

TerraConsult

November 2019
Report 4738L001-1 Issue 1

FORMER ENGLISH MARTYRS TENNIS CLUB, ALNESS ROAD, MANCHESTER

REMEDIATION STRATEGY & VERIFICATION PLAN

Carried out for: **MAI CONSTRUCTION**

FORMER ENGLISH MARTYRS TENNIS CLUB, ALNESS ROAD, MANCHESTER, M16 8HW

REMEDIATION STRATEGY & VERIFICATION PLAN

Date: 05/11/2019

Report 4738L001-1 Issue 1

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DOCUMENT INFORMATION AND CONTROL SHEET

Document Status and Approval Schedule

Report No.	Title
4738/01	**FORMER ENGLISH MARTYRS TENNIS CLUB, ALNESS ROAD, MANCHESTER, M16 8HW** **REMEDIATION STRATEGY & VERIFICATION PLAN**

Issue History

Issue	Status	Date	Contributors	Signature	Date
1	For use	**05/11/2019**	**Prepared By:** D Kennedy	D Kennedy	**04/11/2019**
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DISCLAIMER

This report should be read with the Service Constraints Report Limitations & Planning Requirements set out in Appendix A.

bsi. ISO 9001 Quality Management FS573193

bsi. ISO 14001 Environmental Management EMS573194

FORMER ENGLISH MARTYRS TENNIS CLUB, ALNESS ROAD, MANCHESTER, M16 8HW

REMEDIATION STRATEGY & VERIFICATION PLAN

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FORMER ENGLISH MARTYRS TENNIS CLUB, ALNESS ROAD, MANCHESTER

REMEDIATION STRATEGY & VERIFICATION PLAN

1. INTRODUCTION

1.1 Background Information

1.1.1 TerraConsult Limited was commissioned by MAI Construction Limited to prepare out a Remedial Strategy and Verification Plan for the redevelopment of the former English Martyrs Tennis Club located off Alness Road, Manchester. The early sections of this report additionally include a formal contamination assessment on the geo-environmental information obtained as part of a recent intrusive investigation undertaken in order to better define the remediation requirements.

1.1.2 This report has been devised to generally comply with the relevant principles and requirements of a range of guidance including:

- Part IIA of the Environment Protection Act, 1990;
- Contaminated Land (England) (Amendment) Regulations 2012 and Contaminated Land Statutory Guidance (DEFRA, April 2012);
- National Planning Policy Framework (HCA, February 2019);
- BS5930:2015: “Code of practice for site investigations”;
- BS10175: 2011 +A2:2017 “Investigation of Potentially Contaminated Sites - Code of Practice”;
- The Building Regulations 2010. Part C (HM Government 2013)
- DEFRA/Environment Agency (2004) Report CLR11 “Model Procedures for the Management of Land Contamination”;
- Environment Agency (2011) Report GPLC1 “Guiding Principles for Land Contamination”; and,
- Environment Agency (2017) “The Environment Agency’s Approach to Groundwater Protection” November 2017 Version 1.1.

1.1.3 TerraConsult’s service constraints and report limitations are presented in Appendix A and a description of environmental risk assessment methodology and terminology is presented in Appendix B.

1.2. Development Proposals

1.2.1 The proposed development of the site is understood to comprise the following:

- Construction of 4 plots for residential housing with private gardens; and,
- With associated car parking, access drive and grassed areas.

1.2.2 The proposed site layout is shown in Figure 1.

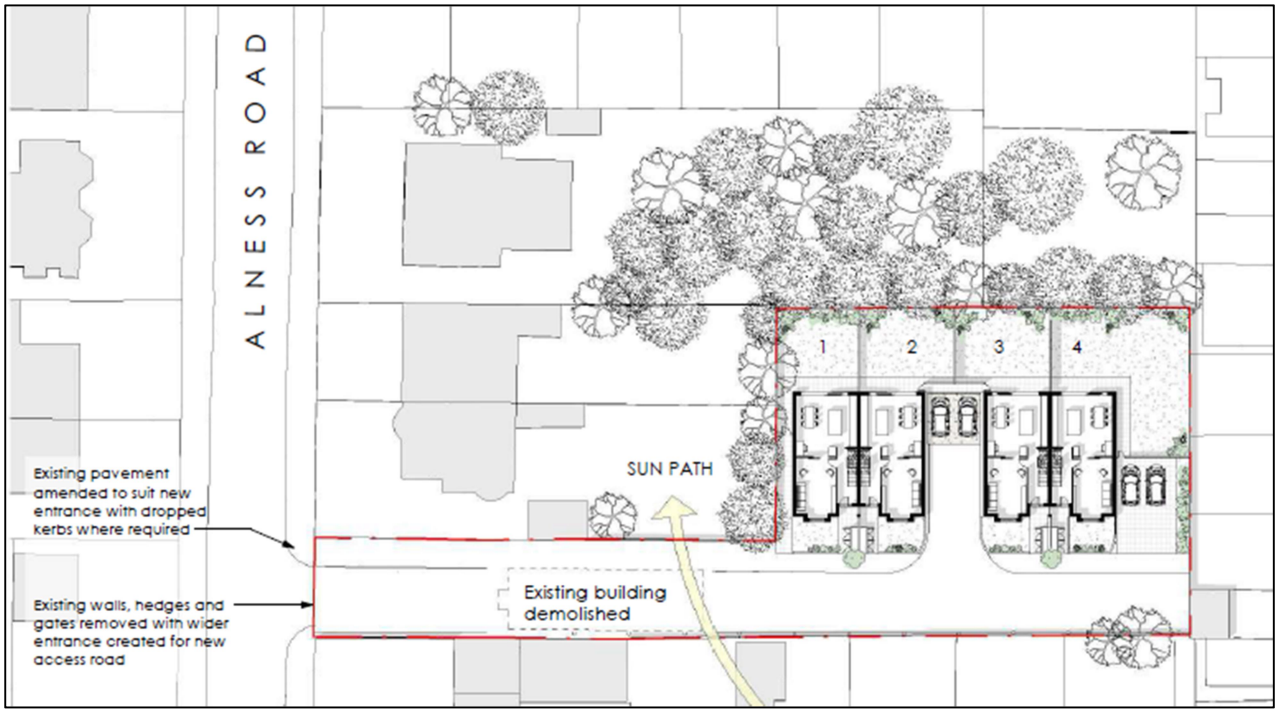

Figure 1: Proposed Development Site Layout Plan (as provided by the Client)

1.2.3 The findings and conclusions of the risk assessments have been set out and recommendations given for the proposed residential end use with plant uptake. If there is a subsequent change in the proposed land the risk assessments and conclusions should be reviewed to determine whether they are still applicable for the revised end use.

1.3. Planning Status & Requirements

1.3.1 This report is designed to comply with the requirements of The National Planning Policy Framework (NPPF, 2019) and is intended to be used by the Developer as part of the submission to gain planning for the works.

1.3.2 This report is also designed to aid the discharge of Planning Condition 5 of application number 121945/FO/2018.

1.4 Scope of the Investigation

1.4.1 The scope of the investigation was to meet the requirements to provide information for planning purposes and for design of the development. The specific activities carried out are as follows:

- assess the general nature and extent of ground conditions and contamination at the site and carry out a contamination risk assessment to determine if the site poses a risk to potential receptors;
- provide an update of the previous recommendations of feasible remedial measures (a Remediation Strategy) to facilitate development of the site;
- include in the Remediation Strategy a contingency plan for dealing with any unexpected contamination; and,
- provide a Verification Plan.

1.5. Previous Investigations

1.5.1 This report should be read in conjunction with the following two reports prepared for the site previously:

- Phase 1 desk based study. ref: Earth A3184/19 Phase 1 – September 2019; carried out by Earth Environmental for MAI Construction;
- Phase 2: provision of factual information relating to BRE 365 soakaways, CBRs, trial pits and WAC testing– October 2019; carried out by TerraConsult Ltd for MAI Construction.

2. SITE LOCATION AND DESCRIPTION

2.1 Site Location

2.1.1 The site is indicated in Figure 2 below and the site location is summarised in Table 1:

Table 1: Site Location	
Location	Approximately 2 miles south of Manchester city centre.
Grid Reference	383248, 394451
Postcode	M16 8HW
Site Area	0.17ha (approx.)
Site Shape	The site is roughly rectangular in shape, with a spur (access way) extending to Alness Road.
Topography	The ground elevation is approximately 29m AOD. The site is flat.

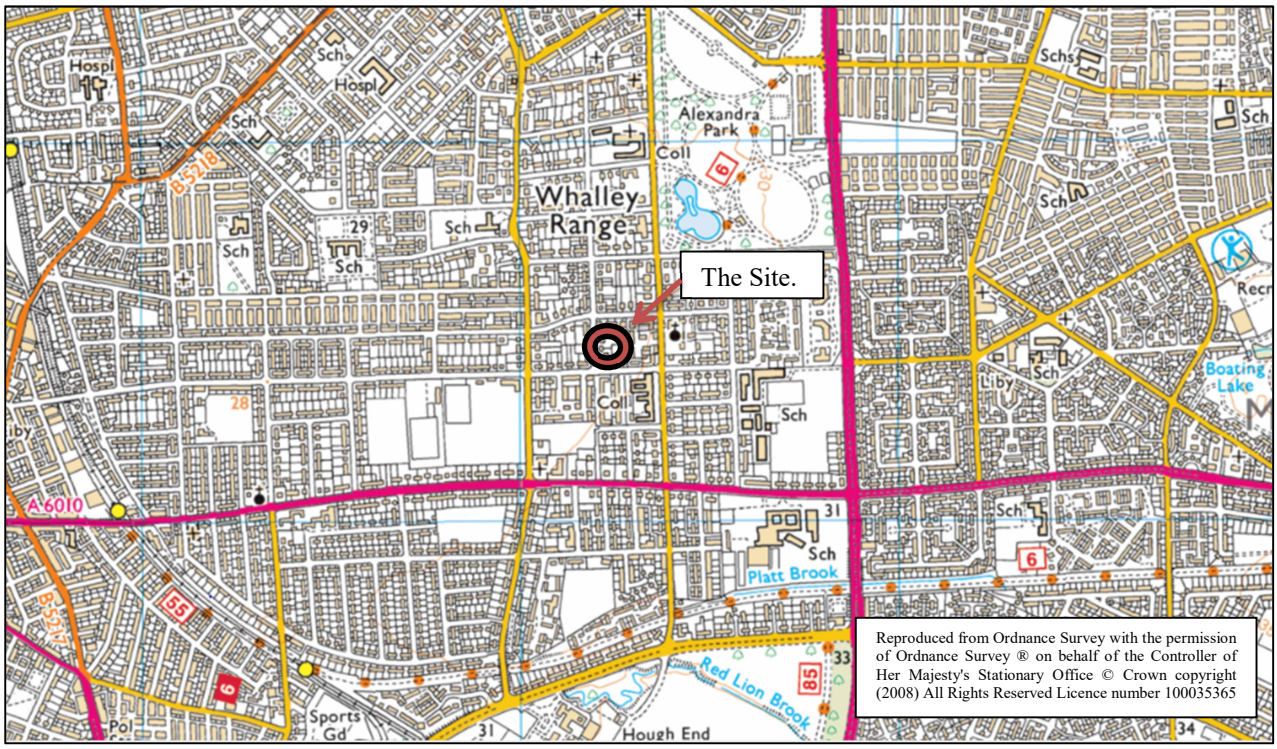

Figure 2: Site Location

2.2 Site Description

2.2.1 The Phase 2 ground investigation work was carried out on the 4th October 2019. The site description is summarised in Table 2.

Table 2: Site Description and its Environs	
Current Use:	The site is currently occupied by two disused tennis courts in the eastern section.
Access	The site can be accessed via a gate on the western site boundary, off Alness Road.
Existing Buildings & Structures	There are no existing buildings or structures currently on the site. All have been demolished.
Site Surface	Tennis courts in the eastern section are heavily overgrown with vegetation. The courts appear to be constructed of finely crushed aggregate.
Vegetation	Tennis courts overgrown with long grass and shrubs. Trees surround the perimeter.
Storage Tanks	No historical tanks recorded on the Groundsure database.
Asbestos	No obvious signs of asbestos were observed on the site. The pavilion appeared to be constructed from wood and brick from an external inspection.
Waste Disposal/ Materials Storage	None observed at the time of the site walkover on 4th October 2019.
Surrounding Area	The site is surrounded by residential properties.
Ecology	There is no evidence of protected burrowing animals (e.g. badgers) or habitats suitable for protected amphibians (e.g. Great Crested Newts). No evidence of invasive plant species was noted. *These comments on the ecology are for initial preliminary assessment. They are based on the assessment of personnel who are **not** trained ecologists and does **not** constitute a Phase I Habitat Survey or similar.*

3.1.1 A summary of the findings of the desk Study performed by Earth Environmental is given below.

- The phase 1 desk study identified that the site was previously a tennis club with a pavilion. No evidence of in-filled land within the site was identified in the investigation. The tennis courts themselves appear to be made up of very finely crushed aggregate that could potentially contain contamination sources;
- Asbestos containing materials (ACMs) could be present within the tennis club pavilion considering the date of construction and,
- There was no evidence of fuel tanks on the site.

2.3 Site Ownership

2.3.1 Site ownership has not currently been disclosed by the Client,

2.4 History

2.4.1 As detailed in the previous desk study by Earth Environmental the site was historically a tennis club with a pavilion that was constructed by 1932.

3 PREVIOUS INVESTIGATIONS

3.1 Previous Reports

As detailed section 1.5.1, there has been a previous Phase 1 report prepared by others for the proposed development together with a Phase 2 ground investigation carried out by TerraConsult.

Phase 2 – Intrusive Investigation

3.1.1 The main fieldwork was carried out on the 4th October 2019. The investigation comprised the following scope:

- 2No. trial pits dug by machine excavator with BRE365 soakaway infiltration testing carried out in each trial pit (located within proposed rear gardens);
- 1No. hand excavated inspection pit;
- 7No. CBR tests (by TRRL DCP method) along the proposed access road;
- Chemical testing (analysis of 2 no. soil samples for Waste Acceptance Criteria solid and eluate analysis in line with BS EN12457-2 at L/S 10 l/kg); and,
- Provision of factual data only.

3.1.2 The investigation has identified the following:

- Made Ground was encountered to a maximum depth of 0.70m below existing ground level. The Made Ground generally comprises of dark grey, silty, sandy gravel of ash, brick, and ceramic with rare concrete, wood, metal and glass. This was underlain by;
- Superficial deposits: Very soft light brown sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine sandstone and siltstone (Devensian Glaciofluvial Sheet Deposits).

3.1.3 Exploratory holes locations were not extended down to sufficient depths during the intrusive investigation to encounter deeper natural Superficial deposits (Devensian Till) or the underlying sandstone bedrock (Wilmslow Sandstone Formation) which has been mapped to underlie the Superficial deposits.

3.1.4 The results of the CBR tests (by TRRL DCP method) are shown in Appendix D.

3.1.5 The ground investigation locations are shown in Figure 4 below.

3.1.6 All the exploratory holes were backfilled with arisings and surface materials replaced on completion.

3.1.7 The samples were submitted to ELAB The Environmental Laboratory LTD of St Leonards on Sea in East Sussex. The laboratory is UKAS accredited and carries out Quality Assurance and Quality Control in accordance with BS ISO 17025 and participate in external laboratory comparison and quality control schemes such as MCERTS for soil analysis in accordance with the Environment Agency's scheme. Details of the accreditation and the methods of analysis are provided on the relevant test reports.

3.1.8 The selected soil samples were tested for a range of typical contamination indicators primarily for waste classification purposes. However, these results along with the results from the previous phase of investigation have been assessed within the following section for risks to human health.

3.1.9 The results of the laboratory analysis are presented in Appendix E.

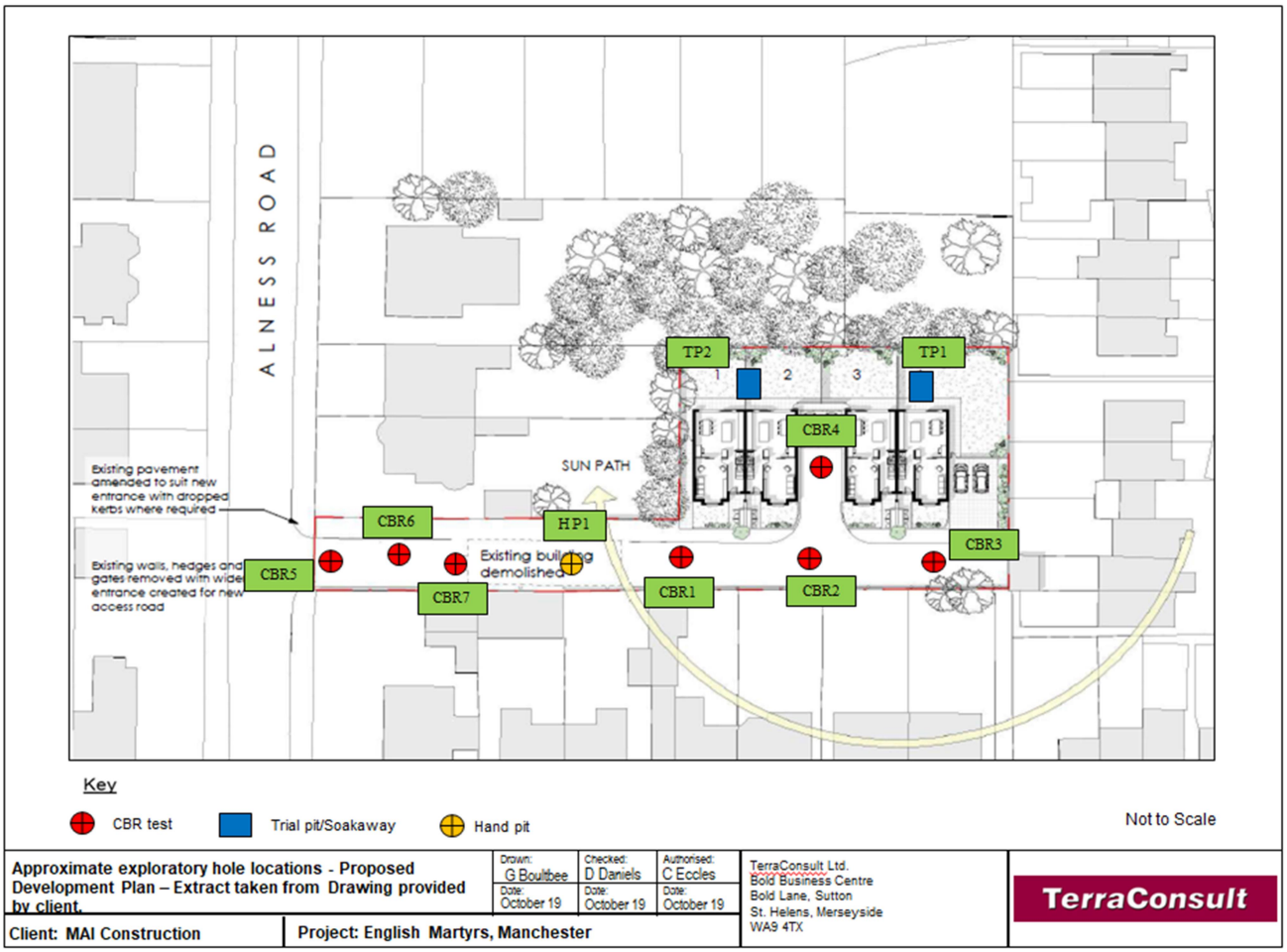

Figure 4: Extract of Exploratory Hole Location Plan

4 GENERIC QUANTITATIVE RISK ASSESSMENT

4.1 Introduction

4.1.1 The assessment of contamination has been carried out on the chemical analyses performed during the intrusive investigation.

4.1.2 Generic risk assessment is a two stage process. Firstly, in the Risk Estimation stage, the measured contaminant concentrations are compared to the relevant GACs or C4SLs/S4ULs where they have been published. Where there is a suitable dataset, this is done after carrying out statistical analysis to determine the upper confidence limit on the true mean. Otherwise, maximum or specific data points are compared directly. The second stage, Risk Evaluation, comprises an authoritative review of the findings with other pertinent information, in cases where the C4SLs or GACs are exceeded, in order to consider if exceedances may be acceptable in the particular circumstances.

4.1.3 The aspects of risk from substances in the ground considered below are as follows:

- human health;
- plant life;
- water supply pipes; and,
- below ground concrete.

4.2 Assessment for the Protection of Human Health

4.2.1 The Generic Qualitative Risk Assessment (GQRA), based on a soil with a Soil Organic Matter of 1%, was carried in accordance with the methodology for assessing soil samples set out in Appendix B based on a residential end use. A full summary of the chemical test results is presented in Appendix F. Exceedances of applicable Generic Assessment Criteria (GAC) threshold concentrations are indicated in yellow (note that the results highlighted in orange do not pose a risk to health bur relate to concrete design). A discussion on the various exceedances is presented below.

4.2.2 The geo-environmental laboratory testing results indicate that elevated concentrations of arsenic and nickel are present within the Made Ground for human health receptors compared to the CLEA GAC, pC4SL and LQM/CIEH S4UL for “residential land use with plant uptake”. Elevated concentrations of lead are also shown to be present within the Made Ground above the pC4SL and LQM/CIEH S4UL for residential with vegetable uptake and public open space (residential). No asbestos was identified in the samples screened for the presence of asbestos. Slightly elevated PAH’s were also identified in the Made Ground at location TP1.

Metals

4.2.3 Several heavy metals exceeded their respective GACs for human health within the two shallow soils sampled, as discussed below:

- Arsenic – Exceeds the pC4SL of 40 mg/kg in both samples at 0.2m in TP1 and 0.1m in HP1 recorded at 179mg/kg and 43.7mg/kg respectively.
- Lead – Exceeds the pC4SL in both of the samples with a maximum concentration of 1,530 mg/kg in TP1 at 0.2 m and 432mg/kg within HP1.
- Nickel – Exceeds the S4UL of 180mg/kg in the sample taken from TP1 at 0.2m recorded at 180mg/kg. The sample taken from HP1 at 0.1m exceeds the GAC of 43mg/kg but not the S4UL with a result of 43.2mg/kg.

