



**BROWNFIELD
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GEO-ENVIRONMENTAL ENGINEERING EXCELLENCE

LIDL UK GMBH

WREXHAM POLICE STATION

Geo-Environmental Assessment Report

JB/C3664/7273

December 2017

EXECUTIVE SUMMARY - LONGSIGHT	
Location	The site covers an area of approximately 1.10 hectares and is situated approximately 0.9 miles north of Wrexham town centre.
Site History	The site was used as fields and a timber yard, with a lane cutting across, in 1899. By 1937 the timber yard had been demolished and the lane was restructured. By 1960 the site was used for playing fields and since 1975 the site has been used as a police station. The police station is currently active.
Geology	The site is indicated to be underlain by included sands and gravels of glaciofluvial Devensian tills. The bedrock is indicated to be sandstones of the Salop Formation, but this was not encountered in this investigation.
Hydrogeology	The superficial and bedrock geology have been classified as secondary (A) aquifers.
Mining	There is a coal seam indicated to be at 670m bgl. Work ceased in 1966 and associated movement should have now stopped.
Ground Conditions	The site was underlain by made ground of depths between 0.50m and 2.40m. Made ground was deepest in raised embankments to the north of site. The natural ground underlying this consisted of gravelly sands with bands of coal present in several exploratory holes across site. To the south of site there was no made ground and there were occasional clayey sand underlying the made ground or topsoil across site.
Foundations and Floor Slabs	Pads and strip foundations are considered suitable. These will need to be taken to the underside of any made ground, founding at a depth of approximately 1.50m bgl where an allowable bearing capacity of 200kN/m ² should be assumed. Suspended floor slabs should be adopted at the site given that made ground in excess of 600mm thickness is present on site.
Soil Contamination	No contamination from asbestos, heavy metals or polyaromatic hydrocarbons have been detected on site. There is a diesel generator indicated to be on site, located inside a western building, with an external port present. It has been recommended that further investigation is undertaken in this area to assess for potential petroleum hydrocarbon contamination.
Ground Gases	No elevated concentrations of carbon dioxide, methane or hydrogen sulphide have been detected on site. The site has an intermediate risk from radon, therefore protection measures from radon will need to be emplaced. Monitoring is ongoing. A full gas monitoring assessment will be undertaken upon completion of the gas monitoring programme.
Highways	CBR values achieved range from 1.9 to 8.8%, indicating ground improvement may be required.
Further Work	• Completion of gas monitoring programme. • Issue gas assessment. • Potentially post-demolition site investigation and sampling in area of diesel generator.

PROJECT QUALITY CONTROL DATA SHEET

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CONTENTS

1.0	INTRODUCTION.....	1
1.1	OBJECTIVES	1
1.2	PROPOSED DEVELOPMENT	1
1.3	LIMITATIONS.....	1
2.0	THE SITE	2
2.1	LOCATION & ACCESS.....	2
2.2	SITE DESCRIPTION.....	2
3.0	SUMMARY OF PREVIOUS REPORTS	3
3.1	REMADA PHASE I REPORT	3
4.0	RISK ASSESSMENT	4
4.1	INTRODUCTION	4
4.2	POTENTIAL CONTAMINATIVE SOURCES.....	4
4.3	PATHWAYS.....	5
4.4	RECEPTORS.....	5
4.5	PRELIMINARY CONCEPTUAL SITE MODEL.....	6
4.6	GROUND GAS RISK ASSESSMENT	7
5.0	METHOD OF INVESTIGATION	8
5.1	OBJECTIVES	8
5.2	SITE WORKS	8
5.3	SAMPLING.....	8
5.4	LABORATORY TESTING	9
5.5	MONITORING	9
6.0	GROUND CONDITIONS	11
6.1	MADE GROUND	11
6.2	NATURAL GROUND	11
6.3	BEDROCK	11
6.4	GROUNDWATER	12
6.5	OBSERVATIONS	12
7.0	TEST RESULTS.....	13
7.1	CHEMICAL TEST RESULTS - SOILS	13
7.2	AGGRESSIVE GROUND CONDITIONS.....	13
7.3	GAS MONITORING RESULTS.....	13
7.4	SOIL PERCOLATION TEST RESULTS	13
8.0	GEOTECHNICAL ASSESSMENT	15
8.1	GENERAL	15
8.2	SOIL PARAMETERS	15
8.3	FOUNDATIONS	16
8.4	BUILDING NEAR TREES.....	16
8.5	FLOOR SLABS	17
8.6	CONSTRUCTION.....	17
8.7	HIGHWAYS	17
8.7	SOAKAWAYS AND FALLING HEAD TESTS	17

9.0	ENVIRONMENTAL ASSESSMENT.....	19
9.1	GENERAL	19
9.2	CONTAMINATION	19
9.3	QUALITATIVE RISK ASSESSMENT	19
9.4	REMEDIAL MEASURES	20
9.5	ASBESTOS	21
9.6	HEALTH AND SAFETY ISSUES.....	21
9.7	WASTE	22
9.8	COMPLIANCE	23
10.0	CONCLUSIONS.....	24
10.1	SUMMARY.....	24
10.2	FURTHER WORK.....	24
11.0	REFERENCES.....	25

DRAWINGS		
Drawing Number	Rev	Title
C3664/01	-	Site Location Plan
C3664/02	-	Exploratory Hole Location Plan

APPENDICES	
APPENDIX A	Remada Phase I Report
APPENDIX B	Exploratory Hole Logs
APPENDIX C	Plate Load Tests
APPENDIX D	Percolation Tests
APPENDIX E	Chemical Testing Results
APPENDIX F	Ground Gas Monitoring Results
APPENDIX G	Contaminated Land Screening Values
APPENDIX H	Ground Gas Guidance
APPENDIX I	Contaminated Land Legislative Background
APPENDIX J	Risk Assessment Methodology
APPENDIX K	Guidance Notes
APPENDIX L	Limitations

GEO-ENVIRONMENTAL ASSESSMENT REPORT FOR A SITE AT WREXHAM POLICE STATION

1.0 INTRODUCTION

1.1 Objectives

- 1.1.1 This report describes a Geo-Environmental Assessment carried out by Brownfield Solutions Limited (BSL) for Lidl UK GMBH at Wrexham Police Station.
- 1.1.2 The objectives of the assessment were to determine the site's environmental setting and likely site conditions, highlighting potential areas of concern that may govern the sites redevelopment.
- 1.1.3 A main intrusive investigation was undertaken to assess suitability for the siting of a proposed Lidl and its car park on the site of an existing police station. The main investigation was undertaken using plate load testing, soakaways and window sampling.
- 1.1.4 The report has been completed to fulfil the requirements of a preliminary risk assessment in accordance with CLR11 "Model Procedures for the Management of Land Contamination".

1.2 Proposed Development

- 1.2.1 The proposed development is commercial end use comprising a steel framed retail building and associated car park areas.

1.3 Limitations

- 1.3.1 This Desk Study Assessment has been carried out based on information obtained from a number of areas, BSL have assumed that this information is correct.
- 1.3.2 There may be other conditions prevailing on the site which are outside the scope of work and have not been highlighted by this assessment and therefore not been taken into account by this report. Responsibility cannot be accepted for such site conditions not revealed by the assessment.
- 1.3.3 This report has been prepared for the sole use of the client. No other third parties may rely upon or reproduce the contents of this report without the written permission of Brownfield Solutions Ltd (BSL). If any unauthorised third party comes into possession of this report they rely on it at their own risk and BSL do not owe them any Duty of Care.

2.0 THE SITE

2.1 Location & Access

- 2.1.1 The site covers an area of approximately 1.10 hectares and is situated approximately 0.9 miles north of Wrexham town centre.
- 2.1.2 The site is centred on National Grid Reference 333778, 350656, as shown on the Site Location Plan C3664/01.
- 2.1.3 Access to the site is gained off Powell Road to the north and Bodhyfryd to the south.

2.2 Site Description

- 2.2.1 The site is currently an active police station and is roughly the shape of a quadrant.
- 2.2.2 The site neighbours a residential area to the west, a hall to the south, a court of law to the south-east and a war memorial to the south-west.
- 2.2.3 The site boundary is marked by raised embankments to the north, north-west and north-east, separating it from roads and footpaths. The south of the site is bordered by private land belonging to the memorial hall and court of law.
- 2.2.4 The northern section of the site is in use as a staff car park for the police station.
- 2.2.5 The southern section of the site consists of a smaller car park and routes heading towards the neighbouring court of law.
- 2.2.6 The centre of the site is occupied by a rectangular shaped police station comprising of a concrete façade, with a prominent tower block located towards the centre of the complex. A diesel generator is located to the west of site, adjacent to the main reception.
- 2.2.7 The land is predominantly flat, but raised embankments border the northern part of the site. The car park to the north is higher in elevation than the southern part of the site.

3.0 SUMMARY OF PREVIOUS REPORTS

3.1 Remada Phase I Report

3.1.1 A previous report by Remada was issued in July 2017. The findings are summarised below:

- The area of the site is approximately 1,100m².
- In the 1899 century the site consisted of fields, a lane and a timber yard. The timber yard was removed by 1937 and the lane was reconstructed. By 1960 the site was converted to open playing fields and by 1975 the police station occupied the site and the lane had gone.
- The site consists of a segmented police station with adjoining car parks and access routes.
- The site is indicated to be underlain by sands and gravels of Devensian glaciofluvial tills and sandstones of the Salop Formation.
- The superficial and bedrock geology have been classified as secondary (A) aquifers.
- The nearest surface water deposit is Bache Brook/River Gwenfro, located 450m to the south.
- The site is indicated to lie in an area which could be affected by coal mining. One seam of coal is present at 670m depth and work ceased in 1966. Subsidence from mining should have ceased.
- An electricity substation, gas room, diesel generator with an external filling point exists in the west of the site.
- There is a very low risk of collapsible ground, landslides and running sand.
- There is a risk of potential contamination from polyaromatic hydrocarbons, petroleum hydrocarbons, heavy metals, asbestos and sulphate from the former timber yard, levelling of the playing fields, the existing police station and a nearby ASDA filling station.
- Wrexham Police Station lies in an area which requires basic radon protection measures.
- There are three landfill sites within 150m of the site, generating a potential risk of ground gas for the site.

3.1.2 The full phase I report by Remada is presented in Appendix A

4.0 RISK ASSESSMENT

4.1 Introduction

- 4.1.1 In light of the absence of a detailed Conceptual Site Model within the Remada report, BSL have undertaken this utilising the available data.
- 4.1.2 The risk posed by any contaminants in soil or groundwater will depend on the nature and level of the source, the probability of exposure occurring, the potential pollution pathway and the likely effects on the receptors.
- 4.1.3 A contaminant is defined as a substance that has the potential to cause harm, a risk is considered to exist if such a substance is present at sufficient concentrations to cause harm and if a pathway is present through which a receptor could be exposed to the contaminant.
- 4.1.4 The following sections discuss the identified potential on-site and off-site sources, and any pollution that could impact receptors via the pathways associated with the proposed development. Pollution linkages are assessed which may represent a risk to human health and/or controlled water receptors from the information gained from the desk study searches. The assessment has been carried out on a qualitative basis and aims to produce a complete and comprehensive Preliminary Conceptual Site Model.
- 4.1.5 Three potential impacts exist for any given site and all three need to be considered in the qualitative risk assessment, these are:
- On- site impacts;
 - The site impacting its surroundings;
 - Off-site sources impacting the subject site.

4.2 Potential Contaminative Sources

On-Site

- 4.2.1 From the information obtained during the desk study the following sources have been identified by the desk study which may affect the redevelopment of the site for residential end use:
- Made ground associated with the current buildings and car parks, as well as historical land use.
 - Electrical Substation (Poly Chlorinated Biphenyls (PCBs).
 - Diesel generator (petroleum hydrocarbons).

Off-Site

- 4.2.2 The offsite sources of contamination include:
- Petrol filling station (Petroleum hydrocarbons, polyaromatic hydrocarbons 149m south-east)

Associated Contaminants

- 4.2.3 The contaminants commonly associated with the potential sources of contamination identified are tabulated below:

Contaminative Sources	Commonly Associated Contaminants
Made Ground (buildings and car parks)	Heavy Metals, Polycyclic Aromatic Hydrocarbons (PAHs), Asbestos, Total Petroleum Hydrocarbons (TPH)
Substation	PCBs (pre-1970s), mineral oils, metals
Diesel Generator	TPHs, PAHs, VOCs, Heavy Metals
Petrol Filling Station	TPHs, PAHs, VOCs, Heavy Metals

4.3 Pathways

- 4.3.1 A pathway is defined as a medium by which a contaminant comes into contact with, or otherwise impacts a receptor. Due to the sites proposed end use being commercial, potential pollution pathways for contaminant migration at the site will exist.
- 4.3.2 At this stage the potential contaminants identified above are considered to present potential risks to site end users and controlled waters through the following pathways:

- Ingestion or inhalation of contaminated soils/dusts;
- Dermal contact with contamination;
- Inhalation of gases or vapours in both indoor and outdoor air;
- Direct contact by buried structures such as services pipes;
- Surface run-off;
- Leaching of mobile contamination into groundwater;
- Migration of free-phase contaminants or impacted perched groundwater in any permeable soils or along existing or proposed service runs;
- Saturated zone flow through the Secondary (A) Aquifers underlying the site.

4.4 Receptors

- 4.4.1 Receptors generally fall into the categories of human health or controlled waters. The identified receptors are listed below:
- Site end-users;
 - Construction workers;
 - Bache Brook/River Gwenfro (450m south);
 - Secondary Aquifer in superficial deposits and bedrock.
- 4.4.2 Contaminants within the soil and groundwater could potentially attack the clean potable water supply pipe, the contaminants should be assessed to determine the correct pipe material and level of precautions.

4.5 Preliminary Conceptual Site Model

4.5.1 The information obtained in the previous sections has been used to compile a Preliminary CSM. The identified potential contaminants and receptors have been assessed in the table below as to whether a plausible source-pathway-receptor pollutant leakage for the proposed end use of the site exists. The risk classification has been estimated in accordance with information in Appendix A.

Human Health

4.5.2 The Preliminary CSM for human health is presented in the table below:

Potential Source	Potential Pathway	Potential Receptor	Likelihood	Severity	Level of Risk
ON-SITE					
Made ground (heavy metals, PAHs, asbestos)	Ingestion, direct contact, inhalation of dusts.	End-users	Unlikely	Medium	Low
Electricity Substation (PCBs)	Ingestion, direct contact, inhalation of dusts.	End-users,	Low	Medium	Moderate/Low
Diesel Generator (petroleum hydrocarbons, PAHs, VOCs)	Ingestion, direct contact, inhalation of dusts.	End-users,	Low	Medium	Moderate/Low
OFF-SITE					
Petrol Filling Station (petroleum hydrocarbons)	Ingestion, direct contact, inhalation of dusts.	End-users	Unlikely	Medium	Low
Landfill (ground gas)	Migration into confined spaces	End-users	Low	Severe	Moderate

Human Health Justification

4.5.3 There has been no major contaminative industry built upon the site through its history. Therefore, contamination in the made ground is unlikely, hence the risk to site end users from made ground is considered to be **low** at this stage.

4.5.4 PCB's are typically associated with electricity substation transformers. The age of the substation is unknown, though it is likely to date to the age of the police station. This predates 1990, so PCBs may be present, therefore the risk is considered to be **moderate/low**.

4.5.5 A diesel generator is stated to be located within a building to the west of site. This is a potential source of petroleum hydrocarbons, PAHs and VOCs. The likely granular nature of the superficial geology indicates that potential contamination would be mobile, so the risk is deemed **moderate/low**.

4.5.6 The only off-site source surrounding the site is the petrol filling station 149m south-east of the site. Migration of contaminants on to site is deemed to be unlikely due to the distances involved, so the risk considered to be **low**.

Controlled Waters

4.5.7 The Preliminary CSM for controlled waters is presented in the table below:

Potential Source	Potential Pathway	Potential Receptor	Likelihood	Severity	Level of Risk
Made Ground (PAH's, Metals)	Migration through groundwater or granular soils	Bache Brook/River Gwenfro	Unlikely	Medium	Low
Made Ground (PAHs, Metals)	Migration through groundwater or granular soils	Superficial Deposits and Bedrock (Secondary Aquifer)	Low	Medium	Moderate/Low
Diesel Generator (Petroleum hydrocarbons)	Migration through groundwater or granular soils	Bache Brook/River Gwenfro, Superficial Deposits and Bedrock (Secondary Aquifer)	Low	Medium	Moderate/Low
Electrical Substation (PCBs)	Migration through groundwater or granular soils	Bache Brook/River Gwenfro, Superficial Deposits and Bedrock (Secondary Aquifer)	Low	Medium	Medium/Low

Controlled Waters Justification

4.5.8 Given the distance of the watercourse from the site (approximately 450m north) it is considered that the risk to surface waters from the made ground is **low**.

4.5.9 Remada identified that the superficial geology on site is likely to be granular, so any contamination on site is likely to be mobile. Therefore, the risk to the secondary (A) aquifers (secondary undifferentiated aquifer) from the made ground, diesel generator and electrical substation is considered to be **moderate/low**.

4.6 Ground Gas Risk Assessment

4.6.1 A potential on-site gas source has been identified and the preliminary CSM considers it to be a moderate risk to site end users.

4.6.2 Gas monitoring undertaken should be in accordance with CIRIA C665, as set out in Appendix H of this report.

5.0 METHOD OF INVESTIGATION

5.1 Objectives

5.1.1 The aim of the fieldwork was to:

- Investigate ground conditions on the site.
- Assess the potential contamination on the site and obtain samples for contamination screening.
- Assess the potential impact of any contamination on controlled waters.
- Assess the need for detailed investigation.
- Obtain geotechnical information on the ground conditions at the site for preliminary foundation design and preliminary pavement design purposes.
- Install standpipes to allow future monitoring.
- Give an assessment of the geo-environmental risks associated with redevelopment of the site.

5.2 Site Works

5.2.1 Twelve window sample boreholes (WS01 to WS12) were drilled to depths of 4.0m using a tracked window sampling rig and liners (windowless) on 11th and 12th November 2017. Three plate load tests and one soakaway test have been undertaken using a JCB 3CX on 11th November 2017.

5.2.2 The approximate locations of the exploratory holes are indicated on the exploratory hole location plan (C3664/02). The exploratory hole logs are presented in Appendix B.

5.2.3 The exploratory holes were positioned to establish general ground conditions on the site and to give comprehensive coverage. The trial pits and window samples were logged by an experienced geo-environmental engineer in general accordance with BS 5930 'Code of Practice for Site Investigations' 1999, BS EN 14688-1:2002 'Geotechnical Investigation and Testing – Identification and classification of soil'. BS EN ISO 14689:2002 "Geotechnical investigation and testing – Identification and classification of rock."

5.3 Sampling

5.3.1 During the drilling of the exploratory holes, representative samples were taken at regular intervals to assist in the identification of the soils and to allow subsequent laboratory testing.

5.3.2 A summary of the samples taken is presented in the table below:

Type	Number
Environmental	21
Disturbed	34

5.3.3 The type of sample is dependent upon the stratum and the purpose of analysis in accordance with current environmental and geotechnical guidance.

5.3.4 Disturbed samples of soil for chemical testing were placed in plastic tubs and amber jars as required by the UKAS accredited laboratory, and transported under secure refrigerated conditions.

5.3.5 The distribution of samples taken across the site is recorded on the exploratory logs.

5.4 Laboratory Testing

5.4.1 As part of the initial assessment for potential contamination of the site, selected samples were taken for the purpose of chemical contamination testing.

5.4.2 The following were analysed at an UKAS approved laboratory:

Determinand	Matrix	Number
Arsenic, cadmium, chromium (total and hexavalent), copper, lead, mercury, nickel, selenium, zinc and pH.	Soil	5
Speciated PAH16	Soil	5

5.4.3 The Chemical Laboratory Testing Results are presented in Appendix E.

5.4.4 Representative disturbed samples were obtained for all soil types encountered. Selected samples were scheduled for testing at an approved laboratory in accordance with BS 1377 'Method of Test for Soils for Civil Engineering Purposes' 1990. The following tests were scheduled:

BS Test Number	Description	No of Samples
Part 3:	Water Soluble Sulphate Content	4

5.5 Monitoring

5.5.1 Gas and water monitoring standpipes were installed in the boreholes and subsequently one monitoring visit has been undertaken. Gas monitoring was undertaken using GA 5000 infrared gas meter with integral electronic flow analyser.

5.5.2 Measurements of the percentage volume in air (%v/v) of oxygen (O₂), carbon dioxide (CO₂) and methane (CH₄) were recorded in addition to the percentage Lower Explosive Limit (%LEL) of methane and the atmospheric pressure. Flow measurements on each standpipe (l/hr) were also taken. (Note: 100% LEL equates to 5% by volume).

5.5.3 The standpipes consisted of polyvinyl chloride (PVC) pipe. A bentonite seal was made around the plain pipe and a clean gravel pack was placed around the slotted pipe. A summary of the installation construction is presented in the table below:

Location	Depth	Response Zone (m bgl)	Targeted Strata	Reason
WS03	3	1	Sand	Ground Gas
WS10	2.5	2	Sand	Ground Gas
WS12	3	2	Sand	Ground Gas

5.5.4 The results monitored peak and steady state conditions. Peak results are those that occur on opening the valve on the borehole tap. Steady state conditions are those that occur a period of time afterwards when the initial (accumulated) gases have been purged from the borehole.

5.5.5 Interim gas monitoring results are presented in Appendix F of this report.

6.0 GROUND CONDITIONS

6.1 Made Ground

- 6.1.1 Made Ground was encountered in all of the window sample locations, except for WS08 and WS09, and the depth ranges between 0.50m and 2.40m below ground level (bgl). Made ground was typically encountered at depths between 0.60m bgl and 1.40m bgl, but was up to 2.40m in the raised embankments. In WS04, WS11, WS11A, TP01 and TP02 concrete was encountered at depths ranging between 0.3m and 2.40m bgl which prevented further progress.
- 6.1.2 Made ground was deepest in embankments found to the north of site, where made ground varied between 1.00m and 2.40m bgl.
- 6.1.3 The made ground generally consisted of a silty sand topsoil, with gravel of sub-angular to angular of siltstone, limestone, brick and concrete. Rare fragments of pottery, glass and wood were observed across site.
- 6.1.4 In TP01, TP02, TP03, WS04, WS05 and WS10 made ground consisting of silty, clayey and gravelly sands were present beneath the silty sand topsoil. The gravels and cobbles were of concrete and brick.
- 6.1.5 WS01 was undertaken in hardstanding and consisted of tarmacadam overlying a gravel of limestone and a red gravel of siltstone with brick and coal.

