyanides & Thiocyanate in Waters	Free (or easily liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Continuous Flow Analysis.
1415	Cations in Waters by ICP-MS	Sodium; Potassium; Calcium; Magnesium	Direct determination by inductively coupled plasma - mass spectrometry (ICP-MS).
1450	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).
1670	Total Petroleum Hydrocarbons (TPH) in Waters by GC-FID	TPH (C6-C40); optional carbon banding, e.g. 3-band - GRO, DRO & LRO	Pentane extraction / GC-FID detection
1700	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Waters by GC-FID	Acenaphthene; Acenaphthylene; Anthracene; Benzo[a]Anthracene; Benzo[a]Pyrene; Benzo[b]Fluoranthene; Benzo[ghi]Perylene; Benzo[k]Fluoranthene; Chrysene; Dibenzo[ah]Anthracene; Fluoranthene; Fluorene; Indeno[123cd]Pyrene; Naphthalene; Phenanthrene; Pyrene	Dichloromethane extraction / GC-FID (GC-FID detection is non-selective and can be subject to interference from co-eluting compounds)
1760	Volatile Organic Compounds (VOCs) in Waters by Headspace GC-MS	Volatile organic compounds, including BTEX and halogenated Aliphatic/Aromatics. (cf. USEPA Method 8260)	Automated headspace gas chromatographic (GC) analysis of water samples with mass spectrometric (MS) detection of volatile organic compounds.
1790	Semi-Volatile Organic Compounds (SVOCs) in Waters by GC-MS	Semi-volatile organic compounds	Solvent extraction / GCMS detection
1920	Phenols in Waters by HPLC	Phenolic compounds including: Phenol, Cresols, Xylenols, Trimethylphenols Note: Chlorophenols are excluded.	Determination by High Performance Liquid Chromatography (HPLC) using electrochemical detection.

Report Information

Key

- U UKAS accredited
- M MCERTS and UKAS accredited
- N Unaccredited
- S This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
- SN This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
- T This analysis has been subcontracted to an unaccredited laboratory
- I/S Insufficient Sample
- U/S Unsuitable Sample
- N/E not evaluated
- < "less than"
- > "greater than"

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis

All Asbestos testing is performed at the indicated laboratory

Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

- A - Date of sampling not supplied
- B - Sample age exceeds stability time (sampling to extraction)
- C - Sample not received in appropriate containers
- D - Broken Container
- E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 45 days from the date of receipt

All water samples will be retained for 14 days from the date of receipt

Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:

customerservices@chemtest.com



Final Report

Report No.: 20-09057-1
Initial Date of Issue: 21-Apr-2020
Client: SP Associates Ltd
Client Address: 1 Market Place
Warwick
Warwickshire
CV34 4SA
Contact(s): Steven Peters
Project: S1671-4 Wrexham Industrial Estate Site
4

Quotation No.:		Date Received:	20-Mar-2020
Order No.:		Date Instructed:	23-Mar-2020
No. of Samples:	6		
Turnaround (Wkdays):	15	Results Due:	14-Apr-2020
Date Approved:	21-Apr-2020	Subcon Results Due:	15-Apr-2020

Approved By:

Details: Glynn Harvey, Technical Manager

Client: BP Associates Ltd	Chemtest Job No:	20-08057	20-08057	20-08057	20-08057	20-08057	20-08057
Quotation No:	Chemtest Sample ID:	000062	000063	000064	000065	000066	000067
	Sample Location:	TP1	TP2	TP3	TP4	BP4	BP4
	Sample Type:	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
	Top Depth (m):	0.00	0.10	0.70	0.10	0.20	0.00
	Bottom Depth (m):	1.00	0.90	0.90	1.20	1.00	0.40
	Date Sampled:	12-Mar-2020	12-Mar-2020	12-Mar-2020	12-Mar-2020	12-Mar-2020	12-Mar-2020
Determinand	Assted	SOP	Units	LOD			
2,4,6-Trinitrotoluene (TNT)	5	mg/kg	5.00	< 5.0	< 5.0	< 5.0	< 5.0
2,4-dinitrotoluene	5	mg/kg	5.00	< 5.0	< 5.0	< 5.0	< 5.0
2,6-dinitrotoluene	5	mg/kg	5.00	< 5.0	< 5.0	< 5.0	< 5.0
Ethylene Glycol Dimethyl Ether (EGDM)	5	mg/kg	5.00	< 5.0	< 5.0	< 5.0	< 5.0
Cyclohexanediethylenetetraamine-HCl	5	mg/kg	5.00	< 5.0	< 5.0	< 5.0	< 5.0
Hexachlorobenzene (HCB)	5	mg/kg	5.00	< 5.0	< 5.0	< 5.0	< 5.0
Nitrocellulose (NC)	5	mg/kg	5000.00	< 5000	< 5000	< 5000	< 5000
Nitrobenzene (NB)	5	mg/kg	5.00	< 5.0	< 5.0	< 5.0	< 5.0
Pentaerythritol tetranitrate (PETN)	5N	mg/kg	5.00	< 5.0	< 5.0	< 5.0	< 5.0
RDX	5	mg/kg	5.00	< 5.0	< 5.0	< 5.0	< 5.0
Cyclotrimethylene trinitramine (RDX)	5	mg/kg	5.00	< 5.0	< 5.0	< 5.0	< 5.0
2,4,6-trinitrophenol	5	mg/kg	5.00	< 5.0	< 5.0	< 5.0	< 5.0
4-methyl-N-2,4,6-trinitroaniline	5	mg/kg	5.00	< 5.0	< 5.0	< 5.0	< 5.0