PAHs

4.2.4 PAH concentrations exceeded GACs for various PAH compounds from the TP1 sample at 0.2m. Details are presented below:

- Benzo(a)anthracene – Exceeds the GAC of 3.1 mg/kg with a concentration of 4.4 mg/kg.
- Benzo(b)fluoranthene – Exceeds the S4UL of 2.6 mg/kg with a concentration of 3.8 mg/kg.
- Benzo(a)pyrene – Exceeds the S4UL of 2.2 mg/kg with a concentration of 4 mg/kg.
- Dibenzo(ah)anthracene) – Exceeds the S4UL of 0.24 mg/kg with a concentration of 0.5 mg/kg.

4.2.5 No elevated PAHs were detected within the soil sampled from HP1.

Petroleum Hydrocarbons (PHC)

4.2.6 Chemical test results of both soil samples show concentrations of PHC which are below the GAC and the S4UL.

4.2.7 The concentrations of BTEX compounds (benzene, toluene, ethylbenzene and xylenes) were all less than the detection limits and no BTEX results exceed the GAC or the S4ULs.

Asbestos

4.2.8 Asbestos can be present in soil as fragments of bulk Asbestos Containing Materials (ACMs) (e.g. asbestos cement sheeting) and also as discrete asbestos fibres within the soil matrix. This investigation has carried out assessments to determine whether both bulk fragments of asbestos and discrete fibres are present in the soil at the site. The asbestos assessment commenced on site with inspection of the Made Ground by our site staff for the presence of bulk ACMs. During the fieldwork, no suspected ACMs were identified

4.2.9 Both samples underwent laboratory assessment to determine whether asbestos fibres or ACM's were present. No asbestos was identified in the samples.

4.3 Ground Gas Assessment

4.3.1 The desk study has shown that there are no significant potential sources of hazardous ground gases on the site. No landfills have been identified on or close to the site and the site investigation has revealed that the Made Ground deposits are less than 0.7m in thickness, containing little to no potentially putrescible material.

4.3.2 Therefore, the CL:AIRE RB17 approach has been used for the ground as risk assessment. The laboratory analysis for TOC shows concentrations vary between 4% and 11%. Both of the samples were taken from the Made Ground which showed visible evidence of ash. These materials will contribute to the laboratory measured concentrations of TOC. However, these materials are not considered to be putrescible and therefore, they will not contribute to the production of ground gases and It is assessed that ground gas conditions at the site, taking into account the age, thickness and nature of materials within the Made Ground is classified as Characteristic Situation 1 and no ground as measures are required in line with BS8485:2015.

4.4 Risks to Human Health (Construction Phase)

4.4.1 Given the elevated concentrations of heavy metals (as arsenic, lead and nickel) plus select PAHs detected within shallow soils and the presence of nearby residential receptors and construction workers, control of fugitive dust will be a priority. As a minimum it is anticipated the works will be undertaken in accordance with BRE best practise guidance to control dust generation.

4.5 Risk to Plant Life

4.5.1 Concentrations of the phytotoxic metals nickel, copper and zinc have been recorded in shallow samples of Made Ground in excess of the guideline values for the protection of plants as presented in BS3882: Specification for the Use of Topsoil and BS:8601 Specification for Subsoil and requirements for use. The results of the phytotoxic screening are presented in the table 3 below and are based on the averaging area pH.

Table 3: Phytotoxic Risk of Made Ground

Determinand	Number of Samples	Trigger Value (mg/kg)	Results Exceeding Trigger Concentration (mg/kg)	Exceeds Tier 1 Screening (Y/N)
Copper	2	200 *	1530	Y
Nickel	2	110 *	180	Y
Zinc	2	300 *	1580, 595	Y
* Soil average pH >7.2				

4.5.2 Within the Made Ground, copper, nickel and zinc are elevated in the sample taken from TP1, and in the sample taken from HP1, there is an elevated concentration of zinc when compared to the relevant GAC. In landscaped areas

the elevated contaminant concentrations may not be acceptable for the proposed end use, and these will require either replacement with appropriate clean inert materials or provision of a suitable capping system to protect end-users.

4.6 Assessment for the Protection of Controlled Waters

4.6.1 Groundwater entries were not encountered during formation of the exploratory holes.

4.6.2 The findings of the current investigation have not identified any visual and olfactory evidence of gross mobile contamination and there are no nearby surface water courses or groundwater abstractions. Therefore, the risks to controlled waters are considered as insignificant and have been assessed as not requiring any remedial action.

4.7 Water Supply Pipe Material Assessment

4.7.1 Plastic pipe materials are potentially vulnerable to attack from elevated concentrations of hydrocarbons, which can potentially lead to contamination of potable water supplies and water supply companies also require the risk to their workers from other contaminants in the ground to be assessed. The current UK Guidance for the Specification of Water Supply Pipes to be used in Brownfield Sites (UK Water Industry Research Ltd. UKWIR, 2014) together with guidance from United Utilities provides threshold concentrations for different pipe material for various chemical groups.

4.7.2 The pipeline materials considered by the guidance are PE, PVC, wrapped steel, wrapped ductile iron or copper pipe and barrier pipe. PE are assessed using threshold concentrations for various chemical groups including volatile organic compounds (VOC) with tentatively identified compounds (TICs), semi-volatile organic compounds (SVOC) with TICs, mineral oils, aldehydes, ketones etc. Wrapped steel, wrapped ductile iron and copper pipe are assessed using corrosive properties. The default recommendation for water supply pipes is to use PE with other types of pipework only used if the limits for PE pipes are exceeded. When assessing the ground for water supply pipes the suite of potential contaminants to be tested only needs to be those contaminants that are potentially present on site based on the desk study. At this site the desk study did not identify there to be a risk from SVOCs (including chlorinated phenols, cresols), aldehydes, ketones, ethers, nitrobenzene and amines so no analysis was carried out for these compounds.

4.7.3 The available data indicates no exceedances for the PE water supply pipe are present and as such the use of PE pipe is deemed permissible with the following caveats:

- should areas of unexpected contamination be found during construction and any water supply pipes are routed though those areas, additional sampling and testing will be required.

- Following confirmation of the water supply pipe route, the water supplier for the area should be contacted and written approval sought. They may require additional chemical data along any proposed potable water supply pipe routes.

4.7.4 The findings have not shown any additional risks to be present. It is also likely that some remediation and/or earthworks will be required to enable the redevelopment of the site.

4.7.5 The effects of the remediation and concentrations of contaminants in the vicinity of any proposed water supply pipe corridor should be assessed following any remedial and/or earthworks.

4.8 Chemical Attack on Below Ground Concrete

4.2.1 Below-ground concrete structures are potentially at risk from elevated sulphates and chlorides, and nitrate where there is low pH in the ground. An assessment of the soil and groundwater data (following the protocol established in BRE Special Digest 1, 2005) for Made Ground excluding pyrite has been made. This indicates that for the Made Ground that ACEC Class AC-3 conditions prevail and a DS3 concrete classification is required if this soil is to remain on site.

4.2.2 Analysis of the soils (Made Ground and natural soils) post remediation will be required to determine/confirm the BRE assessment.

4.2.3 Gross petroleum hydrocarbon contamination can also have an adverse impact on the setting of concrete, which may affect foundation construction and piling. Based on the measured concentrations of PHC at the site, there is no risk of these affecting the setting of concrete.

4.9 Waste Assessment

4.9.1 It is understood there will a shallow site strip from the whole of the site of approximately 0.6m from the existing ground level. As with most developments, there will also be waste materials produced from excavations for drainage/services and foundation/pile arisings. It is understood that the excess materials will have to be removed from the site and therefore will require disposed of to a suitable landfill site

4.9.2 The portion of excess soil may have to be sent to a suitable landfill site. A summary of current relatively complex guidance on categorising waste from earthworks is presented in Appendix F. A two phase approach is required comprising comprises:

- **Waste Characterisation; and,**
- **Waste Classification (Waste Acceptance Criteria).**

4.9.3 A hazardous waste assessment on the 2 samples of Made Ground soil has revealed that for both soil samples, the combined HP14 hazardous calculations plus the ratio of benzo(a)pyrene to mineral oil (unknown oils) have both exceeded the relevant threshold for hazardous waste. Ultimately, this means that excess soils will need to be removed from site and suitably disposed to a hazardous landfill site.

4.9.4 However, Appendix D of the WM3 Guidance provides a mechanism for assessing whether isolated test results can be determined as being insignificant in the data set by establishing the upper 5th and 95th percentile confidence levels. If the mean concentration is below these confidence levels then all the potential waste is not hazardous even though a few samples have exceedances of the hazardous criteria. Further analysis of soil samples followed by appropriate statistical analysis may determine that the Made Ground is not considered as hazardous waste should it be excavated for off-site removal.

4.9.5 An assessment of WAC testing has deemed that the Made Ground is unlikely to be accepted at an inert landfill site owing to elevated percentage of total organic carbon.

4.9.6 No asbestos was encountered within the two soil samples of Made Ground analysed.

4.9.7 Note that if unforeseen ground conditions are encountered during the site works (e.g. any significant quantities of asbestos, significant ashy soils, unusual, brightly coloured or significantly oily or odorous material) would need to be re-tested to confirm its waste category.

4.10 Updated Conceptual Site Model

4.10.1 The conceptual site model initially developed from the desk study and walk-over survey has been updated using the findings of the two phases of ground investigations.

4.10.2 The site investigation revealed the following general downward succession:

Site surface: grass, and finely crushed aggregate (tennis court surface).

Made Ground: Maximum thickness of 0.7m. Heterogenetic. Mixture of sand and ash with gravel of brick, ceramic, wood, and glass.

Glaciofluvial deposit: 1.0m thick of soft, sandy clay.

4.10.3 The updated contamination at the site has been assessed using the contaminant-pathway-receptor linkage approach. Following two phases of site investigation, the plausible contaminant sources identified have been updated or confirmed as follows:

Table 4: Summary of Contaminant Linkages		
Receptor Group	**Pollution Source**	
	Potential Hotspots	**Potentially Pervasive**
Human Health	None Identified	Heavy metals (principally arsenic, lead, nickel) Various PAH compounds
Plant Life	None	Copper, nickel and zinc
Controlled Waters	No unacceptable contamination, subject to confirmation from the Environment Agency.	
Water Supply Pipe Material Assessment	Based on limited investigation. PE pipe is considered to be required for the Made Ground but re-assessment of site specific soil concentrations may be required following any groundworks / remediation undertaken during site development.	
Human health / property (from ground gases)	Radon protection measures are not required. With regards to permanent ground gases it has been recommended that Characteristic Situation 1 should be implemented and no ground as measures are required in line with BS8485:2015+A1:2019.	

5 REMEDIATION STRATEGY

5.1 General

5.1.1 A Remediation Strategy is required in accordance with procedures in CLR 11 'Model Procedures for the Management of Land Contamination. In general terms, any works proposed on site should ensure the Site is 'suitable for use' (see Appendix B). The Remediation Strategy shall state the required remediation targets, identify technically feasible remedial options and then provide a detailed evaluation of the options. In accordance with Part IIA of the Environmental Protection Act, i.e. contamination remaining on site so that the site does not present a significant risk of significant harm to identified receptors.

5.1.2 The risk assessments have concluded that remediation measures are required to address risks to:

- human health (including elevated concentrations of select PAHs, arsenic, lead and nickel) and plant life (including elevated copper, nickel and zinc) recorded within shallow soils within proposed garden areas.

5.1.3 It is understood there will a shallow site strip from the whole of the site of approximately 0.6m from the existing ground level. As with most developments, there will also be waste materials produced from excavations for drainage/services and foundation/pile arisings. It is understood that the excess materials will have to be removed from the site and therefore will require disposal at a suitable landfill site.

5.1.4 Note that there is no significant assessed risk to controlled waters (subject to confirmation from the Environment Agency) or from radon.

5.1.5 It is understood from the Client that the proposed development will be carried out in 3 main phases :

1) Construction of residential dwellings
   (i) Excavate and remove approximately 600mm from existing ground level
   (ii) Construct working platform
   (iii) Construction of dwellings
2) Complete construction of remaining areas

5.1.6 The final construction will consist of a mixture of hard and soft landscaped areas. The areas are broken down into the following:

Table 5: Summary of Contaminant Linkages		
Total Site Area:	1,316 m^2	-
Soft Landscaped Area:	328 m^2	25%
Hard Landscaped Area:	988 m^2	75%

5.1.7 The remedial actions required are:

- Provision of clean cover soils in areas of soft landscaping to break pathways to human and plant life receptors from heavy metals and PAHs across the site.
- The cover system will consist of layers of validated topsoil and sub-soil with an overall thickness of 0.60m. The minimum 0.60m thickness is based on roughly two spade depths.
- In the areas where new trees are proposed, it is recommended that the overall thickness of the cover system and the topsoil is deepened (actual depth depending on type of tree).
- The majority of the soft landscaping areas are proposed for turf / grass, therefore the details given in Figure 5 are considered suitable. The cover system will be made up of Topsoil, Subsoil and inert granular material e.g. sub-base type material.

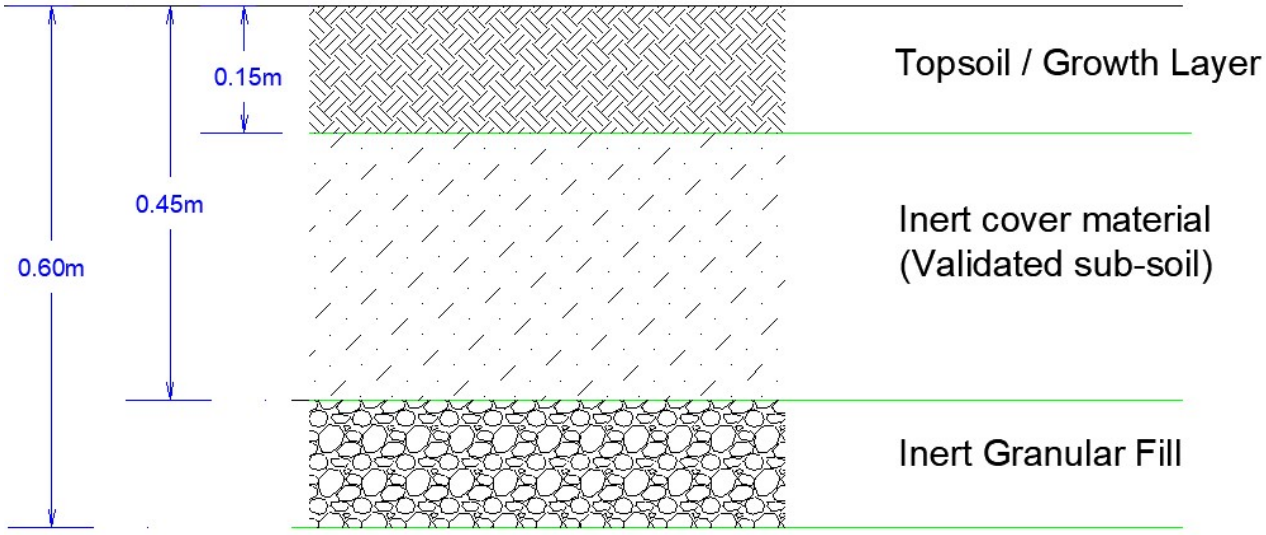

Figure 5: Proposed typical cover system

Asbestos

- No asbestos has been found to be present from the asbestos screens carried out on shallow samples of Made Ground from TP1 and HP1.

5.2 Unexpected Contamination

5.2.1 As with any project on a brownfield site there is the possibility of encountering unexpected contamination. If this occurs, then the procedures set out in Appendix H should be implemented.

5.3 Clean Cover

5.3.1 Clean cover materials of 0.60m thickness are to be derived from imported topsoil, subsoil and potentially granular fill material. The Local Authority will require that material is suitable, there is appropriate sampling and testing of this soil and a verification report is produced. For the soft landscaped areas:

- Topsoil shall meet the requirements of BS 3882:2015;
- Subsoil shall meet the requirements of BS 8601:2013;
- Chemical criteria to be met are as set out in Table 6;
- The 0.60m of clean cover will be a minimum thickness of 450 mm of topsoil/subsoil over a 150 mm thick no dig layer (e.g. granular 6F2 layer or similar); and,
- The Manchester City Council (MCC) guidance[1] for sampling ratios is as follows "*It would be expected as an absolute minimum sampling would consist of at least three samples for each source used. One sample for every 200m^3 from proven 'greenfield' sources and one sample every 50m^3 from 'unknown', 'mixed' or 'brownfield' sources. MCC would also expect to see on site sampling and not just sampling at source to confirm that the soil delivered to the site is suitable for use".*
- In order that regulatory compliance can be confirmed, a copy of all site licences, consents and Waste Transfer Notes shall be included;

Table 6: Typical Suite of Analysis for Topsoil / Subsoil verification

Determinand	Soil Suite
Index Tests	
Asbestos Screen	✓
pH	✓
Metals	
As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Zn (all totals)	✓
Inorganics	
Cyanide – Total	✓
Sulphate (2:1 extract on soil samples)	✓
Organics	
Phenols - Total (monohydric)	✓
Total Organic Carbon (TOC)	✓
PAH (Speciated USEPA 16)	✓
TPH (C_8 to C_{36}) TPH CWG (RBCA) Speciation	✓
Mineral Oil (C_{10} to C_{40})	✓
Benzene, Toluene, Ethyl Benzene, Xylenes (BTEX);	✓

5.3.2 The test results must not exceed the limits specified within Table 7.

[1] Manchester City Council. Environmental Protection Group Contaminated Land Section. Planning Guidance in Relation to Ground Contamination: Guidance Note for Applicants, Developers, Land Owners and Consultants Version 6.00, dated September 2016

Table 7: Acceptance Criteria for Topsoil, Subsoil and Fill

Analyte	Soil Re-Use and Importation Criteria (mg/kg)			Analyte	Soil Re-Use and Importation Criteria (mg/kg)		
Metals				**BTEX**			
Arsenic (total)	37*			Benzene	0.087^	0.17$	0.37£
Beryllium	38			Toluene	130^	290$	660£
Cadmium (total)	22*			Ethyl Benzene	47^	110$	260£
Chromium (total)	400*			Xylene – 0	60^	140$	330£
Chromium (hexavalent)	21*			Xylene – M or P	56^	130$	310£
Copper (total)	200*						
Lead (total)	210*			**Petroleum Hydrocarbons**			
Mercury (total inorganic)	7.4			Aliphatic >C_5 - C_6	42^	78$	160£
Nickel (total)	110*			Aliphatic >C_6 - C_8	100^	230$	530£
Selenium	350			Aliphatic >C_8 - C_{10}	27^	65$	150£
Vanadium	74			Aliphatic >C_{10} - C_{12}	130^	330$	760£
Zinc (total)	300**			Aliphatic >C_{12} - C_{16}	1,100^	2,400$	4,300£
				Aliphatic >C_{16} – C_{35}	2000**		
Inorganic							
Sulphate	2400**						
Phenol	120^	200$	380£	Aromatic >C_5 - C_7	70^	140$	300£
				Aromatic >C_7 - C_8	130^	290$	660£
PAH				Aromatic >C_8 - C_{10}	34^	83$	190£
Naphthalene	2.3^	5.6$	13£	Aromatic >C_{10} - C_{12}	74^	180$	380£
Acenaphthylene	170^	420$	920£	Aromatic >C_{12} - C_{16}	140^	330$	660£
Acenaphthene	210^	510$	1100£	Aromatic >C_{16} - C_{21}	260^	540$	930£
Fluorene	170^	400$	860£	Aromatic >C_{21} - C_{35}	1100^	1500$	1700£
Phenanthrene	95^	220$	440£				
Anthracene	2400^	5400$	11,000£				
Fluoranthene	280^	560$	890£	**Asbestos**	Not detected (detection limit <0.001%)		
Pyrene	620^	1,200$	2,000£				
Benz(a)anthracene	7.2^	11$	13£				
Chrysene	15^	22$	27£				
Benzo(b)fluoranthene	2.6^	3.3$	3.7£				
Benzo(k)fluoranthene	77^	93$	100£	TOC			
Benzo(a)pyrene	2.2^	2.7$	3.0£				
Indeno(123cd)pyrene	27^	36$	41£				
Benzo(ghi)perylene	320^	340$	350£				
Dibenzo(ah)anthracene	0.85						

Notes
Reasonable best values from current Tier 2 GAC residential with veg uptake
** Screening criteria reduced from human health criteria to be protective of controlled waters.
^Based on soil containing 1% SOM (S4UL adopted).
$ Based on soil containing 2.5% SOM (S4UL adopted).
£ Based on soil containing 6% SOM (S4UL adopted).

5.4 Waste Management

5.4.1 Given the size of the development it is anticipated that the fill materials required for the development (i.e. from reuse on site and from importation to the site will

not exceed 1000 tonnes. If this is to be the case, then TerraConsult recommends that the development applies for an Environmental Permit exemption associated with the reuse and importation of fill materials including topsoil, subsoil and other fill materials. There is no cost associated with this, there are just forms on the Environment Agency website to download, complete and return.

5.5 Unforeseen Contamination

5.5.1 As with any project on a brownfield site there is the possibility of encountering unexpected ground contamination. If this occurs then the procedures set out in Appendix C should be implemented.

5.6 Permitting

Reuse and of Soils

5.6.1 Owing to the elevated contamination identified within the Made Ground against human health thresholds, it will not be possible to reuse made ground on the site.

6 VERIFICATION PLAN

6.1 General

6.1.1 The verification of the proposed Remediation Strategy will have to satisfy Manchester City Council (MCC). Guidance is given in the MCC document *Planning Guidance in Relation to Ground Contamination.*

6.1.2 All stages of the remediation works should be verified independently by suitably qualified and experienced personnel. Verification reports should be prepared for each stage. Verification will be required in one stages:

- Initial earthworks/remediation;
- Verification of imported subsoil and topsoil.