6.2 Natural Ground

- 6.2.1 In WS08 and WS09 a sand topsoil was present to depths between 0.30m and 0.50m bgl.
- 6.2.2 The natural strata underlying the made ground and topsoil was generally a loose to medium dense brown silty gravelly sand with gravel of fine to coarse sub-rounded to rounded siltstone.
- 6.2.3 Bands of coal were common in the sand, where they were typically thin, and were identified in WS02, WS05, WS06, WS08, WS09 and WS10.
- 6.2.4 The sand was occasionally clayey, as evident in WS02 from 1.00m to 1.75m bgl, WS09 from 0.30m to 1.50m bgl and WS12 from 2.80m and 2.90m bgl, as well as 3.60m and 4.00m bgl.
- 6.2.5 In WS06 and WS10 the natural ground was of interbedded sands and gravels, which extended to the base of the borehole. In WS12 the interbedded sands extended from 1.80m bgl to the base of the borehole.

6.3 Bedrock

- 6.3.1 Bedrock was not encountered in this investigation.

6.4 Groundwater

- 6.4.1 No groundwater was encountered during the investigation, though sands in WS12 were damp from 3.60m bgl.

6.5 Observations

- 6.5.1 During the works undertaken by BSL observations for both visual and olfactory evidence of contamination were made.

- 6.5.2 No visual or olfactory evidence of contamination was made.

Side Stability and Ease of Excavation

- 6.5.3 The sides of the trial pits were stable upon excavation and they were excavated with ease.

7.0 TEST RESULTS

7.1 Chemical Test Results - Soils

- 7.1.1 The samples were tested for an assessment of the chemical contamination and results were examined with reference to a selection of guidance documents as detailed in Appendix G.
- 7.1.2 The apparent exceedance of the relevant Tier 1 generic screening value for a commercial end use with plant uptake is taken as indicating further detailed assessment or remedial action is required.
- 7.1.3 The samples have been tested for contamination by heavy metals and PAHs. None of the samples contained any determinand above residential screening values.

7.2 Aggressive Ground Conditions

- 7.2.1 Water soluble sulphate testing was undertaken on three of the natural strata and one sample of made ground. The results revealed soluble sulphate (SO₄) contents of 0.0024 to 0.0079g/l in the natural strata and 0.0125g/l in the made ground. Associated pH values obtained ranged between 6.94 and 8.56, indicating neutral to slightly alkaline conditions.

7.3 Gas Monitoring Results

- 7.3.1 One gas monitoring visit has been carried out on 30th November 2017. Interim gas monitoring results are presented in Appendix F.
- 7.3.2 The interim gas monitoring results indicate peak oxygen concentrations of 18.9%v/v and 20.4%v/v, while steady state conditions ranged between 19.2%v/v and 20.9%v/v.
- 7.3.3 Peak carbon dioxide concentrations of between 0.6%v/v and 2.5% v/v have been recorded with steady state concentrations of 0.2%v/v to 2.5%v/v.
- 7.3.4 Methane and hydrogen sulphide have not been detected during the monitoring visit.
- 7.3.5 A maximum flow rate of 0.1l/hr has been detected.
- 7.3.6 The atmospheric pressure was at 1005mb and a steady barometric pressure trend was present during the visit.
- 7.3.7 No groundwater has been detected on site during the monitoring visit.

7.4 Soil Percolation Test Results

- 7.4.1 A soakaway test was undertaken on the 11th November 2017. This yielded a soil infiltration rate of 5.56×10^{-5} m/sec. Falling head tests were undertaken on the 30th November 2017. The results are presented below:

Location	Test	Soil Infiltration Rate (m/sec)
WS03	1	4.61×10^{-4}
WS03	2	1.78×10^{-4}
WS10	1	2.13×10^{-4}
WS10	2	1.26×10^{-4}
WS12	1	4.40×10^{-4}
WS12	2	2.76×10^{-4}

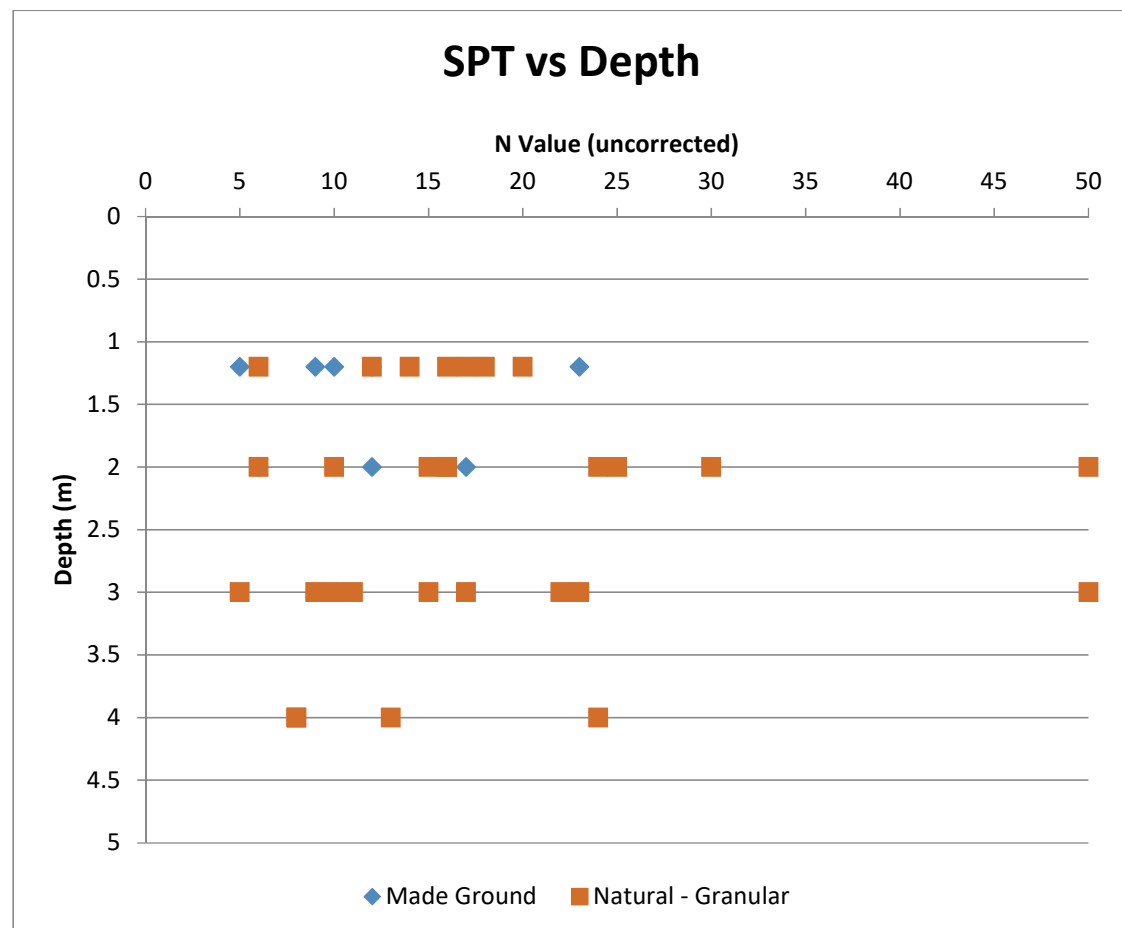
8.0 GEOTECHNICAL ASSESSMENT

8.1 General

- 8.1.1 The site was typically covered by made ground which varied in depth between 0.40m to 2.40m bgl.
- 8.1.2 The made ground was generally underlain by loose to medium dense gravelly sands with bands of coal commonly present across site.
- 8.1.3 Groundwater has not been encountered on site.

8.2 Soil Parameters

- 8.2.1 The test results have been evaluated to derive geotechnical soil parameters for the site. A depth to SPT N value graph is provided below to provide a profile of the ground conditions underlying the site.



- 8.2.2 There is no definitive trend of an increase in soil density or strength with depth for the natural strata. This suggests that some sands are loose with depth. N values of 50 were achieved at shallow depths for two window sample boreholes due to high gravel contents. These were discounted from determining the characteristic N value due to them being anomalous.

8.2.3 Characterisation of the geotechnical parameters above has been undertaken to obtain a characteristic value, which is a cautious estimate of the value affecting the occurrence of the limit state.

8.2.4 An estimated characteristic N value of 15 has been estimated for a depth of 1.50m bgl.

8.3 Foundations

8.3.1 Outline foundation recommendations are provided below. However, no loads were available at the time of writing, therefore the following assessment is provisional and subject to revision at the detailed design stage.

8.3.2 Foundations will need to be taken to the underside of any made ground to found on undisturbed natural ground. This will be to approximately 0.50m to 1.30m bgl in the area of the new development. Deeper made ground is found in embankments flanking the site. Preliminary calculations have determined an allowable bearing capacity of 200kN/m². However, this value is uncertain due to the high variability in the N value data.

8.3.3 Alternatively, if this bearing capacity is deemed unreliable, piling to a suitable founding stratum at depth may be an option. However, it is not possible to determine the ultimate bearing capacity required for piling from this investigation. In order to assess the suitability of piling an intrusive investigation comprising cable percussive boreholes would be required.

8.3.4 If the ground conditions encountered during the construction phase differ significantly to the conditions encountered during construction, work should cease and BSL contacted for further advice.

8.3.5 During the construction phase supervision should be on a continuous basis to check the design assumptions are correct and construction conforms to design. Supervision should include inspections, Control Ground Investigations and monitoring.

8.4 Building Near Trees

8.4.1 If foundation excavations encounter cohesive strata in the vicinity of existing, proposed or recently removed trees, foundations should be adjusted in full accordance with NHBC Standards Chapter 4.2. All foundations should be deepened below roots of greater than 5mm diameter during excavations for footings.

8.4.2 A survey of all trees and hedges on the site and within 30m of the site boundary should be undertaken to identify tree species and heights. This information will be required in order to assess the effects of trees on the cohesive strata.

8.4.3 Where foundation depths due to trees already present or recently removed exceeds 1.50m there is a possibility for heave to occur on removal of the tree.

NHBC Guidance states that compressible material or void former is required against the inside face of all external wall foundations.

8.5 Floor Slabs

- 8.5.1 Made Ground in excess of 600mm is present across site. It is recommended that floor slabs are suspended or made from pre-cast concrete, because made ground was in excess of 600mm thickness across site and Wrexham Police station is in an area requiring basic radon protection.

8.6 Construction

- 8.6.1 Instability of excavations through natural soils is anticipated due to the granular nature of the soil. Instability of the Made Ground should be allowed for. All excavations should be carried out in accordance with CIRIA Report 97 'Trenching Practice'.
- 8.6.2 Excavation depths should generally be readily achieved using conventional plant (JCB or similar) although high specification plant (tracked 360° or similar) is recommended to maintain the build programme. Breaking equipment may also be required locally to penetrate old foundations associated with former construction.
- 8.6.3 Characteristic sulphate values for the natural strata ranged from 0.0024g/l to 0.0079g/l in the natural strata. In the made ground the sulphate value acquired was 0.0125g/l. The soils on site were typically neutral to slightly alkaline, ranging from 6.94 to 8.56, with an average of 7.95.
- 8.6.4 Groundwater has not been encountered on site, but any groundwater at depth is assumed to be mobile due to the permeable nature of the geology.
- 8.6.5 The results of laboratory pH and sulphate content indicate that ACEC Class AC-1 and sulphate class DS-1 conditions prevail in accordance with BRE Special Digest 1 "Concrete in aggressive ground" 2005. The specific concrete mixes (the Design Concrete Class) to be used on site will be determined by the site specific concrete requirements in terms of the durability and structural performance. These are assessed in terms of the Structural Performance Level (SPL) and any need for Additional Protective Measures (APM) detailed in Part D of BRE Special Digest 1 with further guidance in Pt E and F.

8.7 Highways

- 8.7.1 CBR values from the made ground ranged from 1.9%-8.8%. The results of the plate load tests are presented in Appendix C.
- 8.7.2 Some re-engineering of the subgrade is likely to be required prior to highway construction to achieve the required design CBR value.

8.8 Soakaways and Falling Head Tests

- 8.8.1 A percolation test was undertaken where favourable granular strata was encountered, and subsequent falling head tests were undertaken in every window

sample borehole with a standpipe installed. The results show that soakaways within the natural ground are likely to be feasible. The results are present in Appendix D.

- 8.8.2 If drainage of the highway to soakaways is to be considered it is suggested that this is discussed with the Local Authority at the earliest opportunity, to confirm the adequacy of proposed testing and to allow their inspection of any testing.

9.0 ENVIRONMENTAL ASSESSMENT

9.1 General

- 9.1.1 The level of protection for the clean potable water supply pipes should be determined using the local water company risk assessment criteria in accordance with UKWIR.

9.2 Contamination

Soils

- 9.2.1 The chemical testing did not reveal any metal or PAH contaminants above commercial screening values.

Permanent Ground Gases

- 9.2.2 Ground gas monitoring is ongoing. At present, a maximum carbon dioxide concentration of 2.5%v/v has been recorded and no methane has been detected. In addition, a maximum flow rate of 0.1l/hr has been recorded.
- 9.2.3 Based the results to date, no gas protection measures for carbon dioxide and methane will be required, as less than 5%v/v of carbon dioxide has been recorded.
- 9.2.4 Wrexham Police Station lies in an area with an intermediate risk from radon. Therefore, basic radon protection measures will be required.
- 9.2.5 A full ground gas assessment will be carried out on completion of the gas monitoring programme.

9.3 Qualitative Risk Assessment

- 9.3.1 The risk assessment methodology used in this instance is based on **Source – Pathway – Receptor** (SPR) philosophy. The **source** is the presence of contamination, or substance/event likely to cause harm. The **receptor** is the target that may be detrimentally affected by the source. The **pathway** is the means of the contamination to move from the source to the receptor. Where any of these three factors are removed there is deemed to be no risk.
- 9.3.2 The CSMs have been revised based on the findings of the site investigation and laboratory testing results. Risk Assessment Methodology is detailed in Appendix J.

Human Health

Potential Source	Potential Pathway	Potential Receptor	Likelihood	Severity	Level of Risk
ON-SITE					
Made ground (heavy metals, PAHs)	Ingestion, direct contact, inhalation of dusts.	End-users	Unlikely	Medium	Low

Potential Source	Potential Pathway	Potential Receptor	Likelihood	Severity	Level of Risk
ON-SITE					
Made ground (petroleum hydrocarbons)	Ingestion, direct contact, inhalation of vapours.	End-users	Low	Medium	Moderate/Low
Asbestos	Inhalation of fibres	End-users	Unlikely	Medium	Low
OFF-SITE					
Ground gases from landfill	Ingestion, direct contact, inhalation of vapours	End Users	Unlikely	Severe	Moderate/Low

Human Health Justification

- 9.3.3 The lack of any identified contamination from asbestos, heavy metals or PAHs indicates that the risk from asbestos, heavy metals and PAHs is **low**.
- 9.3.4 The diesel generator is a potential source for future contamination. Due to the sandy ground conditions the migration pathway will be vertical. Investigations lateral to the tank will unlikely detect any potential contamination. Therefore, we recommend a post-demolition investigation around the tank and watching brief during removal. At present the risk is deemed **moderate to low**.
- 9.3.5 Three landfill sites have been identified within 150m from the site indicating a potential gas risk. The distance from site is sufficient for it to be deemed a **moderate to low** gas risk.

Controlled Waters

Potential Source	Potential Pathway	Potential Receptor	Likelihood	Severity	Level of Risk
Made Ground (heavy metals, PAHs, petroleum hydrocarbons)	Migration through groundwater or granular soils	Controlled waters	Unlikely	Medium	Low

Controlled Waters Justification

- 9.3.6 No contamination has been identified on site from the made ground. Therefore, the risk of contamination to controlled waters is deemed **low**.

9.4 Remedial Measures

- 9.4.1 No specific remedial measures are considered necessary with respect to soils at the site based on this site investigation. Testing also indicates the topsoil is suitable for reuse on the proposed development.
- 9.4.2 The initial gas monitoring visits indicate gas precautions against carbon dioxide or methane will not be required. However, there should be a membrane emplaced

that is resistant to radon. A full assessment will be carried out on completion of the gas monitoring programme.

9.5 Asbestos

9.5.1 The investigation of asbestos issues within structures was beyond the scope of this report. Four samples on site have been tested for asbestos and no asbestos has been identified. However, guidance from UK Government indicates that asbestos should be assumed to be present in buildings unless proven otherwise.

9.5.2 Any asbestos within structures will require removal prior to re-development. This will need to be done by a suitably qualified experienced and licensed contractor, who ensures that adequate PPE is provided to operatives, and that all the relevant legislation is adhered to.

9.5.3 In addition, the presence of asbestos within the ground will require, a safe system of work to be set up on site to deal with the asbestos risk from the made ground. This may include but be not limited to:

- The use of qualified personnel where required.
- Careful segregation of stockpiles on site.
- Defining transport routes.
- Cleaning down of machinery in designated areas.
- Decontamination unit for ground workers.
- Damping down of soils to prevent dust migration.

9.5.4 All such works will need to be agreed with the regulatory bodies (HSE, LA)

9.5.5 Additional guidance is provided within the Guidance Note in Appendix K

9.6 Health and Safety Issues

9.6.1 During the reclamation and construction phases of the site development it will be necessary to protect the health and safety of site personnel. The risk to construction and ground workers is assessed in the table below:

Potential Source	Potential Pathway	Potential Receptor	Likelihood	Severity	Level of Risk
ON-SITE					
Made Ground	Ingestion, direct contact, inhalation of dusts.	End-users	Unlikely	Medium	Low

Discussion

9.6.2 As no contamination has been noted within the made ground it has been determined that the associated risk to construction workers will be low.

9.6.3 Made ground was encountered in the majority of the holes. Where made ground is identified during the construction phase, good site practice should be implemented to minimise contact. Additionally, the correct PPE and welfare facilities should be provided.

9.6.4 General guidance on these matters is given in the Health and Safety Executive (HSE) document “Protection of Workers and the General Public during the Redevelopment of Contaminated Land”. In summary, the following measures are suggested to provide a minimum level of protection:

- All ground workers should be issued with the relevant protective clothing, footwear and gloves. These protective items should not be removed from the site and personnel should be instructed as to why and how they are to be used.
- Hand-washing and boot-washing facilities should be provided.
- Care should be taken to minimise the potential for off-site migration of contamination by the provision of dust suppression control and wheel cleaning equipment during the construction works.
- Good practices relating to personal hygiene should be adopted on the site.
- The contractor shall satisfy the Health and Safety Executive with regard to any other matters concerning the health, safety and welfare of persons on the site.

9.7 Waste

9.7.1 Details of how material should be classified for waste disposal are presented in Appendix K

9.7.2 Waste Acceptance Criteria (WAC) testing was outside the scope of this investigation and the guidance given below is general.

9.7.3 Initially, the waste should be classified based on their total concentrations of contaminants.

9.7.4 At this stage, it is assumed that the natural soils will be classified as non-hazardous.

Waste Acceptance Criteria

9.7.5 The possibility of automatic inert classification of the natural soils should be explored in accordance with Section 4.3 of the EA guidance document. The Council Decision includes a list of wastes in Section 2.1.1 of the document that are assumed to be inert and therefore acceptable at a landfill for inert waste without testing, this is the case if:

- *They are single stream waste of a single waste type (although different waste types from the list may be accepted together if they are from a single source) and*
- *There is no suspicion of material or substances such as metals, asbestos, plastics, chemicals, etc to an extent which increases the risk associated with the waste sufficiently to justify contamination and they do not contain other their disposal in other classes of landfill.*

General

9.7.6 If any gross hydrocarbon contaminated material is encountered during the construction phase, it is possible that this may be classified as hazardous and testing should be undertaken at that time.

9.7.7 Where it is necessary to dispose material off site it is recommended that materials are segregated and where necessary sufficient time is allowed to further classify the material properly, including discussion with landfill sites and waste transfer stations to find the best disposal route.

9.7.8 As a significant proportion of the soils likely to be generated on site are clean it is recommended that where possible that the soils could be recycled at a suitable local waste treatment plant or transfer station rather than a landfill disposal route.

9.8 Compliance

9.8.1 It is recommended that the approval of the Local Authority is obtained for to the proposed remedial scheme prior to any irrevocable action being taken.

10.0 CONCLUSIONS

10.1 Summary

Environmental

- 10.1.1 No sources of contamination have been identified in the soils from this investigation and the risk to site end users is considered to be low.
- 10.1.2 Initial gas monitoring results indicate that there are no elevated concentrations of carbon dioxide, methane or hydrogen sulphide present. However, the site lies within an area requiring basic radon protection measures, so a radon proof membrane will be required. A full gas assessment will be made under a separate cover upon completion of the gas monitoring programme.
- 10.1.3 Potential contamination is evident from a diesel generator inside the building. We have recommended a post-demolition investigation in the area of the tank and a watching brief during removal.
- 10.1.4 At this stage it is assumed that the waste will be classified as inert.

Geotechnical

- 10.1.5 An allowable bearing capacity of 200kN/m² at a founding depth of 1.50m bgl has been assessed. Floor slabs on site are recommended to be suspended due to the presence of deep made ground on site.
- 10.1.6 Percolation tests have yielded soil infiltration rates of 5.56×10^{-5} m/sec to 4.61×10^{-4} m/sec indicating that drainage across the site is good.
- 10.1.7 CBR values achieved on site range from 1.9 to 8.8% indicating that some improvement of the sub-base may be required.