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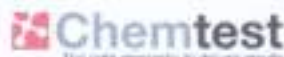
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:

customerservices@chemtest.com



2183



The right chemistry to deliver results

Chemtest Ltd
Deport Road
Newmarket
CB8 6AL
Tel: 01638 806870
Email: info@chemtest.com

Amended Report

Report No.:	20-09057-2		
Initial Date of Issue:	21-Apr-2020	Date of Re-Issue:	24-Apr-2020
Client:	BP Associates Ltd		
Client Address:	1 Market Place Warwick Warwickshire CV34 4SA		
Contact(s):	Steven Peters		
Project:	S1671-4 Wrexham Industrial Estate Site 4		
Quotation No.:	Q19-18628	Date Received:	20-Mar-2020
Order No.:		Date Instructed:	22-Apr-2020
No. of Samples:	6		
Turnaround (Wkdays):	5	Results Due:	28-Apr-2020
Date Approved:	24-Apr-2020	Subcon Results Due:	15-Apr-2020
Approved By:			

Details: Glynn Harvey, Technical Manager

Deviations

In accordance with ISO 9001:2015 clause 8.5.3, Chemtest have a procedure to ensure 'upon receipt of each sample a comparison laboratory shall verify whether the sample is suitable with regard to the requested body'. This policy and the respective holding times applied, can be supplied upon request. The reason a sample is declared as deviating is detailed below. Where applicable the analysis remains UNBESICHTIGT (uncontrolled) but the results may be compromised.

Sample:	Sample Ref:	Sample ID:	Sample Location:	Sampled Date:	Deviation Code(s):	Containers Received:
990002			TP1	12-Mar-2020	B	Amber Glass 250ml
990002			TP1	12-Mar-2020	B	Plastic Bag
990001			TP2	12-Mar-2020	B	Amber Glass 250ml
990001			TP2	12-Mar-2020	B	Plastic Bag
990004			TP3	12-Mar-2020	B	Amber Glass 250ml
990004			TP3	12-Mar-2020	B	Plastic Bag
990005			TP4	12-Mar-2020	B	Amber Glass 250ml
990005			TP4	12-Mar-2020	B	Plastic Bag
990006			Dr2	12-Mar-2020	B	Amber Glass 250ml
990006			Dr2	12-Mar-2020	B	Plastic Tub 500g
990007			Br4	12-Mar-2020	B	Amber Glass 250ml
990007			Br4	12-Mar-2020	B	Plastic Tub 500g

BOP	Title	Parameters Included	Method summary
2010	pH Value of Soils	pH	pH Meter
2020	Aluminum and Iron Content of Soils/Representative of MCERTS	Aluminum content	Determination of minimum content of soil as a percentage of its as received mass obtained by XRF
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron, Sulphate, Magnesium, Chromium	Aqueous extraction / ICP-OES
2150	Asbestos	Asbestos	Polarised light microscopy / Grindability
2450	Acid Soluble Metals in Soils	Metals, including: Arsenic, Barium, Beryllium, Cadmium, Chromium, Cobalt, Copper, Lead, Manganese, Mercury, Molybdenum, Nickel, Selenium, Vanadium, Zinc	Acid digestion followed by determination of metals in extract by ICP-MS
2660	TPH A/A Split	Aliphatics: <C15-C15, <C15-C18, <C18-C21, <C21-C25, <C25-C30, >C30-C35, >C35-C40, >C40-C45, >C45-C50, >C50-C55, >C55-C60, >C60-C65, >C65-C70, >C70-C75, >C75-C80, >C80-C85, >C85-C90, >C90-C95, >C95-C100, >C100-C105, >C105-C110, >C110-C115, >C115-C120, >C120-C125, >C125-C130, >C130-C135, >C135-C140, >C140-C145, >C145-C150, >C150-C155, >C155-C160, >C160-C165, >C165-C170, >C170-C175, >C175-C180, >C180-C185, >C185-C190, >C190-C195, >C195-C200, >C200-C205, >C205-C210, >C210-C215, >C215-C220, >C220-C225, >C225-C230, >C230-C235, >C235-C240, >C240-C245, >C245-C250, >C250-C255, >C255-C260, >C260-C265, >C265-C270, >C270-C275, >C275-C280, >C280-C285, >C285-C290, >C290-C295, >C295-C300, >C300-C305, >C305-C310, >C310-C315, >C315-C320, >C320-C325, >C325-C330, >C330-C335, >C335-C340, >C340-C345, >C345-C350, >C350-C355, >C355-C360, >C360-C365, >C365-C370, >C370-C375, >C375-C380, >C380-C385, >C385-C390, >C390-C395, >C395-C400, >C400-C405, >C405-C410, >C410-C415, >C415-C420, 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Report Information**Key**