6.1.3 On completion a copy of the Verification Reports should be sent to the local authority Environmental Health Officer and the Environment Agency Contaminated Land Officer for their approval so that planning conditions can be discharged. A copy of the report should be sent to the NHBC, local authority building control officer or other similar authority for their approval. Where such organisations are involved in the development process, it is advised that approval be sought to any remediation works from these organisations prior to the commencement of development.

6.2 Verification of Remediation

6.2.1 The verification works/ report should include:

- A description of the works, sample location plan, test results, photographs, interpretation;
- In order that regulatory compliance can be confirmed, a copy of all site licences, consents and Waste Transfer Notes shall be included.

6.3 Verification of Imported Subsoil and Topsoil

6.3.1 The import and placement of all topsoil and subsoil should be verified. If there is sectional completion/handover then separate verification reports should be produced for each area. The verification of this clean cover shall include:

- A description of the works, sample location plan, test results, photographs, interpretation;
- Confirmation of the chemical properties of the material used in the cover system meets the specification;
- Confirmation of thickness and suitability of the topsoil/cover layers (in accordance with BS 3882:2015 and NHBC, 2017);
- In order that regulatory compliance can be confirmed, a copy of all site licences, consents and Waste Transfer Notes shall be included;

7 CONCLUSIONS

7.1 Ground Profile

7.1.1 The site investigation revealed the following general downward succession:

Site surface: grass, and finely crushed aggregate (tennis court surface).

Made Ground: Maximum thickness of 0.70m. Heterogenetic. Mixture of sand and ash with gravel of brick, with ceramic, occasional wood, metal and glass fragments.

Glaciofluvial Sheet Deposits: at least 1.0m thick very soft, sandy clay.

7.2 Remediation and Recommendations for Further Works

7.2.1 The remedial actions required are:

- Provision of clean cover soils in areas of soft landscaping to break pathways to human and plant life receptors from heavy metals and PAHs across the site. A 0.60 m thick cover of 'clean and inert' capping soils is proposed to all gardens and other soft landscaped areas of the site together with an inert granular layer;

7.2.2 However, as with any project on a Brownfield site, there is the possibility of encountering unexpected contamination. If this occurs, then the procedures set out in Appendix H should be implemented.

Verification

7.2.3 All stages of the remediation shall be carried out with verification will be required in three stages:

- Initial earthworks/remediation including description of works, photographs and interpretation;
- Verification of imported subsoil and topsoil including confirmation of capping thickness and chemical test results.

Regulatory Liaison

7.2.4 Any proposals to remediate or develop the site should be agreed with the relevant authorities (e.g. local authority environmental health officer, Environment Agency etc.) to obtain Planning Permission prior to commencement of the works and should be agreed with the NHBC or similar, or with the local authority building control officer prior to commencement of the works.

Re-use of Soil on site and Importation of Fill

7.2.5 Owing to the elevated concentration of contaminants recorded within the Made Ground, it is recommended that these soils are not reused on the site. Given the size of the development it is anticipated that the fill materials required for the development (i.e. from reuse on site and from importation to the site will not exceed 1000 tonnes. If this is to be the case, then TerraConsult recommends that the development applies for an Environmental Permit exemption associated with the reuse and importation of fill materials including topsoil, subsoil and other fill materials. There is no cost associated with this, there are just forms on the Environment Agency website to download, complete and return.

7.3 Health and Safety

7.3.1 As outlined within the HSE publication "Successful Health and Safety Management – HSG65" this report should inform your development of safe systems of work and information as an input into the safety management system. The contents of this report may be used to supplement the contents of the Health and Safety File as required under the Construction Design and Management (CDM) Regulations 2015. All risk control measures should be in accordance with the guidelines laid down within the Management of Health and Safety at Work Regulations 1999 and the Asbestos Working Plan implemented.

Risks to Human Health (Construction Phase)

7.3.2 Given the elevated concentrations of heavy metals (arsenic, lead and nickel) plus select PAHs encountered within shallow soils and the presence of nearby residential receptors and construction workers, control of fugitive dust will be a priority. As a minimum it is anticipated the works will be undertaken in accordance with BRE best practise guidance to control dust generation including:

- access roads and any stockpiles created during groundworks should be regularly damped down with water;
- vehicle movements and speed should be kept to a minimum within the site;
- dust generating equipment (e.g. mobile crushing and screening equipment) should be located to minimise potential nuisance impacts to receptors as far as practicable; and,
- minimising drop heights of all loading and unloading activities that involve the transfer of soils and demolition materials.
- all vehicles entering and leaving the site during the construction period should be jet-washed;
- vehicles used to transport materials/wastes and aggregates should be enclosed or tarpaulined;
- local roads should be regularly cleaned;
- workers to wear suitable Personal Protective Equipment (PPE);

- having adequate site hygiene facilities allowing staff to keep a good level of personal hygiene;
- all groundworkers should have been trained in asbestos awareness and should keep a look out for this being encountered during excavations. ;
- only permitting smoking or eating on site in appropriate pre-designated areas.
- workers wear suitable Personal Protective Equipment (PPE) and if necessary appropriate RPE;
- having adequate site hygiene facilities allowing staff to keep a good level of personal hygiene;
- all groundworkers should have been trained in asbestos awareness and should keep a look out for this being encountered during excavations. A supervisor should be present whilst all works are being carried out who has training for Non-notifiable Non Licenced Work;
- the Asbestos Working Plan has a contingency plan which should be implemented is the presence of asbestos is suspected in groundworks;
- only permitting smoking or eating on site in appropriate pre-designated areas.

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DRAWINGS

List of Drawings

4738/01/001	Exploratory Hole Location Plan

APPENDICES

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APPENDIX A

Service Constraints, Report Limitations & Planning

Service Constraints, Report Limitations & Planning Requirements

This consultancy contract, report and the site investigation (together comprise the "Services") were compiled and carried out by TerraConsult Limited (TCL) for MAI Construction (the "client") on the basis of a defined programme and scope of works and the terms of a contract between TCL and the "client." The Services were performed by TCL with all reasonable skill and care ordinarily exercised by a reasonable environmental consultant at the time the Services were performed. Further, and in particular, the Services were performed by TCL taking into account the limits of the scope of works required by the client, the prevailing site conditions, the time scale involved and the resources, including financial and manpower resources, agreed between TCL and the client. TerraConsult Ltd cannot accept responsibility to any parties whatsoever, following the issue of this report, for any matters arising which may be considered outwith the agreed scope of works.

Other than that expressly contained in the above paragraph, TCL provides no other representation or warranty whether express or implied, is made in relation to the Services. Unless otherwise agreed this report has been prepared exclusively for the use and reliance of the client in accordance with generally accepted consulting practices and for the intended purposes as stated in the agreement under which this work was completed. This report may not be relied upon, or transferred to, by any other party without the written agreement of a Director of TCL. If a third party relies on this report, it does so wholly at its own and sole risk and TCL disclaims any liability to such parties.

It is TCL's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of, or reliance upon the report in those circumstances by the client without TCL 's review and advice shall be at the client's sole and own risk.

The information contained in this report is protected by disclosure under Part 3 of the Environmental Information Regulations 2004 pursuant to the provisions of Regulation 12(5) without the consent in writing of a Director of TerraConsult Limited.

The report was written in November 2019 and should be read in light of any subsequent changes in legislation, statutory requirements and industry practices. Ground conditions can also change over time and further investigations or assessment should be made if there is any significant delay in acting on the findings of this report. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of TCL. In the absence of such written advice of TCL, reliance on the report in the future shall be at the client's own and sole risk. Should TCL be requested to review the report in the future, TCL shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between TCL and the client.

The observations and conclusions described in this report are based solely upon the Services that were provided pursuant to the agreement between the client and TCL. TCL has not performed any observations, investigations, studies or testing not specifically set out or mentioned within this report. TCL is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt,

unless otherwise expressly referred to in the introduction to this report, TCL did not seek to evaluate the presence on or off the site of asbestos, electromagnetic fields, lead paint, radon gas or other radioactive or hazardous materials.

The Services are based upon TCL's observations of existing physical conditions at the site gained from a walkover survey of the site together with TCL's interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The findings and recommendations contained in this report are based in part upon information provided by third parties, and whilst TerraConsult Ltd have no reason to doubt the accuracy and that it has been provided in full from those it was requested from, the items relied on have not been verified. No responsibility can be accepted for errors within third party items presented in this report. Further TCL was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services. TCL is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to TCL and including the doing of any independent investigation of the information provided to TCL save as otherwise provided in the terms of the contract between the client and TCL.

Where field investigations have been carried out these have been restricted to a level of detail required to achieve the stated objectives of the work. Ground conditions can also be variable and as investigation excavations only allow examination of the ground at discrete locations. The potential exists for ground conditions to be encountered which are different to those considered in this report. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition, chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and TCL] based on an understanding of the available operational and historical information, and it should not be inferred that other chemical species are not present.

The groundwater conditions entered on the exploratory hole records are those observed at the time of investigation. The normal speed of investigation usually does not permit the recording of an equilibrium water level for any one water strike. Moreover, groundwater levels are subject to seasonal variation or changes in local drainage conditions and higher groundwater levels may occur at other times of the year than were recorded during this investigation.

Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan, but is (are) used to present the general relative locations of features on, and surrounding, the site.

Throughout the report the term ‘geotechnical’ is used to describe aspects relating to the physical nature of the site (such as foundation requirements) and the term ‘geoenvironmental’ is used to describe aspects relating to ground-related environmental issues (such as potential contamination). However, it should be appreciated that this is an integrated investigation and these two main aspects are inter-related. The geoenvironmental sections are written in broad agreement with BS 10175:2011+A2 2017. For the geotechnical aspects of the report, the general requirements of Eurocode 7 (BS EN 1997-2:2007) are to produce a Ground Investigation Report (GIR) which shall form part of the Geotechnical Design Report (GDR). The geotechnical section of this report is intended to fulfil the general requirements of the GIR as outlined in BS EN 1997-2, Section 6. The GIR contains the factual information including geological features and relevant data, and a geotechnical evaluation of the information stating the assumptions made in the interpretation of the test results. This report shall not be considered as being a GDR.

Planning Requirements

The National Planning Policy Framework (NPPF, 2012) has twelve core land-use planning principles, two of which directly relate to the potential for pollution and contaminated land:

- Requirement to *"contribute to conserving and enhancing the natural environment and reducing pollution"* and setting out of a preference for developments to be on land of "*lesser environmental value*"; and
- *"encourage the effective use of land by re-using land that has been previously developed (brownfield land), providing that it is not of high environmental value.".*

In accordance with the core principles of NPPF, Paragraph 109 clarifies that enhancing the natural environment includes:

- *"preventing both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or noise pollution or land instability; and*
- *remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate."*.

Paragraph 121 of NPPF states that planning policies and decisions for developments should also ensure that:

- *"the site is suitable for its new use taking account of ground conditions and land instability, including from natural hazards or former activities such as mining, pollution arising from previous uses and any proposals for mitigation including land remediation or impacts on the natural environment arising from that remediation;*
- *after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990; and*
- *adequate site investigation information, prepared by a competent person, is presented."*.

This report has been prepared and authorised by staff that are competent as defined in the NPPF.

Unexploded Ordnance

Clients have a legal duty under the CDM 2015 Regulations to provide designers and contractors with project-specific health and safety information needed to identify hazards and risks. This includes the possibility of unexploded ordnance (UXO) being encountered on the site. Further details are given in CIRIA Report C681 (Stone et al 2009). A non-UXO specialist screening exercise has been carried out for the site by considering any evidence of UK defence activities on or near the site evident from the gathered desk study information and the unexploded aerial delivered bomb (UXB) regional risk maps produced by Zetica. Other data sources are available, but as a first stage screening exercise the freely available Zetica maps have been used. The level of risk stated is that determined by Zetica, a company experience in the desk study, field investigation and clearance of UXO/UXB.

APPENDIX B

Environmental Risk Assessment Methodology & Terminology

ENVIRONMENTAL RISK ASSESSMENT METHODOLOGY & TERMINOLOGY

LEGISLATION OVERVIEW

This report includes hazard identification and environmental risk assessment in line with the risk-based methods referred to in relevant UK legislation and guidance. Government environmental policy is based upon a "suitable for use approach," which is relevant to both the current use of land and also to any proposed future use. The contaminated land regime is the statutory regime for remediation of contaminated land that causes an unacceptable level of risk and is set out in Part 2A of the Environmental Protection Act 1990 ("EPA 1990"). The main objective of introducing the Part IIA regime is to provide an improved system for the identification and remediation of land where contamination is causing unacceptable risks to human health or the wider environment given the current use and circumstances of the land. Part IIA provides a statutory definition of contaminated land under Section 78A(2) as:

> *"any land which appears to the Local Authority in whose area it is situated to be in such a condition, by reason of substances in, on, or under the land, that:*
>
> *(a) Significant harm is being caused or there is a significant possibility of such harm being caused;*
>
> *or*
>
> *(b) Pollution of controlled waters is being, or is likely to be, caused."*

In order to assist in establishing if there is a "*significant possibility of significant harm*" there must be a "*contaminant linkage"* for potential harm to exist. That means there must be a source(s) of contamination, sensitive receptors present and a connection or pathway between the two. This combination of contaminant-pathway-receptor is termed a "contaminant linkage or CPR linkage."

Part IIA of The Environmental Protection Act 1990 is supported by a substantial quantity of guidance and other Regulations. Key implementing legislation of the Part 2A regime includes the Contaminated Land (England) Regulations 2006 (SI 2006/1380) as amended by the overarching legislation for the contaminated land regime, which implements the provisions of Part IIA of the Environmental Protection Act 1990 (as inserted by section 57 of the Environment Act 1995), came into force on 14th July 2000 together with recent amended regulations: Contaminated Land (England) (Amendment) Regulations 2012 (SI 2012/263). Revised Contaminated Land Statutory Guidance was published by DEFRA in April 2012. Part IIA defines the duties of Local Authorities in dealing with it. Part IIA places contaminated land responsibility as a part of planning and redevelopment process rather than Local Authority direct action except in situations of very high pollution risk.

In the planning process guidance is provided by National Planning Policy Framework (NPPF) of March 2012 which requires that a site which has been developed shall not be capable of being determined "contaminated land" under Part IIA. In practice, Planning Authorities require sites being developed to have a lower level of risk post development than the higher level of risk that is required in order to determine a site as being contaminated in accordance with Part IIA. This is to ensure that there is a suitable zone of safety below the level for Part IIA determination and prevent recently developed sites becoming reclassified as contaminated land if there are future legislative or technical changes (e.g. a substance is subsequently found to be more toxic than previously assessed this increases its hazard).

The criteria for assessing concentrations of contaminants and hence determining whether a site represents a hazard are based on a range of techniques, models and guidance. Within this context it is relevant to note that Government objectives are:

(a) to identify and remove unacceptable risks to human health and the environment;
(b) to seek to bring damaged land back into beneficial use;
(c) to seek to ensure that the cost burdens faced by individuals, companies and society as a whole are proportionate, manageable and economically sustainable.

These three objectives underlie the "suitable for use" approach to risk management and remediation of contaminated land. The "suitable for use" approach focuses on the risks caused by land contamination. The approach recognises that the risks presented by any given level of contamination will vary greatly according to the use of the land and a wide range of other factors, such as the underlying geology of the site. Risks therefore should be assessed on a site-by-site basis.

The "suitable for use" approach then consists of three elements:

(a) *ensuring that land is suitable for its current use* - in other words, identifying any land where contamination is causing unacceptable risks to human health and the environment, assessed on the basis of the current use and circumstances of the land, and returning such land to a condition where such risks no longer arise ("remediating" the land); the contaminated land regime provides the regulatory mechanisms to achieve this;

(b) *ensuring that land is made suitable for any new use, as planning permission is given for that new use* - in other words, assessing the potential risks from contamination, on the basis of the proposed future use and circumstances, before official permission is given for the development and, where necessary to avoid unacceptable risks to human health and the environment, remediating the land before the new use commences; this is the role of the town and country planning and building control regimes; and

(c) *limiting requirements for remediation to the work necessary to prevent unacceptable risks to human health or the environment in relation to the current use or future use of the land for which planning permission is being sought* - in other words, recognising that the risks from contaminated land can be satisfactory assessed only in the context of specific uses of the land (whether current or proposed), and that any attempt to guess what might be needed at some time in the future for other uses is likely to result either in premature work (thereby running the risk of distorting social, economic and environmental priorities) or in unnecessary work (thereby wasting resources).

The mere presence of contaminants does not therefore necessarily warrant action, and consideration must be given to the scale of risk involved for the use that the site has, and will have in the future.

OVERALL METHODOLOGY

The work presented in this report has been carried out in general accordance with recognised best practice as detailed in guidance documents such as in the CLR 11 Model Procedures for the Management of Land Contamination (Environment Agency, 2004), and BS10175:2011+A2 2017. Important aspects of the risk assessment process are transparency and justification. The particular rationale behind the risk assessments presented is given in this appendix.

The first stage of a two-staged investigation and assessment of a site is the Preliminary Investigation (BS 10175:2011), often referred to as the Phase 1 Study, comprising desk study and walk-over survey, which culminates in the Preliminary Risk Assessment. A preliminary conceptual site model (CSM) is developed which identifies potential geotechnical and geo-environmental hazards and the qualitative degree of risk associated with them. From the geo-environmental perspective, the Hazard Identification process uses professional judgement to evaluate all the hazards in terms of potential contaminant linkages (of contaminant source-pathway-receptor). Potential contaminant linkages are potentially unacceptable risks in terms of the current contaminated land regime legal framework and require either remediation or further assessment. These are normally addressed via intrusive ground investigation and generic risk assessment.

The second stage is the Ground Investigation, Generic Risk Assessment and Geotechnical Interpretation. This represents the further assessment mentioned above. The scope of the Ground Investigation is based on the findings of the Preliminary Risk Assessment and is designed to reduce uncertainty in the

geotechnical and geoenvironmental hazard identification. The Ground Investigation comprises fieldwork, laboratory testing and usually also on-site monitoring. The Ground Investigation may include the Exploratory, Main and Supplementary Investigations described in BS 10175:2011+A2 2017. The results of the Ground Investigation reduces uncertainty in the geotechnical and geoenvironmental risks. Depending on the findings more detailed investigations or assessments may be required.

PRELIMINARY RISK ASSESSMENT

Current practice recommends that the determination of potential liabilities that could arise from land contamination be carried out using the process of risk assessment, whereby "risk" is defined as:

"(a) The probability, or frequency, or occurrence of a defined hazard; and

(b) The magnitude (including the seriousness) of the consequences."

The UK's approach to the assessment of environmental risk is set out in by the Department of the Environment Transport and the Regions (2000) publication "A Guide to Risk Assessment and Risk Management for Environmental Protection" (also called Greenleaves II). This established an iterative, systematic staged process which comprises:

(a) Hazard identification;
(b) Hazard assessment;
(c) Risk estimation;
(d) Risk evaluation;
(e) Risk assessment;

At each stage during the development process, the above steps are repeated as more detailed information becomes available for the site.

For an environmental risk to be present, all three of the following elements must be present:

- Source/Contaminant: hazardous substance that has the potential to cause adverse impacts;
- Receptor: target that may be affected by contamination: examples include human occupants/users of site, water resources (rivers or groundwater), or structures;
- Pathway: a viable route whereby a hazardous substance may come into contact with the receptor.

The absence of one or more of each component (contaminant, pathway, receptor) would prevent a contaminant linkage being established and there would be no significant environmental risk.

The identification of potential contaminant linkages is based on a Conceptual Model of the site, which is subject to continual refinement as additional data becomes available. As part of a Preliminary Risk Assessment (Desk Study and site walk over) a Preliminary Conceptual Site Model (PCSM) is formed. Based on the PCSM, potential contaminant linkages can be assessed. If the PCSM and hazard assessment indicate that a contaminant linkage is not of significance then no further assessment or action is required for this linkage. For each significant and potential linkage a risk assessment is carried out. The linkages which potentially pose significant risks may require a variety of responses ranging from immediate remedial action or risk management or, more commonly, further investigation and risk assessment. This next stage is termed a Phase II Main Site Investigation and should provide additional data to allow refinement of the Conceptual Site Model and assess the level of risk from each contaminant linkage.

Definition of Risk Assessment Terminology

The criteria used for risk assessment are broadly based on those presented in DETR's "A Guide to Risk Assessment and Risk Management for Environmental Protection" (2000). The Severity of the risk is classified according to the criteria in Table B.1 below:

Table B.1 Severity/Consequence of Risk	
Severe	Acute risks to human health. Catastrophic damage to buildings/property (e.g. by explosion). Direct pollution of sensitive water receptors or serious pollution of other controlled water (watercourses or groundwater) bodies.
Medium	Harm to human health from long-term exposure. Slight pollution of sensitive controlled waters (surface waters or aquifers) or pollution of other water bodies. Significant effects on sensitive ecosystems or species.
Mild	No significant harm to human health in either short or long term. No pollution of sensitive controlled waters, no more than slight pollution of non-sensitive waters. Significant damage to buildings or structures. Requirement for protective equipment during site works to mitigate health effects.
Negligible	Damage to non-sensitive ecosystems or species. Minor damage to buildings or structures. No harm or pollution of water.

The probability of the risk occurring is classified according to criteria given in Table B.2 below:

Table B.2: Probability of Risk Occurring	
High likelihood	Contaminant linkage may be present, and risk is almost certain to occur in the long term, or there is evidence of harm to the receptor.
Medium/Reasonably Foreseeable	Contaminant linkage may be present, and it is probable that the risk will occur over the long term.
Low/Unlikely	Contaminant linkage may be present and there is a possibility of the risk occurring, although there is no certainty that it will do so.
Negligible/ Not credible	Contaminant linkage may be present but the circumstances under which harm would occur are improbable.