10.2 Further Work

- 10.2.1 The following further work is considered necessary to progress the site to construction phase:

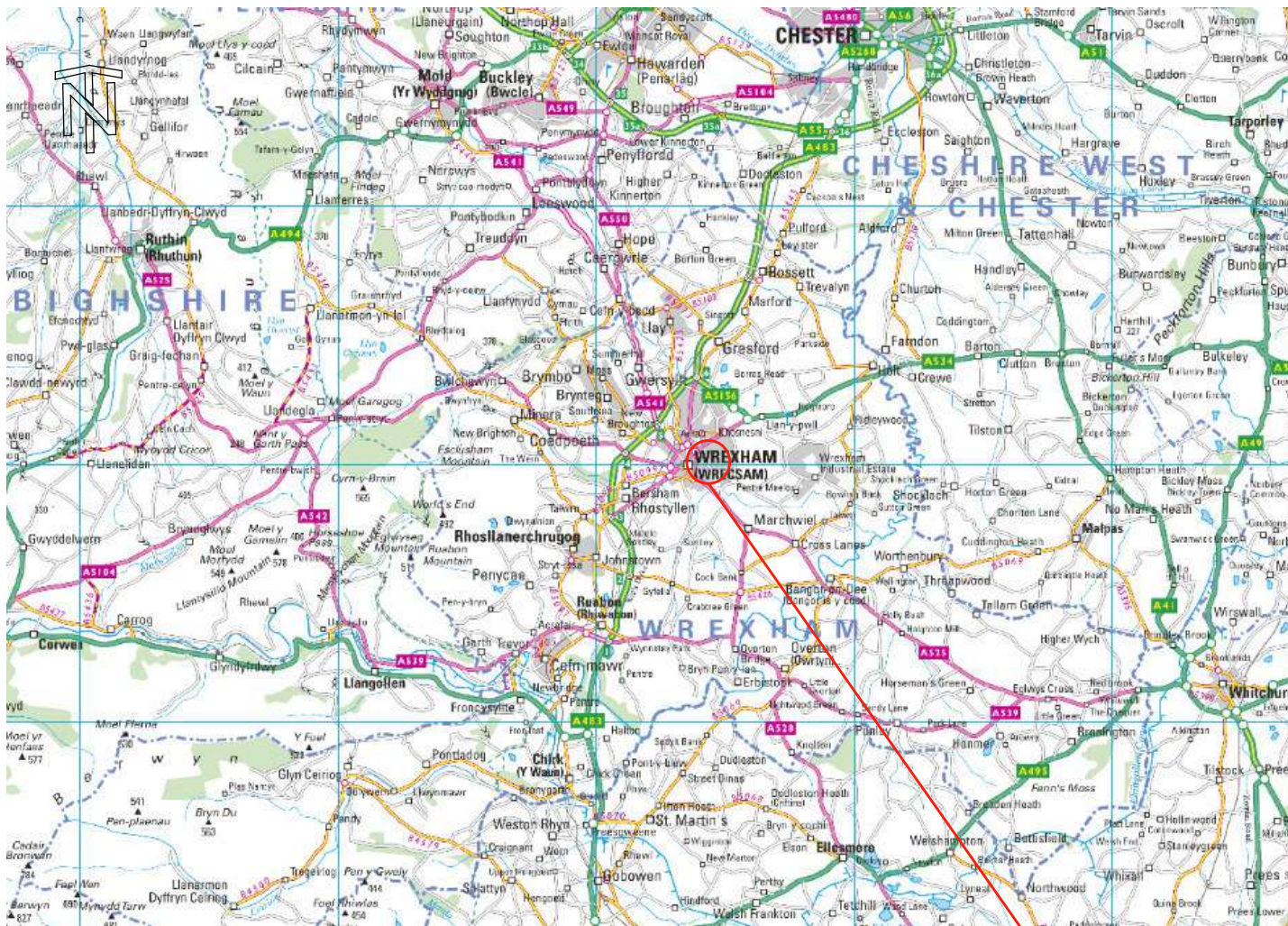
- Completion of gas monitoring programme.
- Issue gas assessment.
- Potential post-demolition site investigation and sampling in area of diesel generator.

11.0 REFERENCES

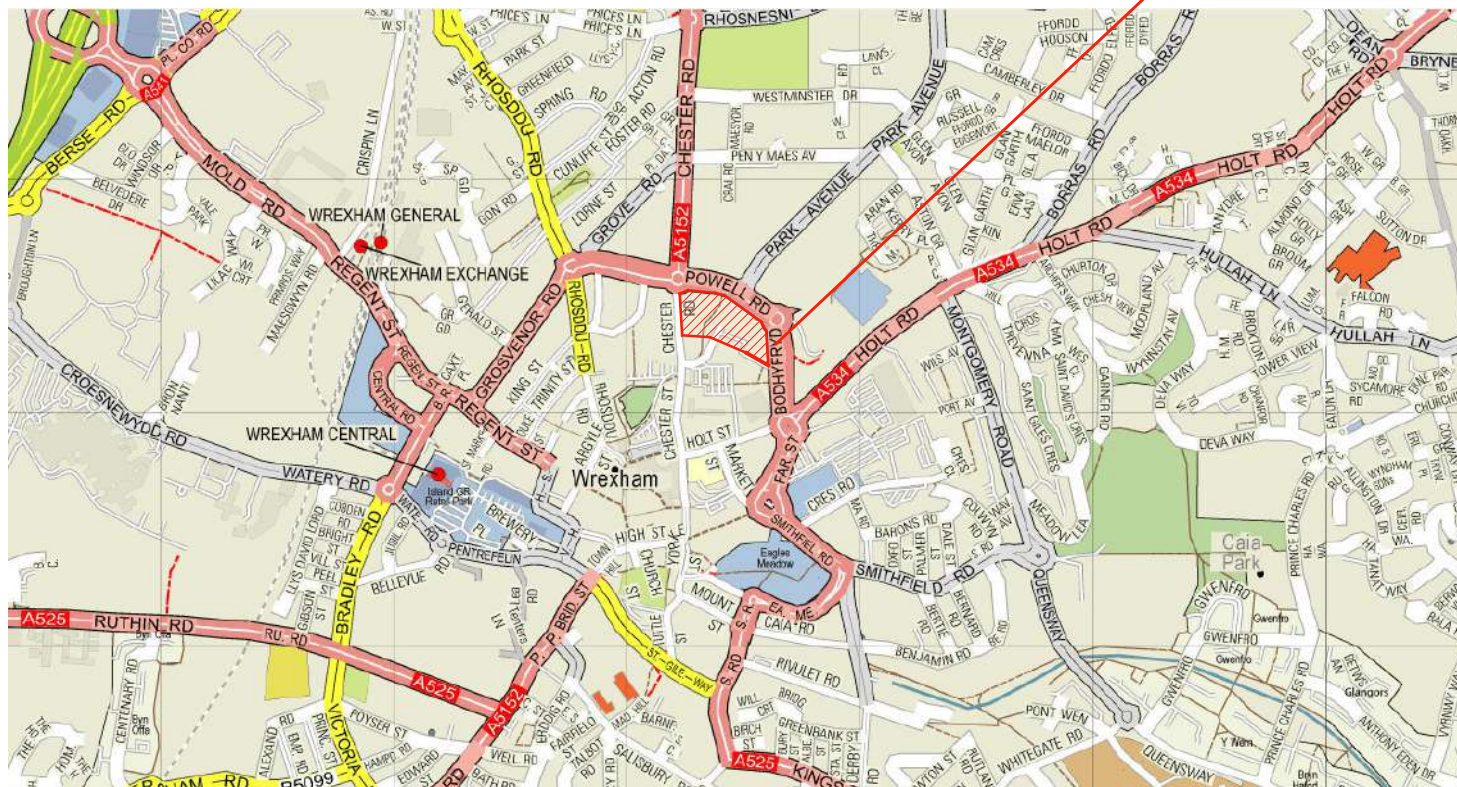
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DRAWINGS



SITE



CLIENT

LIDL UK GMBH

PROJECT TITLE

WREXHAM POLICE STATION

DRAWING DETAIL

SITE LOCATION PLAN

DATE

OCT 2017

SCALE

NTS

DRAWING NUMBER

C3664/01

REVISION

—

DRAWN

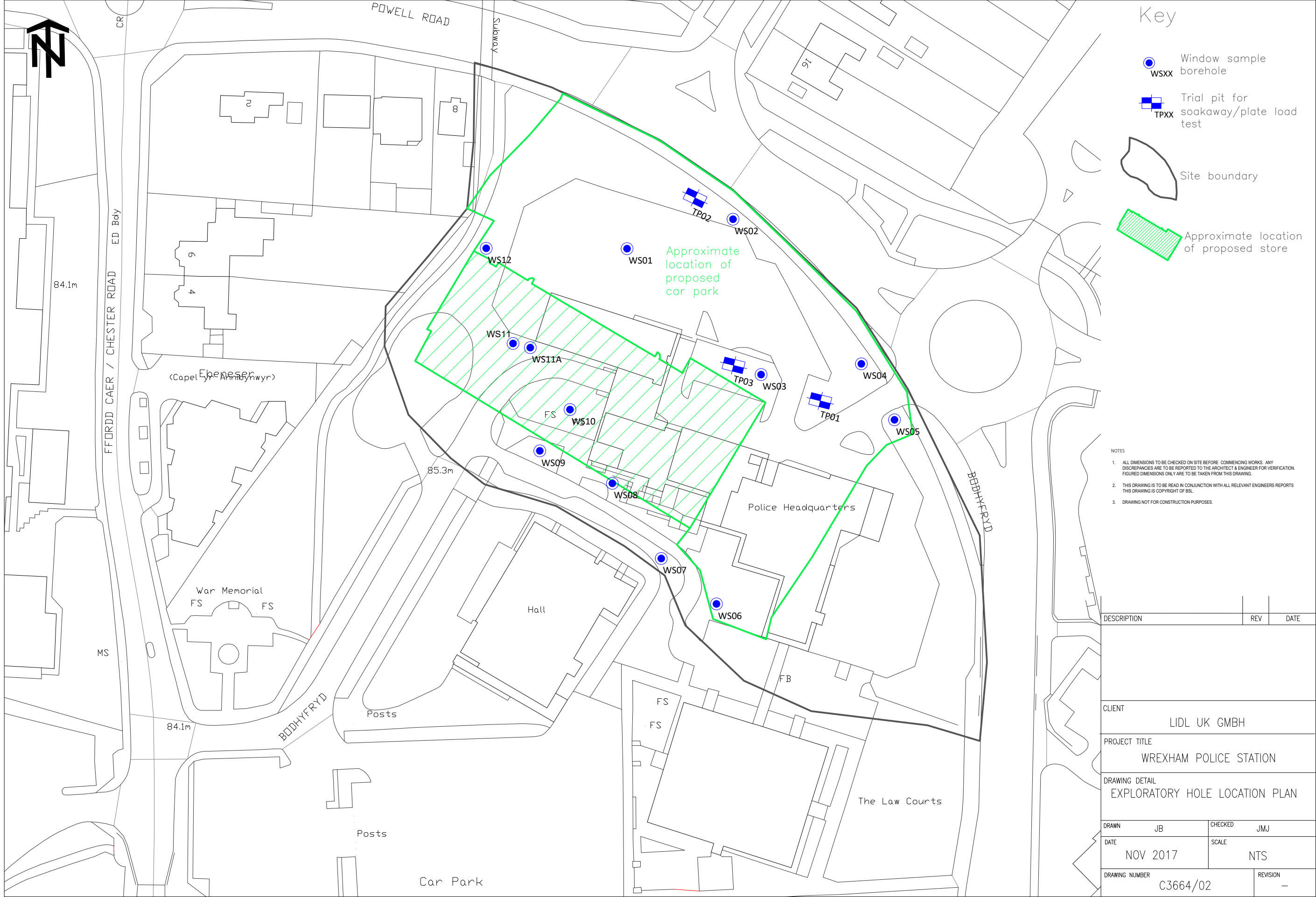
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APPENDIX C

Coal Authority Non Residential Mining Search



The Coal
Authority

Resolving the **impacts** of mining

CON29M Non-Residential Mining Report

NORTH WALES POLICE AUTHORITY
DIVISIONAL POLICE HEADQUARTERS
BODHYFRYD
WREXHAM
LL12 7BW

Date of enquiry: 04 July 2017
Date enquiry received: 04 July 2017
Issue date: 04 July 2017

Our reference: 51001513135001
Your reference: 525.01



CON29M Non-Residential Mining Report

This report is based on, and limited to, the records held by the Coal Authority and the Cheshire Brine Subsidence Compensation Board's records, at the time we answer the search.

Client name

Remada Ltd

Enquiry address

NORTH WALES POLICE AUTHORITY, DIVISIONAL
POLICE HEADQUARTERS, BODHYFRYD, WREXHAM,
LL12 7BW

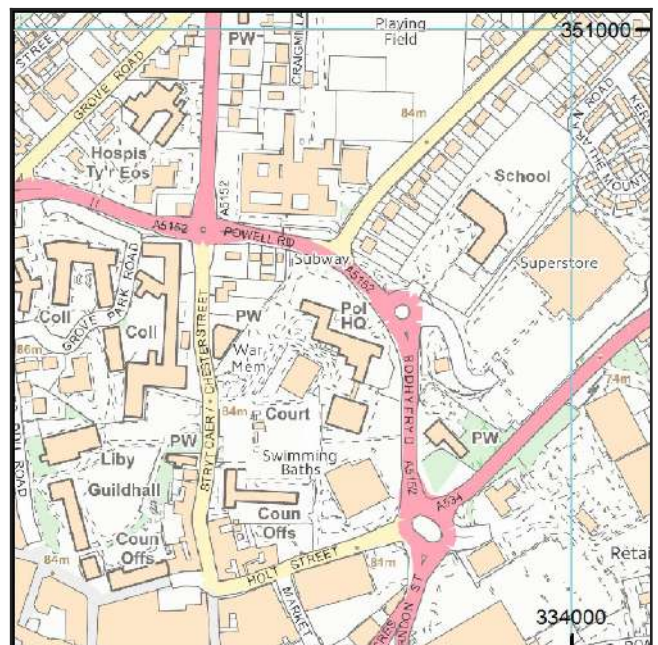
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Mansfield
Nottinghamshire
NG18 4RG

www.groundstability.com

 /company/the-coal-authority
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Approximate position of property



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Summary

Has the search report highlighted evidence or potential of		
1	Past underground coal mining	Yes
2	Present underground coal mining	No
3	Future underground coal mining	Yes
4	Mine entries	No
5	Coal mining geology	No
6	Past opencast coal mining	No
7	Present opencast coal mining	No
8	Future opencast coal mining	No
9	Coal mining subsidence	No
10	Mine gas	No
11	Hazards related to coal mining	No
12	Withdrawal of support	Yes
13	Working facilities order	No
14	Payments to owners of former copyhold land	No
15	Information from the Cheshire Brine Subsidence Compensation Board	No

For detailed findings, please go to page 4.

Detailed findings

1. Past underground coal mining

The property is in a surface area that could be affected by underground mining in 1 seam of coal at 670m depth, and last worked in 1966.

Any movement in the ground due to coal mining activity should have stopped.

2. Present underground coal mining

The property is not within a surface area that could be affected by present underground mining.

3. Future underground coal mining

The property is not in an area where the Coal Authority has plans to grant a licence to remove coal using underground methods.

The property is not in an area where a licence has been granted to remove or otherwise work coal using underground methods.

The property is not in an area likely to be affected from any planned future underground coal mining.

However, reserves of coal exist in the local area which could be worked at some time in the future.

No notices have been given, under section 46 of the Coal Mining Subsidence Act 1991, stating that the land is at risk of subsidence.

4. Mine entries

There are no known coal mine entries within, or within 20 metres of, the boundary of the property.

5. Coal mining geology

The Coal Authority is not aware of any damage due to geological faults or other lines of weakness that have been affected by coal mining.

6. Past opencast coal mining

The property is not within the boundary of an opencast site from which coal has been removed by opencast methods.

7. Present opencast coal mining

The property does not lie within 200 metres of the boundary of an opencast site from which coal is being removed by opencast methods.

8. Future opencast coal mining

There are no licence requests outstanding to remove coal by opencast methods within 800 metres of the boundary.

The property is not within 800 metres of the boundary of an opencast site for which a licence to remove coal by opencast methods has been granted.

9. Coal mining subsidence

The Coal Authority has not received a damage notice or claim for the subject property, or any property within 50 metres, since 31 October 1994.

There is no current Stop Notice delaying the start of remedial works or repairs to the property.

The Coal Authority is not aware of any request having been made to carry out preventive works before coal is worked under section 33 of the Coal Mining Subsidence Act 1991.

10. Mine gas

The Coal Authority has no record of a mine gas emission requiring action.

11. Hazards related to coal mining

The property has not been subject to remedial works, by or on behalf of the Authority, under its Emergency Surface Hazard Call Out procedures.

12. Withdrawal of support

The property is in an area where a notice to withdraw support was given in 1949.

The property is not in an area where a notice has been given under section 41 of the Coal Industry Act 1994, cancelling the entitlement to withdraw support.

13. Working facilities order

The property is not in an area where an order has been made, under the provisions of the Mines (Working Facilities and Support) Acts 1923 and 1966 or any statutory modification or amendment thereof.

14. Payments to owners of former copyhold land

The property is not in an area where a relevant notice has been published under the Coal Industry Act 1975/Coal Industry Act 1994.

15. Information from the Cheshire Brine Subsidence Compensation Board

The property lies outside the Cheshire Brine Compensation District.

Additional remarks

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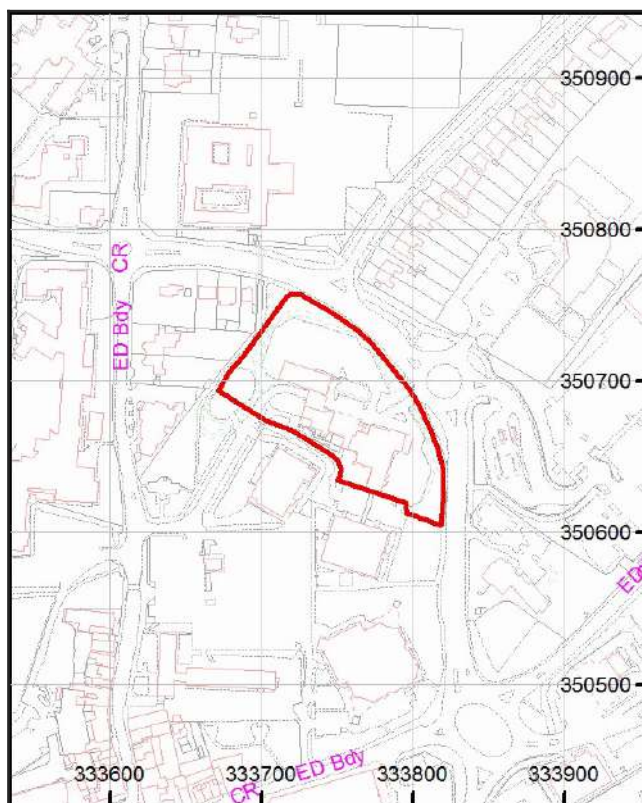
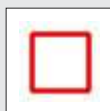
Alternative formats

If you would like this report in an alternative format, please contact our communications team.

Enquiry boundary

Key

Approximate position of enquiry boundary shown



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VAT receipt

Issued by	The Coal Authority 200 Lichfield Lane Mansfield Nottinghamshire NG18 4RG
Tax point date	04 July 2017
Issued to	REMADA LTD THE COURTYARD THE COURTYARD BARSTON LANE KNOWLE WEST MIDLANDS B92 0HS
Property search for	NORTH WALES POLICE AUTHORITY DIVISIONAL POLICE HEADQUARTERS BODHYFRYD WREXHAM LL12 7BW
Reference number	51001513135001
Date of issue	04 July 2017
Cost	£78.30
VAT @ 20%	£15.66
Total received	£93.96
VAT registration	598 5850 68

APPENDIX B
Exploratory Hole Logs



173-183 Witton Street,
Northwich,
Cheshire,
CW9 5LP

Trial Pit Log

Trialpit No

TP01

Sheet 1 of 1

Project Name: WREXHAM POLICE STATION

Project No.
C3664

Co-ords: -
Level:

Date
11/11/2017

Location: WREXHAM

Dimensions
(m):

Depth
1.35

Scale
1:25

Logged
FINAL

Client: LIDL UK GMBH

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.20	ES		0.30			MADE GROUND: Grass over clayey silty sand with roots. Rare gravel of rounded fine to coarse siltstone (TOPSOIL).	
				0.80			MADE GROUND: Light brown slightly clayey slightly silty fine sand. Occasional cobbles of sub-rounded concrete.	
	1.00	D		1.30			MADE GROUND: Brown sandy gravel of angular fine to coarse siltstone. High cobble content of angular siltstone.	1
				1.35			MADE GROUND: Grey sub-angular concrete cobbles. End of pit at 1.35 m	
								2
								3
								4
								5

Remarks: 1. No groundwater encountered. 2. Hole terminated at 1.35m bgl due to presence of concrete cobbles and potential service.

Stability:





173-183 Witton Street,
Northwich,
Cheshire,
CW9 5LP

Trial Pit Log

Trialpit No

TP02

Sheet 1 of 1

Project Name: WREXHAM POLICE STATION

Project No.
C3664

Co-ords: -
Level:

Date
11/11/2017

Location: WREXHAM

Dimensions
(m):

Depth
1.10

Scale
1:25

Logged
FINAL

Client: LIDL UK GMBH

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.50	ES					MADE GROUND: Grass over dark brown silty sand with roots. Rare gravel of rounded fine to coarse siltstone. Low cobble content of rounded siltstone and brick (TOPSOIL).	
	1.00	D		0.75 1.10 1.10			MADE GROUND: Light brown clayey slightly silty sand with occasional sub-angular brick cobbles.	1
							MADE GROUND: Concrete. End of pit at 1.10 m	
								2
								3
								4
								5

Remarks: 1. No groundwater encountered. 2. Hole terminated at 1.10m bgl due to presence of concrete.

Stability:





173-183 Witton Street,
Northwich,
Cheshire,
CW9 5LP

Trial Pit Log

Trialpit No

TP03

Sheet 1 of 1

Project Name: WREXHAM POLICE STATION

Project No.
C3664

Co-ords: -
Level:

Date
11/11/2017

Location: WREXHAM

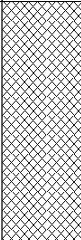
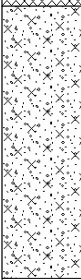
Dimensions
(m):

Depth
2.00

Scale
1:25

Logged
FINAL

Client: LIDL UK GMBH

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.50	ES					MADE GROUND: Grass over dark brown silty sand with roots. Low cobble content of angular brick and concrete, and sub-rounded siltstone. <i>Cobbles are occasional from 0.30m bgl.</i>	
				0.80				
				1.10			MADE GROUND: Brown gravelly sand Gravel is fine to coarse of angular brick.	1
	1.40	D						
	1.50	ES					Orange brown slightly silty gravelly SAND. Gravel of fine to coarse rounded siltstone. Medium cobble content of rounded siltstone.	
				2.00			End of pit at 2.00 m	2
								3
								4
								5

Remarks: 1. No groundwater encountered.

Stability:





173-183 Witton Street,
Northwich,
Cheshire,
CW9 5LP

Borehole Log

Borehole No.