- U - UKAS accredited
- M - MCERTS and UKAS accredited
- N - Unaccredited
- S - This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
- SN - This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
- T - This analysis has been subcontracted to an unaccredited laboratory
- IS - Insufficient Sample
- US - Unusable Sample
- NE - not evaluated
- - "less than"
- - "greater than"

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis: TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at $\approx 37^{\circ}\text{C}$ prior to analysis

All Asbestos testing is performed at the indicated laboratory

Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

- A - Date of sampling not supplied
- B - Sample age exceeds stability time (sampling to extraction)
- C - Sample not received in appropriate containers
- D - Broken Container
- E - Insufficient Sample (Applies to LOT in Tonnage Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 45 days from the date of receipt

All water samples will be retained for 14 days from the date of receipt

Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com

APPENDIX F

Geotechnical Test Results



Determination of Moisture Content and Atterberg Limits

Client: SP Associates Ltd
Client Address: 1 Market Place
Warwick
Warwickshire
Postcode: CV34 4SA
Contact: Steve Peters
Site: LL13 9XE, Wrexham

Report No: 51055776
Batch Number: DAM0078289
Client Reference: See Below
Sampled by: Client
Date Sampled: Not Advised
Date Received: 20.03.2020
Tested From: 27.03.2020
Sample Type: BULK BAG

Test Results:

Laboratory Reference	Location	Depth (m)	Description	Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	% Passing 425µm (Estimated)
45366514	Site 2, BH1	1.0 - 2.0	Firm SlightlySandy, Brown / Grey CLAY	24	51	22	29	N/R
45366515	Site 2, BH2	1.0 - 2.0	Firm SlightlySandy, Brown / Grey CLAY	21	49	24	25	N/R
45366516	Site 2, BH4	1.0 - 2.0	Firm SlightlySandy, Brown / Grey CLAY	26	52	24	28	N/R
45366517	Site 2, BH5	1.0 - 2.0	Firm SlightlySandy, Brown / Grey CLAY	24	53	26	27	N/R
45366518	Site 3, BH1	0.7 - 1.0	Firm Brown / Grey CLAY	26	49	23	26	N/R
45366519	Site 3, BH2	1.0 - 2.0	Firm Brown / Grey CLAY	24	50	25	25	N/R
45366520	Site 2, BH3	1.0 - 2.0	Firm Brown / Grey CLAY	26	53	25	28	N/R
45366521	Site 3, BH4	1.0 - 2.0	Firm SlightlySandy, Brown / Grey CLAY	21	48	25	23	N/R
45366522	Site 4, BH1	1.0 - 2.0	Firm Brown / Grey CLAY	21	56	26	30	N/R
45366523	Site 4, BH4	1.0 - 2.0	Very Soft Slightly Silty Sandy Brown CLAY	27	59	24	35	N/R

Sample Preparation: As Received

Certified that the laboratory testing was carried out in accordance with BS 1377-2: 1990; Method 3.2, 4.4 and 5

Page: 1 of 2
Date Reported: 01.05.2020

Signed

[] J. Caiger - Materials Section Manager
[X] S. Bourton - Laboratory Manager

For and on behalf of SOCOTEC UK Limited

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation

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SOCOTEC UK Limited, Registered in England No. 2880981, Registered Office: SOCOTEC House, Bostly Business Park, Aulby Road, Daventry Northants NN11 8YJ



Determination of Moisture Content and Atterberg Limits

Client: SP Associates Ltd
Client Address: 1 Market Place
Warwick
Warwickshire
Postcode: CV34 4SA
Contact: Steve Peters
Site: LL13 9XE, Wrexham

Report No: 51055776
Batch Number: DAM0078289
Client Reference: See Below
Sampled by: Client
Date Sampled: Not Advised
Date Received: 20.03.2020
Tested From: 27.03.2020
Sample Type: BULK BAG

Test Results:

Laboratory Reference	Location	Depth (m)	Description	Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	% Passing 425µm (Estimated)
45366524	Site 4, BH4	1.0 - 1.4	Firm SlightlySandy, Brown / Grey CLAY	23	48	23	25	N/R
45366525	Site 4, BH5	1.0 - 1.5	Firm SlightlySandy, Brown / Grey CLAY	27	52	25	27	N/R
45366526	Site 5B, BH1	1.0 - 1.5	Firm SlightlySandy, Brown / Grey CLAY	23	52	24	28	N/R
45366527	Site 5B, BH3	1.0 - 1.5	Firm SlightlySandy, Brown / Grey CLAY	32	49	23	26	N/R
45366528	Site 5B, BH4	1.0 - 1.5	Firm Slightly Silty Brown / Grey CLAY	28	52	25	27	N/R
45366529	Site 5B, BH5	1.0 - 1.5	Firm Slightly Silty and Sandy Brown / Grey CLAY	25	46	22	24	N/R