An overall evaluation of the level of risk is gained from a comparison of the severity and probability, as shown in Table B.3 below:

Table B.3: Comparison of Severity and Probability					
		Severity			
		Severe	**Medium**	**Mild**	**Negligible**
Probability	**High likelihood**	Very High Risk	High Risk	Medium/Low Risk	Low Risk
	Medium/Reasonably Foreseeable	High Risk	Medium Risk	Low Risk	Near Zero
	Low/Unlikely	High/Medium Risk	Medium/Low Risk	Low Risk	Near Zero
	Negligible/ Not credible	Medium/Low Risk	Low Risk	Low Risk	Near Zero

The various risk rankings provide guidance for recommended actions, whether this is:

AR - Action Required, Remediation or mitigation or site investigation works required
SIR - Site Investigation Required, further assessment is required.
NAR - No Action Required.

A description of the evaluated risk is as follows:

Table B.4 – Description of the Classified Risks and Likely Action Required	
Evaluated Risk	**Recommended Actions**
Very High Risk	AR: 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 to a designated receptor is currently happening. This risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.
High Risk	AR: 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 (if not undertaken already) is required and remedial works may be necessary in the short term and are likely over the long term.
Medium Risk	SI: It is possible that harm could arise to a designated receptor from an identified hazard. However, it is relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer term.
Low Risk	NAR: It is possible that harm could arise to a designated receptor from an identified hazard, but there is a low likelihood of this hazard occurring and if realised, harm would at worst normally be mild.
Near Zero	NAR: There is a negligible possibility that harm could arise to a receptor. In the event of such harm being realised, it is not likely to be severe.

GENERIC QUANTITATIVE RISK ASSESSMENT

In the following sections the current UK guidance on risks to the following receptors are discussed: human health, plant life and controlled waters

- **Human Health**
  The overall methodology for assessing the risk to human health from potential contaminants in soil is set out in the Environment Agency's guidance "Using Soil Guideline Values" SC050021/SGV Introduction, March 2009 and using the CLEA 1.06 model software (and CLEA 1.071 for nickel). The generic assessment criteria are in accordance with the following:

  - Science Report SC050021/SR2: Human health toxicological assessment of contaminants in soil;
  - Science Report SC050021/SR3: Updated technical background to the CLEA model;
  - Science Report SC050021/SR4: CLEA Software (Version 1.071, 2014) & Handbook;
  - Toxicological reports and SGV technical notes;
  - Toxicological data published by LQM/CIEH (2009) and CL:AIRE/EIC/AGS (2009)
  - DEFRA Development of Category 4 Screening Levels for assessment of land affected by contamination - SP1010 (December 2013).
  - LQM/CIEH Suitable 4 Use Levels (S4ULs) for Human Health Risk Assessment
  - Toxicology review published by the European Food Safety Authority for nickel (2015)

  In March 2014 six 'proposed' Category 4 Screening Levels (pC4SL) were issued by Defra. These screening values are considered to be within Category 4 as defined in the Contaminated Land Statutory Guidance and indicate safe levels for new developments passing through the planning system. The SGV for lead has been withdrawn, and the pC4SL for lead has been derived using current best practice. In January 2015 LQM/CIEH published S4ULs for 89 contaminants in accordance with the C4SL methodology.

  Note that groundwater contamination may pose a risk to human health but that there are no relevant generic assessment criteria available for comparison. TerraConsult has derived our own assessment criteria for this.

- **Phytotoxic Risks**
  Generic assessment of phytotoxicity is by comparison with guideline values presented in the British Standard for Topsoil and the MAFF document "Code of Good agricultural practice for the protection of soil", October 1998. This is in accordance with CLR's reference to DEFRA notice CLAN 4/04.
- **Controlled Waters**
  Risks to controlled waters (groundwater and surface waters) from contaminants are assessed in accordance with the EA documents "The Environment Agency's Approach to Groundwater Protection" (2017) and Remedial Targets Methodology (RTM, 2006). Pollutant inputs from contaminated land sites are considered as passive inputs under the European Water Framework Directive (2000/60/EC) (WFD) and its daughter Directives, and as such are regulated under the Environment Agency's 'limit' pollution objective. Acceptable water quality targets (WQT) are defined for protection of human health (based on Drinking Water Standards (DWS)) and for protection of aquatic ecosystems (Environmental Quality Standards (EQS)). The risk posed to controlled waters from total soil concentrations cannot be directly assessed. The risk is assessed either by comparison of results of leachate tests carried out on soil samples, or from the direct testing of samples of groundwater to screening criteria. Leachate testing generally forms a conservative assessment and is not appropriate for organic contaminants.

CURRENT GUIDANCE ON INTERPRETATION OF CHEMICAL ANALYSIS OF SOILS

Contaminated land is defined under law through Part IIA of the Environmental Protection Act 1990, implemented through Section 57 of the Environment Act 1995. This supports a 'suitable for use' based approach to the risk assessment of potentially contaminated land. The site specific risk assessment is based upon assessment of plausible contaminant linkages, referred to as the contaminant-pathway-receptor model, based upon the current or proposed use of the site.

Before undertaking a risk assessment a conceptual site model is devised in order to identify the potential contaminants, pathways and receptors. The individual contaminants, pathways and receptors then need to be further investigated in order to refine the initial assessment and risk assessment undertaken.

In March 2002, the Department for Environment, Food and Rural Affairs (DEFRA) and the Environment Agency published the Contaminated Land Exposure Assessment (CLEA) Model and a series of related reports. These were designed to provide a scientifically based framework for the assessment of chronic risks to human health from contaminated land. These reports (CLR7-10) together with associated "SGV" documents were withdrawn and the following documents have been published as revised guidance to the CLEA assessment:

- Environment Agency : 2008: Using Soil Guideline Values SC050021/SGV Introduction, March 2008.
- Environment Agency : 2008: Science Report SC050021/SR2: Human health toxicological assessment of contaminants in soil.
- Environment Agency : 2008: Science Report SC050021/SR3: Updated technical background to the CLEA model.
- Environment Agency : 2008 : Compilation of Data for Priority Organic Contaminants for Derivation of Soil Guideline Values Science report SC050021/SR7
- Environment Agency : Science Report SC050021/SR4: CLEA Software (Version 1.071, 2015) & Handbook.
- DEFRA Development of Category 4 Screening Levels for assessment of land affected by contamination - SP1010 (December 2013).
- LQM/CIEH Suitable 4 Use Levels for Human Health Risk Assessment

Additional guidance on statistical assessment replacing CLR 7 is partly provided in:

- CL:AIRE: 2009: Guidance on Comparing Data With a Critical Concentration

A different approach to the statistical appraisal of data is required depending on whether the assessment of risk is to assess whether land is Contaminated Land in accordance with regulations, or whether the assessment is to assess whether the site is suitable for new development in according with Planning guidance. This is discussed further in CL:AIRE: 2009 "Guidance on Comparing Data With a Critical Concentration".

The introduction of the Contaminated Land (England) (Amendment) Regulations 2012 and Contaminated Land Statutory Guidance (DEFRA, 2012) reassessed the CLEA Model and the derived SGVs (and associated GACs calculated using the model). This re-assessment concluded that the SGVs/GACs were conservative screening criteria for determining the suitability of soil with regard to the risk to human health under the planning regime and defined a new upper limit for planning purposes which is the boundary between the new Category 3 and 4. In March and September 2014 DEFRA issued guidance on these new Category 4 Screening Levels (C4SL) and these are discussed further below.

Soil Guideline Values

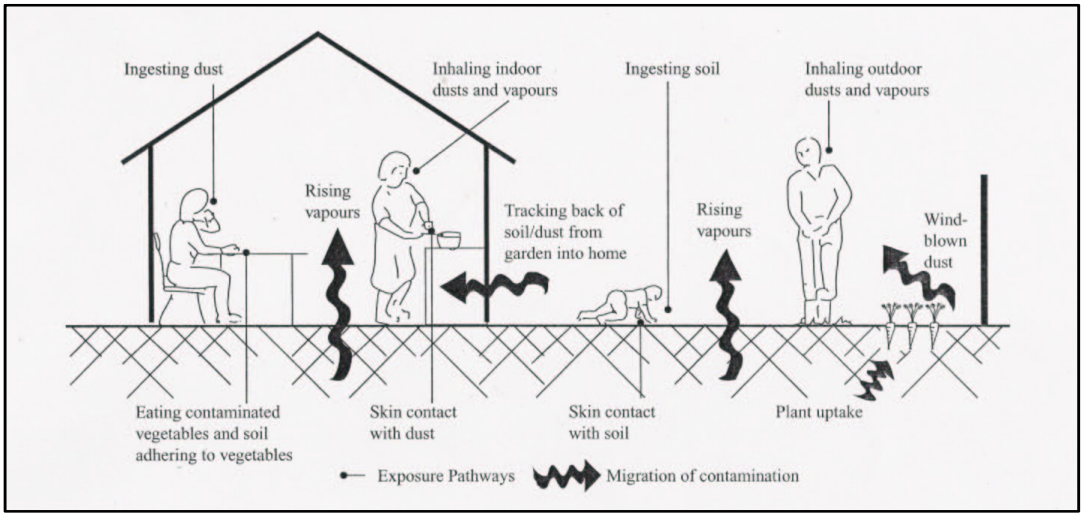
A program for the derivation of SGVs based on the above guidance is provided by the Environment Agency and is entitled "CLEA Software Version 1.06". These reports, together with supporting toxicology reviews ("Tox" or Supplementary Information Reports) for individual substances (which will be gradually updated), Soil Guideline Value Reports and other guidance referred to in the above documents, provide guidance and the scientific basis for assessing the risk to human health from potential contaminants. Soil Guideline Value Reports (SGV Reports) have been published for a number of contaminants and these are published on the Environment Agency website. Eventually the reports will include SGVs for:

- heavy metals and other inorganic compounds: arsenic, cadmium, chromium, cyanide, lead (now withdrawn), mercury nickel (now withdrawn), and selenium;
- benzene, ethylbenzene, toluene and xylenes;
- phenol;
- dioxins and dioxin-like polychlorinated biphenyls (PCBs);
- polycyclic aromatic hydrocarbons (PAHs) – 11 substances.

In September 2015, CLEA was re-issued as 'CLEA Version 1.071'. Currently, the software has been used to produce an in-house GAC for nickel, following with withdrawal of the SGV.

In addition CIEH through LQM and the EIC have published generic assessment criteria (GACs) for a wide variety of other parameters including metals, hydrocarbons, chlorinated aliphatic compounds, PAHs and explosive substances for three standard land uses. These have been produced to supplement the Environment Agency guidance. These GACs will be replaced by SGVs when or if the Environment Agency publishes any more SGVs.

The CLEA model has been developed to calculate an estimated tolerable daily soil intake (TDSI) for site users given a set 'default' exposure pathways. Ten human exposure pathways are covered in the CLEA model as presented below:



- **Ingestion**
  - ingestion of outdoor soil;
  - ingestion of indoor dust;
  - ingestion of home grown vegetables;
  - ingestion of soil attached to home grown vegetables.
- **Dermal Contact**
  - dermal contact with outdoor soil;
  - dermal contact with indoor dust.

- **Inhalation**
  - inhalation of outdoor dust;
  - inhalation of indoor dust;
  - inhalation of outdoor soil vapour;
  - inhalation of indoor soil vapour.

It should be noted that there are other potential exposure pathways on some sites not included in the CLEA model e.g. certain organic compounds can pass through plastic water pipes into drinking water supply.

The presence and/or significance of each of the above exposure pathways are dependent on the type of land use being considered and the nature of the contaminant under scrutiny. Accordingly, the CLEA model considers for principle 'default' land use types and makes a series of 'default' assumptions with regard to human exposure frequency, duration and critical human target groups for each land use considered:

- residential land use;
- allotments;
- commercial and industrial land use.

The land use categories defined in the CLEA are detailed below.

Residential: This land use category assumes that people live in a variety of dwellings including terraced, detached and semi-detached houses up to two storeys high. The structure of buildings varies. Default parameters for building materials and building design are included in CLEA documents to calculate the relevant multi-layer diffusion coefficients for vapour intrusion and to model indoor vapour intrusion. The CLEA model assumes that regardless of the style of housing the residents will have access to either a private garden or community open space nearby, and that soil tracked into the home will form indoor dust. It allows for the ingestion pathways from home grown vegetables.

Allotments: The CLEA model incorporates an assessment of land provided by local authorities specifically for people to grow fruit and vegetables for their own consumption. Consumption of such fruit and vegetables present several exposure pathways; plants absorb contaminants mainly via water uptake through roots, the contaminants move to edible portions of plants via translocation and contaminated soil particles become trapped in the skin and between leaves. At present the model fails to account for exposure through the consumption of animals, and their products (e.g. eggs), which have been reared on contaminated land.

Commercial/Industrial: Although there are a wide variety of workplaces and work-related activities, the CLEA assessment of this land-use assumes that work occurs in a permanent, three-storey structure, where employees spend most time indoors, conducting office-based or light physical work. The model assumes employees sit outside during breaks for most of the year. Limitations in applying this land-use to different industries is detailed in EA publication "Updated technical background to the CLEA model" (2011). The generic model assumes that the site would not be covered by hard standing. Risk of exposure to contaminants would be clearly less where commercial land is essentially all buildings and hard standing.

Based on the assumptions of each land use and the associated applicable exposure pathways, a 'Soil Guideline Value' (SGV) may be calculated for each contaminant under consideration for a particular land use in order to determine whether certain contaminant soil concentrations pose a significant risk to human health. The primary purpose of the CLEA SGVs are as 'trigger values' – indicators to a risk assessor that soil concentrations below this level require no further assessment as it can be assumed that the soil is suitable for the proposed use. Where soil concentrations occur above the SGV then further assessment of the results is required. The Contaminated Land (England) (Amendment) Regulations 2012 and Contaminated Land Statutory Guidance (DEFRA, 2012) which came into force in early April 2012 provides new clarity on the assessment of risk where soil concentrations exceed the SGV. The guidance introduces a four stage classification system relating to concentration of contaminants and the assessed risk which indicates appropriate actions. Category 1 and 2 sites are classified as "Contaminated Land" as defined in Part IIA of The Environmental Protection Act (1990). Category 3 and 4 sites are not considered as "Contaminated Land" in accordance with the Act. This can be explained using the figure on the following page.

There are also difficulties in establishing soil concentrations of contaminants beyond which risks from exposure to these contaminants would be 'unacceptable' and that they would lead to "significant possibility of significant harm" as defined in Part IIA of The Environmental Protection Act (1990) and determine that the land is "contaminated." This ultimately requires detailed 'toxicological' information of the health effects of individual contaminants and also a scientific judgement on what constitutes an 'unacceptable' risk. It is for local authorities or the Environment Agency to determine whether a particular site is contaminated land and it is for local Planning Authorities to determine whether land affected by contamination can be redeveloped.

Given the SGVs have been derived only for a limited number of contaminants and there was little prospect of further SGVs being published, two professional groupings have produced Generic Assessment Criteria (GACs) in accordance with the CLEA model for a large number of additional contaminants. These GACs were recognised in the new Contaminated Land Statutory Guidance (DEFRA, 2012) and have been produced as follows:

LQM/CIEH : 2009 Nathaniel CP, McCaffrey C, Ashmore MH, Cheng NPS GROUP, Gillett A, Ogden R & Scott D : 2009 . The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (2nd edition). Land Quality Press, Nottingham.

CL:AIRE/EIC/AGS: 2009 : Soil Generic Assessment Criteria (GAC) for Human Health Risk Assessment. Contaminated Land: Applications in Real Environments, Environment Industries Commission & Association of Geotechnical and Environmental Specialists. December 2009.

Category 4 Screening Levels and LQM/CIEH Suitable 4 Use Levels

For new developments progressing through the planning regime, it is desirable that the soil concentrations are within Category 4 where there is a valid contaminant linkage. The upper boundary between Category 4

and 3 is not defined in the guidance. This boundary can also be better defined by carrying out a Detailed Quantified Risk Assessment (DQRA) and this is discussed later in this appendix.

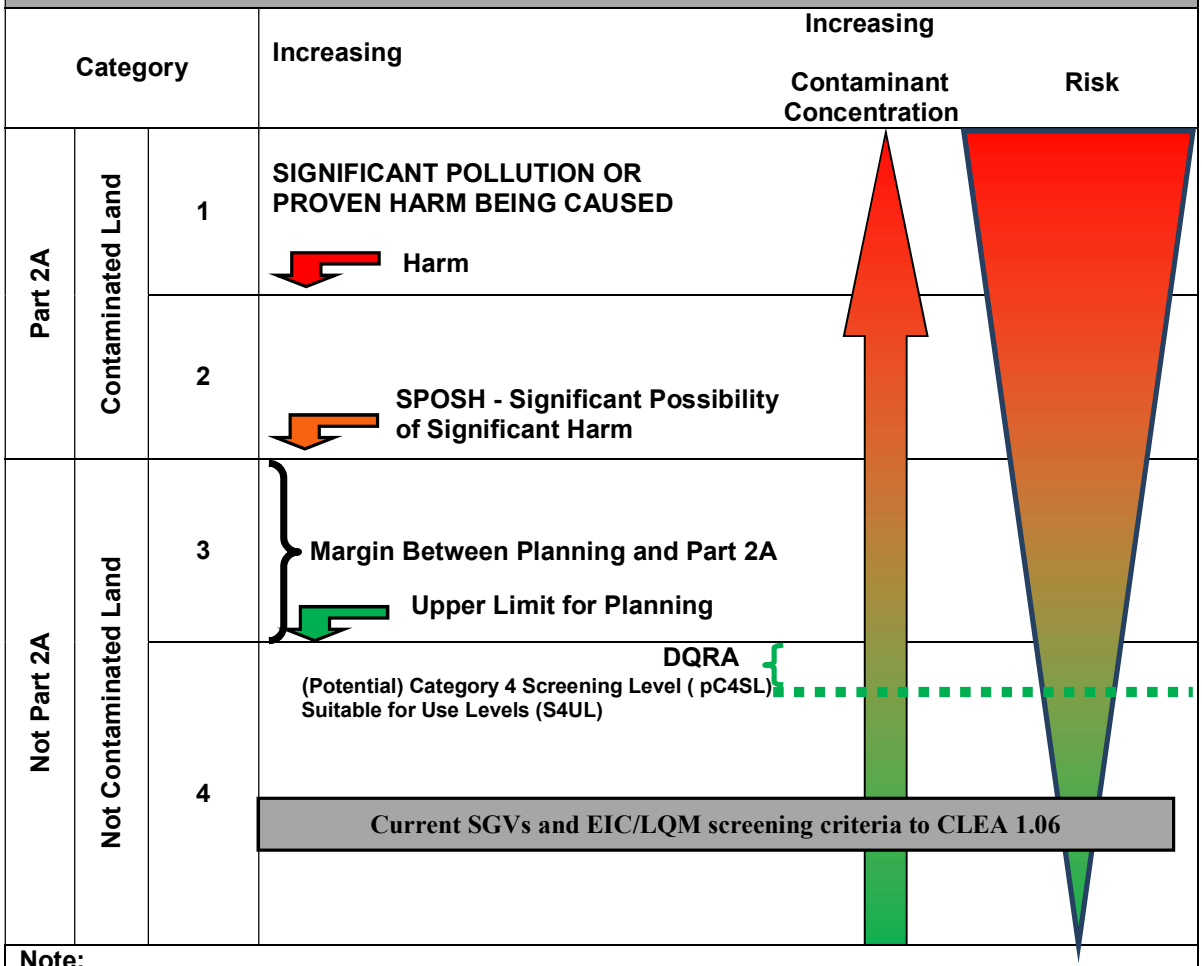
In December 2013 Defra issued the findings of a research project undertaken by CL:AIRE to set out the framework by which potential Category 4 Screening Levels (pC4SL) may be derived. The report was not designed to produce 'final' C4SL as the steering group producing the report believes that final C4SL should be set by a 'relevant authority' (e.g. Defra), the toxicological framework proposed has not been reviewed by the Committee on Toxicity and the document has yet to be subject to peer review.

In March 2014, appendices to the main Defra report were published detailing the derivation of pC4SL for 6 contaminants and other appendices regarding a review of the CIEH/CL:AIRE statistics guidance and sensitivity analysis. For each contaminant, a range of pC4SL have been produced relating to modifying toxicological parameters only, modifying exposure parameters only or by modifying both. It should be noted that the pC4SL produced for lead (the SGV was withdrawn in 2011) has undertaken a relatively large toxicological review in relation to modelling blood lead concentrations. pC4SL have been produced for:

- Arsenic;
- Benzene;
- Benzo(a)pyrene (as a surrogate marker for PAHs);
- Cadmium;
- Chromium (VI); and
- Lead

As previously discussed the values were initially published as 'potential' C4SL but have become 'final' following DEFRA having issued a policy decision letter indicating that they are to be used in the planning regime (letter of 3rd September 2014). It is considered that the pC4SL provide a simple test for deciding whether land is suitable for use without any remediation. The pC4SL represent a new set of screening levels that are more pragmatic (but strongly precautionary) compared to the existing soil guideline values (SGVs and the other GACs calculate in accordance with the existing CLEA methodology). The pC4SL provide cautious estimates of contaminant concentrations in soil that are still considered to present an acceptable level of risk, within the context of Part 2A, by combining information on toxicology, exposure assessment and normal levels of exposure to these contaminants. pC4SL values should not be seen as 'SPOH values.' Exceeding a pC4SL means that further investigation is required, not that the land is necessarily contaminated. In January 2015, LQM published Suitable 4 Use Levels (S4ULs) for a further 89 contaminants using the Defra C4SL methodology. In a similar manner to the pC4SLs, no authoritative review has been undertaken although the approach and quality of the work undertaken is widely accepted as being of high quality.

Relationship Between Contaminant Concentration, Risk and Screening Values



Note:
The vertical scale should not be considered as being linear and will be site and contaminant specific.

- SPOSH concentrations could be 10 to 100 times the SGV/EIC/LQM screening concentration.
- C4SL were issued as 'potential' but have become 'final' following DEFRA having issued a policy decision letter indicating that they are to be used in the planning regime (letter of 3rd September 2014).

Lead

The SGV for lead was withdrawn in 2011 and is not used in this report. The pC4SL for lead provides a technically robust and conservative assessment tool using significantly updated toxicological modelling in line with current scientific understanding of lead toxicology.