WS01

Sheet 1 of 1

Project Name: WREXHAM POLICE STATION

Project No.
C3664

Co-ords: -

Hole Type
WS

Location: WREXHAM

Level:

Scale
1:25

Client: LIDL UK GMBH

Dates: 12/11/2017 -

Logged By
FINAL

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
		0.55	ES		0.15			MADE GROUND: Macadam.	1	
					0.30			MADE GROUND: Light brown gravel of sub-rounded limestone. High cobble content of sub-rounded limestone.		
					0.60			MADE GROUND: Red gravel of sub-angular brick, charcoal and siltstone. Low cobble content of sub-angular brick and siltstone.		
								Made ground is predominantly gravel of siltstone beyond 0.4m bgl.		
		0.90	ES					Medium dense brown slightly silty gravelly SAND. Sand is medium grained. Gravel is rounded fine to coarse of siltstone.		2
		1.00	D							
		1.20		N=14 (4,4/4,4,3,3)						
		2.00	D	N=10 (2,2/3,2,3,2)						
		2.00								
		3.00		N=11 (2,3/3,2,3,3)				3		
3.70	D			3.60			Loose orange brown very gravelly SAND. Sand is medium grained. Gravel is rounded fine to coarse of siltstone.	4		
4.00		N=8 (3,3/2,2,2,2)	4.00			End of borehole at 4.00 m				
									5	



173-183 Witton Street,
Northwich,
Cheshire,
CW9 5LP

Borehole Log

Borehole No.

WS02

Sheet 1 of 1

Project Name: WREXHAM POLICE STATION

Project No.
C3664

Co-ords: -

Hole Type
WS

Location: WREXHAM

Level:

Scale
1:25

Client: LIDL UK GMBH

Dates: 12/11/2017 -

Logged By
FINAL

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.30	ES					MADE GROUND: Grass over silty sand with roots. Low gravel content of sub-angular fine to coarse brick. Low cobble content of sub-rounded siltstone (TOPSOIL).	
					1.00			<i>Rare sub-rounded brick cobbles from 0.80m bgl.</i>	1
		1.20		N=6 (1,1/1,1,2,2)				Light brown clayey slightly silty SAND. Sand is fine to medium grained.	
		1.30	ES					<i>Bands of coal present between 1.30 and 1.40m bgl.</i>	
		1.50	D		1.75				
		2.00		N=6 (1,1/1,2,1,2)				Loose orange brown slightly silty gravelly SAND. Sand is medium grained. Gravel is sub-rounded fine to coarse of siltstone.	2
		2.50	D					<i>Rare sub-rounded limestone cobbles from 2.4m to 2.5m bgl.</i>	
		3.00		N=5 (1,1/1,2,1,1)	3.20				
								Loose orange brown SAND. Sand is medium grained. Gravel is sub-rounded fine to coarse of siltstone.	
								<i>Sand is medium to coarse from 3.60m bgl.</i>	
		4.00		N=8 (2,2/2,2,2,2)	4.00			End of borehole at 4.00 m	4
									5

Remarks

1. Hand dug pit to 1.20m bgl. 2. No groundwater encountered. 3. Hole backfilled upon completion.





173-183 Witton Street,
Northwich,
Cheshire,
CW9 5LP

Borehole Log

Borehole No.

WS03

Sheet 1 of 1

Project Name: WREXHAM POLICE STATION

Project No.
C3664

Co-ords: -

Hole Type
WS

Location: WREXHAM

Level:

Scale
1:25

Client: LIDL UK GMBH

Dates: 12/11/2017 -

Logged By
FINAL

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.30	ES					MADE GROUND: Grass over silty gravelly sand with roots. Gravel is sub-rounded fine to coarse of siltstone and brick. Low cobble content of sub-rounded siltstone and brick (TOPSOIL).	
								<u>Very gravelly from 0.50m bgl.</u>	
								<u>Angular limestone cobble at 0.85m bgl.</u>	1
		1.20		N=23 (7,7/7,6,5,5)	1.40				
		1.50	D					Medium dense orange brown fine to medium slightly silty gravelly SAND. Gravel is sub-rounded fine to coarse siltstone. Rare fragments of coal. Occasional cobbles of sub-rounded siltstone.	
		2.00		N=25 (5,7/7,7,6,5)					2
		2.60	D					<u>Sand is slightly gravelly from 2.60m bgl.</u>	
		3.00		N=15 (3,3/3,4,4,4)	3.00			End of borehole at 3.00 m	3
									4
									5

Remarks

1. Hand dug pit to 1.20m bgl. 2. Hole collapsing to 2.60m bgl. 3. No groundwater encountered. 4. Standpipe installed to 2.50m bgl; 1.50m plain, 1.00m slotted





173-183 Witton Street,
Northwich,
Cheshire,
CW9 5LP

Borehole Log

Borehole No.

WS04

Sheet 1 of 1

Project Name: WREXHAM POLICE STATION

Project No.
C3664

Co-ords: -

Hole Type
WS

Location: WREXHAM

Level:

Scale
1:25

Client: LIDL UK GMBH

Dates: 12/11/2017 -

Logged By
FINAL

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.70	ES		0.70			MADE GROUND: Grass over sand with roots. Rare gravel of sub-rounded to rounded fine to coarse siltstone and brick. Low cobble content of rounded siltstone (TOPSOIL).	
		1.20		N=9 (1,2/3,2,2,2)				MADE GROUND: Dark brown very gravelly sand. Gravel is rounded fine to coarse of brick, concrete and siltstone. Medium cobble content of rounded siltstone and limestone.	1
		1.70	ES						
		2.00		N=6 (1,1/1,1,2,2)				Less gravelly and low cobble content from 2.00m to 2.30m bgl.	2
		2.30	D		2.40			Rare sub-angular concrete cobbles from 2.30 to 2.40m bgl.	
								End of borehole at 2.40 m	3
									4
									5

Remarks

1. Hand dug pit to 1.20m bgl. 2. Hole terminated due to casing bouncing off suspected concrete. 3. No groundwater encountered. 4. Hole backfilled upon completion.





173-183 Witton Street,
Northwich,
Cheshire,
CW9 5LP

Borehole Log

Borehole No.

WS05

Sheet 1 of 1

Project Name: WREXHAM POLICE STATION

Project No.
C3664

Co-ords: -

Hole Type
WS

Location: WREXHAM

Level:

Scale
1:25

Client: LIDL UK GMBH

Dates: 12/11/2017 -

Logged By
FINAL

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.60	ES		0.60			MADE GROUND: Grass over dark brown gravelly sand with roots. Gravel is sub-angular fine to coarse of siltstone. Medium cobble content of sub-rounded siltstone and brick (TOPSOIL).	
		1.20 1.20	D	N=5 (1,1/1,1,1,2)				MADE GROUND: Dark brown slightly clayey sand and gravel. Gravel is sub-rounded fine to coarse of brick. Rare fragments of pottery. <i>Rare glass fragment at 0.80m bgl.</i>	1
		2.00		N=12 (3,5/4,3,2,3)				<i>Frequent coal fragments from 2.10m to 2.30m bgl.</i>	2
		2.40	D		2.30			Medium dense orange brown fine to medium slightly silty gravelly SAND. Gravel is of sub-rounded fine to coarse of siltstone. Medium cobble content of sub-rounded siltstone.	
		3.00		N=10 (2,2/2,2,3,3)				<i>Bands of coal from 2.80m to 2.90m bgl.</i>	3
		3.60	D					<i>Bands of coal from 3.70m to 3.90m bgl.</i>	
		4.00		N=13 (3,3/3,3,3,4)	4.00			End of borehole at 4.00 m	4
									5

Remarks

1. Hand dug pit to 1.20m bgl. 2. No groundwater encountered. 3. Hole backfilled upon completion.





173-183 Witton Street,
Northwich,
Cheshire,
CW9 5LP

Borehole Log

Borehole No.

WS06

Sheet 1 of 1

Project Name: WREXHAM POLICE STATION

Project No.
C3664

Co-ords: -

Hole Type
WS

Location: WREXHAM

Level:

Scale
1:25

Client: LIDL UK GMBH

Dates: 11/11/2017 -

Logged By
FINAL

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10	ES		0.40			MADE GROUND: Dark brown slightly gravelly organic silty fine sand with rootlets and roots. Gravel is subrounded to rounded fine to coarse of mixed lithologies. Pieces of plastic sheeting. (TOPSOIL)	1
		0.50	D					Dark brown slightly gravelly organic silty fine sand with rootlets and roots. Gravel is subrounded to rounded fine to coarse of mixed lithologies. (TOPSOIL)	
		1.20 1.20	D	N=17 (5,5/4,4,5)	0.90			Medium dense brown orange silty SAND and GRAVEL. Sand is fine grained. Gravel is subangular to rounded fine to coarse of mixed lithologies including siltstone and limestone.	
		2.00		N=30 (3,7/7,8,8,7)				Bands of coal present between 2.30m bgl and 2.60m bgl.	2
		2.70	D						
		3.00		50 (7,10/50 for 240mm)	3.00			End of borehole at 3.00 m	3
									4
									5

Remarks

1. Hand dug pit to 1.20m bgl. 2. Hole terminated due to SPT refusal. 3. No groundwater encountered. 4. Hole backfilled upon completion.





173-183 Witton Street,
Northwich,
Cheshire,
CW9 5LP

Borehole Log

Borehole No.

WS07

Sheet 1 of 1

Project Name: WREXHAM POLICE STATION

Project No.
C3664

Co-ords: -

Hole Type
WS

Location: WREXHAM

Level:

Scale
1:25

Client: LIDL UK GMBH

Dates: 11/11/2017 -

Logged By
FINAL

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	ES	N=10 (4,3/3,2,2,3)	1.30			MADE GROUND: Grass over dark brown organic clayey sand. Sand is fine grained. Low cobble content of concrete and pottery. (TOPSOIL). <i>Becoming gravelly from 0.10m bgl. Gravel is subangular fine to coarse of mixed lithologies.</i>	1
		1.00	ES						
		1.20							
		1.50	D	N=50 (8,10/10,12,15,13)	2.00			Medium dense brown orange SAND. Sand is medium grained.	2
		2.00							
								End of borehole at 2.00 m	3
									4
									5

Remarks

1. Hand dug pit to 1.20m bgl. 2. Hole terminated due to SPT refusal. 3. No groundwater encountered. 4. Hole backfilled upon completion.





173-183 Witton Street,
Northwich,
Cheshire,
CW9 5LP

Borehole Log

Borehole No.

WS08

Sheet 1 of 1

Project Name: WREXHAM POLICE STATION

Project No.
C3664

Co-ords: -

Hole Type
WS

Location: WREXHAM

Level:

Scale
1:25

Client: LIDL UK GMBH

Dates: 11/11/2017 -

Logged By
FINAL

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	ES		0.50			Grass over light brown slightly organic slightly gravelly silty fine sand with rootlets. Gravel is subrounded fine to medium of mixed lithologies. (TOPSOIL).	1
		0.60	D					Orangish brown slightly organic slightly gravelly silty fine SAND. Gravel is subrounded fine to medium of mixed lithologies.	
		1.20 1.30	D	N=16 (3,6/3,4,4,5)				Medium dense brown orange silty SAND and GRAVEL. Sand is fine to medium grained. Gravel is subangular to rounded fine to medium of limestone and siltstone. Low cobble content of limestone.	
		2.00		N=24 (6,8/6,6,6,6)	3.00				2
		2.50	D					Bands of coal present between 2.40m bgl and 2.60m bgl.	
		3.00		N=23 (5,5/5,6,6,6)					
								End of borehole at 3.00 m	3
									4
									5

Remarks

1. Hand dug pit to 1.20m bgl. 2. Hole collapsing to 2.00m bgl. 3. No groundwater encountered. 4. Hole backfilled upon completion.





173-183 Witton Street,
Northwich,
Cheshire,
CW9 5LP

Borehole Log

Borehole No.

WS09

Sheet 1 of 1

Project Name: WREXHAM POLICE STATION

Project No.
C3664

Co-ords: -

Hole Type
WS

Location: WREXHAM

Level:

Scale
1:25

Client: LIDL UK GMBH

Dates: 11/11/2017 -

Logged By
FINAL

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	ES		0.30			Grass over dark brown silty organic SAND with roots and rootlets. (TOPOSOIL)	
		1.20 1.20	D	N=18 (3,3/3,7,4,4)	1.50			Medium dense dark brown orange slightly clayey SAND and GRAVEL. Sand is fine to medium grained. Gravel is rounded to subangular fine to coarse of mixed lithologies.	1
		1.70	D					Medium dense ight brown silty SAND and GRAVEL. Sand is fine to medium grained. Gravel is subrounded to rounded fine to coarse of mixed lithologies including limestone. Low cobble content of limestone.	2
		2.00		N=16 (4,5/4,4,4,4)					
		2.50	D					<u>Bands of coal present from 2.40m bgl.</u>	
		3.00		N=22 (4,5/5,5,6,6)					3
		3.50	D						
					4.00			End of borehole at 4.00 m	4
									5

Remarks

1. Hand dug pit to 1.20m bgl. 2. Hole collapsing to 3.00m bgl. 3. No groundwater encountered. 4. Hole backfilled upon completion.





173-183 Witton Street,
Northwich,
Cheshire,
CW9 5LP

Borehole Log

Borehole No.

WS10

Sheet 1 of 1

Project Name: WREXHAM POLICE STATION

Project No.
C3664

Co-ords: -

Hole Type
WS

Location: WREXHAM

Level:

Scale
1:25

Client: LIDL UK GMBH

Dates: 11/11/2017 -

Logged By
FINAL

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	ES		0.30			MADE GROUND: Grass over dark brown slightly clayey organic silty sand with rootlets. Sand is fine grained. (TOPSOIL).	
		0.40 0.40	D ES					MADE GROUND: Brown orange silty sand and gravel. Sand is fine to coarse grained. Gravel is subangular to rounded fine to coarse of mixed lithologies with rare gravels of concrete, glass and wood. Low cobble content of mixed lithologies.	
					0.90			Medium dense brown orange silty SAND and GRAVEL. Sand is fine to medium grained. Gravel is subrounded to angular fine to coarse of limestone and siltstone. Low cobble content of limestone.	1
		1.20		N=20 (5,6/4,5,5,6)					
		1.40	D						
					2.00				2
		2.00		N=15 (5,4/4,3,4,4)					
					2.40				
		2.40	D						
					3.00				3
		3.00		N=17 (4,4/4,5,4,4)					
					3.40				
		3.40	D						
					4.00				4
		4.00		N=24 (4,5/4,6,7,7)					
					4.00			End of borehole at 4.00 m	5

Remarks

1. Hand dug pit to 1.20m bgl. 2. Hole collapsing to 2.50m bgl. 3. No groundwater encountered. 4. Standpipe installed to 2.50m bgl; 0.50m plain, 2.00m slotted.





173-183 Witton Street,
Northwich,
Cheshire,
CW9 5LP

Borehole Log

Borehole No.

WS11

Sheet 1 of 1

Project Name: WREXHAM POLICE STATION

Project No.
C3664

Co-ords: -

Hole Type
WS

Location: WREXHAM

Level:

Scale
1:25

Client: LIDL UK GMBH

Dates: 11/11/2017 -

Logged By
FINAL

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	ES		0.30			MADE GROUND: Grass over brown slightly gravelly sandy clay with roots. Sand is coarse grained. Gravel is rounded fine to coarse of mixed lithologies. (TOPSOIL)	
					0.35			MADE GROUND: Concrete. End of borehole at 0.30 m	
									1
									2
									3
									4
									5

Remarks

1. Hand dug pit to 0.30m bgl. 2. Hole terminated due to concrete slab. 3. Hole moved 1m east.





173-183 Witton Street,
Northwich,
Cheshire,
CW9 5LP

Borehole Log

Borehole No.

WS11A

Sheet 1 of 1

Project Name: WREXHAM POLICE STATION

Project No.
C3664

Co-ords: -

Hole Type
WS

Location: WREXHAM

Level:

Scale
1:25

Client: LIDL UK GMBH

Dates: 11/11/2017 -

Logged By
FINAL

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.30			MADE GROUND: Grass over brown slightly gravelly sandy clay with roots. Sand is coarse grained. Gravel is rounded fine to coarse of mixed lithologies. (TOPSOIL)	
					0.35			MADE GROUND: Concrete. End of borehole at 0.30 m	
									1
									2
									3
									4
									5

Remarks

1. Hand dug pit to 0.30m bgl. 2. Hole terminated due to concrete slab.





173-183 Witton Street,
Northwich,
Cheshire,
CW9 5LP

Borehole Log

Borehole No.

WS12

Sheet 1 of 1

Project Name: WREXHAM POLICE STATION

Project No.
C3664

Co-ords: -

Hole Type
WS

Location: WREXHAM

Level:

Scale
1:25

Client: LIDL UK GMBH

Dates: 11/11/2017 -

Logged By
FINAL

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.30	ES		0.50			MADE GROUND: Grass over light brown gravelly SAND. Sand is fine to medium grained. Gravel is subangular fine to coarse of mixed lithologies including brick, concrete and pottery. Low cobble content of mixed lithologies.	1
		0.60	D					Medium dense light brown orange silty gravelly SAND with rare rootlets. Sand is fine grained. Gravel is subangular to rounded fine to medium of mixed lithologies.	
		1.20		N=12 (2,1/1,3,3,5)	1.80			Medium dense brown orange silty SAND and GRAVEL. Sand is fine to medium grained. Gravel is subrounded to rounded fine to coarse of mixed lithologies.	2
		1.40	D						
		1.90	D						
		2.00		N=16 (4,4/4,4,4,4)					
		2.80	D		3.60			<i>Sand becoming fine to coarse from 2.70m bgl.</i> <i>Becoming very clayey between 2.90m and 3.00m bgl.</i>	3
		3.00		N=9 (3,3/2,2,2,3)					
		3.70	D		4.00			Loose damp brown orange slightly clayey SAND and GRAVEL. Sand is medium grained. Gravel is rounded fine to coarse of mixed lithologies.	4
								End of borehole at 4.00 m	

Remarks

1. Hand dug pit to 1.20m bgl. 2. Hole collapsing to 3.00m bgl. 3. No groundwater encountered. 4. Standpipe installed to 3.00m bgl; 1.00m plain, 2.00m slotted.



APPENDIX C

Plate Load Tests

Plate Load Test

B1377: Part 9

LIDL GMBH WREXHAM POLICE STATION

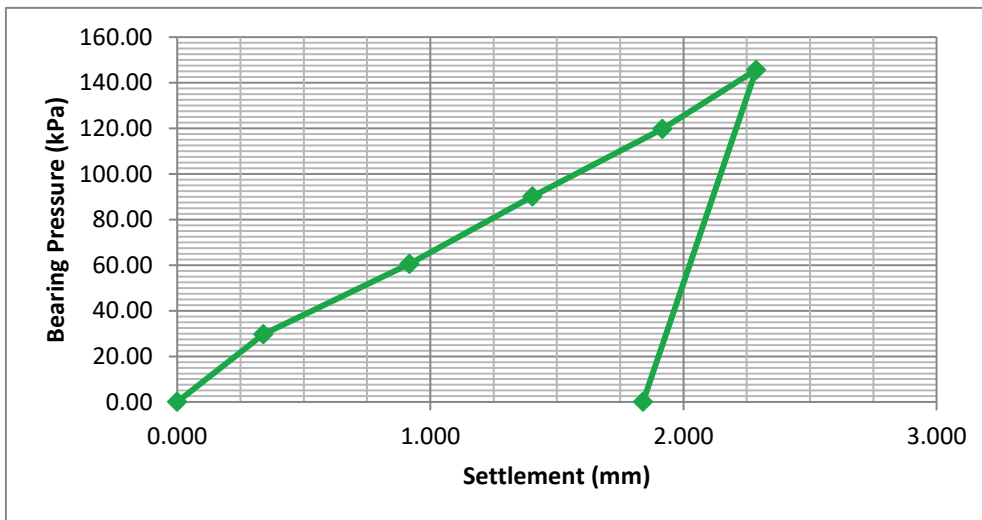


C3664

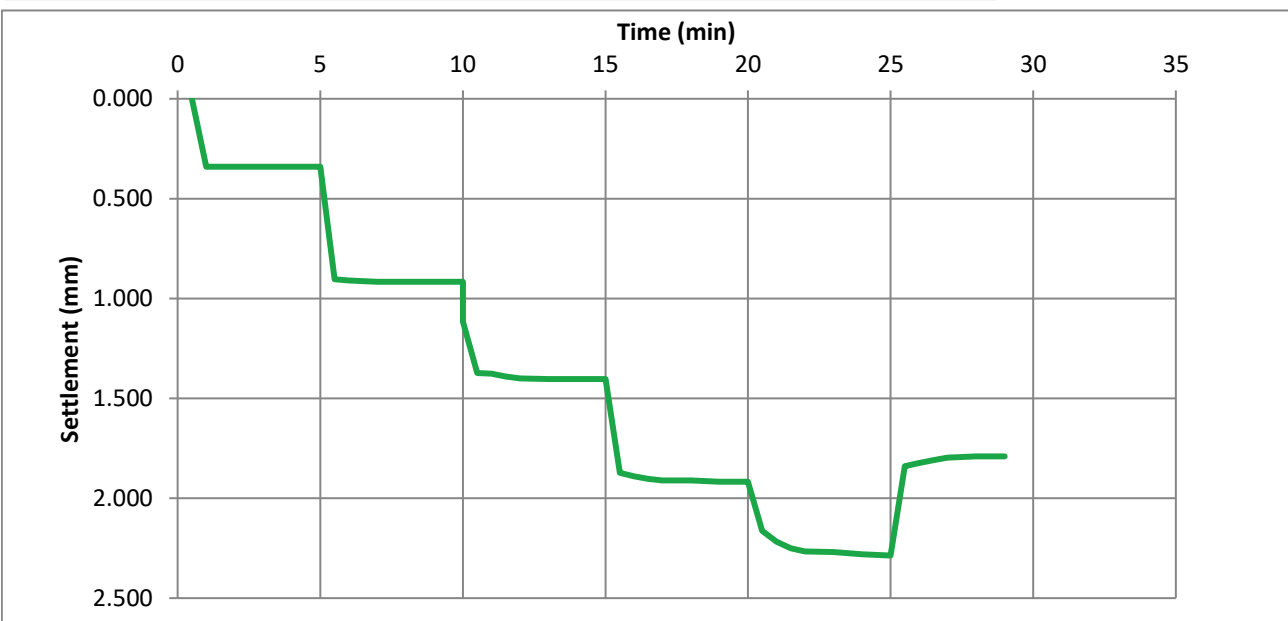
11/11/2017

Test Position:	TP01	Kentledge	Wheeled
Depth (mm)	400	Moisture Content (%)	N/A
Plate Ø (mm)	450	Plate Area (m ²)	0.159
Max Applied Force (kPa)	145.6	Maximum Deformation (mm)	2.287