Sample Preparation: As Received

Certified that the laboratory testing was carried out in accordance with BS 1377-2: 1990: Method 3.2, 4.4 and 5

Page: 1 of 2
Date Reported: 01.05.2020

Signed

[] J. Caiger - Materials Section Manager
[X] S. Bourton - Laboratory Manager

For and on behalf of SOCOTEC UK Limited

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SOCOTEC UK Limited, Registered in England No. 2898795. Registered Office: SOCOTEC House, Drayton Business Park, Aulby Road, Barton on Trent DE12 5YZ

APPENDIX G

CBR Test Results

Determination of California Bearing Ratio

Client: SP Associates
Client Address: 1 Market Place
Warwick
Warwickshire
Postcode: CV34 4SA
Steven Peters

Report No: 51055776/20/01
Our Ref: DAM0078135
Lab Ref: CBR 1
Date Tested: 03.02.2020

Site: LL13 9XE, Wrexham Industrial Estate

Test Results:

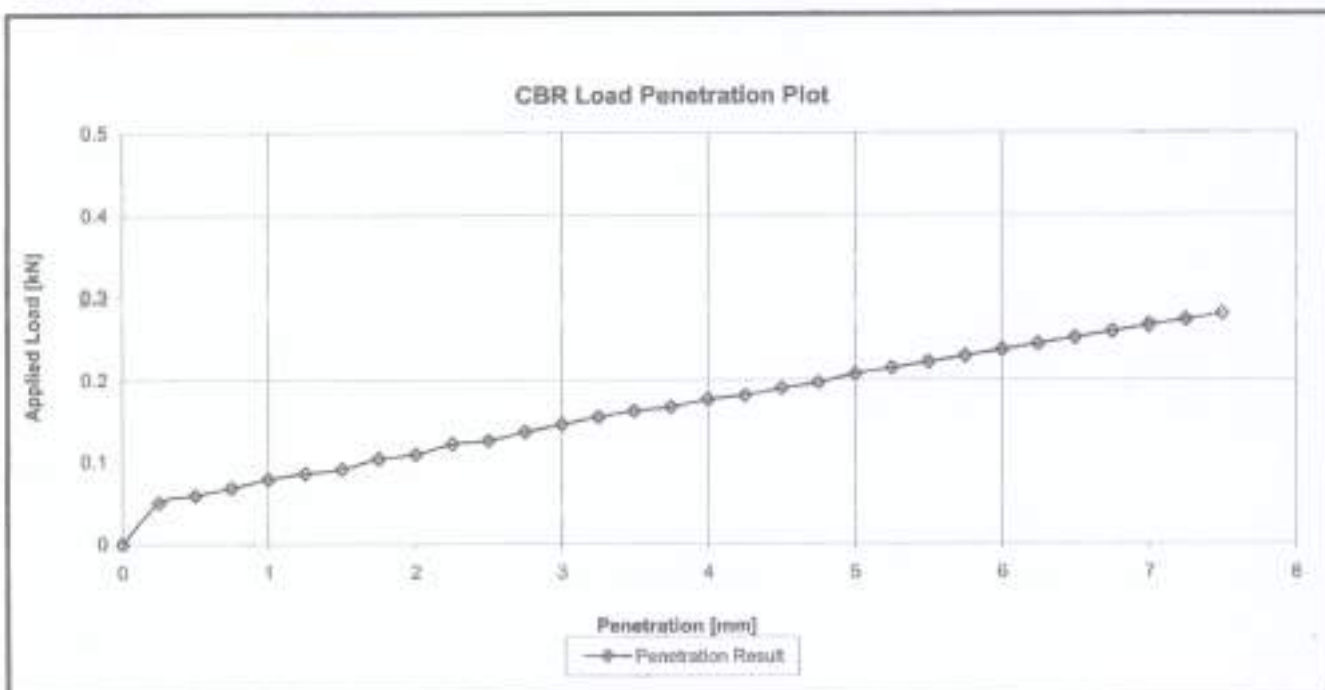
Sample Description: Brown CLAY
Sample Location: Site 4
Client Reference: CBR 1

Test Depth: >0.40m
Weather: Overcast

Moisture Content: 43%
Material >20mm below plunger: Yes
Retained on 20mm Test Sieve:

Applied Surcharge: 9.0kg
Applied Seating Load: 6 N

CBR Value: 1.0%



Comments: The CBR value for a given soil depends upon its dry density and moisture content, therefore the CBR value reported is related to the soil moisture content at time of test.