Nickel

The SGV for nickel was withdrawn in 2015 and is not used in this report. In-house GACs for nickel have been produced using the updated toxicological review by the EFSA and the CLEA 1.071 software.

Public Open Space

The Defra report (December 2013) has also introduced exposure scenarios for two other commonly occurring land uses which require assessment (under the planning and Part 2A regimes) on a relatively frequent basis. These exposure scenarios are:

- Public Open Space – Space Near Residential Housing (POS_{resi}); and
- Public Open Space – Public Park (POS_{park}).

Potential use of pC4SL relating to Public Open Space (POS) require care due to the significant variability in exposure characteristics. For example, POS may include:

- Children's play areas, public parks where children practise sport several times a week and teenagers only once a week;
- Grassed areas adjacent to residential properties which are rarely used;
- Dedicated sports grounds where exposure is only to players and groundworkers; and
- Nature reserves or open ground with low level activity (for example, dog walking).

Within the Defra report (December 2013) the following exposure scenarios have been modelled as these are considered the most important for potential exposure for the critical receptor i.e. young children:

- Green open space close to housing, including tracking back of soil (POS_{resi}); and
- Park-type scenario where distance is considered sufficient to discount tracking back of soil (POS_{park}).

Detailed Quantified Risk Assessment (DQRA)

SGVs, GACs, pC4SL and S4ULs are based on a number of basic assumptions. There are two main options for developing Site Specific Assessment Criteria (SSAC) by adjusting the CLEA model so that they have greater relevance to the site:

- **Simple adjustment of the generic SGV / C4SL model**. Such adjustment is restricted to the choice of exposure routes selected for the generic land use, building type, soil type and soil organic matter content within the CLEA software.

- **Detailed adjustment.** It may be relevant to make greater modifications to the model due to the specific use of the land in question. This can include modification to any parameter value, including exposure assumptions, building parameters, and the choice and application of fate and transport models. This is equally relevant to site-specific modifications of existing generic land uses, the development of new land uses, and the inclusion of additional exposure pathways. Much of this can be undertaken using the CLEA software. Depending on the complexity of the detailed adjustments required, it may be necessary to use other tools either alone or in conjunction with the CLEA software. Both options should follow established protocols for DQRA and require sufficient justification and supporting information for the adjustments made. Detailed adjustments are likely to require substantially greater technical justification and supporting documentation, especially if modifications are based on information not contained within the SGV framework documents.

The two choices present the risk assessor with three options/decisions:

(1) Use a published SGV/GAC/pC4SL/S4UL if it can be demonstrated that the assumptions inherent in the value are appropriate to the site in question. If they are not, proceed to either option 2 or 3 below.

(2) Make simple site-specific adjustments to the generic exposure model used to derive the SSAC. Three examples of when this could be appropriate are:

a. High density residential development with no exposed contaminated soil at surface. It is appropriate in this case to consider the relevance of direct contact pathways and consumption of homegrown produce.

b. Soil type is significantly different (specifically when soil type is likely to be less protective e.g. made ground) to that assumed in the SGV/GAC/pC4SL/S4UL.

c. Soil organic matter content is significantly different to that assumed in the derivation of the SGV/GAC/pC4SL/S4UL.

(3) If simple adjustments are not sufficient to reflect site conditions, undertake a DQRA. This may be undertaken using the CLEA software or by using an alternative risk assessment methodology that is relevant, appropriate, authoritative and scientifically based. Changes to toxicological end points may also be considered, although this should only be undertaken by an toxicology expert. In the context of this guidance, simple adjustments of a generic land use scenario for soil type or SOM content for example are not considered sufficient to be classed as a DQRA.

DQRAs should be conducted with the agreement of the local authority (or the Environment Agency) since it is the authority that determines whether land is Contaminated Land or whether Planning Permission for a new development may be granted.

Representative Data

The type, quantity and quality of the available soil data influence the method chosen to obtain a site representative soil concentration that is compared with a SGV/GAC/pC4SL/S4UL in the screening process. The soil data should be representative of the exposure scenario being considered. This can include factors such as:

- averaging area over which exposure occurs;
- sample depth;
- heterogeneity of soil

where the 'averaging area' is defined as:

> *That area (together with a consideration of depth) of soil to which a receptor is exposed or which otherwise contributes to the creation of hazardous conditions'.*

Site investigations take discrete samples from a given area (and to a certain depth). It has to be assumed that these samples are to some degree representative of the contaminant concentration throughout that volume of soil. The critical soil volume (taking into account area and depth) which might be usefully compared with a SGV/GAC/pC4SL/S4UL is a site-specific decision, but a starting point is the generic land use scenarios used in the derivation of the SGV/GAC/pC4SL/S4UL. The critical soil volume depends on two factors:

- Contaminant distribution and vertical profile (bands of highly contaminated material or lateral hot spots should not necessarily be averaged out with more extensive cleaner areas of soil without justification)
- Contribution to average exposure underpinning the SGV. Direct contact exposure pathways depend on the adult or child coming into contact with near-surface soils and the area over which that exposure occurs is usually important (i.e. the averaging area). Vapour pathways are less dependent on surface area, for example vapour intrusion may result from a highly concentrated

hot spot beneath a building leading to elevated average indoor air concentrations. For the three standard land uses for which SGVs are derived, relevant considerations are:

- For the standard **residential or allotment land use**, the critical soil volume is the area of an individual garden, communal play area or working plot from the surface to a depth of between 0.5m and 1.0m. This is the ground over which children are most likely to come into contact with soil or from which vegetable and fruit produce will be harvested. In the case of volatile contaminants, it may also be appropriate to consider the volume of soil underneath the footprint of the building although vapour intrusion may be driven by a soil volume much smaller than this if the contaminant source is highly concentrated.
- For the standard **commercial land use**, the critical soil volume has to be decided on a case-by-case basis due to the wide range of possible site layouts. However, for non-volatile contaminants, landscaped and recreational areas around the perimeter of office buildings are likely to be most important. For volatile contaminants, the footprint occupied by the building itself should also be considered.
- For **most exposure pathways**, the contamination is assumed to be at or within one metre of the surface.

The use of averaging areas must be justified on the basis of relevance to the exposure scenario. SGVs are relevant only when the exposure assumptions inherent in them are appropriate for the identified exposure averaging area. Further guidance on critical soil volumes and the consideration of averaging exposure areas can be found in:

- *Secondary model procedure for the development of appropriate soil sampling strategies for land contamination (Environment Agency, 2000);*
- *Guidance on comparing soil contamination data with a critical concentration (CIEH/CL:AIRE, 2009); and*
- *Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Appendix I (Defra December 2013, March 2014)*

It is the mean soil concentration for the individual contaminant within an individual averaging area, which is compared to the SGV. However, as contaminant concentrations vary across a site, and sampling and analysis will introduce measurement errors, the comparison between measured mean concentration and the SGV must take this uncertainty into account.

There are two principal options available to obtain site representative soil concentrations from a site investigation dataset; statistical and non-statistical methods. Data objectives, quality and quantity are likely to determine which approach is most appropriate. If statistical methods such as those presented in CIEH/CL:AIRE (2011) are to be used, sufficient data need to be available or obtained. No one single statistical approach is applicable to all sites and circumstances. The wider range of robust statistical techniques developed by organisations including the US Environmental Protection Agency (USEPA) are also important tools. Risk assessors should choose an appropriate statistical approach on the basis of the specific site and the decision that is being made. For further guidance on the appropriate use of statistical approaches, refer to USEPA 2006 or good environmental monitoring statistics textbooks.

When statistical approaches are inappropriate (this will depend on the objectives of the site investigation), individual or composite samples should be compared directly to the SGV. Guidance on use of alternative data handling approaches such as the use of composite sampling can be found in documents such as:

- *Verification of remediation of land contamination* (Environment Agency, 2010);
- *Sampling and testing of wastes to meet landfill Waste Acceptance Criteria* (Environment Agency, 2005);
- *Guidance on choosing a sampling design for environmental data collection* (USEPA, 2002);
- *Soil Quality – Sampling, ISO 10381 series* (ISO, 2002–2007).

The statistical tests should not be used as arbiters for decisions under Part 2A. They are an additional, useful line of evidence to assist in decision-making. The implications of the basis for the derivation of the site representative soil concentration must be taken into account in any decision-making process and clearly documented.

Where the statistical tests are conducted in accordance with the method described in CL:AIRE 2009:

- For the Planning situation, it has to be demonstrated that the concentration of contaminants is low compared to the pC4SL/S4UL or SSAC. All of the test data should be below the screening criteria and no statistical analysis is required or if there are exceedances of the criteria then a statistical assessment is required. For the statistical assessment this decision is based on whether there is at least a 95% confidence level that the true mean of the dataset is lower than the screening criteria.
- For the Part 2A scenario the regulator needs to determine whether the concentration of contaminants is greater than the SGV/GAC/pC4SL/S4UL or SSAC. This decision is based on whether there is at least a 95% confidence level that the true mean of the dataset is higher than the SSAC. However, the regulator may proceed with determination if there is just a 51% probability, "on the balance of probabilities."

If the screening levels are exceeded then more sophisticated quantitative risk assessment can be undertaken or remedial action may be taken to break the contaminant linkages. The benefits of undertaking a quantitative risk assessment must be weighed against the likelihood that it will bring about cost savings in the proposed remediation. Further information about the use of soil guideline values is provided in Environment Agency : 2008: Using Soil Guideline Values SC050021/SGV Introduction, March 2008.

GENERIC RISK ASSESSMENT CRITERIA FOR RISK TO PLANTS

Soil contaminants, if present at sufficient concentrations, can have an adverse effect on the plant population. Phytotoxic effects can be manifested by a variety of responses, such as growth inhibition, interference with plant processes, contaminant-induced nutrient deficiencies and chlorosis (yellowing of leaves). All chemicals are probably capable of causing phytotoxic effects. Thus the phytotoxic potential of substances is dependent on the concentrations capable of having adverse effects on plants and the concentrations likely to be found at contaminated sites. Phytotoxicity is a difficult parameter to quantify given that experimental techniques vary widely and variations exist in plant tolerances, soil effects and synergistic/antagonistic reactions between chemicals. Contaminants may be taken up and accumulated by plants through a range of mechanisms. The principal pathways are active and/or passive uptake through the plant root, adsorption to root surfaces and volatilisation from the soil surface followed by foliar uptake. After plant uptake, contaminants may be metabolised or excreted, or they may be bioaccumulated and this is highly species dependant. Many of the substances capable of adversely affecting vegetation exert this effect because of their water solubility, a characteristic that could result in their transport from contaminated sites into adjacent locations where the chemical may generate a phytotoxic response. This could be important if, for example, the adjacent site has important conservation status.

The concentration in soil at which substances become phytotoxic depend on a range of factors including plant type, soil type, pH, the form and availability of the contaminant and other vegetation stress factors that may be present (such as drought). Some plants (including some rare plants will only grow in soils where there are relatively high concentrations which would be phytotoxic to other species. Whilst many contaminants may be phytotoxic, data are limited. Some heavy metals are essential as trace elements for plant growth but may become toxic at higher concentrations.

TerraConsult has carried out a review of a number of current and former guidance documents and other texts on phytotoxicity. It is not possible to produce a definitive list of phytotoxic substances on account of the variables mentioned above. However, a number of metals are repeatedly cited as commonly occurring priority pollutants. As a result, the following list is adopted by TerraConsult as indicators of the potential for

phytotoxicity: As, Cr, Cu, Ni and Zn (note that Boron has been excluded from this list because the more modern studies do not assess this).

As the CLEA framework is a risk based approach, applied to humans, an alternative strategy is required to assess the risk to plants from substances that are phytotoxic. Reference to published criteria and background concentrations can help put site data into context. Published assessment criteria for the protection of plant life from a number of countries are given in the following Table. The most authoritative source is the British Standard for topsoil, but this only lists three elements. CLR 11 states that the ICRCL Guidance Note 70/90 can be used for initial screening criteria. This approach has been adopted by TerraConsult where BS3882 is lacking, but where an ICRCL 70/90 criterion is lacking, the lowest criterion in Table below from, firstly UK, and, secondly, European and then other worldwide criteria. The adopted criteria are highlighted in the table 3.8. The MAFF value of 250 mg/kg has been chosen for As over the ICRCL value of 50 mg/kg as MAFF explains the 50 is applicable to vegetables and human health, whereas 250 is applicable to the plants themselves.

Table B.5: Published Assessment Criteria for Phytotoxic Elements (mg/kg)							
Reference	**As**	**CR (Total)**	**Cr (III)**	**Cr (VI)**	**Cu**	**Ni**	**Zn**
British Standard for topsoil (BS3882:2007)	-	-	-	-	200 (pH >7) 135 (pH 6-7) 100 (pH 5.5-6.0)	110 (pH >7) 75 (pH 6-7) 60 (pH 5.5-6.0)	300 (pH >7) 200 (pH 6-7) 200 (pH 5.5-6.0)
MAFF Code of Good Agricultural Practice for the Protection of Soil (1998)	250	-	400 for sites containing sewage and sludge	-	500 (grass) but may fall to 250 for clover and sensitive species (at pH>6)	110 (pH>7) 75 (pH 6-7) 60 (pH 5.5-6.0)	1000 (clover & grass at pH 6), may fall to 300 for sensitive species (at pH 6-7)
ICRCL 59/83 (1987) now withdrawn for human health assessment	-	-	-	-	130	70	300
ICRCL 70/90 (1990) threshold trigger value	50	-	-	25 *	250	-	1000
Dutch ecotoxicological intervention value (Swartjes 1993 & 1994)	40	230	-	7	190	-	-
Australian Guideline B(1) (1999), Interim Urban Ecological Investigation Level (EIL). Soils not generally considered phytotoxic below these EILs.	20	-	400	1	100	60	200
New Zealand guidelines for timber treatment sites (1977), estimated based on Cu bioavailability *	-	-	-	-	500 - 1000 clay soils	-	-
New Zealand guidelines for timber treatment sites (1977), soil criteria for protection of plant life (residential/ agricultural setting)	10-20	-	600	25	130	-	-
Note: * Cr (VI) is only likely to be present in as a significant proportion of total Cr where pH >12 so this does not routinely need to be tested for regarding plant health.							

GLOSSARY

TERMS		UNITS	
AST	Above Ground Storage Tank	m	Metres
BGS	British Geological Survey	km	Kilometres
BSI	British Standards Institute	%	Percent
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes	%v/v	Percent volume in air
CIEH	Chartered Institute of Environmental Health	mb	Milli Bars (atmospheric pressure)
CIRIA	Construction Industry Research Association	l/hr	Litres per hour
CLEA	Contaminated Land Exposure Assessment	ha	Hectare (10,000 m^2)
CSM	Conceptual Site Model	µg/l	Micrograms per Litre (parts per billion)
DNAPL	Dense Non-Aqueous Phase Liquid (chlorinated solvents, PCB)	ppb	Parts Per Billion
DWS	Drinking Water Standard	mg/kg	Milligrams per kilogram (parts per million)
EA	Environment Agency	ppm	Parts Per Million
EQS	Environmental Quality Standard	mg/m^3	Milligram per metre cubed
GAC	General Assessment Criteria	Mg/m^3 cubed	Megagram per metre
GL	Ground Level	$µg/m^3$	Microgram per metre cubed
GSV	Gas Screening Value	m bgl Level	Metres Below Ground
HCV	Health Criteria Value	m bcl	Metre Below Cover Level
LNAPL	Light Non-Aqueous Phase Liquid (petrol, diesel)	mOD	Metres Above Ordnance Datum (sea level)
ND	Not Detected	kN/m^2	Kilo Newtons per metre squared
LMRL	Lower Method Reporting Limit	kPa kN/m^2	Kilo Pascal – same as
NR	Not Recorded	µm	Micro metre
OD	Ordnance Datum		
PAH	Poly Aromatic Hydrocarbon		
PCB	Poly-Chlorinated Biphenyl		
PID	Photo Ionisation Detector		
PCSM	Preliminary Conceptual Site Model		
SGV	Soil Guideline Value		
TPH (CWG)	Total Petroleum Hydrocarbon (Criteria Working Group)		
SPT	Standard Penetration Test		
SVOC	Semi Volatile Organic Compound		
UST	Underground Storage Tank		
VCCs	Vibro Concrete Columns	VSCs	Vibro Stone Columns
VOC	Volatile Organic Compound		

APPENDIX C

Exploratory Hole Records – 2018 Exploratory Hole Logs

Trial Pit Log

TerraConsult

Personnel:		Equipment & methods:		Dimensions:		Coordinates & level:	Dates:	
Logged by:	GB	Method:	Machine excavated	Width:	0.63		Start:	04/10/2019
Checked by:				Length:	1.45		End:	04/10/2019
		Plant:	5T tracked excavator	**Orientation:**			Logged:	04/10/2019
		Shoring:		Bearing =		Grid:		

Backfill/ Instal'n	Water-strike	Legend	Level & Depth (Thickness)	Stratum Description	Samples & In Situ Testing: Depth	Type & No	Results
			(0.40)	Dark grey silty sandy fine angular to subrounded fine to medium GRAVEL of predominanly ash with brick, ceramic, pottery and rare glass. (Made Ground)			
			0.40	Soft brown sandy CLAY.			
			0.60	Very soft light brown slightly sandy CLAY.			
			(0.90)				
			1.50	Trial pit ends at 1.50m (Target depth)			

Depth	Type & No	Results

Groundwater entries:

Depth:	Rose to:	Remarks:

Depth related remarks:

From	to:	Remarks:

General remarks:

Weather:

Stability: Unstable within the Made Ground

Remarks:

AGS

Notes: For explanation of symbols and abbreviations see Key Sheet. All depths and reduced levels are in metres.

Log issue:

Scale: 1:25

Project: English Martyrs

Project No: 4738

Client: MAI Construction

Exploratory position reference:

TP01

Trial Pit Log

TerraConsult

Personnel:		Equipment & methods:		Dimensions:		Coordinates & level:	Dates:	
Logged by:	GB	Method:	Machine excavated	Width:	0.57		Start:	04/10/2019
Checked by:				Length:	1.12		End:	04/10/2019
		Plant:	5T tracked excavator	**Orientation:**			Logged:	04/10/2019
		Shoring:		Bearing =		Grid:		

Backfill/ Instal'n	Water-strike	Legend	Level & Depth (Thickness)	Stratum Description	Samples & In Situ Testing		
					Depth	Type & No	Results
			(0.70)	Dark grey silty sandy fine angular to subrounded fine to medium GRAVEL of predominanly ash with brick, ceramic, tile and rare metal. (Made Ground)			
			0.70				
			(0.70)	Very soft light brown sandy slightly gravell CLAY. Gravel is subangular to subrounded fine sandstone and siltstone.			
			1.40	Trial pit ends at 1.40m (Target depth)			
					Depth	Type & No	Results

Groundwater entries:

Depth: Rose to: Remarks:

Depth related remarks:

From to: Remarks:

General remarks:

Weather:

Stability: Unstable within the Made Ground

Remarks:

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths and reduced levels are in metres.

Log issue:

Scale: 1:25

Project: English Martyrs

Project No: 4738

Client: MAI Construction

Exploratory position reference:

TP02

Sheet 1 of 1

Borehole Log

TerraConsult

Borehole formation details: | **Location details:**

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Barrel type:	Drill Bit:	Logged:	Logger:	Remarks:	
IP		0.50	04-10-19	04-10-19		Hand digging tools			04-10-19	GB		Grid:

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (thick-ness)	Stratum Description	Samples & In Situ Testing: Water	Casing	Depth	Type & No	Results/Remarks
				(0.50)	Dark brown clayey gravelly fine to coarse SAND with a medium to high cobble content of brick and wood. Gravel is predominantly subangular to subrounded fine to coarse brick with concrete and wood.					
				0.50	(Made Ground)					
					Borehole ends at 0.50m (Unable to deepen)					

	Inst (Ø)					Water	Casing	Depth	Type & No	Results

Groundwater entries:

Struck:	Rose to:	Casing:	Sealed:

Diameter & casing:

Dia (mm):	Depth:	Casing:

Depth related remarks:

From:	To:	Remarks:

Chiselling details:

From:	to:	Duration:	Tool:

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths and reduced levels are in metres.