Formation Description: Made Ground



Bearing Pressure (kPa)	Plate Settlement (mm)
0.00	0.000
29.62	0.340
60.48	0.917
90.10	1.403
119.72	1.917
145.64	2.287
0.00	1.840



Settlement required for CBR Value 1.25mm	
Load at 1.25mm settlement (kPa)	80
k (Modulus of subgrade reaction KN/m ² /mm)	64
k ₇₆₂ (Modulus of subgrade reaction KN/m ² /mm)	39.79
CBR Value (%)	5.7

Compiled By:

JB

Checked By:

JMJ

Plate Load Test

B1377: Part 9

LIDL GMBH WREXHAM POLICE STATION

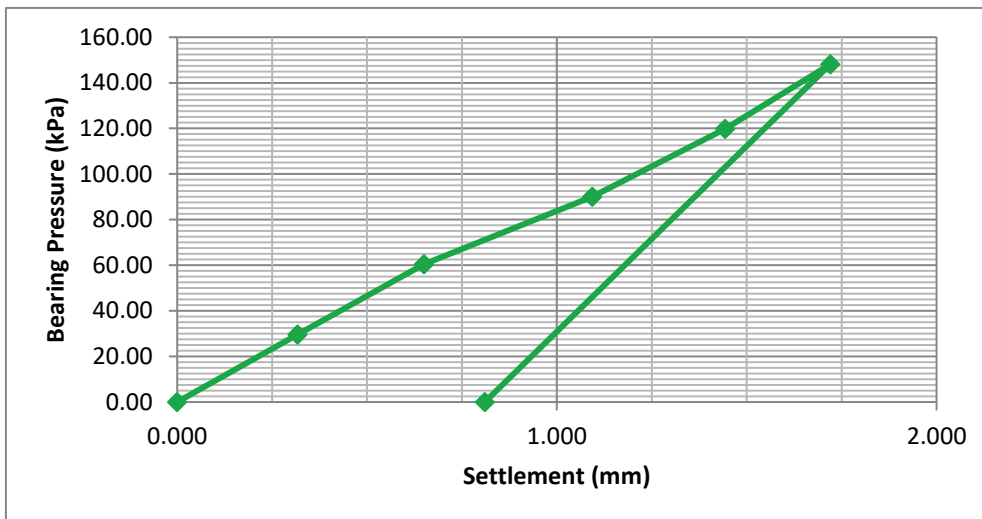


C3664

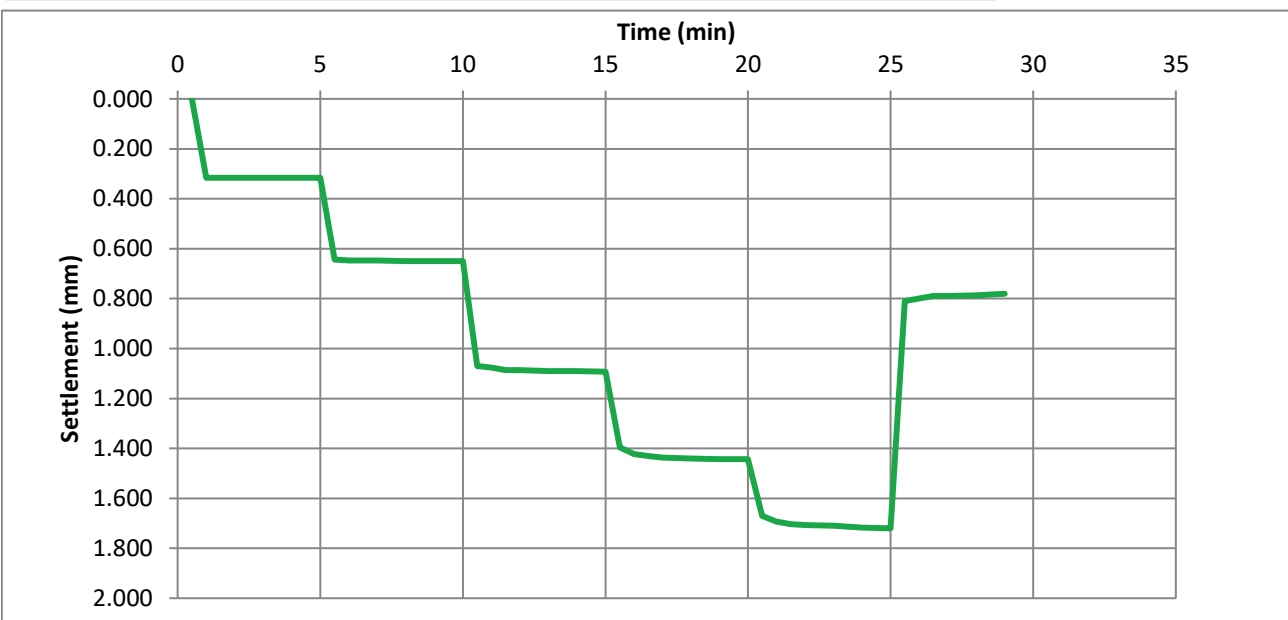
11/11/2017

Test Position:	TP02	Kentledge	Wheeled
Depth (mm)	700	Moisture Content (%)	N/A
Plate Ø (mm)	450	Plate Area (m ²)	0.159
Max Applied Force (kPa)	148.1	Maximum Deformation (mm)	1.720

Formation Description: Made Ground



Bearing Pressure (kPa)	Plate Settlement (mm)
0.00	0.000
29.62	0.317
60.48	0.650
90.10	1.093
119.72	1.443
148.11	1.720
0.00	0.810



Settlement required for CBR Value 1.25mm	
Load at 1.25mm settlement (kPa)	102.5
k (Modulus of subgrade reaction KN/m ² /mm)	82
k ₇₆₂ (Modulus of subgrade reaction KN/m ² /mm)	50.98
CBR Value (%)	8.8

Compiled By:

JB

Checked By:

JMJ

Plate Load Test

B1377: Part 9

LIDL GMBH WREXHAM POLICE STATION

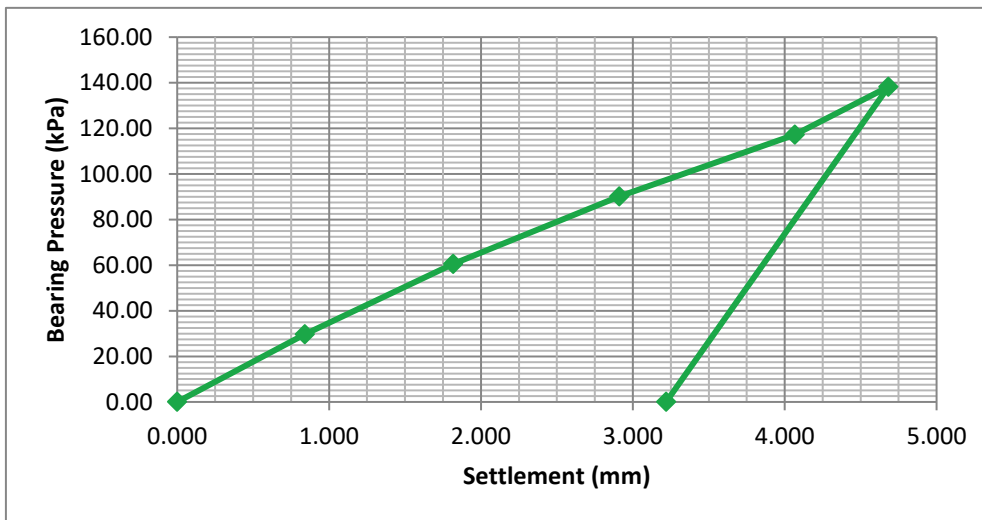


C3664

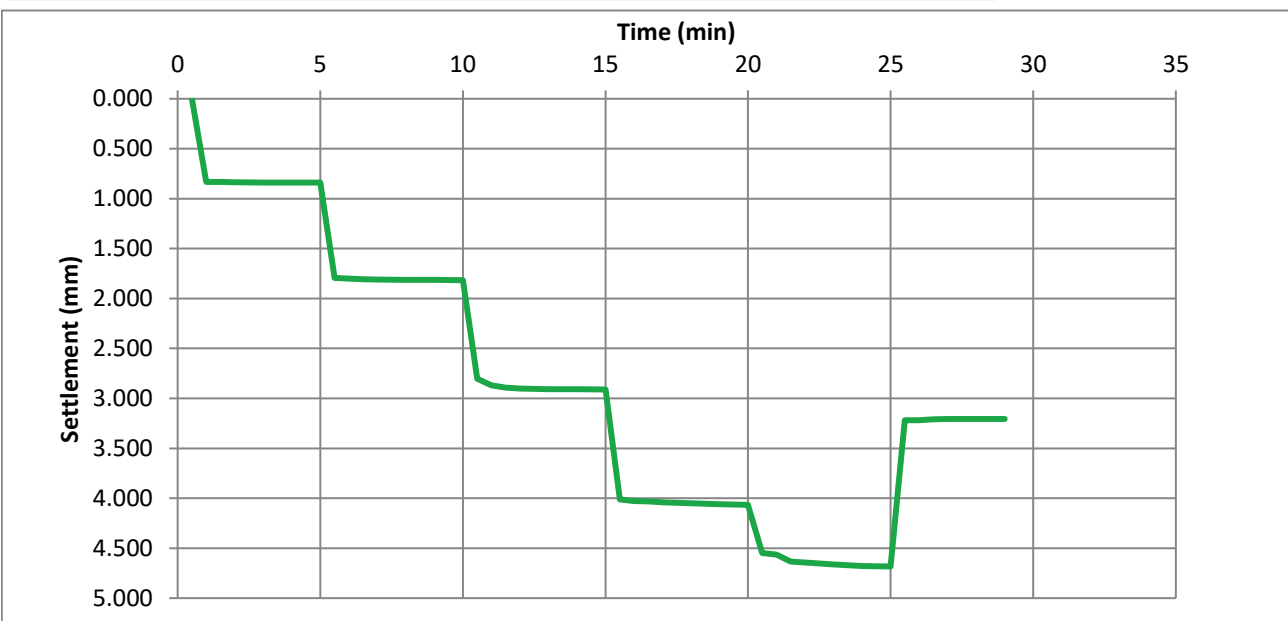
11/11/2017

Test Position:	TP03	Kentledge	Wheeled
Depth (mm)	700	Moisture Content (%)	N/A
Plate Ø (mm)	450	Plate Area (m ²)	0.159
Max Applied Force (kPa)	138.2	Maximum Deformation (mm)	4.683

Formation Description: Made Ground



Bearing Pressure (kPa)	Plate Settlement (mm)
0.00	0.000
29.62	0.840
60.48	1.817
90.10	2.910
117.25	4.067
138.24	4.683
0.00	3.220



Settlement required for CBR Value 1.25mm	
Load at 1.25mm settlement (kPa)	42.5
k (Modulus of subgrade reaction KN/m ² /mm)	34
k ₇₆₂ (Modulus of subgrade reaction KN/m ² /mm)	21.14
CBR Value (%)	1.9

Compiled By:

JB

Checked By:

JMJ

APPENDIX D

Percolation Tests

Percolation Test

LIDL GMBH**TP03**

Test 1

WREXHAM P[OLICE STATION

C3664


**BROWNFIELD
SOLUTIONS LTD**
GEO-ENVIRONMENTAL ENGINEERING EXCELLENCE

Date:

11/11/2017

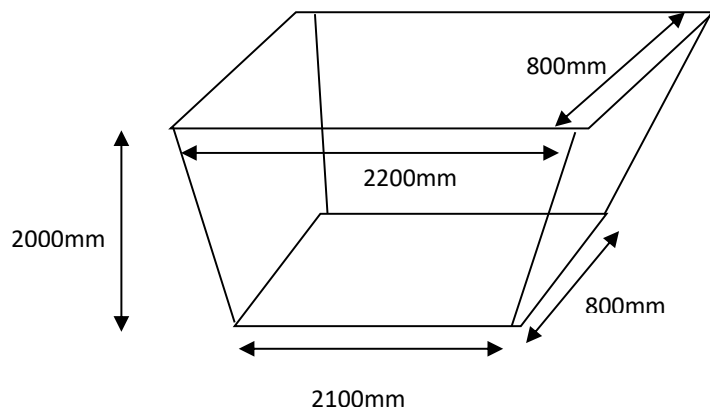
Logged:

JB

Checked:

JMJ

Dimensions of Pit (mm)



Pit Depth: 2000 mm

Pit Details: Open with no stone filling

Time (mins)	Depth to water (mm)	Time (mins)	Depth to water (mm)
0	1330	30	1785
0.5	1340	40	1880
1	1350	60	1990
1.5	1370	65	2000
2	1390		
3	1420		
4	1440		
5	1465		
7	1500		
10	1535		
15	1595		
20	1655		

Percolation Test

LIDL GMBH**TP03**

Test 1

WREXHAM P[OLICE STATION

C3664


**BROWNFIELD
SOLUTIONS LTD**
GEO-ENVIRONMENTAL ENGINEERING EXCELLENCE

Date:

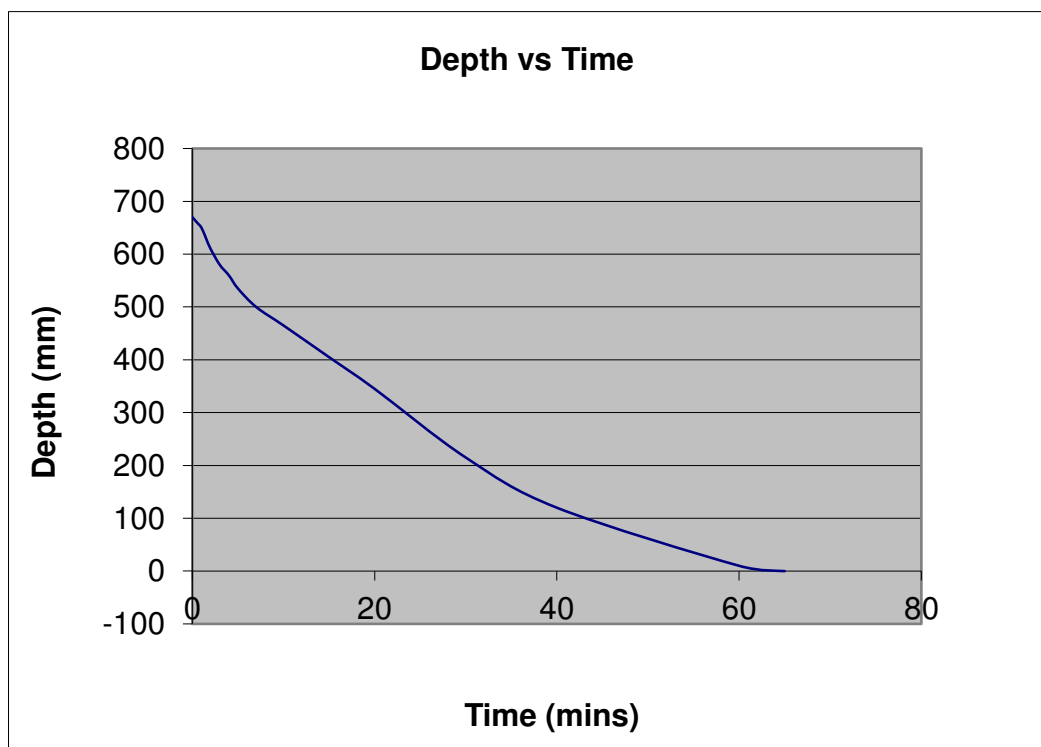
11/11/2017

Logged:

JB

Checked:

JMJ



Volume of Pit (m ³)	3.28	Void Ratio of Infill	1
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Volume of Infill (m ³)	N/A	Volume of Water in Pit (m ³)	1.0988
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Compliance Check

Water Level at 75% effective depth (mm)	502.5
Water Level at 25% effective depth (mm)	167.5
Compliant with BRE 365	

Percolation Rate Calculation

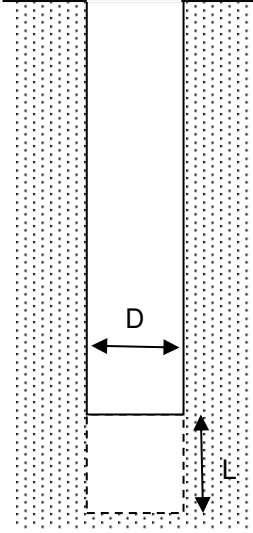
Water Level 1	502.5
Water Level 2	167.5
Time to Drain from Level 1 to Level 2 (mins)	48
Volume of water discharged (m ³)	0.5494

Discharge Area (m ²)	3.4295
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Soil Infiltration Rate (m/min)	0.003337464
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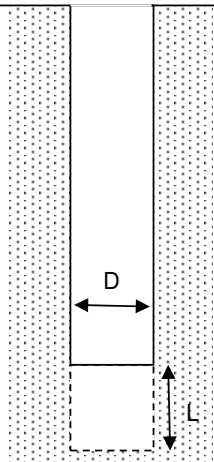
Soil Infiltration Rate (m/sec)	5.56E-05
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Calculation Sheet 1 of 3	LIDL GMBH		 BROWNFIELD SOLUTIONS LTD Geotechnical Engineering & Construction Solutions				
	WREXHAM POLICE STATION						
	C3664						
		Date:	30/11/2017	By:	JB	Checked:	JMJ
WS03 Test 1	Falling Head Permeability Test						
	Depth below top of casing/standpipe to:		Weather:		Clear		
	(a) bottom of borehole:		2.50	m			
	(b) bottom of casing:		2.5	m			
	(c) top of filter material:		1.50	m			
	(d) initial groundwater level:			m			
	(e) centre of piezometer tip:			m			
	Height of casing/standpipe above surface			m			
	Diameter of casing/standpipe		35	mm			
	Length of filter		1000	mm			
Test Record:							
	Time Elapsed (minutes)	Depth to water level (m)		Time Elapsed (minutes)	Depth to water level (m)		
	0	1.44		9			
	0.5	1.72		10			
	1	2.02		15			
	1.5	2.18		20			
	2	2.29		25			
	2.5	2.38		30			
	3	2.45		40			
	3.5	2.47		50			
	4	2.50		60			
	4.5			70			
	5			80			
	5.5			90			
	6			100			
	7			110			
	8			120			
Remarks: Eg. Depth to water level taken from top of standpipe/Standpipe silted up, etc							

Calculation Sheet 2 of 3	LIDL GMBH	 BROWNFIELD SOLUTIONS LTD GROUNDWATER INVESTIGATION SPECIALISTS		
	WREXHAM POLICE STATION			
	C3664			
WS03 Falling Head Permeability in accordance with BS 5930 Test 1 Calculation of Intake Factor (F)		Date: 30/11/2017	By: JB	Checked: JMJ
 Area of base A = 0.0962 m² Diameter D = 35 mm 0.35 m Length 1000 mm 1 m $F = \frac{2 \pi L}{\ln \left[\left(\frac{L}{D} \right) + \sqrt{1 + \left(\frac{L}{D} \right)^2} \right]}$ $F = \frac{6.283}{1.772}$ F = 3.545				

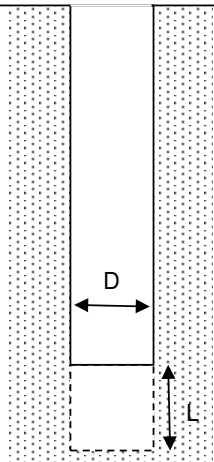
Calculation Sheet 3 of 3	LIDL GMBH		 BROWNFIELD SOLUTIONS LTD GROUNDWATER INVESTIGATION SPECIALISTS
	WREXHAM POLICE STATION		
	C3664		
WS03 Test 1		Falling Head Permeability in accordance with BS 5930	
		Date:	30/11/2017
		By:	JB
		Checked:	JMJ
At time = 0 mins (t_1) Depth to water = 1.44 Depth to base of borehole = 2.50 Depth of Water (H_1) = 1.06		t_1	0 sec
At time = 3.5 mins (t_2) Depth to water = 2.47 Depth to base of borehole = 2.50 Depth of Water (H_2) = 0.03		t_2	210 sec
$k = \frac{A}{F(t_2 - t_1)} \ln \frac{H_1}{H_2}$			
$k = \frac{0.0962}{744.51} \ln \frac{1.06}{0.03}$			
$k = 4.61E-04 \text{ m/s}$			

Calculation Sheet 1 of 3	LIDL GMBH		 BROWNFIELD SOLUTIONS LTD SOIL REMEDIATION SPECIALISTS				
	WREXHAM POLICE STATION						
	C3664						
		Date:	30/11/2017	By:	JB	Checked:	JMJ
WS03	Falling Head Permeability Test						
Test 2	Depth below top of casing/standpipe to:		Weather:		Clear		
(a) bottom of borehole:		2.50	m				
(b) bottom of casing:		2.5	m				
(c) top of filter material:		1.50	m				
(d) initial groundwater level:			m				
(e) centre of piezometer tip:			m				
Height of casing/standpipe above surface			m				
Diameter of casing/standpipe		35	mm				
Length of filter		1000	mm				
Test Record:							
	Time Elapsed (minutes)	Depth to water level (m)		Time Elapsed (minutes)	Depth to water level (m)		
	0	1.33		9			
	0.5	1.45		10			
	1	1.49		15			
	1.5	1.56		20			
	2	1.68		25			
	2.5	1.74		30			
	3	1.85		40			
	3.5	1.96		50			
	4	2.04		60			
	4.5			70			
	5	2.19		80			
	5.5			90			
	6	2.29		100			
	7	2.38		110			
	8	2.45		120			
Remarks: Eg. Depth to water level taken from top of standpipe/Standpipe silted up, etc							

Calculation Sheet 2 of 3	LIDL GMBH	 BROWNFIELD SOLUTIONS LTD OLD-BROWNFIELD OPERATIONAL DEVELOPMENT EXCELLENCE		
	WREXHAM POLICE STATION			
	C3664			
WS03 Falling Head Permeability in accordance with BS 5930 Test 2 Calculation of Intake Factor (F)		Date: 30/11/2017	By: JB	Checked: JMJ
 Area of base A = 0.0962 m² Diameter D = 35 mm 0.35 m Length 1000 mm 1 m $F = \frac{2 \pi L}{\ln \left[\left(\frac{L}{D} \right) + \sqrt{1 + \left(\frac{L}{D} \right)^2} \right]}$ $F = \frac{6.283}{1.772}$ F = 3.545				

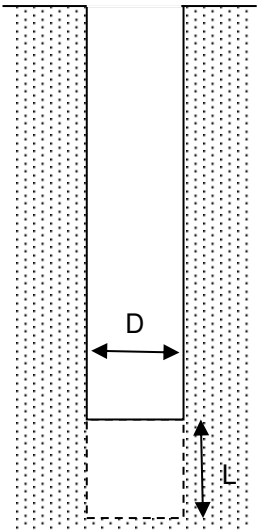
Calculation Sheet 3 of 3	LIDL GMBH		 BROWNFIELD SOLUTIONS LTD LAND-DEVELOPMENT AND REMEDIATION SPECIALISTS
	WREXHAM POLICE STATION		
	C3664		
WS03 Falling Head Permeability in accordance with BS 5930 Test 2		Date: 30/11/2017 By: JB Checked: JMJ	
At time = 0 mins (t_1) Depth to water = 1.33 Depth to base of borehole = 2.50 Depth of Water (H_1) = 1.17 At time = 8 mins (t_2) Depth to water = 2.45 Depth to base of borehole = 2.50 Depth of Water (H_2) = 0.05 $k = \frac{A}{F(t_2 - t_1)} \ln \frac{H_1}{H_2}$ $k = \frac{0.0962}{1701.73} \ln \frac{1.17}{0.05}$ k = 1.78E-04 m/s		t_1 0 sec t_2 480 sec	

Calculation Sheet 1 of 3	LIDL GMBH		 BROWNFIELD SOLUTIONS LTD SOIL REMEDIATION SPECIALISTS				
	WREXHAM POLICE STATION						
	C3664						
		Date:	30/11/2017	By:	JB	Checked:	JMJ
WS10	Falling Head Permeability Test						
Test 1	Depth below top of casing/standpipe to:		Weather:		Clear		
		(a) bottom of borehole:	2.27	m			
		(b) bottom of casing:	2.27	m			
		(c) top of filter material:	0.50	m			
		(d) initial groundwater level:		m			
		(e) centre of piezometer tip:		m			
		Height of casing/standpipe above surface		m			
		Diameter of casing/standpipe	35	mm			
		Length of filter	2000	mm			
Test Record:							
		Time Elapsed (minutes)	Depth to water level (m)			Time Elapsed (minutes)	Depth to water level (m)
		0	1.09			9	
		0.5	1.28			10	
		1	1.47			15	
		1.5	1.66			20	
		2	1.85			25	
		2.5				30	
		3	2.01			40	
		3.5				50	
		4	2.15			60	
		4.5				70	
		5	2.21			80	
		5.5				90	
		6				100	
		7	2.26			110	
		8	2.45			120	
Remarks: Standpipe silted up to 2.27m bgl.							