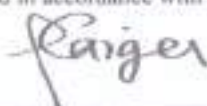
Certified that the test was carried out in accordance with BS 1377- 9: 1990 Method 4.3

Certified that the Moisture Content was determined in accordance with BS 1377- 2: 1990 Method 3.2

Page: 1 of 1

Date : 27.09.18

Signed:



[✓] J. Caiger - Field Services Manager

For and on behalf of SOCOTEC UK Limited

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SOCOTEC UK Limited
2 Newton Close
Drayton Fields Industrial Estate
Daventry
Northants NN11 8RR
Telephone: +44 (0) 1327 703828
Facsimile: +44 (0) 1327 300154



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TEST REPORT

Determination of California Bearing Ratio

Client:	SP Associates	Report No:	51055776/20/02
Client Address:	1 Market Place	Our Ref:	DAM0078135
	Warwick	Lab Ref:	CBR 2
	Warwickshire	Date Tested:	03.02.2020
Postcode:	CV34 4SA		
	Steven Peters		

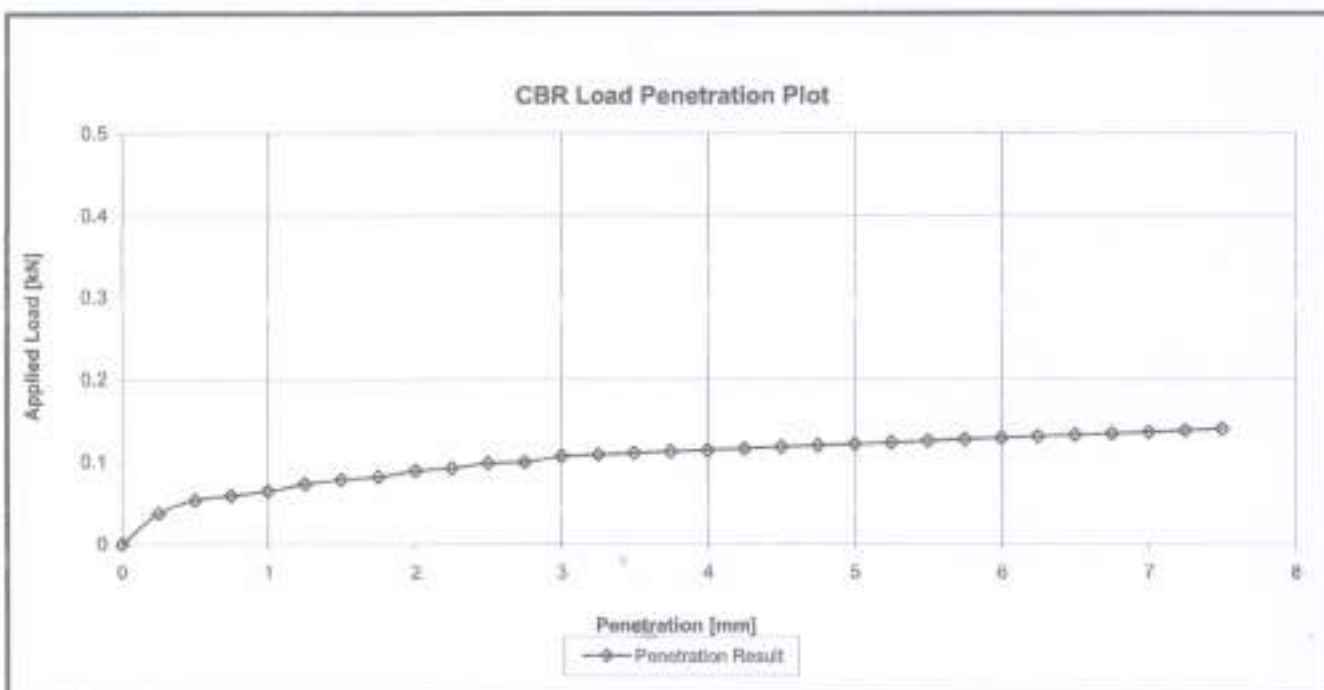
Site: LL13 9XE, Wrexham Industrial Estate

Test Results:

Sample Description:	Brown CLAY	Test Depth :	>0.40m
Sample Location:	Site 4	Weather:	Sunny Spells
Client Reference:	CBR 2		

Moisture Content:	35%	Applied Surcharge:	9.0kg
Material >20mm below plunger:	Yes	Applied Seating Load:	6 N
Retained on 20mm Test Sieve:			

CBR Value: 0.7%



Comments: The CBR value for a given soil depends upon its dry density and moisture content, therefore the CBR value reported is related to the soil moisture content at time of test.

Certified that the test was carried out in accordance with BS 1377- 9: 1990 Method 4.3

Certified that the Moisture Content was determined in accordance with BS 1377- 2: 1990 Method 3.2

Page: 1 of 1

Date : 27.09.18

Signed:

[✓] J. Caiger - Field Services Manager

For and on behalf of SOCOTEC UK Limited

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SOCOTEC UK Limited, Registered in England No. 2088901, Registered Office: SOCOTEC House, Wootby Bassett Park, Ashby Road, Bardon on Trent DN11 0YE

Determination of California Bearing Ratio

Client: SP Associates
Client Address: 1 Market Place
Warwick
Warwickshire
Postcode: CV34 4SA
Steven Peters

Report No: 51055776/20/03
Our Ref: DAM0078135
Lab Ref: CBR 3
Date Tested: 03.02.2020

Site: LL13 9XE, Wrexham Industrial Estate

Test Results:

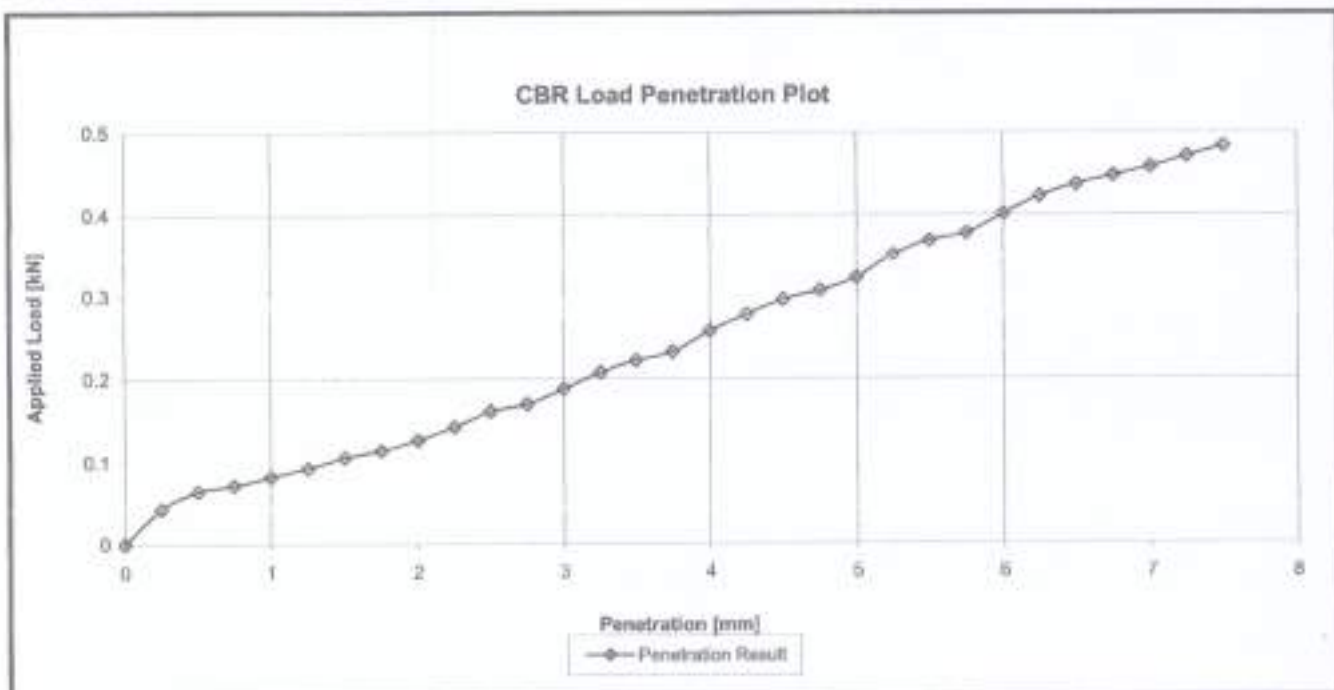
Sample Description: Brown CLAY
Sample Location: Site 4
Client Reference: CBR 3

Test Depth: >0.40m
Weather: Sunny Spells

Moisture Content: 30%
Material >20mm below plunger: Yes
Retained on 20mm Test Sieve:

Applied Surcharge: 9.0kg
Applied Seating Load: 6 N

CBR Value: 1.6%



Comments: The CBR value for a given soil depends upon its dry density and moisture content, therefore the CBR value reported is related to the soil moisture content at time of test.

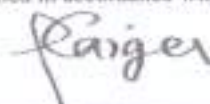
Certified that the test was carried out in accordance with BS 1377- 9: 1990 Method 4.3

Certified that the Moisture Content was determined in accordance with BS 1377- 2: 1990 Method 3.2

Page: 1 of 1

Date : 27.09.18

Signed:



[✓] J. Caiger - Field Services Manager

For and on behalf of SOCOTEC UK Limited

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Determination of California Bearing Ratio

Client:	SP Associates	Report No:	51055776/20/04
Client Address:	1 Market Place	Our Ref:	DAM0078135
	Warwick	Lab Ref:	CBR 4
	Warwickshire	Date Tested:	03.02.2020
Postcode:	CV34 4SA		
	Steven Peters		