Log issue:

Scale: 1:50

Project: English Martyrs

Project No: 4738

Client: MAI Construction

Exploratory position reference:

HP01

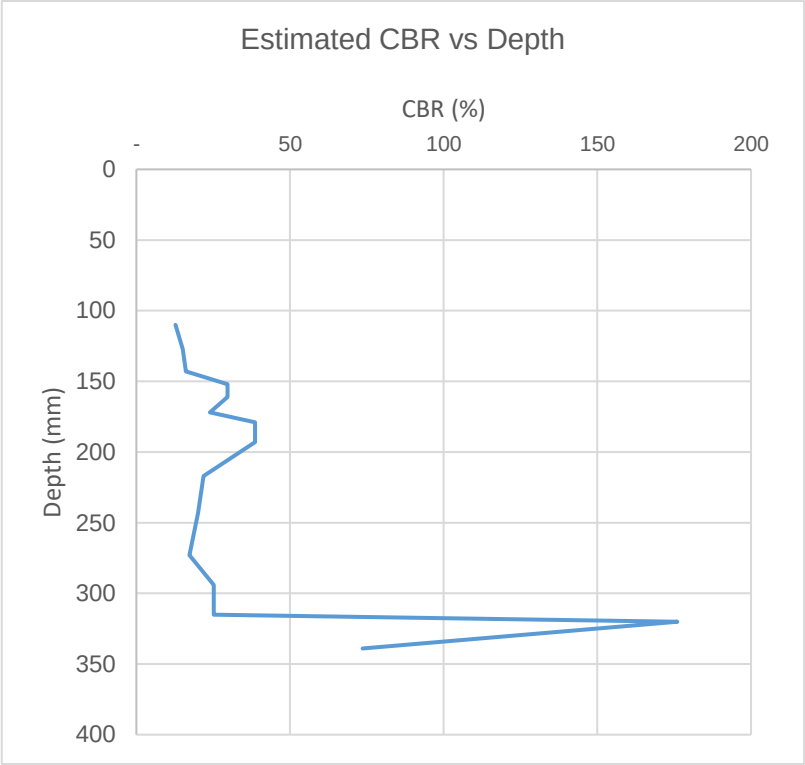
Sheet 1 of 1

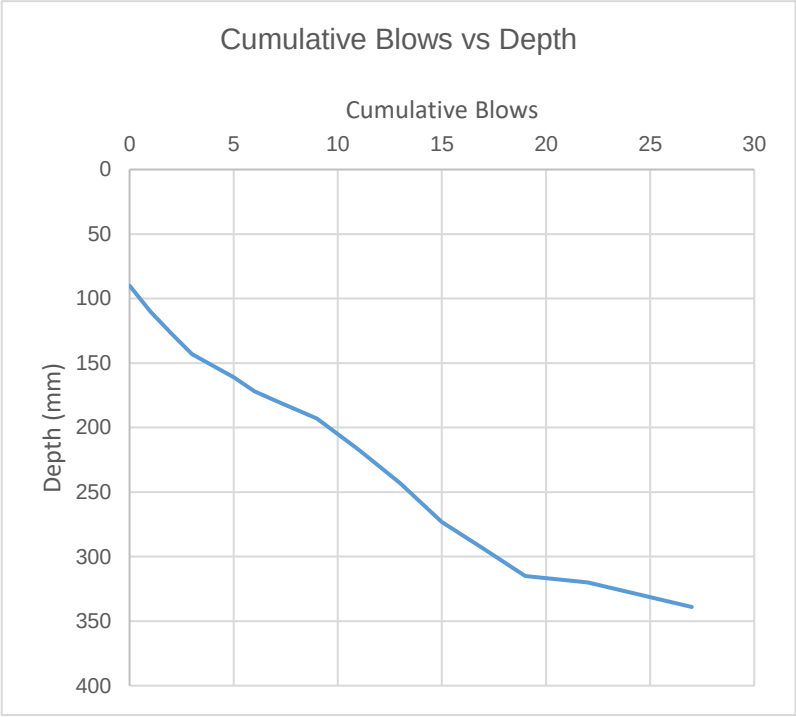
IN SITU CBR (TRRL DCP)

TerraConsult

Operator:	Date:	Weather:	Remarks:	Location:
GB	04/10/2019	Cloudy/ Overcast		mE:
				mN:
Chkd by:	Start depth:	Surface layer:	Zero reading (mm):	Termination reason:
DD	90		90	mAOD:
				Grid:

Depth to top of increment:	Cumulative blows:	Cumulative pen (mm):	Increment blows:	Increment pen (mm):	mm per blow:	Layer CBR (%)
90	0	0	0	0		
110	1	20	1	20	20.00	
127	2	37	1	17	17.00	15
143	3	53	1	16	16.00	
152	4	62	1	9	9.00	
161	5	71	1	9	9.00	
172	6	82	1	11	11.00	32
179	7	89	1	7	7.00	
193	9	103	2	14	7.00	
217	11	127	2	24	12.00	
243	13	153	2	26	13.00	
273	15	183	2	30	15.00	22
294	17	204	2	21	10.50	
315	19	225	2	21	10.50	
320	22	230	3	5	1.67	>100
339	27	249	5	19	3.80	74





AGS

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths in meters.

Issue: Draft

Project: English Martyrs
Project No: 4738
Client: MAI Construction

Test reference:

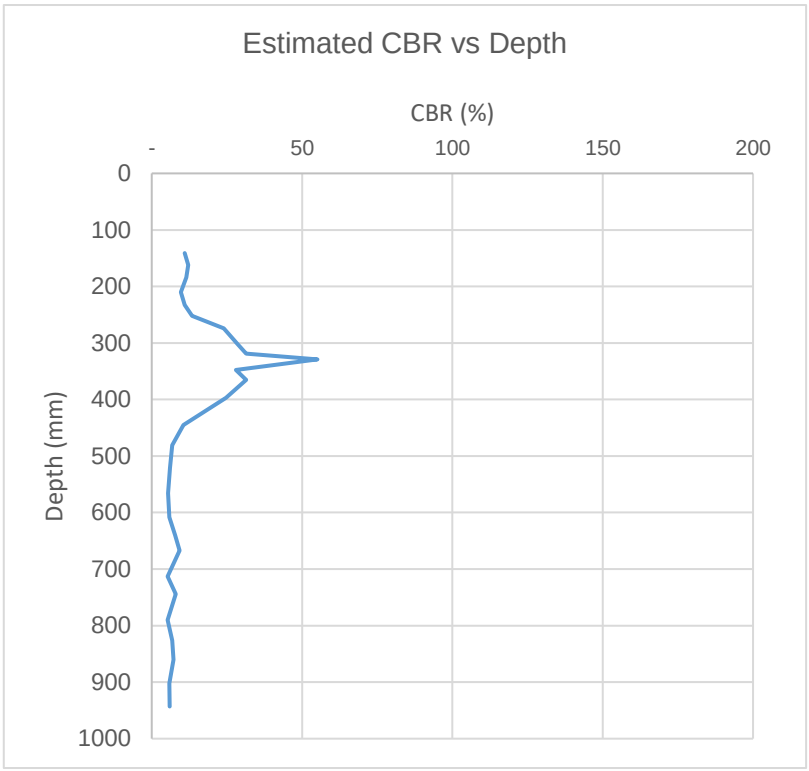
DCP1

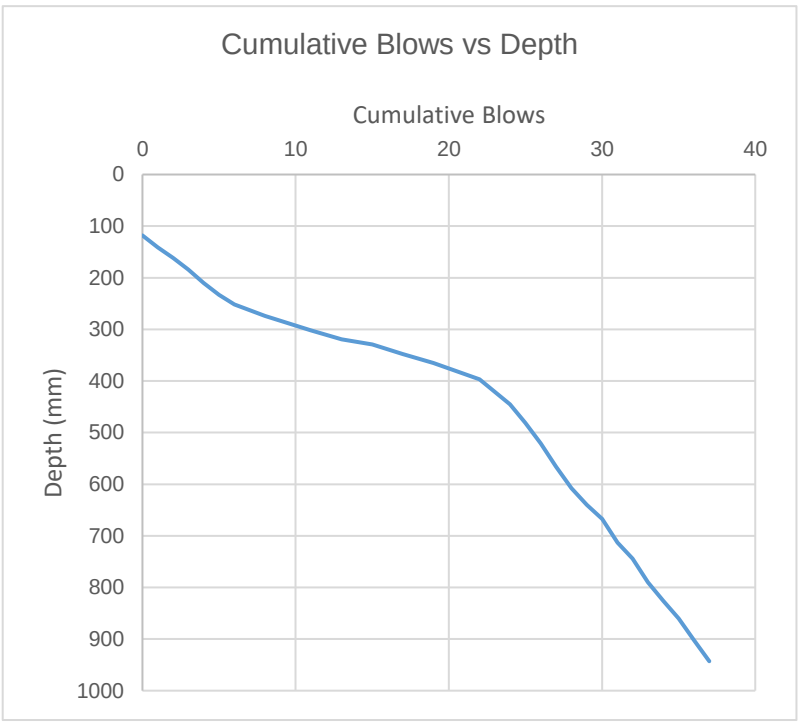
IN SITU CBR (TRRL DCP)

TerraConsult

Operator:	Date:	Weather:	Remarks:	Location:
GB	04/10/2019	Cloudy/ Overcast		mE:
				mN:
Chkd by:	Start depth:	Surface layer:	Zero reading (mm):	Termination reason:
DD	118		118	mAOD:
				Grid:

Depth to top of increment:	Cumulative blows:	Cumulative pen (mm):	Increment blows:	Increment pen (mm):	mm per blow:	Layer CBR (%)
118	0	0	0	0		
141	1	23	1	23	23.00	
162	2	44	1	21	21.00	
184	3	66	1	22	22.00	
210	4	92	1	26	26.00	11
233	5	115	1	23	23.00	
252	6	134	1	19	19.00	
274	8	156	2	22	11.00	
302	11	184	3	28	9.33	
319	13	201	2	17	8.50	
329	15	211	2	10	5.00	32
348	17	230	2	19	9.50	
365	19	247	2	17	8.50	
397	22	279	3	32	10.67	
445	24	327	2	48	24.00	
481	25	363	1	36	36.00	
521	26	403	1	40	40.00	
566	27	448	1	45	45.00	
608	28	490	1	42	42.00	
640	29	522	1	32	32.00	
667	30	549	1	27	27.00	7
713	31	595	1	46	46.00	
744	32	626	1	31	31.00	
790	33	672	1	46	46.00	
826	34	708	1	36	36.00	
860	35	742	1	34	34.00	
902	36	784	1	42	42.00	
943	37	825	1	41	41.00	





AGS

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths in meters.

Issue: Draft

Project: English Martyrs
Project No: 4738
Client: MAI Construction

Test reference:

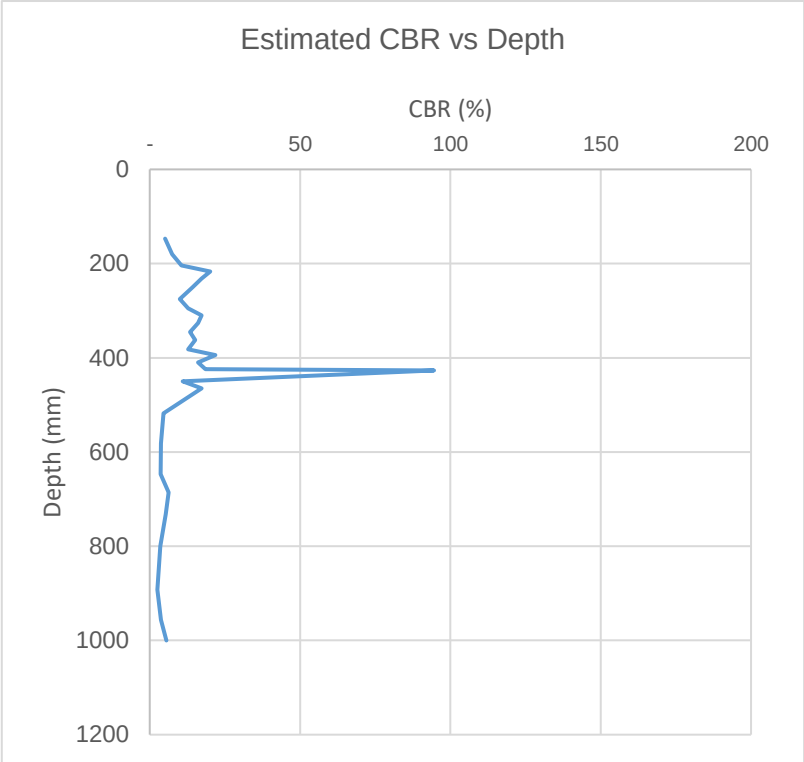
DCP2

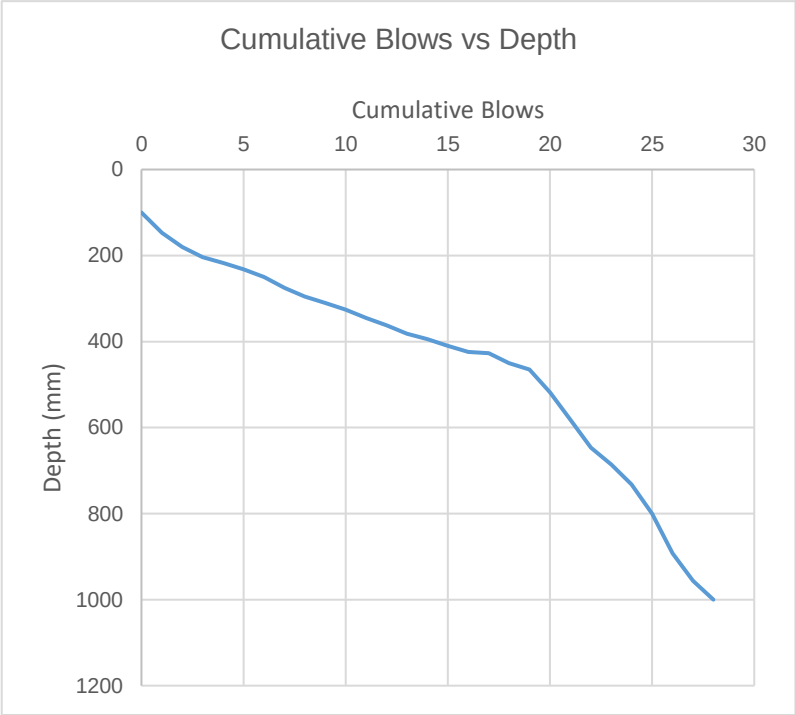
IN SITU CBR (TRRL DCP)

TerraConsult

Operator:	Date:	Weather:	Remarks:	Location:
GB	04/10/2019	Cloudy/ Overcast		mE:
				mN:
Chkd by:	Start depth:	Surface layer:	Zero reading (mm):	Termination reason:
DD	100		100	mAOD:
				Grid:

Depth to top of increment:	Cumulative blows:	Cumulative pen (mm):	Increment blows:	Increment pen (mm):	mm per blow:	Layer CBR (%)
100	0	0	0	0		
147	1	47	1	47	47.00	6
180	2	80	1	33	33.00	
204	3	104	1	24	24.00	
217	4	117	1	13	13.00	
232	5	132	1	15	15.00	
250	6	150	1	18	18.00	
275	7	175	1	25	25.00	
295	8	195	1	20	20.00	
310	9	210	1	15	15.00	15
326	10	226	1	16	16.00	
345	11	245	1	19	19.00	
362	12	262	1	17	17.00	
382	13	282	1	20	20.00	
394	14	294	1	12	12.00	
410	15	310	1	16	16.00	
424	16	324	1	14	14.00	
427	17	327	1	3	3.00	95
450	18	350	1	23	23.00	14
465	19	365	1	15	15.00	
518	20	418	1	53	53.00	
582	21	482	1	64	64.00	
647	22	547	1	65	65.00	
686	23	586	1	39	39.00	
732	24	632	1	46	46.00	4
800	25	700	1	68	68.00	
892	26	792	1	92	92.00	
956	27	856	1	64	64.00	
1000	28	900	1	44	44.00	





AGS

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths in meters.

Issue: Draft

Project: English Martyrs
Project No: 4738
Client: MAI Construction

Test reference:

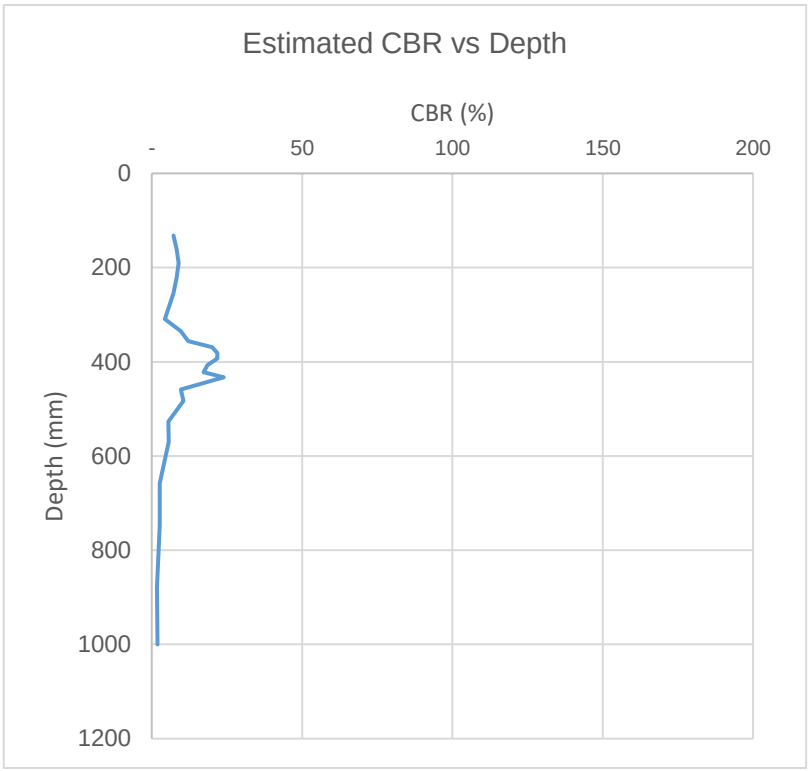
DCP3

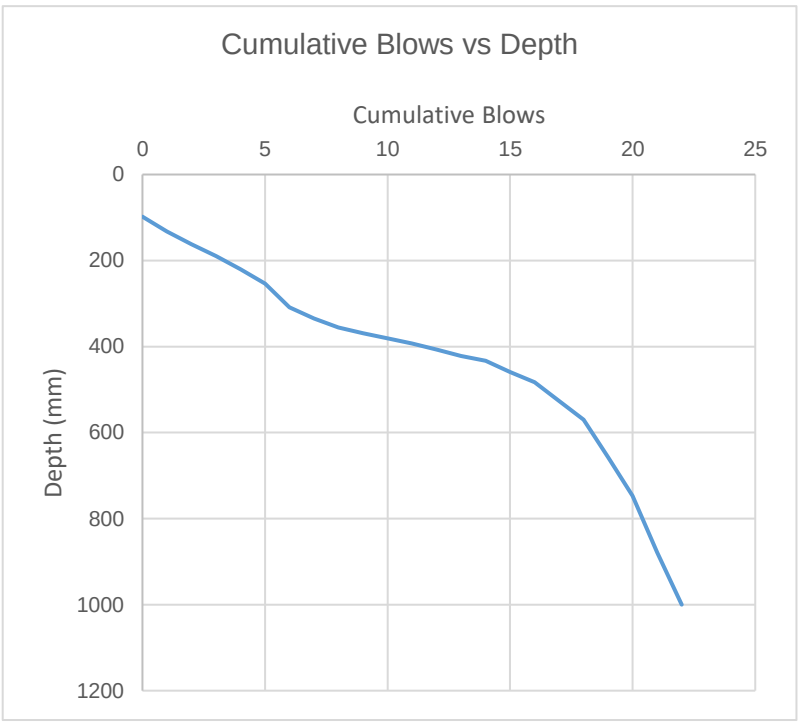
IN SITU CBR (TRRL DCP)

TerraConsult

Operator:	Date:	Weather:	Remarks:	Location:
GB	04/10/2019	Cloudy/ Overcast		mE:
				mN:
Chkd by:	Start depth:	Surface layer:	Zero reading (mm):	Termination reason:
DD	98		98	mAOD:
				Grid:

Depth to top of increment:	Cumulative blows:	Cumulative pen (mm):	Increment blows:	Increment pen (mm):	mm per blow:	Layer CBR (%)
98	0	0	0	0		
132	1	34	1	34	34.00	
162	2	64	1	30	30.00	
190	3	92	1	28	28.00	
220	4	122	1	30	30.00	
254	5	156	1	34	34.00	8
309	6	211	1	55	55.00	
335	7	237	1	26	26.00	
356	8	258	1	21	21.00	
369	9	271	1	13	13.00	
381	10	283	1	12	12.00	
393	11	295	1	12	12.00	21
407	12	309	1	14	14.00	
422	13	324	1	15	15.00	
433	14	335	1	11	11.00	
459	15	361	1	26	26.00	10
483	16	385	1	24	24.00	
527	17	429	1	44	44.00	
570	18	472	1	43	43.00	
658	19	560	1	88	88.00	3
747	20	649	1	89	89.00	
879	21	781	1	132	#####	
1000	22	902	1	121	#####	





AGS

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths in meters.