Calculation Sheet 2 of 3	LIDL GMBH	 BROWNFIELD SOLUTIONS LTD OLD-WAYTECH OPERATIONS DEVELOPMENT EXCELLENCE		
	WREXHAM POLICE STATION			
	C3664			
WS10 Falling Head Permeability in accordance with BS 5930 Test 1 Calculation of Intake Factor (F)		Date: 30/11/2017	By: JB	Checked: JMJ
 Area of base A = 0.0962 m² Diameter D = 35 mm 0.35 m Length 2000 mm 2 m $F = \frac{2 \pi L}{\ln \left[\left(\frac{L}{D} \right) + \sqrt{1 + \left(\frac{L}{D} \right)^2} \right]}$ $F = \frac{12.566}{2.444}$ F = 5.142				

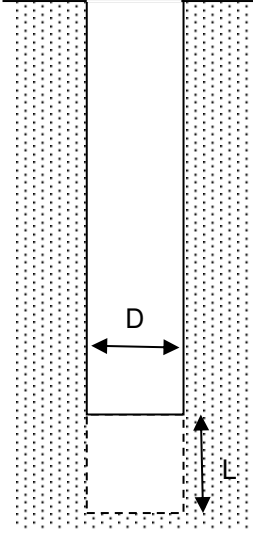
Calculation Sheet 3 of 3	LIDL GMBH		 BROWNFIELD SOLUTIONS LTD ENVIRONMENTAL & GEOTECHNICAL ENGINEERING	
	WREXHAM POLICE STATION			
	C3664			
WS10 Falling Head Permeability in accordance with BS 5930 Test 1		Date: 30/11/2017	By: JB	Checked: JMJ
At time = 0 mins (t ₁) Depth to water = 1.09		t ₁	0 sec	
Depth to base of borehole = 2.27				
Depth of Water (H ₁) = 1.18				
At time = 7 mins (t ₂) Depth to water = 2.26		t ₂	420 sec	
Depth to base of borehole = 2.27				
Depth of Water (H ₂) = 0.01				
k = $\frac{A}{F(t_2 - t_1)} \ln \frac{H_1}{H_2}$				
k = $\frac{0.0962}{2159.80} \ln \frac{1.18}{0.01}$				
k = 2.13E-04 m/s				

Calculation Sheet 1 of 3	LIDL GMBH		 BROWNFIELD SOLUTIONS LTD Geotechnical Engineering & Construction				
	WREXHAM POLICE STATION						
	C3664						
		Date:	30/11/2017	By:	JB	Checked:	JMJ
WS10	Falling Head Permeability Test						
Test 2	Depth below top of casing/standpipe to:		Weather:		Clear		
		(a) bottom of borehole:	2.27	m			
		(b) bottom of casing:	2.27	m			
		(c) top of filter material:	0.50	m			
		(d) initial groundwater level:		m			
		(e) centre of piezometer tip:		m			
		Height of casing/standpipe above surface		m			
		Diameter of casing/standpipe	35	mm			
		Length of filter	2000	mm			
Test Record:							
		Time Elapsed (minutes)	Depth to water level (m)			Time Elapsed (minutes)	Depth to water level (m)
		0	0.73			9	
		0.5	1.09			10	
		1	1.21			15	
		1.5	1.34			20	
		2	1.44			25	
		2.5	1.53			30	
		3	1.65			40	
		3.5	1.73			50	
		4	1.80			60	
		4.5				70	
		5	1.92			80	
		5.5				90	
		6	2.03			100	
		7	2.10			110	
		8	2.21			120	
Remarks: Standpipe silted up to 2.27m bgl.							

Calculation Sheet 2 of 3	LIDL GMBH	 BROWNFIELD SOLUTIONS LTD GROUNDWATER INVESTIGATION SPECIALISTS		
	WREXHAM POLICE STATION			
	C3664			
		Date:	By:	Checked:
		30/11/2017	JB	JMJ
WS10 Test 2 Falling Head Permeability in accordance with BS 5930 Calculation of Intake Factor (F)  Area of base A = 0.0962 m² Diameter D = 35 mm 0.35 m Length 2000 mm 2 m F = $\frac{2 \pi L}{\ln \left[\left(\frac{L}{D} \right) + \sqrt{1 + \left(\frac{L}{D} \right)^2} \right]}$ F = $\frac{12.566}{2.444}$ F = 5.142				

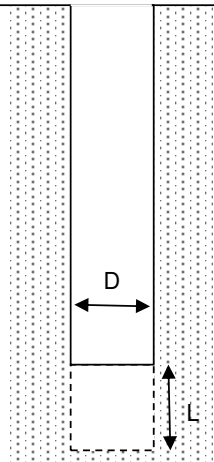
Calculation Sheet 3 of 3	LIDL GMBH		 BROWNFIELD SOLUTIONS LTD GROUNDWATER INVESTIGATION SPECIALISTS			
	WREXHAM POLICE STATION					
	C3664					
WS10 Test 2		Falling Head Permeability in accordance with BS 5930		Date: 30/11/2017	By: JB	Checked: JMJ
		At time = 0 mins (t_1) Depth to water =	0.73	t_1	0 sec	
		Depth to base of borehole =	2.27			
		Depth of Water (H_1) =	1.54			
		At time = 8 mins (t_2) Depth to water =	2.21	t_2	480 sec	
		Depth to base of borehole =	2.27			
		Depth of Water (H_2) =	0.06			
		$k = \frac{A}{F(t_2 - t_1)} \ln \frac{H_1}{H_2}$				
		$k = \frac{0.0962}{2468.34} \ln \frac{1.54}{0.06}$				
		$k =$1.26E-04 m/s				

Calculation Sheet 1 of 3	LIDL GMBH		 BROWNFIELD SOLUTIONS LTD Geotechnical Engineering & Construction Solutions				
	WREXHAM POLICE STATION						
	C3664						
		Date:	30/11/2017	By:	JB	Checked:	JMJ
WS12	Falling Head Permeability Test						
Test 1	Depth below top of casing/standpipe to:		Weather:		Clear		
		(a) bottom of borehole:	2.50			m	
		(b) bottom of casing:	2.5			m	
		(c) top of filter material:	1.00			m	
		(d) initial groundwater level:				m	
		(e) centre of piezometer tip:				m	
		Height of casing/standpipe above surface				m	
		Diameter of casing/standpipe	35			mm	
		Length of filter	1500			mm	
Test Record:							
		Time Elapsed (minutes)	Depth to water level (m)			Time Elapsed (minutes)	Depth to water level (m)
		0	1.3			9	
		0.5	1.82			10	
		1	2.08			15	
		1.5	2.19			20	
		2	2.29			25	
		2.5	2.37			30	
		3	2.41			40	
		3.5	2.45			50	
		4	2.49			60	
		4.5				70	
		5				80	
		5.5				90	
		6				100	
		7				110	
		8				120	
Remarks: Standpipe silted up to 2.5m bgl.							

Calculation Sheet 2 of 3	LIDL GMBH	 BROWNFIELD SOLUTIONS LTD GROUNDWATER INVESTIGATION SPECIALISTS		
	WREXHAM POLICE STATION			
	C3664			
WS12 Falling Head Permeability in accordance with BS 5930 Test 1 Calculation of Intake Factor (F)		Date:	By:	Checked:
		30/11/2017	JB	JMJ
 Area of base A = 0.0962 m² Diameter D = 35 mm 0.35 m Length 1500 mm 1.5 m $F = \frac{2 \pi L}{\ln \left[\left(\frac{L}{D} \right) + \sqrt{1 + \left(\frac{L}{D} \right)^2} \right]}$ $F = \frac{9.425}{2.162}$ F = 4.360				

Calculation Sheet 3 of 3	LIDL GMBH	 BROWNFIELD SOLUTIONS LTD GROUNDWATER INVESTIGATION SPECIALISTS			
	WREXHAM POLICE STATION				
	C3664				
WS12 Test 1		Date:		By:	Checked:
		30/11/2017		JB	JMJ
Falling Head Permeability in accordance with BS 5930		At time = 0 mins (t ₁) Depth to water = 1.30 t ₁ 0 sec			
		Depth to base of borehole = 2.50			
		Depth of Water (H ₁) = 1.20			
		At time = 4 mins (t ₂) Depth to water = 2.49 t ₂ 240 sec			
		Depth to base of borehole = 2.50			
		Depth of Water (H ₂) = 0.01			
k = $\frac{A}{F(t_2 - t_1)}$ ln $\frac{H_1}{H_2}$					
k = $\frac{0.0962}{1046.34}$ ln $\frac{1.20}{0.01}$					
k = 4.40E-04 m/s					

Calculation Sheet 1 of 3	LIDL GMBH		 BROWNFIELD SOLUTIONS LTD GROUNDWATER INVESTIGATION, ENGINEERING, REGULATION				
	WREXHAM POLICE STATION						
	C3664						
		Date:	30/11/2017	By:	JB	Checked:	DMG
WS12 Test 2		Falling Head Permeability Test					
		Depth below top of casing/standpipe to:		Weather:		Clear	
		(a) bottom of borehole:		2.50	m		
		(b) bottom of casing:		2.5	m		
		(c) top of filter material:		1.00	m		
		(d) initial groundwater level:			m		
		(e) centre of piezometer tip:			m		
		Height of casing/standpipe above surface			m		
		Diameter of casing/standpipe		35	mm		
		Length of filter		1500	mm		
Test Record:							
		Time Elapsed (minutes)	Depth to water level (m)			Time Elapsed (minutes)	Depth to water level (m)
		0	0.79			9	
		0.5	1.45			10	
		1	1.72			15	
		1.5	1.86			20	
		2	2.01			25	
		2.5	2.12			30	
		3	2.20			40	
		3.5	2.28			50	
		4	2.34			60	
		4.5	2.40			70	
		5	2.46			80	
		5.5				90	
		6				100	
		7				110	
		8				120	
Remarks: Standpipe silted up to 2.5m bgl.							

Calculation Sheet 2 of 3	LIDL GMBH	 BROWNFIELD SOLUTIONS LTD OLD-WAYTED OPERATIONAL DEVELOPMENT & EXCAVATION		
	WREXHAM POLICE STATION			
	C3664			
WS12 Falling Head Permeability in accordance with BS 5930 Test 2 Calculation of Intake Factor (F)		Date: 30/11/2017	By: JB	Checked: JMJ
 Area of base A = 0.0962 m² Diameter D = 35 mm 0.35 m Length 1500 mm 1.5 m $F = \frac{2 \pi L}{\ln \left[\left(\frac{L}{D} \right) + \sqrt{1 + \left(\frac{L}{D} \right)^2} \right]}$ $F = \frac{9.425}{2.162}$ F = 4.360				

APPENDIX E

Chemical Testing Results



Exova Jones Environmental

Registered Address : Exova (UK) Ltd, Lochend Industrial Estate, Newbridge, Midlothian, EH28 8PL

Unit 3 Deeside Point
Zone 3
Deeside Industrial Park
Deeside
CH5 2UA

Brownfield Solutions Limited
173-183 Witton Street
Northwich
Cheshire
CW9 5LP

Tel: +44 (0) 1244 833780

Fax: +44 (0) 1244 833781



Attention :	John Ball
Date :	22nd November, 2017
Your reference :	C3664
Our reference :	Test Report 17/18799 Batch 1
Location :	Wrexham Police Station
Date samples received :	15th November, 2017
Status :	Final report
Issue :	2

Twenty four samples were received for analysis on 15th November, 2017 of which ten were scheduled for analysis. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied. All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Compiled By:

Bruce Leslie
Project Co-ordinator

Client Name: Brownfield Solutions Limited
Reference: C3664
Location: Wrexham Police Station
Contact: John Ball
JE Job No.: 17/18799

Report : Solid

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

J E Sample No.	1-3	19-21	22	29-31	32-34	44-46	47	51-53	54		Please see attached notes for all abbreviations and acronyms		
Sample ID	WS01	WS03	WS03	WS07	WS07	WS10	WS10	WS12	WS12				
Depth	0.55	0.30	1.50	0.20	1.00	0.40	1.40	0.30	1.90				
COC No / misc													
Containers	V J T	V J T	T	V J T	V J T	V J T	T	V J T	T				
Sample Date	12/11/2017	12/11/2017	12/11/2017	11/11/2017	11/11/2017	11/11/2017	11/11/2017	11/11/2017	11/11/2017				
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil				
Batch Number	1	1	1	1	1	1	1	1	1				
Date of Receipt	15/11/2017	15/11/2017	15/11/2017	15/11/2017	15/11/2017	15/11/2017	15/11/2017	15/11/2017	15/11/2017		LOD/LOR	Units	Method No.
Arsenic #	2.5	6.3	-	5.6	-	7.0	-	8.0	-		<0.5	mg/kg	TM30/PM15
Cadmium #	0.4	0.3	-	0.3	-	0.2	-	0.3	-		<0.1	mg/kg	TM30/PM15
Chromium #	19.7	60.9	-	37.1	-	68.0	-	56.9	-		<0.5	mg/kg	TM30/PM15
Copper #	5	16	-	22	-	19	-	21	-		<1	mg/kg	TM30/PM15
Lead #	9	52	-	68	-	70	-	82	-		<5	mg/kg	TM30/PM15
Mercury #	<0.1	<0.1	-	<0.1	-	<0.1	-	<0.1	-		<0.1	mg/kg	TM30/PM15
Nickel #	5.6	15.0	-	12.0	-	21.0	-	17.8	-		<0.7	mg/kg	TM30/PM15
Selenium #	<1	<1	-	<1	-	<1	-	<1	-		<1	mg/kg	TM30/PM15
Sulphur as S	0.16	0.03	-	0.05	-	0.02	-	0.05	-		<0.01	%	TM30/PM15
Total Sulphate as SO ₄ #	1051	333	-	429	-	250	-	836	-		<50	mg/kg	TM50/PM29
Water Soluble Boron #	0.5	0.4	-	0.9	-	0.3	-	0.8	-		<0.1	mg/kg	TM74/PM32
Zinc #	23	53	-	66	-	78	-	80	-		<5	mg/kg	TM30/PM15
PAH MS													
Naphthalene #	<0.04	<0.04	-	<0.04	-	<0.04	-	<0.04	-		<0.04	mg/kg	TM4/PM8
Acenaphthylene	<0.03	<0.03	-	0.06	-	<0.03	-	<0.03	-		<0.03	mg/kg	TM4/PM8
Acenaphthene #	<0.05	<0.05	-	<0.05	-	<0.05	-	<0.05	-		<0.05	mg/kg	TM4/PM8
Fluorene #	<0.04	<0.04	-	<0.04	-	<0.04	-	<0.04	-		<0.04	mg/kg	TM4/PM8
Phenanthrene #	<0.03	<0.03	-	0.17	-	0.03	-	0.13	-		<0.03	mg/kg	TM4/PM8
Anthracene #	<0.04	<0.04	-	0.06	-	<0.04	-	<0.04	-		<0.04	mg/kg	TM4/PM8
Fluoranthene #	<0.03	0.03	-	0.53	-	0.07	-	0.33	-		<0.03	mg/kg	TM4/PM8
Pyrene #	<0.03	0.03	-	0.52	-	0.06	-	0.29	-		<0.03	mg/kg	TM4/PM8
Benzo(a)anthracene #	<0.06	<0.06	-	0.31	-	<0.06	-	0.21	-		<0.06	mg/kg	TM4/PM8
Chrysene #	<0.02	<0.02	-	0.34	-	0.04	-	0.21	-		<0.02	mg/kg	TM4/PM8
Benzo(bk)fluoranthene #	<0.07	<0.07	-	0.65	-	<0.07	-	0.33	-		<0.07	mg/kg	TM4/PM8
Benzo(a)pyrene #	<0.04	<0.04	-	0.38	-	<0.04	-	0.19	-		<0.04	mg/kg	TM4/PM8
Indeno(123cd)pyrene #	<0.04	<0.04	-	0.26	-	<0.04	-	0.14	-		<0.04	mg/kg	TM4/PM8
Dibenzo(ah)anthracene #	<0.04	<0.04	-	<0.04	-	<0.04	-	<0.04	-		<0.04	mg/kg	TM4/PM8
Benzo(ghi)perylene #	<0.04	<0.04	-	0.25	-	<0.04	-	0.12	-		<0.04	mg/kg	TM4/PM8
PAH 16 Total	<0.6	<0.6	-	3.5	-	<0.6	-	2.0	-		<0.6	mg/kg	TM4/PM8
Benzo(b)fluoranthene	<0.05	<0.05	-	0.47	-	<0.05	-	0.24	-		<0.05	mg/kg	TM4/PM8
Benzo(k)fluoranthene	<0.02	<0.02	-	0.18	-	<0.02	-	0.09	-		<0.02	mg/kg	TM4/PM8
PAH Surrogate % Recovery	100	99	-	104	-	101	-	103	-		<0	%	TM4/PM8
Total Phenols HPLC	<0.15	<0.15	-	<0.15	-	<0.15	-	<0.15	-		<0.15	mg/kg	TM26/PM21
Natural Moisture Content	2.1	9.2	-	10.7	-	10.0	-	7.5	-		<0.1	%	PM4/PM0
Hexavalent Chromium #	<0.3	<0.3	-	<0.3	-	<0.3	-	<0.3	-		<0.3	mg/kg	TM38/PM20
Sulphate as SO ₄ (2:1 Ext) #	-	-	0.0079	-	0.0125	-	0.0024	-	0.0039		<0.0015	g/l	TM38/PM20
Free Cyanide	<0.5	<0.5	-	<0.5	-	<0.5	-	<0.5	-		<0.5	mg/kg	TM89/PM45
Total Cyanide #	<0.5	<0.5	-	<0.5	-	<0.5	-	<0.5	-		<0.5	mg/kg	TM89/PM45

Please include all sections of this report if it is reproduced

Please see attached notes for all abbreviations and acronyms

Client Name: Brownfield Solutions Limited
Reference: C3664
Location: Wrexham Police Station
Contact: John Ball

Note:

Asbestos Screen analysis is carried out in accordance with our documented in-house methods PM042 and TM065 and HSG 248 by Stereo and Polarised Light Microscopy using Dispersion Staining Techniques and is covered by our UKAS accreditation. Detailed Gravimetric Quantification and PCOM Fibre Analysis is carried out in accordance with our documented in-house methods PM042 and TM131 and HSG 248 using Stereo and Polarised Light Microscopy and Phase Contrast Optical Microscopy (PCOM). Samples are retained for not less than 6 months from the date of analysis unless specifically requested.

Opinions, including ACM type and Asbestos level, lie outside the scope of our UKAS accreditation.

Where the sample is not taken by a Jones Environmental Laboratory consultant, Jones Environmental Laboratory cannot be responsible for inaccurate or unrepresentative sampling.

Signed on behalf of Jones Environmental Laboratory:



Ryan Butterworth
 Asbestos Team Leader

J E Job No.	Batch	Sample ID	Depth	J E Sample No.	Date Of Analysis	Analysis	Result
17/18799	1	WS03	0.30	21	15/11/2017	General Description (Bulk Analysis)	Soil/Stone
					15/11/2017	Asbestos Fibres	NAD
					15/11/2017	Asbestos Fibres (2)	NAD
					15/11/2017	Asbestos ACM	NAD
					15/11/2017	Asbestos ACM (2)	NAD
					15/11/2017	Asbestos Type	NAD
					15/11/2017	Asbestos Type (2)	NAD
					15/11/2017	Asbestos Level Screen	NAD
17/18799	1	WS05	0.60	25	15/11/2017	General Description (Bulk Analysis)	Soil/Stone
					15/11/2017	Asbestos Fibres	NAD
					15/11/2017	Asbestos Fibres (2)	NAD
					15/11/2017	Asbestos ACM	NAD
					15/11/2017	Asbestos ACM (2)	NAD
					15/11/2017	Asbestos Type	NAD
					15/11/2017	Asbestos Type (2)	NAD
					15/11/2017	Asbestos Level Screen	NAD
17/18799	1	WS07	0.20	31	15/11/2017	General Description (Bulk Analysis)	Soil/Stone
					15/11/2017	Asbestos Fibres	NAD
					15/11/2017	Asbestos Fibres (2)	NAD
					15/11/2017	Asbestos ACM	NAD
					15/11/2017	Asbestos ACM (2)	NAD
					15/11/2017	Asbestos Type	NAD
					15/11/2017	Asbestos Type (2)	NAD
					15/11/2017	Asbestos Level Screen	NAD
17/18799	1	WS10	0.40	46	15/11/2017	General Description (Bulk Analysis)	Soil/Stone
					15/11/2017	Asbestos Fibres	NAD
					15/11/2017	Asbestos Fibres (2)	NAD
					15/11/2017	Asbestos ACM	NAD
					15/11/2017	Asbestos ACM (2)	NAD
					15/11/2017	Asbestos Type	NAD
					15/11/2017	Asbestos Type (2)	NAD
					15/11/2017	Asbestos Level Screen	NAD
17/18799	1	WS12	0.30	53	15/11/2017	General Description (Bulk Analysis)	Soil/Stone
					15/11/2017	Asbestos Fibres	NAD
					15/11/2017	Asbestos Fibres (2)	NAD

Client Name: Brownfield Solutions Limited
Reference: C3664
Location: Wrexham Police Station
Contact: John Ball

[illegible]

Client Name: Brownfield Solutions Limited

Reference: C3664

Location: Wrexham Police Station

Contact: John Ball

[illegible]

Please note that only samples that are deviating are mentioned in this report. If no samples are listed it is because none were deviating. Only analyses which are accredited are recorded as deviating if set criteria are not met.