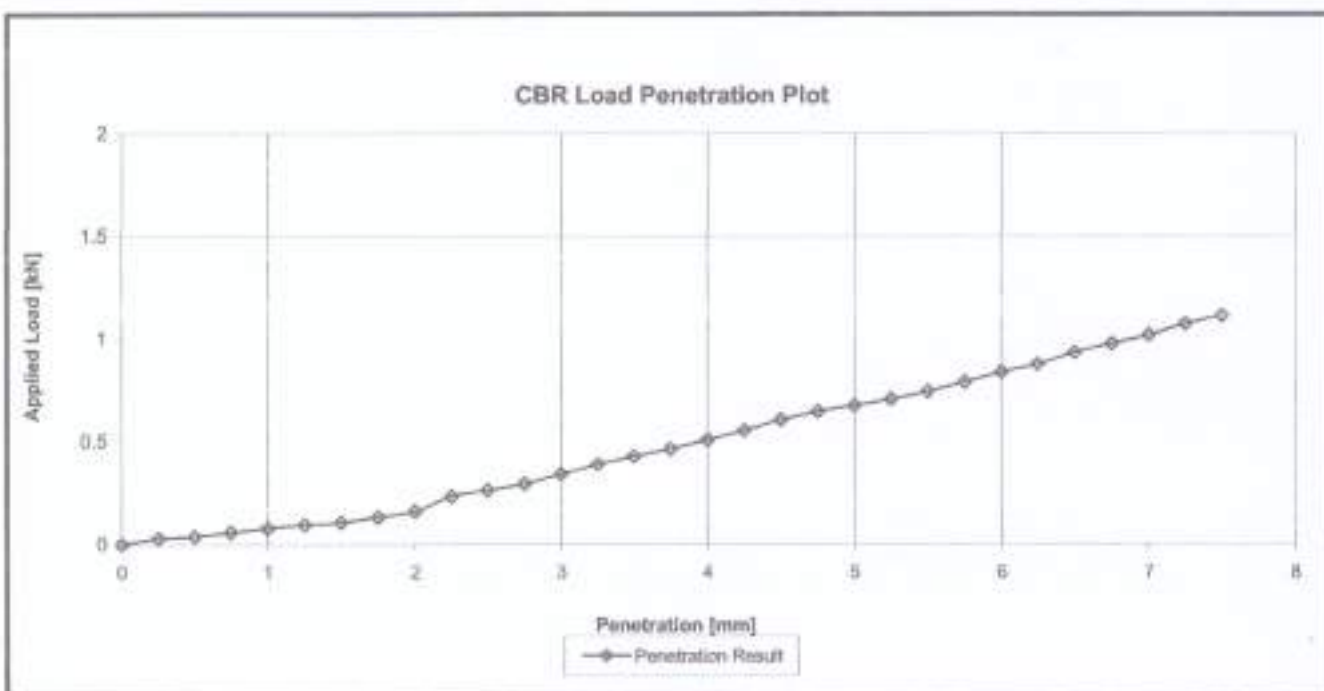
Site: LL13 9XE, Wrexham Industrial Estate

Test Results:

Sample Description:	Brown CLAY	Test Depth :	>0.40m
Sample Location:	Site 4	Weather:	Sunny Spells
Client Reference:	CBR 4		

Moisture Content:	25%	Applied Surcharge:	9.0kg
Material >20mm below plunger:	Yes	Applied Seating Load:	6 N
Retained on 20mm Test Sieve:			

CBR Value: 3.4%



Comments: The CBR value for a given soil depends upon its dry density and moisture content, therefore the CBR value reported is related to the soil moisture content at time of test.

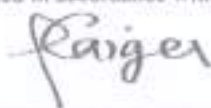
Certified that the test was carried out in accordance with BS 1377- 9: 1990 Method 4.3

Certified that the Moisture Content was determined in accordance with BS 1377- 2: 1990 Method 3.2

Page: 1 of 1

Date : 27.09.18

Signed:



[✓] J. Caiger - Field Services Manager

For and on behalf of SOCOTEC UK Limited

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TEST REPORT

Determination of California Bearing Ratio

Client: SP Associates
Client Address: 1 Market Place
Warwick
Warwickshire
Postcode: CV34 4SA
Steven Peters

Report No: 51055776/20/05
Our Ref: DAM0078135
Lab Ref: CBR 5
Date Tested: 03.02.2020

Site: LL13 9XE, Wrexham Industrial Estate

Test Results:

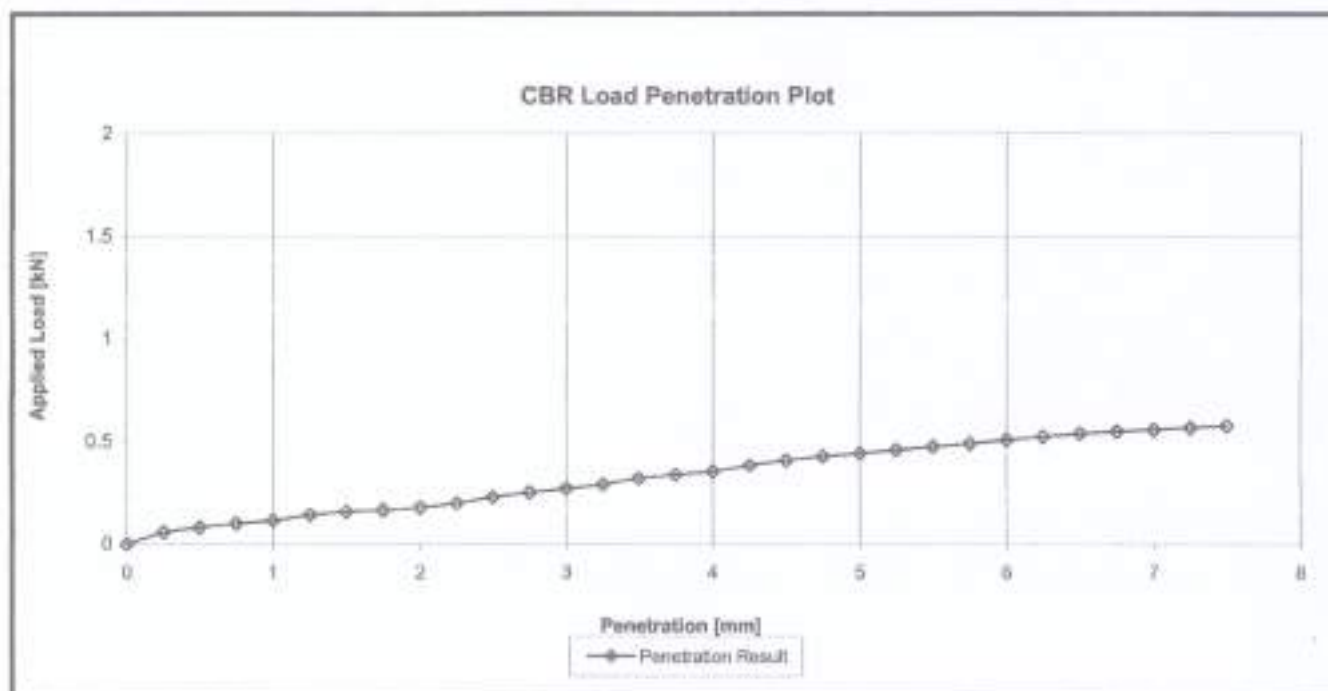
Sample Description: Brown CLAY
Sample Location: Site 4
Client Reference: CBR 5