Issue: Draft

Project: English Martyrs
Project No: 4738
Client: MAI Construction

Test reference:

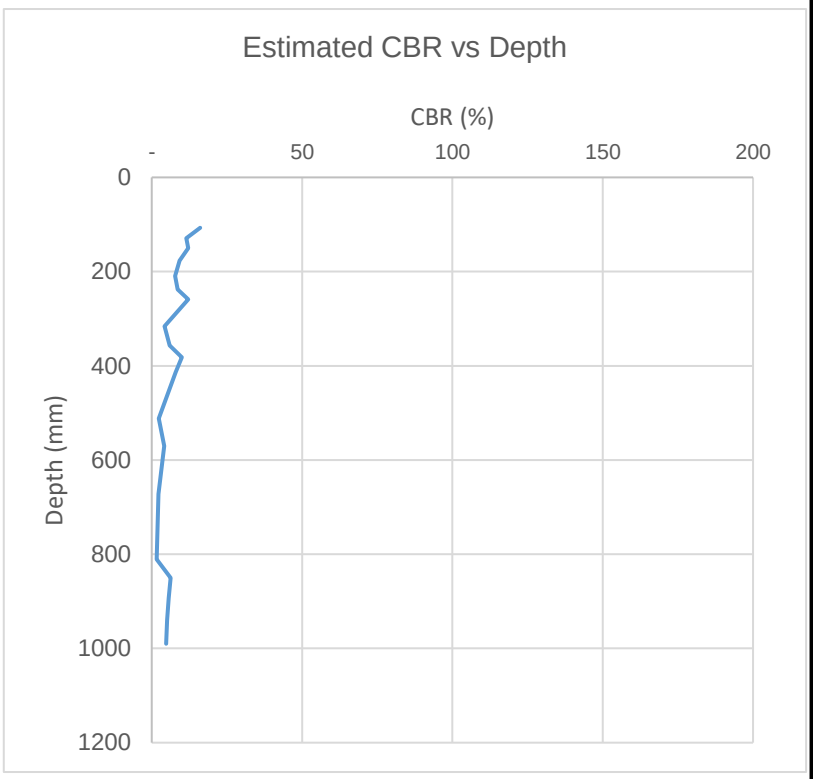
DCP4

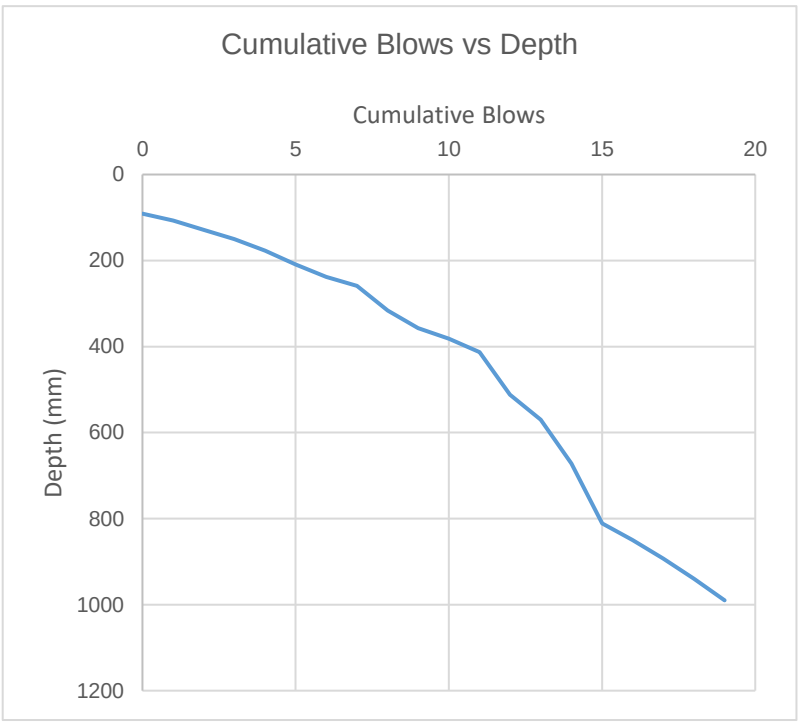
IN SITU CBR (TRRL DCP)

TerraConsult

Operator:	Date:	Weather:	Remarks:	Location:
GB	04/10/2019	Cloudy/ Overcast		mE:
				mN:
Chkd by:	Start depth:	Surface layer:	Zero reading (mm):	Termination reason:
DD	91		91	mAOD:
				Grid:

Depth to top of increment:	Cumulative blows:	Cumulative pen (mm):	Increment blows:	Increment pen (mm):	mm per blow:	Layer CBR (%)
91	0	0	0	0		
107	1	16	1	16	16.00	
129	2	38	1	22	22.00	
150	3	59	1	21	21.00	
177	4	86	1	27	27.00	
209	5	118	1	32	32.00	
238	6	147	1	29	29.00	10
259	7	168	1	21	21.00	
316	8	225	1	57	57.00	
357	9	266	1	41	41.00	
382	10	291	1	25	25.00	
413	11	322	1	31	31.00	
512	12	421	1	99	99.00	
570	13	479	1	58	58.00	
672	14	581	1	102	#####	
811	15	720	1	139	#####	4
850	16	759	1	39	39.00	
893	17	802	1	43	43.00	
940	18	849	1	47	47.00	
990	19	899	1	50	50.00	





AGS

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths in meters.

Issue: Draft

Project: English Martyrs
Project No: 4738
Client: MAI Construction

Test reference:

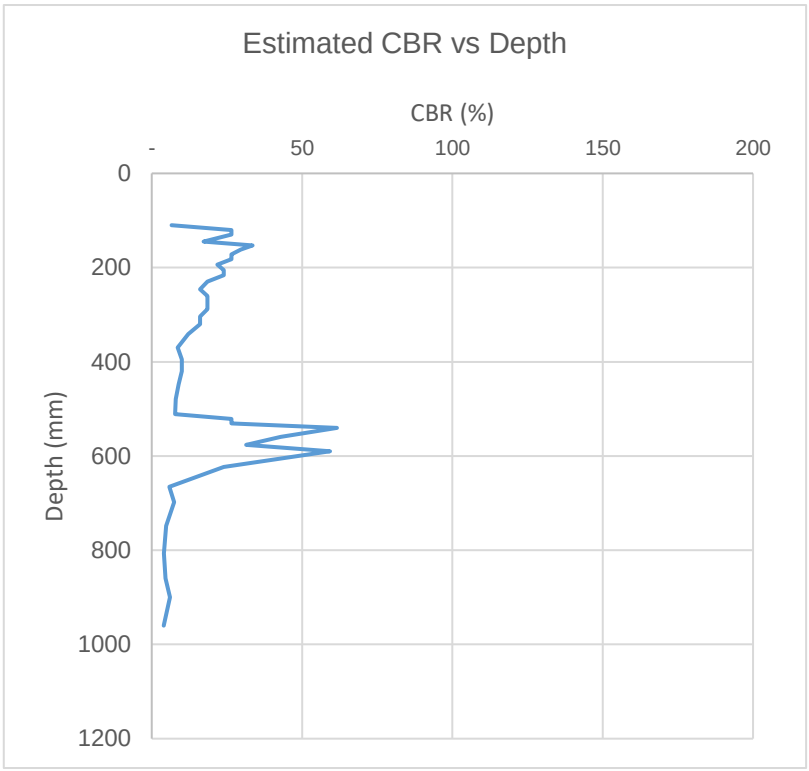
DCP5

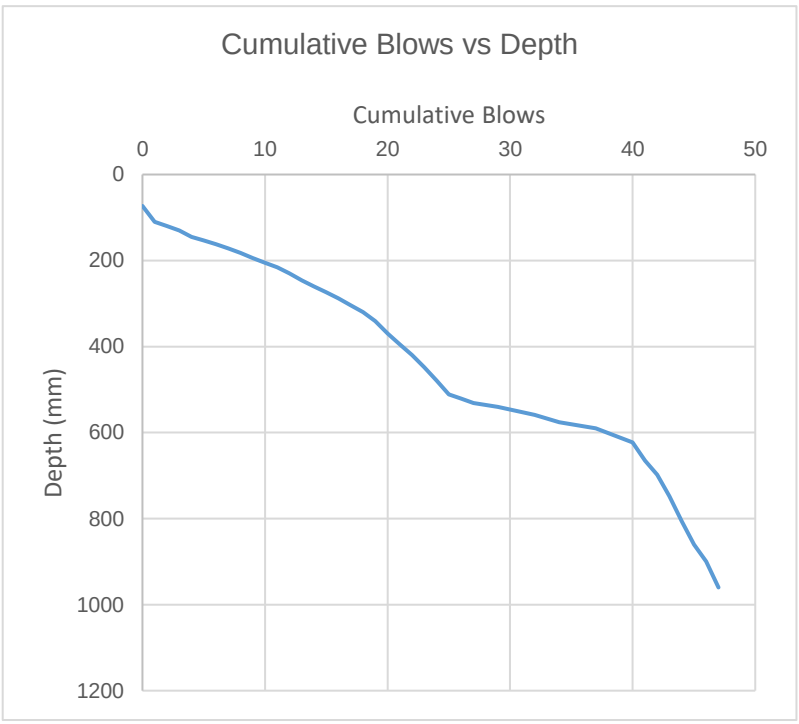
IN SITU CBR (TRRL DCP)

TerraConsult

Operator:	Date:	Weather:	Remarks:	Location:
GB	04/10/2019	Cloudy/ Overcast		mE:
				mN:
Chkd by:	Start depth:	Surface layer:	Zero reading (mm):	Termination reason:
DD	73		73	mAOD:
				Grid:

Depth to top of increment:	Cumulative blows:	Cumulative pen (mm):	Increment blows:	Increment pen (mm):	mm per blow:	Layer CBR (%)
73	0	0	0	0		
110	1	37	1	37	37.00	7
120	2	47	1	10	10.00	
130	3	57	1	10	10.00	
145	4	72	1	15	15.00	
153	5	80	1	8	8.00	
162	6	89	1	9	9.00	
172	7	99	1	10	10.00	26
182	8	109	1	10	10.00	
194	9	121	1	12	12.00	
205	10	132	1	11	11.00	
216	11	143	1	11	11.00	
230	12	157	1	14	14.00	
246	13	173	1	16	16.00	
260	14	187	1	14	14.00	
274	15	201	1	14	14.00	17
288	16	215	1	14	14.00	
304	17	231	1	16	16.00	
320	18	247	1	16	16.00	
341	19	268	1	21	21.00	
370	20	297	1	29	29.00	
395	21	322	1	25	25.00	
420	22	347	1	25	25.00	9
448	23	375	1	28	28.00	
479	24	406	1	31	31.00	
511	25	438	1	32	32.00	
521	26	448	1	10	10.00	
531	27	458	1	10	10.00	
540	29	467	2	9	4.50	
559	32	486	3	19	6.33	39
576	34	503	2	17	8.50	
590	37	517	3	14	4.67	
623	40	550	3	33	11.00	
665	41	592	1	42	42.00	
698	42	625	1	33	33.00	
748	43	675	1	50	50.00	
807	44	734	1	59	59.00	5
860	45	787	1	53	53.00	
900	46	827	1	40	40.00	
960	47	887	1	60	60.00	





AGS

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths in meters.

Issue: Draft

Project: English Martyrs
Project No: 4738
Client: MAI Construction

Test reference:

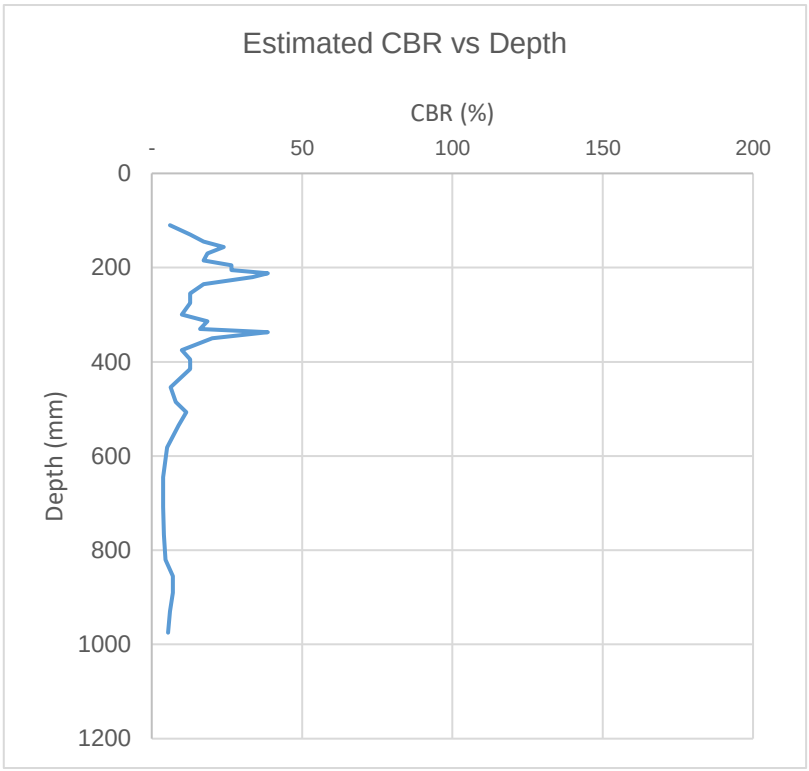
DCP6

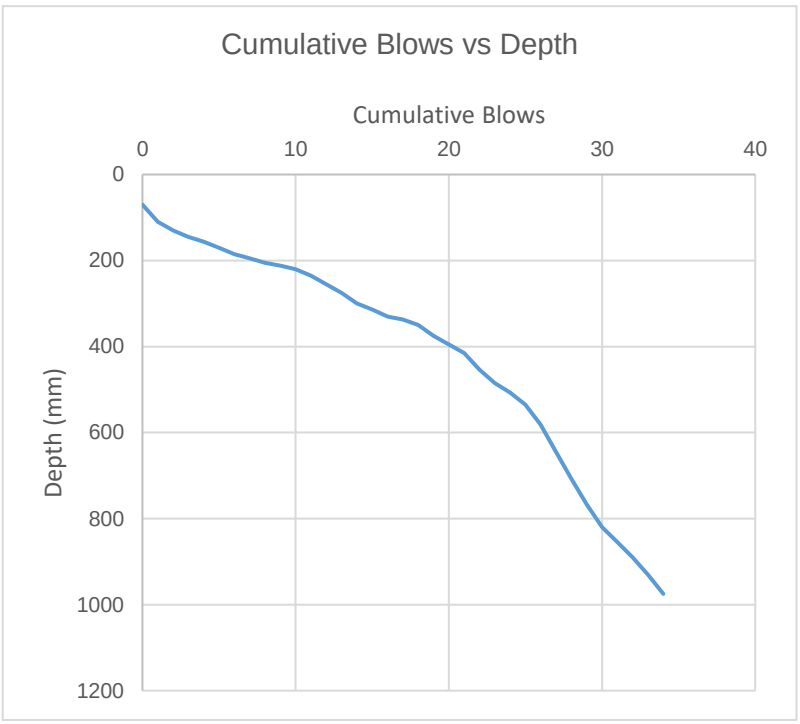
IN SITU CBR (TRRL DCP)

TerraConsult

Operator:	Date:	Weather:	Remarks:	Location:
GB	04/10/2019	Cloudy/ Overcast		mE:
				mN:
Chkd by:	Start depth:	Surface layer:	Zero reading (mm):	Termination reason:
DD	70		70	mAOD:
				Grid:

Depth to top of increment:	Cumulative blows:	Cumulative pen (mm):	Increment blows:	Increment pen (mm):	mm per blow:	Layer CBR (%)
70	0	0	0	0		
110	1	40	1	40	40.00	6
130	2	60	1	20	20.00	
145	3	75	1	15	15.00	
156	4	86	1	11	11.00	18
170	5	100	1	14	14.00	
185	6	115	1	15	15.00	
195	7	125	1	10	10.00	
205	8	135	1	10	10.00	31
212	9	142	1	7	7.00	
220	10	150	1	8	8.00	
235	11	165	1	15	15.00	
255	12	185	1	20	20.00	
275	13	205	1	20	20.00	
300	14	230	1	25	25.00	
314	15	244	1	14	14.00	
330	16	260	1	16	16.00	17
337	17	267	1	7	7.00	
350	18	280	1	13	13.00	
375	19	305	1	25	25.00	
395	20	325	1	20	20.00	
415	21	345	1	20	20.00	
454	22	384	1	39	39.00	
485	23	415	1	31	31.00	
507	24	437	1	22	22.00	
535	25	465	1	28	28.00	
582	26	512	1	47	47.00	
645	27	575	1	63	63.00	
708	28	638	1	63	63.00	6
767	29	697	1	59	59.00	
820	30	750	1	53	53.00	
855	31	785	1	35	35.00	
890	32	820	1	35	35.00	
930	33	860	1	40	40.00	
975	34	905	1	45	45.00	
-		(70)				





AGS

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths in meters.

Issue: Draft

Project: English Martyrs
Project No: 4738
Client: MAI Construction

Test reference:

DCP7

APPENDIX D

Laboratory Chemical Test Results

Infiltration Test Report

TerraConsult

Carried out by:	Date:	Method:				Trial pit dimensions:	Before:	After:	Location:	Grid: OSGB
GB	04/10/19	BRE Digest DG 365: 2016				Length (m):	1.45	1.45	mE:	
Chkd by:	Test no:	Granular infill:	Datum height (m agl):	Depth to water: Start:	End:	Width (m):	0.63	0.63	mN:	
DD	1	None	0.00	0.82	0.83	Depth (m):	1.30	1.30	m OD:	

Elapsed time (mins):	Water depth (m below datum):	Elapsed time (mins):	Water depth (m below datum):
0	0.82		
1	0.82		
2	0.825		
3	0.825		
4	0.825		
5	0.825		
6	0.825		
7	0.825		
8	0.825		
9	0.825		
10	0.825		
22	0.83		
40	0.83		
120	0.83		
140	0.83		

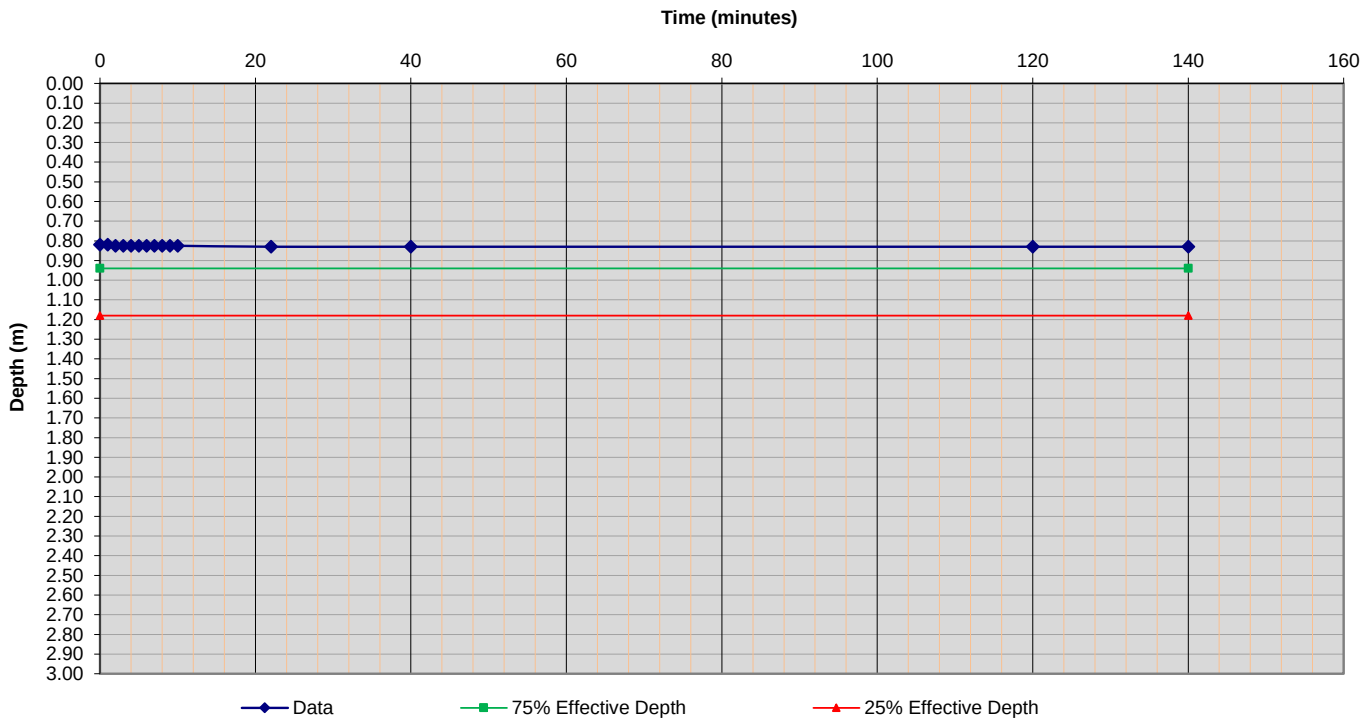
Effective depth (m):		Elapsed time (mins) (from graph):	
75%	0.94	75%	
50%	1.06		
25%	1.18	25%	

Base area of pit	0.91	m^2
Mean surface area through which outflow occurs	1.91	m^2
Volume outflow between 75 and 25% effective depth	0.22	m^3

Soil infiltration rate, f	N/A	$m^3/m^2/s$
Soil infiltration rate, f	N/A	m/hr
Percolation Value, vp	N/A	s/mm

TEST NOT VALID - INSUFFICEINT INFILTRATION TO CALCULATE RATE

Notes:
1. Test carried out in natural strata - Very soft sandy slightly gravelly CLAY.



AGS

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths in meters.

Issue: Draft

Project: English Matyrs, Manchester
Proj. No: 4738
Client: MAI Construction

Test reference: **TP1**

Infiltration Test Report

TerraConsult

Carried out by:	Date:	Method:				Trial pit dimensions:	Before:	After:	Location:	Grid: OSGB
GB	04/10/19	BRE Digest DG 365: 2016				Length (m):	1.12	1.12	mE:	
Chkd by:	Test no:	Granular infill:	Datum height (m agl):	Depth to water: Start:	End:	Width (m):	0.59	0.59	mN:	
DD	1	None	0.00	0.99	0.99	Depth (m):	1.40	1.40	m OD:	

Elapsed time (mins):	Water depth (m below datum):	Elapsed time (mins):	Water depth (m below datum):
0	0.99		
1	0.99		
2	0.985		
3	0.985		
4	0.985		
5	0.985		
6	0.985		
7	0.985		
8	0.985		
9	0.985		
10	0.985		
15	0.99		
30	0.99		
40	0.99		
50	0.99		
120	0.99		
180	0.99		
220	0.99		

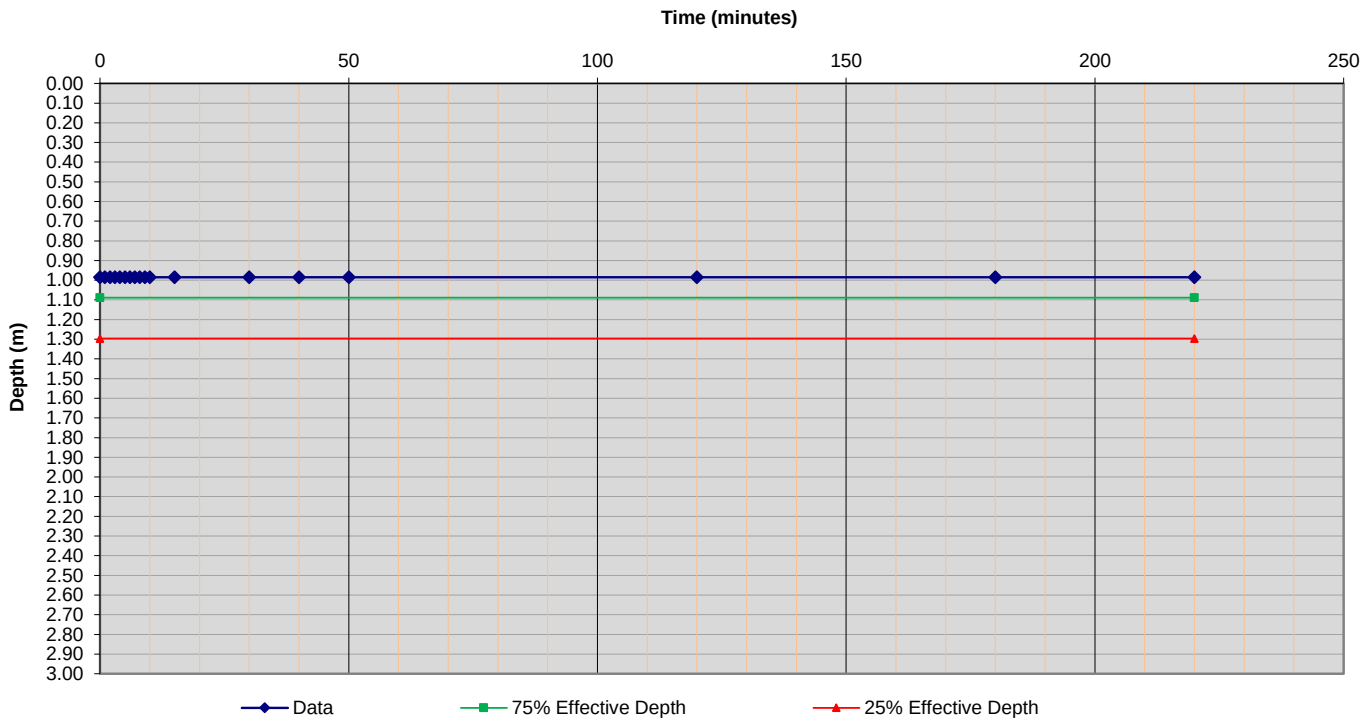
Effective depth (m):		Elapsed time (mins) (from graph):	
75%	1.09	75%	
50%	1.19		
25%	1.30	25%	

Base area of pit	0.66	m^2
Mean surface area through which outflow occurs	1.37	m^2
Volume outflow between 75 and 25% effective depth	0.14	m^3

Soil infiltration rate, f	N/A	$m^3/m^2/s$
Soil infiltration rate, f	N/A	m/hr
Percolation Value, vp	N/A	s/mm

TEST NOT VALID - INSUFFICEINT INFILTRATION TO CALCULATE RATE

Notes:
1. Test carried out in natural strata - Very soft sandy slightly gravelly CLAY.