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

JE Job No.: 17/18799

SOILS

Please note we are only MCERTS accredited (UK soils only) for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

% Asbestos in Asbestos Containing Materials (ACMs) is determined by reference to HSG 264 The Survey Guide - Appendix 2 : ACMs in buildings listed in order of ease of fibre release.

Negative Neutralization Potential (NP) values are obtained when the volume of NaOH (0.1N) titrated (pH 8.3) is greater than the volume of HCl (1N) to reduce the pH of the sample to 2.0 - 2.5. Any negative NP values are corrected to 0.

The calculation of Pyrite content assumes that all oxidisable sulphides present in the sample are pyrite. This may not be the case. The calculation may be an overestimate when other sulphides such as Barite (Barium Sulphate) are present.

WATERS

Please note we are not a UK Drinking Water Inspectorate (DWI) Approved Laboratory .

ISO17025 accreditation applies to surface water and groundwater and usually one other matrix which is analysis specific, any other liquids are outside our scope of accreditation.

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

DEVIATING SAMPLES

Samples must be received in a condition appropriate to the requested analyses. All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. If this is not the case you will be informed and any test results that may be compromised highlighted on your deviating samples report.

SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

DILUTIONS

A dilution suffix indicates a dilution has been performed and the reported result takes this into account. No further calculation is required.

BLANKS

Where analytes have been found in the blank, the sample will be treated in accordance with our laboratory procedure for dealing with contaminated blanks.

NOTE

Data is only reported if the laboratory is confident that the data is a true reflection of the samples analysed. Data is only reported as accredited when all the requirements of our Quality System have been met. In certain circumstances where all the requirements of the Quality System have not been met, for instance if the associated AQC has failed, the reason is fully investigated and documented. The sample data is then evaluated alongside the other quality control checks performed during analysis to determine its suitability. Following this evaluation, provided the sample results have not been effected, the data is reported but accreditation is removed. It is a UKAS requirement for data not reported as accredited to be considered indicative only, but this does not mean the data is not valid.

Where possible, and if requested, samples will be re-extracted and a revised report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.

REPORTS FROM THE SOUTH AFRICA LABORATORY

Any method number not prefixed with SA has been undertaken in our UK laboratory unless reported as subcontracted.

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ABBREVIATIONS and ACRONYMS USED

#	ISO17025 (UKAS Ref No. 4225) accredited - UK.
SA	ISO17025 (SANAS Ref No.T0729) accredited - South Africa.
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
++	Result outside calibration range, results should be considered as indicative only and are not accredited.
*	Analysis subcontracted to a Jones Environmental approved laboratory.
AD	Samples are dried at 35°C ±5°C
CO	Suspected carry over
LOD/LOR	Limit of Detection (Limit of Reporting) in line with ISO 17025 and MCERTS
ME	Matrix Effect
NFD	No Fibres Detected
BS	AQC Sample
LB	Blank Sample
N	Client Sample
TB	Trip Blank Sample
OC	Outside Calibration Range

JE Job No: 17/18799

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/ANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
PM4	Gravimetric measurement of Natural Moisture Content and % Moisture Content at either 35°C or 105°C. Calculation based on ISO 11465 and BS1377.	PM0	No preparation is required.				
TM4	Modified USEPA 8270 method for the solvent extraction and determination of 16 PAHs by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.			AR	Yes
TM4	Modified USEPA 8270 method for the solvent extraction and determination of 16 PAHs by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.	Yes		AR	Yes
TM26	Determination of phenols by Reversed Phased High Performance Liquid Chromatography and Electro-Chemical Detection.	PM21	As received solid or water samples are extracted in Methanol: Sodium Hydroxide (0.1M NaOH) (60:40) by orbital shaker.			AR	Yes
TM30	Determination of Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry). Modified US EPA Method 200.7, 6010B and BS EN ISO 11885 2009	PM15	Acid digestion of dried and ground solid samples using Aqua Regia refluxed at 112.5 °C. Samples containing asbestos are not dried and ground.			AD	Yes
TM30	Determination of Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry). Modified US EPA Method 200.7, 6010B and BS EN ISO 11885 2009	PM15	Acid digestion of dried and ground solid samples using Aqua Regia refluxed at 112.5 °C. Samples containing asbestos are not dried and ground.	Yes		AD	Yes
TM38	Soluble Ion analysis using the Thermo Aquakem Photometric Automatic Analyser. Modified US EPA methods 325.2, 375.4, 365.2, 353.1, 354.1	PM20	Extraction of dried and ground or as received samples with deionised water in a 2:1 water to solid ratio using a reciprocal shaker for all analytes except hexavalent chromium. Extraction of as received sample using 10:1 ratio of 0.2M sodium hydroxide to soil for hexavalent chromium using a reciprocal shaker.	Yes		AD	Yes
TM38	Soluble Ion analysis using the Thermo Aquakem Photometric Automatic Analyser. Modified US EPA methods 325.2, 375.4, 365.2, 353.1, 354.1	PM20	Extraction of dried and ground or as received samples with deionised water in a 2:1 water to solid ratio using a reciprocal shaker for all analytes except hexavalent chromium. Extraction of as received sample using 10:1 ratio of 0.2M sodium hydroxide to soil for hexavalent chromium using a reciprocal shaker.	Yes		AR	Yes
TM50	Acid soluble sulphate (Total Sulphate) analysed by ICP-OES	PM29	Dried and ground solid sample is boiled with dilute hydrochloric acid, the resulting liquor is then analysed.	Yes		AD	Yes
TM65	Asbestos Bulk Identification method based on HSG 248.	PM42	Solid samples undergo a thorough visual inspection for asbestos fibres prior to asbestos identification using TM065.	Yes		AR	

JE Job No: 17/18799

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/ANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM73	Modified US EPA methods 150.1 and 9045D and BS1377:1990. Determination of pH by Metrohm automated probe analyser.	PM11	Extraction of as received solid samples using one part solid to 2.5 parts deionised water.	Yes		AR	No
TM74	Analysis of water soluble boron (20:1 extract) by ICP-OES.	PM32	Hot water soluble boron is extracted from dried and ground samples using a 20:1 ratio.	Yes		AD	Yes
TM89	Modified USEPA method OIA-1667. Determination of cyanide by Flow Injection Analyser. Where WAD cyanides are required a Ligand displacement step is carried out before analysis.	PM45	As received solid samples are extracted with 1M NaOH by orbital shaker for Cyanide and Thiocyanate analysis.			AR	Yes
TM89	Modified USEPA method OIA-1667. Determination of cyanide by Flow Injection Analyser. Where WAD cyanides are required a Ligand displacement step is carried out before analysis.	PM45	As received solid samples are extracted with 1M NaOH by orbital shaker for Cyanide and Thiocyanate analysis.	Yes		AR	Yes
TM106	Determination of Sulphide by Skalar Continuous Flow Analyser	PM119	As received solid samples are extracted with 1M NaOH by orbital shaker for Sulphide and Thiocyanate analysis.			AR	Yes
TM107	Determination of Thiocyanate by Skalar Continuous Flow Analyser	PM119	As received solid samples are extracted with 1M NaOH by orbital shaker for Sulphide and Thiocyanate analysis.			AR	Yes

APPENDIX F

Ground Gas Monitoring Results

30/11/2017



	Percentage Concentrations				Parts per Million		mb				
Ambient	Oxygen (O₂)	Carbon Dioxide (CO₂)	Methane (CH₄)	LEL	Hydrogen Sulphide (H₂S)	Carbon Monoxide (CO)	Atm Pressure	Monitored by	Equipment	Weather	Pressure Trend
Start	20.9	0.1	ND	ND	ND	NA	1005	JB	GA5000	Clear	Steady
Finish	21.1	0.1	ND	ND	ND	NA	1005				

		Percentage Concentrations				Parts Per Million		m bgl	litres/hour	mb	litres/hour		litres/hour	
Location	State (Peak/Steady)	Oxygen (O ₂)	Carbon Dioxide (CO ₂)	Methane (CH ₄)	LEL	Hydrogen Sulphide (H ₂ S)	Carbon Monoxide (CO)	Water Level	Flow	Relative Pressure	Sheen (Y/N)	Q _{hg} CO ₂	Q _{hg} CH ₄	Notes
WS03	Peak	18.9	2.5	ND	ND	ND	NA	NGW	0.1	-0.2	No	0.00	0.00	
	Steady	19.2	2.5	ND	ND	ND	NA							
WS10	Peak	20.4	0.6	ND	ND	ND	NA	NGW	0.1	-0.3	No	0.00	0.00	
	Steady	20.8	0.2	ND	ND	ND	NA							
WS12	Peak	19.4	2.2	ND	ND	ND	NA	NGW	0.1	-0.3	No	0.00	0.00	
	Steady	20.9	0.2	ND	ND	ND	NA							

APPENDIX G

Contaminated Land Screening Values

Contaminated Land Screening Values

In assessing the potential for contamination Brownfield Solutions Limited (BSL) follows UK guidance and current best practice.

General

The current recommended method for assessing contamination is on the basis of:

Source-Pathway-Receptor

Where any one of these “pollution linkages” is absent there is deemed to be no risk.

Fundamentally receptors can be considered as humans and controlled waters (surface and ground waters).

The purpose of using Tier 1 screening levels is to have a simple means of assessing the potential contamination of a site and to inform decisions on whether further investigation is warranted or whether an option to undertake clean up based on the data to hand is cost effective.

Human Health

Current UK guidance is provided by DEFRA and the Environment Agency (EA). Publications forming part of the guidance include; CLEA Model, toxicological reports and soil guideline values (SGV), collectively referred to as the CLEA Guidance. The CLEA Guidance has included a number of publications which have provided initial screening values for soil contamination based on standard land uses and soil assumptions.

CLEA guidance has gone through a number of revisions, all of the original SGV's that were published have been withdrawn and publication of new SGV's commenced in 2009.

For determinands where no SGVs are available, S4UL values have been published using the CLEA 1.06 Model. These are the third set of generic assessment criteria generated by CIEH, and replace the previous two sets of GACs. The revised S4UL values are based on greater knowledge of relevant toxicology and further consideration of exposure frequencies.

No SGV or S4UL is available for lead as this is derived based on blood lead levels. C4SL values for six determinands including lead was published by DEFRA/CL:AIRE in December 2014 and they represent a low risk as opposed to minimal risk. The C4SL values are based on a sandy loam with 6% Soil Organic Matter. These screening values were published by DEFRA for Part 2A use, although with the dual purpose for use under planning. However these have not been officially accepted by Local Government for use under planning. S4ULs remain the first reference due to the broader range of end uses and soil organic content.

The preference from the EA is that site specific screening levels are used wherever possible. Due to numerous factors it is not always possible to utilise site specific values. In these instances the following data sources are used in the order of preference given below:

- Current UK SGV's
- CIEH S4UL values (derived by CIEH/LQM)
- DEFRA/CL:AIRE C4SL's
- CL:AIRE GAC values
- Guidance from other European countries
- Guidance from the outside Europe.

Controlled Waters

The European Water Framework Directive (WFD) became UK law in December 2003. It was created to ensure that European countries manage their rivers, groundwater and lakes so that they stay healthy for people and for wildlife.

This is achieved by the use of chemical standards for surface waters and groundwater. These values describe concentrations of chemicals that are not expected to cause harm to environmental organisms or human health, provided they are not exceeded. The same chemical may have several standards for different environmental regimes, and for different protection objectives.

Statutory Standards are set in legislation and if exceeded, this constitutes non-compliance with statutory obligations. European Directives are implemented in England and Wales by corresponding statutory instruments (i.e. regulations). The statutory instruments can be the exact same standards as they appear in the Directive or be more stringent.

A number of non-statutory standards also exist, these are set by various organisations (including the EA) for chemicals that are considered to be of concern, but are not covered by any specific legislation.

The chemical standards used in the UK to control impact of contamination on controlled waters are Environmental Quality Standards (EQS). The EQS's cover a large number of compounds.

Where certain compounds are not covered by the EQS these are commonly compared to the UK Drinking Water Standards (DWS).

Further Assessment

When screening values are exceeded then further consideration is required. This could include the use of simple measures to break the pollution pathway and mitigate the risk, further more detailed investigation, including the deriving of site specific values to better define the risk and to design appropriate remedial measures.

APPENDIX H

Ground Gas Guidance

Ground Gas Guidance

Redevelopment on brownfield sites is an ever increasing occurrence, including those sites where a potential ground gas issue is present.

CIRIA C665 is the current guidance which gives up-to-date advice on all aspects of ground gas. It outlines good practice in investigation, the collection of relevant data and monitoring programmes in a risk-based approach to gas contaminated land. Two semi-quantitative methods are set out for the assessment of risk:

- 1 For low rise housing with a ventilated under floor void at minimum 150 mm (Boyle and Witherington);
- 2 For all other development types (Wilson and Card).

Both methods use the concept of Gas Screening Values (GSVs) to identify levels of risk. The mitigation and management of potentially unacceptable risk is described with reference to both passive and active systems of gas. Source removal is also discussed as an option.

CIRIA C665 and the advice it contains has been prepared to be generally consistent with CLR11 *Model Procedures for the management of land contamination* (Defra and Environment Agency, 2004a). The aim of CIRIA C665 is a consistent approach to decision making, particularly relating to the scope of protective design measures on a site specific basis.

Legislative Framework

CIRIA C665 provides technical guidance however also recognises the context into which the guidance has to be employed. Government policy is based upon a “suitable for use approach”, which is relevant to both the current and proposed future use of land. When considering the current use of land, Part IIA of the Environment Protection Act 1990 provides the regulatory regime. The presence of hazardous ground gases could provide the “source” in a “pollutant linkage” which could lead the regulator to determine that considerable harm or there is a significant possibility of such harm being caused. Under such circumstances, the regulator would determine the land to be “contaminated land” under the provisions of the Act, setting out the process of remediation as described in the DETR Circular 02/2000 *Statutory guidance on contaminated land* (DETR, 2000a).

Frequency and Duration of Monitoring

The monitoring period for a specific site covers the “worst case” scenario. A “worst case” scenario will occur during falling atmospheric pressure and, in particular, weather conditions such as rainfall, frost and dry weather.

The benefits of the additional information and whether it is likely to change the scope of gas protection should be considered, as are the consequences of failing to characterise adequately pollutant linkages. Investigations concerned with soil gas are required to provide monitoring data sufficient to allow prediction of worst case conditions enabling the confident assessment of risk and subsequent design of appropriate gas protection schemes. Monitoring programmes should not be an academic exercise in data collection.

Below are matrices that will aid in determining an appropriate number of gas monitoring visits and the length of monitoring period.

Typical/idealised periods of monitoring

		Generation of Potential Source				
		Very Low	Low	Moderate	High	Very High
Sensitivity of Development	Low (Commercial)	1 month	2 months	3 months	6 months	12 months
	Moderate (Flats)	2 months	3 months	6 months	12 months	24 months
	High (Residential with Gardens)	3 months	6 months	6 months	12 months	24 months

Typical/idealised frequency of monitoring

		Generation of Potential Source				
		Very Low	Low	Moderate	High	Very High
Sensitivity of Development	Low (Commercial)	4	6	6	12	12
	Moderate (Flats)	6	6	9	12	24
	High (Residential with Gardens)	6	9	12	24	24

Note

- 1 NHBC guidance also recommends this period of monitoring (Boyle and Witherington, 2007).
- 2 There is no industry consent over "high", "medium" or "low" generation potential of source.
- 3 At least two sets of readings should be at low and falling atmospheric pressure (but not restricted to periods below <1000 mb) known as worst case conditions. Historical data can be used as part of the data set (Table 5.5b).

It is recommended that newly installed monitoring wells are left for 24 hours to allow the soil gas to reach equilibrium. It should be recognised, however, that some soil gas regimes could take considerably longer (up to seven days). Interpretation of any initial readings should take this equilibrium process into account.

APPENDIX I
Contaminated Land Legislative Background

Environmental liabilities and risks have been evaluated in terms of a source -pathway - target relationship in accordance with the approach set out in:

- The 1995 Environment Act;
- The Contaminated Land (England) Regulations 2000;
- The DETR circular 02/2000 Environmental Protection Act 1990: Part IIA Contaminated Land.

Contaminated land is defined within the legislative framework as land which is in such condition by reason of substances in, on or under the land that:

- 1) Significant harm is being caused or there is a significant possibility of such harm being caused;
- 2) Significant pollution of controlled waters is being or is likely to be caused.

The potential for harm is based on the presence of three factors:

- **Source** - substances that are potential contaminants or pollutants that may cause harm;
- **Pathway** - a potential route by which contaminants can move from the source to the receptor;
- **Receptor** - a receptor that may be harmed, for example the water environment, humans and water.

Where a source, pathway and target are all present a pollutant linkage exists and there is potential for harm to be caused. The presence of a source does not automatically imply that a contamination problem exists, since contamination must be defined in terms of pollutant linkages and unacceptable risk of harm. The nature and importance of both pathways and receptors are site specific and will vary according to the intended end use of the site, its characteristics and its surroundings.

The key principle which supports the SPR approach is 'suitable for use' criteria. This requires remedial action only where contamination is considered to pose unacceptable actual or potential risks to health or the environment and, taking into account the proposed use of the site.

Relevant Guidance Documents

This report has been prepared in accordance with the list of guidance below however the list is not exhaustive:

- CLR11 – Model Procedures;
- Contamination and Environmental Matters - Their implications for Property Professionals (2nd Edition RICS Nov 2003);
- Brownfields – Managing the development of previously developed land – A client's guide, CIRIA 2002;
- DEFRA and Environment Agency publications CLR7 – 10, supported by the TOX guides and SGV guides, dated March 2002;
- DETR Circular 02/2000, Contaminated Land: Implementation of Part IIA of the Environmental Protection Act 1990;
- Environment Agency technical advice to third parties on Pollution of Controlled Waters for Part IIA of the EPA1990, May 2002;

Relevant Legislative Documents

The following is a non-exhaustive list of legislative framework documents that has been considered in the production of this report:

- The Environment Act (1995);
- The Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance (2012);
- The Environment Protection Act (1990);
- The Contaminated Land (England) Act (2000);
- Contaminated Land (England) Regulations (2012);
- The Water Resources Act (1991);
- The Pollution Prevention and Control (England and Wales) Regulations (2000);
- The Landfill Regulations (England and Wales) Regulations (2002);
- The Landfill (England and Wales) (Amendment) Regulations (2004);
- Health and Safety at Work Act;

APPENDIX J
CIRIA Risk Assessment Methodology

Contaminated Land Risk Assessment

Contaminated Land Risk Assessment is a technique that identifies and considers the associated risk, determines whether the risks are significant and whether action needs to be taken. The four main stages of risk assessment are:

Hazard Identification ➡ Hazard Assessment ➡ Risk Estimation ➡ Risk Evaluation

CLR11 outlines the framework to be followed for risk assessment in the UK. The framework is designed to be consistent with UK legislation and policies including planning. The starting point of the risk assessment is to identify the context of the problem and the objectives of the process. Under CLR11, three tiers of risk assessment exist - Preliminary, Generic Quantitative and Detailed Quantitative.

Formulating and developing a conceptual model for the site is an important requirement of risk assessment, this supports the identification and assessment of pollutant linkages. Development of the conceptual model forms the main part of preliminary risk assessment, and the model is subsequently refined or revised as more information and understanding is obtained through the risk assessment process.

Risk is a combination of the likelihood of an event occurring and the magnitude of its consequences. Therefore, both the likelihood and the consequences of an event must be taken into account when assessing risk.

The risk assessment process needs to take into account the degree of confidence required in decisions. Identification of uncertainties is an essential step in risk assessment.

The likelihood of an event is classified on a four-point system using the following terms and definitions from CIRIA C552:

- **High likelihood:** There is a pollution linkage and an event appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution;
- **Likely:** There is a pollution linkage and all the elements are present and in the right place, which means it is probable that an event will occur. Circumstances are such that the event is not inevitable, but possible in the short term and likely over the long term;
- **Low likelihood:** There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain even over a longer period such event would take place, and is less likely in the short term;
- **Unlikely:** There is a pollution linkage but circumstances are such that it is improbable the event would occur even in the long term.

The severity is also classified using a system based on CIRIA C552. The terms and definitions are:

- **Severe:** Short term (acute) risk to human health likely to result in 'significant harm' as defined by the Environment Protection Act 1990, Part IIA. Short-term risk of pollution of sensitive water resources. Catastrophic damage to buildings or property. A short-term risk to a particular ecosystem or organism forming part of that ecosystem (note definition of ecosystem in 'Draft Circular on Contaminated Land', DETR 2000);
Examples – High concentrations of contaminant on surface of recreation area, major spillage of contaminants from site into controlled waters, explosion causing building to collapse;
- **Medium:** Chronic damage to human health ('significant harm' as defined in DETR 2000). Pollution of sensitive water resources. A significant change in a particular ecosystem or organism forming part of that ecosystem (note definition of ecosystem in 'Draft Circular on Contaminated Land', DETR 2000);
Examples - Concentrations of contaminants exceed the generic assessment criteria, leaching of contaminants from a site to a Principal or Secondary Aquifer, death of species within a designated nature reserve;
- **Mild:** Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services ('significant harm' as defined in 'Draft Circular on Contaminated Land', DETR 2000). Damage to sensitive buildings, structures, services or the environment;
Examples – Pollution of non-classified groundwater or damage to buildings rendering it unsafe to occupy.
- **Minor:** harm, not necessarily significant harm, which may result in financial loss or expenditure to resolve. Non-permanent health effects to human health (easily prevented by use of personal protective clothing etc). Easily repairable effects of damage to buildings, structures and services.
Examples – Presence of contaminants at such concentrations PPE is required during site work, loss of plants in landscaping scheme or discolouration of concrete.