Test Depth: >0.40m
Weather: Sunny Spells

Moisture Content: 30%
Material >20mm below plunger: Yes
Retained on 20mm Test Sieve:

Applied Surcharge: 9.0kg
Applied Seating Load: 6 N

CBR Value: 2.2%



Comments: The CBR value for a given soil depends upon its dry density and moisture content, therefore the CBR value reported is related to the soil moisture content at time of test.

Certified that the test was carried out in accordance with BS 1377- 9: 1990 Method 4.3

Certified that the Moisture Content was determined in accordance with BS 1377- 2: 1990 Method 3.2

Page: 1 of 1

Date : 27.09.18

Signed:

[✓] J. Caiger - Field Services Manager

For and on behalf of SOCOTEC UK Limited

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APPENDIX H

Amended CSM

Wrexham Industrial Estate – Site 4

Amended Conceptual Site Model

Source	Pathway	Receptor	Risk Matrix Assessment	Assessment of Linkage Significance/Potential Mitigation Measures
Contaminated Soils and Groundwater from historical and current on-site sources.	Direct ingestion, direct contact and inhalation of dust, vapours and liquids	Future site users	Low	Some Made Ground materials are present associated with historical site structures; however, concentrations of potential contaminants of concern are below threshold levels for an industrial site use. Acetone and explosives testing has failed to detect these materials at concentrations above laboratory detection limits. No soil remedial measures are proposed to protect human health.
		Construction workers	Moderate	Some shallow and laterally discontinuous perched water is present within the natural formation; however, most measured determinants conform to UK Drinking Water Standards. A controlled waters quantified risk assessment is not proposed and nor are controlled waters remedial measures.
	Leaching and vertical and lateral migration	Controlled waters	Low	Site workers to wear appropriate PPE and adopt appropriate hygiene and safe working practices including a 'hotspot' protocol to be established. It is recommended that an explosives testing protocol is established and this should form part of the H and S file.
	Direct infiltration in water supply pipes	Service Conduits	Low	Leaching through near surface Made Ground materials could impact controlled waters. However, it is unlikely that any significant contamination would migrate to sensitive surface water receptors through the Glacial Till formation that contains significant horizons of low permeability cohesive soils. In addition, the Secondary Undifferentiated Aquifer is not considered to be overly sensitive.
				Shallow contaminated groundwater could potentially infiltrate service conduits; however, most of the groundwater determinants conform to UK Drinking Water Standards.
				Requirement for upgraded pipework considered to be low.

	Plant uptake	Vegetation within soft landscape areas	Low	Some phytotoxic contamination possible in near surface soils. Clean sub-soil and imported topsoil cover unlikely to be required.
	Lateral migration through groundwater	Off-site neighbouring properties	Low	Significant lateral migration unlikely due to the laterally discontinuous and perched nature of the shallow groundwater system.
Potentially contaminated groundwater: migration from off-site sources onto site	Direct contact or ingestion and inhalation of dust and vapours Vertical and lateral migration	Future site users Controlled waters	Very low Low	No significant upstream sources in terms of groundwater flow. Geology not conducive to migration.
Ground gases generated on-site Ground gas migration onto site from off-site sources	Vertical and lateral migration Lateral migration	Buildings and human occupiers Buildings and human occupiers	Very Low Low	The ground gas regime conforms to Characteristic Situation 1 whereby no gas mitigation measures are required. No apparent nearby source.
High sulphate and low pH in site soils	Direct contact and within shallow groundwater	Below ground concrete	Very Low	pH and soluble sulphate conditions conform to the most benign category.