Once the likelihood and severity have been determined, a risk category can be assigned using the table below.

		Consequences			
		Severe	Medium	Mild	Minor
Probability	Highly likely	Very high	High	Moderate	Moderate/low
	Likely	High	Moderate	Moderate/low	Low
	Low likelihood	Moderate	Moderate/low	Low	Very low
	Unlikely	Moderate/low	Low	Very Low	Very low

Definitions of the risk categories obtained from the above table are as follows together with an assessment of the further work that might be required:

- **Very high:** There is a high probability that severe harm could arise to a designated receptor from an identified hazard or there is evidence that severe harm is currently happening. This risk, if realised, could result in substantial liability. Urgent investigation and remediation are likely to be required;
- **High:** Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation is required and remedial works may be necessary in the short term and are likely over the longer term;
- **Moderate:** It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it would be more likely to be relatively mild. Investigation is normally required to clarify the risk and determine the liability. Some remedial works may be required in the longer term;
- **Low:** It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild;
- **Very Low:** There is a low possibility that harm could arise to a receptor. In the event of such harm being realised, it is not likely to be severe.

**APPENDIX K
Guidance Notes**

WASTE CLASSIFICATION FOR SOILS

Introduction

Waste producers have a duty of care classify the waste they are producing:

- before it is collected, disposed of or recovered.
- to identify the controls that apply to the movement of the waste.
- to complete waste documents and records.
- to identify suitably authorised waste management options.
- to prevent harm to people and the environment.

The most sustainable and economic method of dealing with waste soil is usually the retention and re-use on site. Where this is not possible there are three main options for the disposal of soils:

1. Disposal to a permitted waste recycling facility.
2. Re-use on another site (subject to the suitability).
3. Disposal to a landfill site.

The disposal to a permitted facility will be subject to the **specific conditions of the permits for each of individual facility** and will vary dependent on location and environmental sensitivity of the receiving site. Re-use on another site will also be subject to the acceptability criteria of that site.

The guidance below relates to disposal to landfill sites only.

Background for Landfill Disposal

In July 2005 the United Kingdom implemented the European Directive 1999/31/EC (The Landfill Directive), this introduced the current regime for waste and waste disposal to landfill. The Landfill Directive places controls on waste disposal. These controls include requirements to follow the waste acceptance procedures and criteria that have been agreed by the Council of the European Union and are laid out in Council Decision 2003/33/EC.

Before a waste can be accepted at a landfill site, the landfill **operator** must be satisfied that the waste meets his permit conditions, the waste acceptance procedures (WAP) and waste acceptance criteria (WAC).

If disposal to landfill is the best management option for the waste soils, these procedures **must** be followed or the operator may refuse to accept the waste.

Key Points

- Not all waste can be landfilled
- Landfills are classified according to whether they can accept **hazardous**, **non-hazardous** or **inert** wastes.
- Wastes can only be accepted at a landfill if they meet the waste acceptance criteria (WAC) for that class of landfill.
- Most wastes must be treated before you can send them to landfill.
- There are formal processes for identifying and checking wastes that must be followed before wastes can be accepted at a landfill site.

Classification

Wastes are listed in the European Waste Catalogue (EWC 2002) and grouped according to generic industry, process or waste types. Wastes within the EWC are either hazardous or non-hazardous. Some of these wastes are hazardous without further assessment (absolute entries) or are 'mirror' entries that require further assessment of their hazardous properties in order to determine whether they are hazardous waste.

Waste soil has mirror entries on the EWC and as such the first phase of the waste classification process is that of determining if the waste is hazardous or not ie the hazard assessment. The most common EWC waste codes related to soil are:

17 05	soil (including excavated soil from contaminated sites), stones and dredging spoil
17 05 03*	soil and stones containing dangerous substances
17 05 04	soil and stones other than those mentioned in 17 05 03

Soils may contain certain contaminants (eg asbestos, diesel) which have prescribed concentration thresholds, that if breached will render the material hazardous waste. These are based on “risk phrases” which can include risks such as carcinogenicity, flammability or toxicity.

In the first instance the concentrations of plausible contaminants within the soil should be identified and wastes should be **classified based on their total concentrations**.

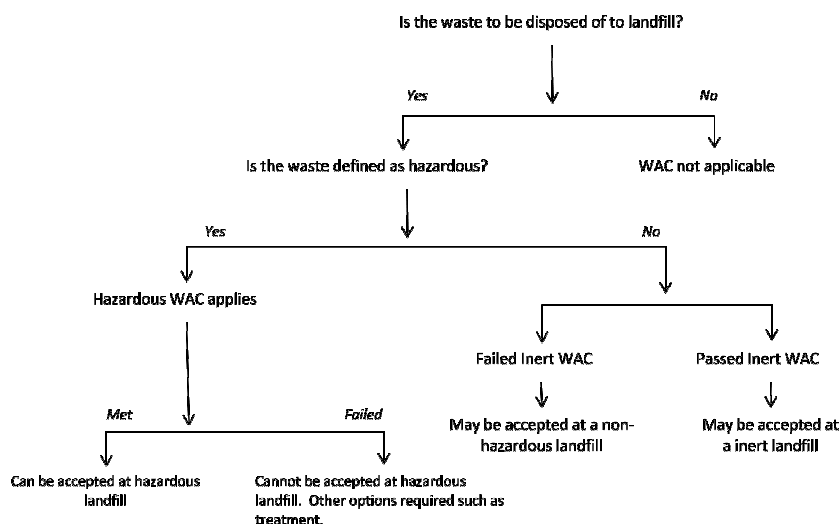
Waste Definitions

Inert	- Will not undergo any significant physical, chemical or biological transformations. - Will not dissolve. - Will not burn. - Will not physically or chemically react. - Will not biodegrade. - Will not adversely affect other matter with which it comes into contact in a way likely to give rise to environmental pollution or harm to human health. - Has insignificant total leachability and pollutant content. - Produces a leachate with an ecotoxicity that is insignificant (if it produces leachate).
Non-Hazardous	Is not inert (see above) Is not hazardous (see below)
Hazardous	Soil has hazardous properties as defined in WM3 (.Guidance on the classification and assessment of waste (1st edition 2015)- Technical Guidance)
Stable Non-reactive hazardous waste [#]	Hazardous waste, the leaching behaviour of which will not change adversely in the long-term, under landfill design conditions or foreseeable accidents: in the waste alone (for example, by biodegradation); under the impact of long-term ambient conditions (for example, water, air, temperature or mechanical constraints); by the impact of other wastes (including waste products such as leachate and gas)

This option allows hazardous waste that has been stabilised and thus has a low leaching potential to be deposited in cells with a standard of containment consistent with non-hazardous wastes.

WAC Testing

The purpose of WAC analysis is to confirm that the waste complies with the relevant WAC for the receiving landfill. The WAC limits **cannot be used to make an assessment of whether a waste is hazardous**. WAC testing does however define if a non-hazardous waste is suitable for an inert landfill.



Hydrocarbons in Soils

WM3 uses the term Oil or Waste Oil to cover hydrocarbons products such as fuel oil, petrol or diesel. These are defined by WM3 as hazardous under an absolute entry in the List of Wastes. However hydrocarbons in soils are a mixture rather than a pure product and absolute entries are not relevant.

Known Oils

The simplest scenario is where the identity of the contaminating oil is known, or can be identified. If the oil is known the manufacturer's or supplier's REACH compliant safety data sheet for the specific oil can be obtained and the hazard statement codes on that Safety Data Sheet can be used for the hazardous waste assessment.

Where the identity of the oil can only be identified down to a petroleum group level (i.e. the contaminating oil is known to be diesel, but the specific type/brand is unknown), then the classification of that petroleum group should be used in the assessment. The marker compounds associated with that petroleum group may be used to confirm carcinogenicity.

Oils may contain a range of hydrocarbons, so the presence of for instance Diesel Range Organics (DRO) does not enable the assessor to conclude that diesel is present. These hydrocarbons may have arisen from other oils, the laboratory needs to provide an interpretation that the chromatograph is consistent with diesel or weathered diesel as a whole.

The concentration of known oils should be determined using a method that as a minimum spans the range in which the carbon numbers for that known oil fall.

Unknown Oils

Where hydrocarbons are contaminating soils it is likely that the oil will be unknown or cannot be determined.

WM3 states that:

For contaminated land specific consideration must be given to the following before proceeding;

- The presence of other organic contaminants, for example solvents or coal tar that could be detected as hydrocarbons. Coal Tar is not an oil and is considered separately in example 2. Where the site history or investigation indicates the presence of hydrocarbons from oil and other sources (e.g. coal tar), and the origin of the hydrocarbons cannot reliably be assigned to either, then a worst case approach of considering the hydrocarbons both as, waste oil (in accordance with this example) and from other sources, for example coal tar should be taken.
- The presence of diesel, or weathered diesel, should be specifically considered by the laboratory and where this is confirmed by the hydrocarbon profile the oil should be assessed as a known or identified oil (diesel).

The use of marker compounds is optional; however it is recommended that where possible the marker compounds should be used.

WM3 states:

If the identity of the oil is unknown, and the petroleum group cannot be established, then the oil contaminating the waste can be classified as non-carcinogenic/mutagenic due to the presence of oil if all three of the following criteria are met:

- The waste contains benzo[a]pyrene (BaP) at a concentration of less than 0.01% (1/10,000th) of the TPH concentration (This is the carcinogenic limit specified in table 3.1 of the CLP for BaP)
- This has been determined by an appropriate and representative sampling approach in accordance with the principles set out in Appendix D, and
- The analysis clearly demonstrates, for example by carbon bands or chromatograph, and the laboratory has reasonably concluded that the hydrocarbons present have not arisen from petrol or diesel.

For example:

TPH Concentration (mg/kg)	Petrol or Diesel	BaP (mg/kg)	Classification
10,000	No	0.9	Non- Hazardous
1,000	No	Not available	Hazardous
1,000	Yes	Not relevant	Hazardous

References

1. Environmental Permitting (England and Wales) Regulations 2010 (as amended) (EP Regulations), the Landfill Directive (1999/31/EC) and the Council Decision (2003/33/EC).
2. Environment Agency Environmental Permitting Regulations: *"Inert Waste Guidance- Standards and Measures for the Deposit of Inert Waste on Land"* 2009.
3. Environment Agency *"Waste acceptance at landfills - Guidance on waste acceptance procedures and criteria"* Nov 2010.
4. Environment Agency *"Guidance on the classification and assessment of waste (Technical Guidance WM3)"* 1st edition May 2015.
5. Classification, Labelling and Packaging of Substances Regulation (EC 1272/2008) (CLP).

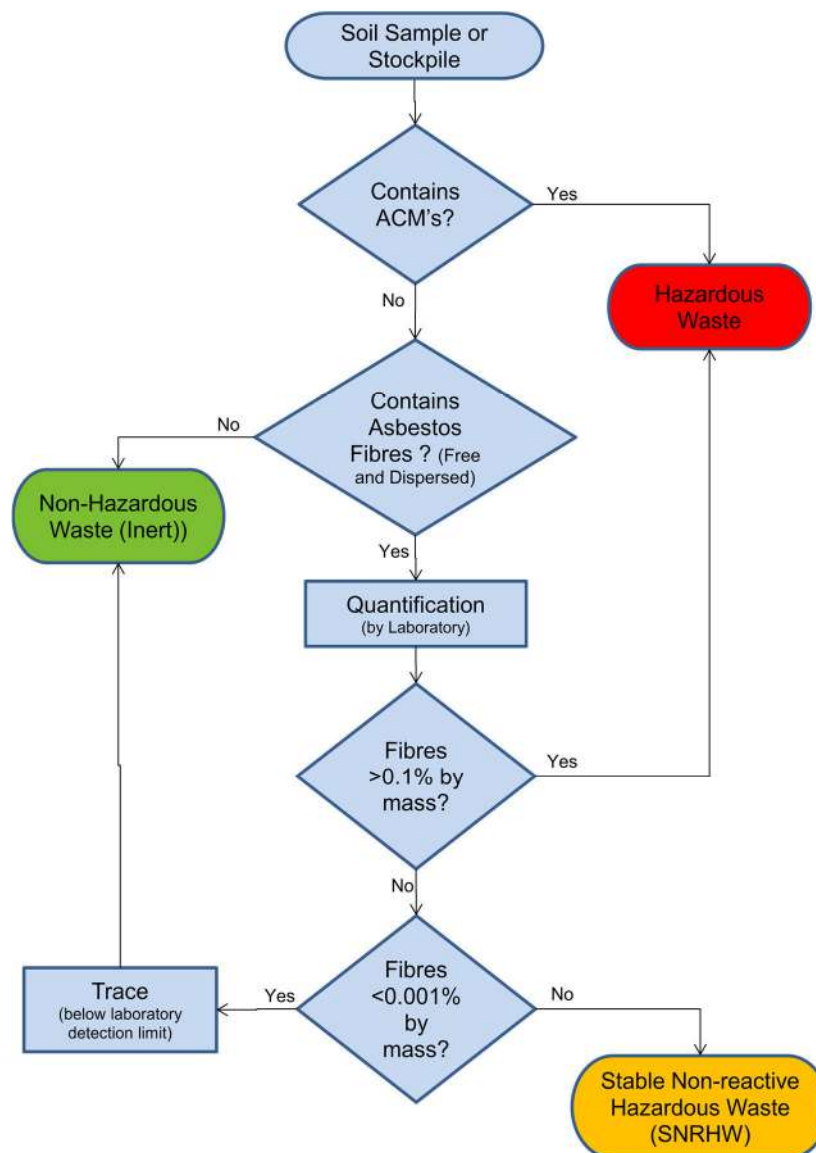
ADDITIONAL ASBESTOS GUIDANCE NOTE

Disposal

The 1st Edition of WM3 “Guidance on the classification and assessment of waste” published in May 2015, details the way in which Asbestos is assessed within soils.

The assessment of asbestos containing waste is dependent on whether the asbestos is present as:

- Fibres that are free and dispersed, or
- Identifiable pieces of asbestos containing materials (ACM's)



Identifiable pieces of asbestos are any particle of a size that can be identified as potentially being asbestos by a competent person if examined by the naked eye. The result is that commonly soils with visible ACM's are sorted and the ACM's removed by hand picking and separate disposal.

Asbestos concentrations below 0.001% by mass are below standard laboratory detection limits and are not currently regarded as containing asbestos for the purposes of disposal and may be disposed of to an inert landfill site¹. These levels are often termed “trace” by laboratories.

Asbestos concentrations between 0.001% and 0.1% are stable non-reactive hazardous waste (SNRHW)¹. Waste transfer stations where soil recycling takes place may be able to take SNRHW, but are unlikely to take soils containing asbestos above trace concentrations.

The following codes should be assigned to the asbestos waste as appropriate:

17 06	Insulation materials and asbestos-containing construction materials
17 06 01	Insulation materials containing asbestos
17 06 03	Other insulation materials consisting of or containing hazardous substances
17 06 04	Insulation materials other than those mentioned in 17 06 01 and 17 06 03
17 06 05	Construction material containing asbestos

WM3 indicates that 17 06 05 would normally be used in preference to 17 06 01 for the asbestos in asbestos contaminated soil and stones.

Construction materials containing asbestos and “*other suitable materials*” may be landfilled at landfills for non-hazardous waste in accordance with the Landfill Directive without testing.

This means that wastes that are only hazardous because of their asbestos content can be disposed of at landfills for non-hazardous waste in separate landfill cells that only accept asbestos wastes and other suitable materials. The Landfill Directive requires that stable non-reactive hazardous waste shall not be deposited with biodegradable waste (for example organic material, household waste, paper etc..) and must meet the waste acceptance criteria set out in accordance with Annex II.

Construction

Health and Safety Executive (HSE) guidance on asbestos is not directly related to soil and much of the guidance focuses on the removal of asbestos from buildings. The overarching legislation is the Control of Asbestos Regulation (CAR 2012). However where work involves (or is likely to involve) contact with asbestos then CAR 2012 requires a risk assessment including whether or not the work is licensed or notifiable non-licensed work and may require an Asbestos Management Plan. Work becomes notifiable if it is considered that the control limit could be exceeded.

Brownfield sites frequently have soils that contain asbestos and the presence of asbestos needs to be considered within the context of construction, particularly in relation to groundworks. The exposure of soils and the use of excavators and plant to move soil around increases the possibility of fibres becoming airborne. However it is good site practice to not generate dusts and to employ dust suppression on all sites regardless of the presence of asbestos.

The legal control limit for asbestos is 0.1f/ml over a continuous four hour period. The control limit is not a ‘safe’ level and exposure from work activities involving asbestos must be reduced to as far below the control limit as possible.

Clearly the higher the concentrations in the soil the greater potential there is for fibres to be released, however IOM publication TM/88/14 “the release of dispersed asbestos fibres from soil” 1988 concludes that:

- Mixtures of asbestos in dry soils with asbestos content as low as 0.001% can produce airborne respirable asbestos concentrations greater than 0.1f/ml in dust clouds where the respirable dust concentrations are less than 5mg/m³.
- An action limit is recommended of no higher than 0.001% asbestos in soils above which steps should be taken to minimise exposure to airborne fibres (eg by wetting).

- The addition of relatively small quantities (10%) of water can reduce the airborne fibre concentrations by an order of magnitude.

Where asbestos has been identified at concentrations above 0.001% as free and dispersed fibres in the soil precautions need to be adopted. Concentrations below this are considered to be normal background, although good site practice dictates that the generation of dusts should be avoided and therefore any fugitive fibre release from minor concentrations should be kept to a practical minimum.

End Use

The use of materials containing asbestos and material containing asbestos is prohibited under EU legislation. There is currently a Joint Industry Working Group (JIWG) tasked with producing a Code of Practice for Asbestos in Soil, Made Ground and Construction & Demolition Material that will clarify in due course the position of the various government agencies.

Asbestos containing materials can remain in situ under a suitable cover system which may be hardsurfacing or soft landscaping (with or without hard dig layers and markers).

There is a risk that future maintenance may compromise such systems and details of the presence of asbestos should be kept in the Health and Safety File.

Preliminary publications from JIWG (April 2015) provide guides for decision making in relation to construction. These are at a "Beta" test stage and further publications will be provided in due course.

The re-use of waste soils should be undertaken in accordance with the CL:AIRE Code of Practice and is subject to suitable risk assessments demonstrating low risk. There is nothing that specifically excludes the re-use of soils containing asbestos as fill to raise levels. However the movement of materials increases the risk of fibres becoming airborne and suitable precautions will be required.

The re-use of soils containing asbestos at concentrations above hazardous waste levels is likely to meet with regulatory opposition. Assuming a suitable strategy could be agreed this would take a considerable amount of time and is only likely to be feasible where there is a long program for implementation.

1 – This is based on asbestos concentration only and consideration of other hazardous substances needs to be made and this may affect the classification of the waste.

Asbestos in Soil as Free Fibres

Concentration (by weight)	Waste Disposal				Construction Issues	End Use	
	Recycle	Inert	SNR Hazardous	Hazardous		Suitable for re-use on site	Precautions
Not detected	✓	✓			No precautions necessary, however on a brownfield site asbestos not previously identified may be found during works and a statement within the contractors method statement for how they will deal with this unforeseen asbestos would be good practice to ensure compliance with CAR2012.	Yes	None
Trace (<0.001%)		✓ ²			Precautions are unlikely to be required, however a detailed method statement may be required to ensure compliance with CAR2012. Basic asbestos management good practice will be required. Typically precautions would include: - Ensuring soils do not dry out to become dusty. - Site personnel have the risk communicated at induction stage.	Yes Soils can be re-used under CL:AIRE CoP with the correct precautions in place.	Generally clean cover or hardstanding cover required.
0.001% – 0.099%			✓		Contractor needs to produce an Asbestos Management Plan in accordance with CAR2012 as part of their method statement. Typical precautions would include: - Site personnel have the risk communicated at induction stage. - Ensuring personnel have suitable training. - Task monitoring to inform PPE requirements. - Ensuring soils do not dry out to become dusty and that misting is available during groundworks. - Separate stockpiling. - Clean haulage routes.	Possibly Soils may be able to be re-used under CL:AIRE CoP, subject to a satisfactory Risk Assessment and regulatory agreement with the correct precautions in place.	Clean cover or hardstanding cover required.
0.1+%				✓	Contractor needs to produce an Asbestos Management Plan in accordance with CAR2012 as part of their method statement. Typical precautions would include: - Site personnel have the risk communicated at induction stage. - Ensuring personnel have suitable training. - Task monitoring to inform PPE requirements. - Site wide and or perimeter monitoring. - Ensuring soils do not dry out to become dusty and that misting is available during groundworks. - Separate stockpiling. - Clean haulage routes. - Decontamination unit	Unlikely ³ Re-use of soils containing asbestos within an earthworks scheme will involve significant engineering and the risk for generating dusts will be significantly increased with repeated handling and compaction.	Clean cover and a hard dig layer. A plan should be in place for future excavations as part of the Health and Safety File.

- 2 The standard laboratory detection limit is normally 0.001%. Below 0.001% is trace and currently regarded as not containing asbestos for the purposes of disposal off site. However the waste producer has a duty to fully classify the waste and the presence of trace asbestos should be declared. Consequently it is unlikely that a waste treatment site will take this soil and an inert landfill may make a commercial decision to only take it under some circumstances.
- 3 The re-use of soils containing asbestos at concentrations above hazardous waste is likely to meet with regulatory opposition. Assuming a suitable strategy could be agreed this would take a considerable amount of time and is only likely to be warranted where there a long program for implementation.

APPENDIX L

Limitations

Standard Limitations

This desk study report was conducted and has been prepared for the sole internal use and reliance of the Client, Lidl UK GMBH. This report shall not be relied upon or transferred to any other parties without the express written authorisation of BSL. If an unauthorised third party comes into possession of this report they rely on it at their risk and the authors owe them no duty of care or skill.

The findings and opinions conveyed via the desk study are based on information obtained from a variety of sources as detailed within this report, which BSL believes are reliable. Nevertheless, BSL cannot and does not guarantee the authenticity or reliability of the information it has relied upon.

Any recommendations made in this report should be confirmed with the Regulatory bodies and Planning Authority prior to implementation to ensure compliance.

No existing manhole covers were lifted or drainage runs inspected during the course of this ground investigation.

The site plans enclosed in this report should not be scaled off.