AGS

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths in meters.

Issue: Draft

Project: English Matyrs, Manchester
Proj. No: 4738
Client: MAI Construction

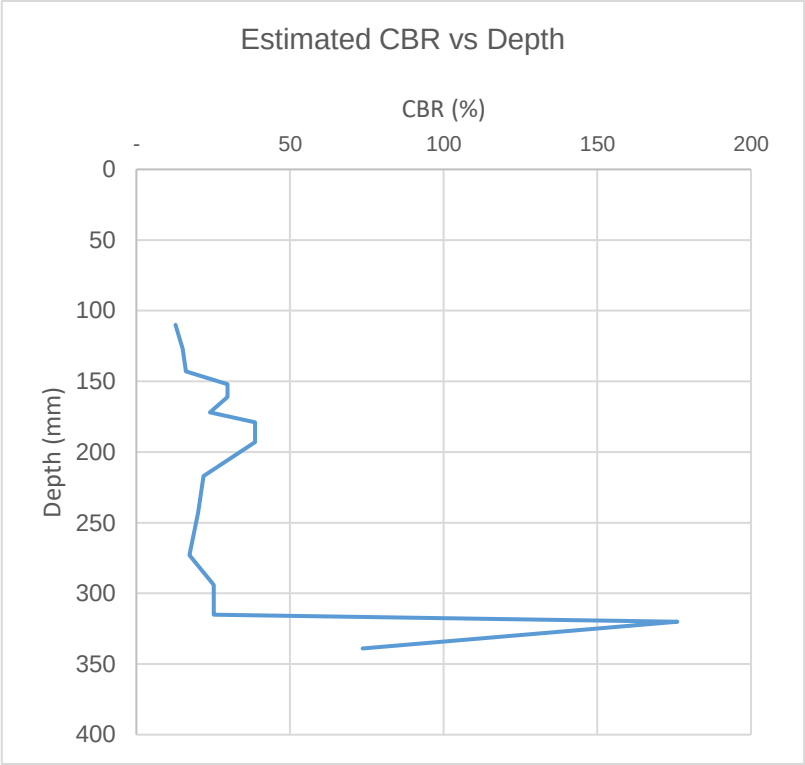
Test reference: **TP2**

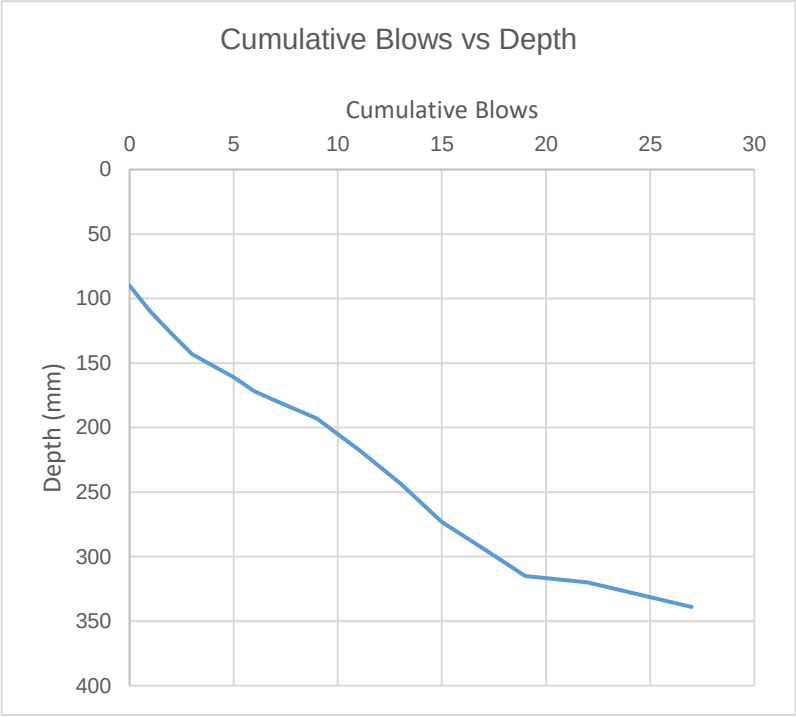
IN SITU CBR (TRRL DCP)

TerraConsult

Operator:	Date:	Weather:	Remarks:	Location:
GB	04/10/2019	Cloudy/ Overcast		mE:
				mN:
Chkd by:	Start depth:	Surface layer:	Zero reading (mm):	Termination reason:
DD	90		90	mAOD:
				Grid:

Depth to top of increment:	Cumulative blows:	Cumulative pen (mm):	Increment blows:	Increment pen (mm):	mm per blow:	Layer CBR (%)
90	0	0	0	0		
110	1	20	1	20	20.00	
127	2	37	1	17	17.00	15
143	3	53	1	16	16.00	
152	4	62	1	9	9.00	
161	5	71	1	9	9.00	
172	6	82	1	11	11.00	32
179	7	89	1	7	7.00	
193	9	103	2	14	7.00	
217	11	127	2	24	12.00	
243	13	153	2	26	13.00	
273	15	183	2	30	15.00	22
294	17	204	2	21	10.50	
315	19	225	2	21	10.50	
320	22	230	3	5	1.67	>100
339	27	249	5	19	3.80	74





AGS

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths in meters.

Issue: Draft

Project: English Martyrs
Project No: 4738
Client: MAI Construction

Test reference:

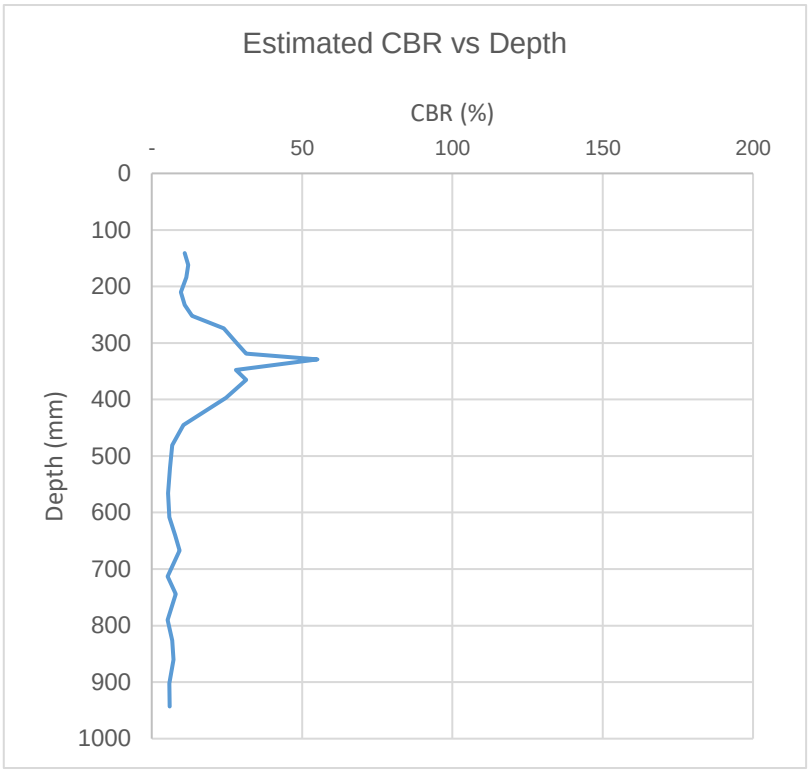
DCP1

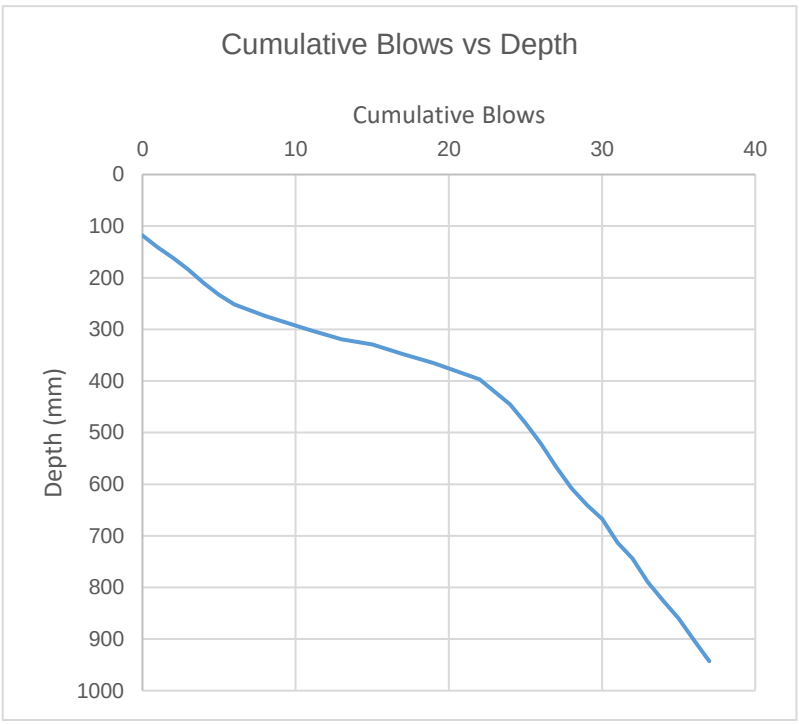
IN SITU CBR (TRRL DCP)

TerraConsult

Operator:	Date:	Weather:	Remarks:	Location:
GB	04/10/2019	Cloudy/ Overcast		mE:
				mN:
Chkd by:	Start depth:	Surface layer:	Zero reading (mm):	Termination reason:
DD	118		118	mAOD:
				Grid:

Depth to top of increment:	Cumulative blows:	Cumulative pen (mm):	Increment blows:	Increment pen (mm):	mm per blow:	Layer CBR (%)
118	0	0	0	0		
141	1	23	1	23	23.00	
162	2	44	1	21	21.00	
184	3	66	1	22	22.00	
210	4	92	1	26	26.00	11
233	5	115	1	23	23.00	
252	6	134	1	19	19.00	
274	8	156	2	22	11.00	
302	11	184	3	28	9.33	
319	13	201	2	17	8.50	
329	15	211	2	10	5.00	32
348	17	230	2	19	9.50	
365	19	247	2	17	8.50	
397	22	279	3	32	10.67	
445	24	327	2	48	24.00	
481	25	363	1	36	36.00	
521	26	403	1	40	40.00	
566	27	448	1	45	45.00	
608	28	490	1	42	42.00	
640	29	522	1	32	32.00	
667	30	549	1	27	27.00	7
713	31	595	1	46	46.00	
744	32	626	1	31	31.00	
790	33	672	1	46	46.00	
826	34	708	1	36	36.00	
860	35	742	1	34	34.00	
902	36	784	1	42	42.00	
943	37	825	1	41	41.00	





AGS

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths in meters.

Issue: Draft

Project: English Martyrs
Project No: 4738
Client: MAI Construction

Test reference:

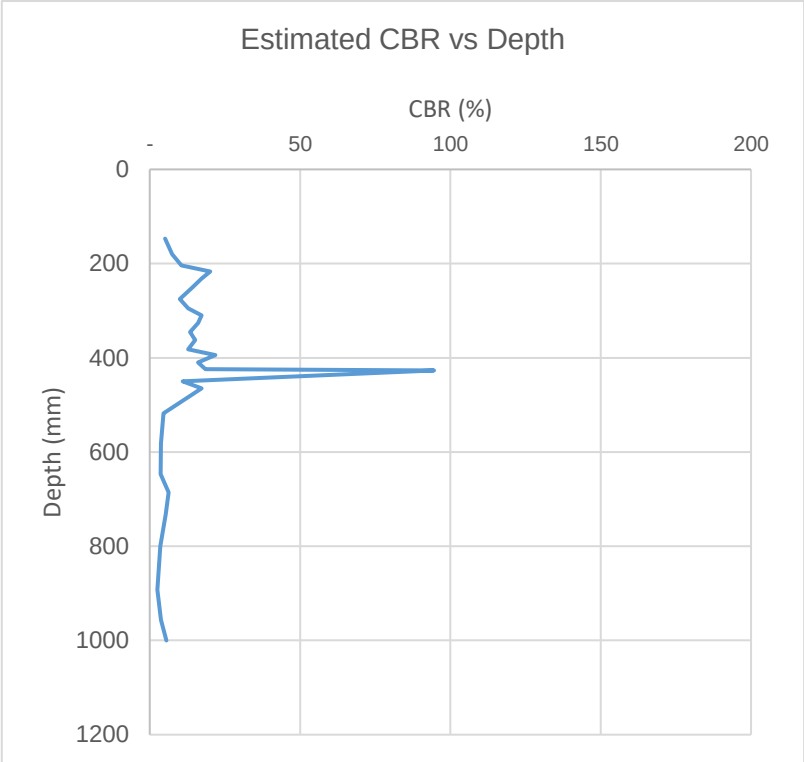
DCP2

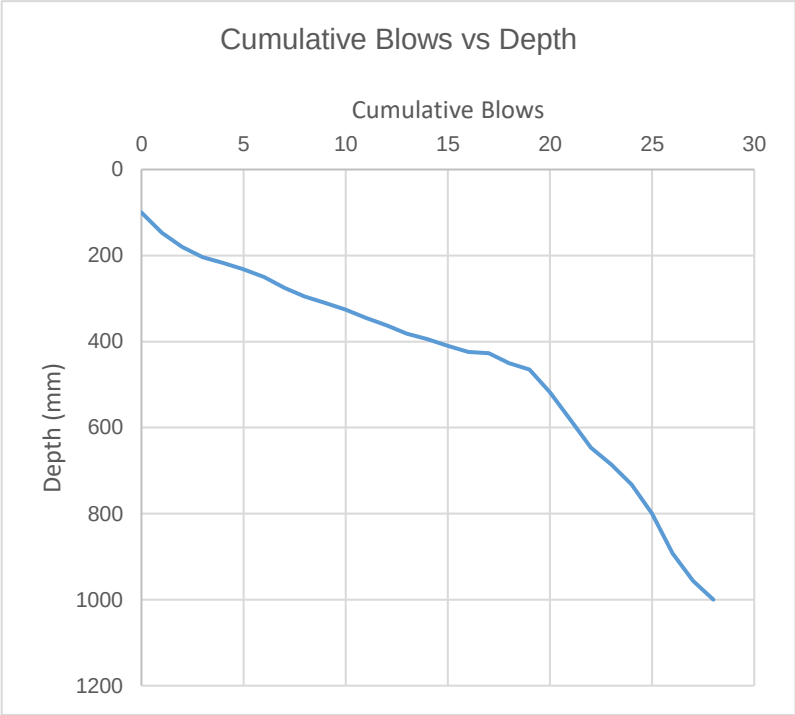
IN SITU CBR (TRRL DCP)

TerraConsult

Operator:	Date:	Weather:	Remarks:	Location:
GB	04/10/2019	Cloudy/ Overcast		mE:
				mN:
Chkd by:	Start depth:	Surface layer:	Zero reading (mm):	Termination reason:
DD	100		100	mAOD:
				Grid:

Depth to top of increment:	Cumulative blows:	Cumulative pen (mm):	Increment blows:	Increment pen (mm):	mm per blow:	Layer CBR (%)
100	0	0	0	0		
147	1	47	1	47	47.00	6
180	2	80	1	33	33.00	
204	3	104	1	24	24.00	
217	4	117	1	13	13.00	
232	5	132	1	15	15.00	
250	6	150	1	18	18.00	
275	7	175	1	25	25.00	
295	8	195	1	20	20.00	
310	9	210	1	15	15.00	15
326	10	226	1	16	16.00	
345	11	245	1	19	19.00	
362	12	262	1	17	17.00	
382	13	282	1	20	20.00	
394	14	294	1	12	12.00	
410	15	310	1	16	16.00	
424	16	324	1	14	14.00	
427	17	327	1	3	3.00	95
450	18	350	1	23	23.00	14
465	19	365	1	15	15.00	
518	20	418	1	53	53.00	
582	21	482	1	64	64.00	
647	22	547	1	65	65.00	
686	23	586	1	39	39.00	
732	24	632	1	46	46.00	4
800	25	700	1	68	68.00	
892	26	792	1	92	92.00	
956	27	856	1	64	64.00	
1000	28	900	1	44	44.00	





AGS

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths in meters.

Issue: Draft

Project: English Martyrs
Project No: 4738
Client: MAI Construction

Test reference:

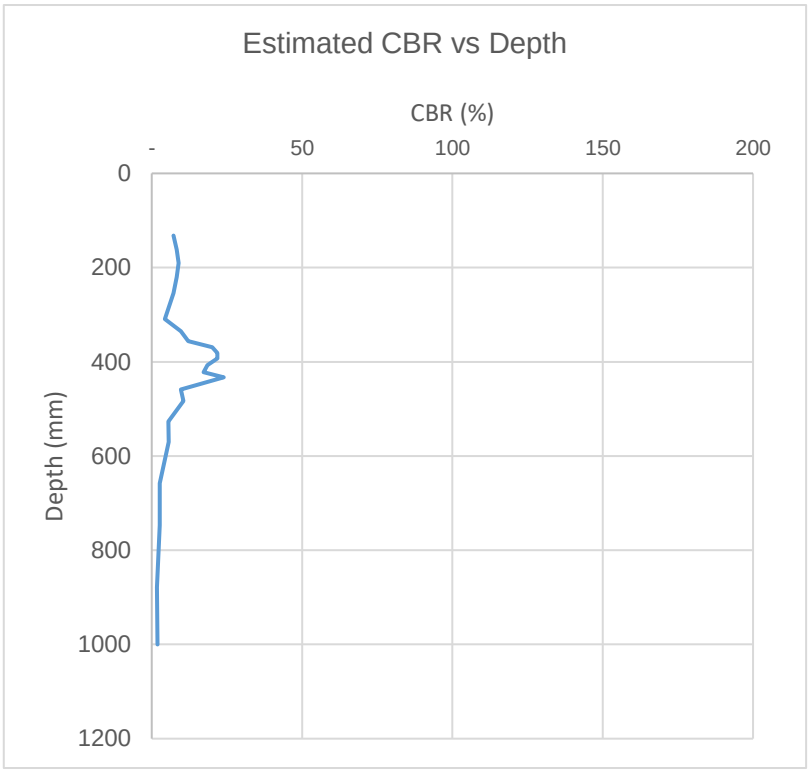
DCP3

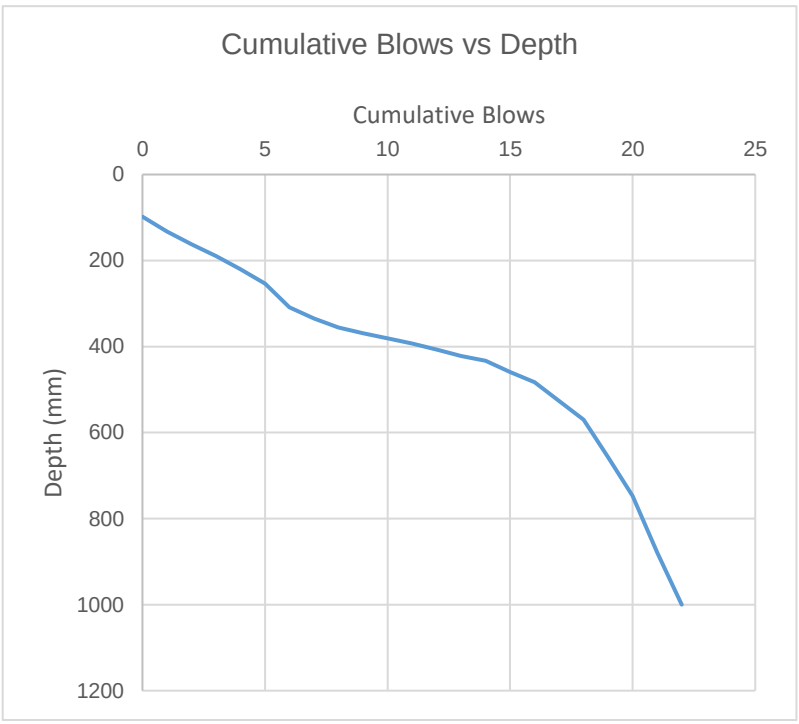
IN SITU CBR (TRRL DCP)

TerraConsult

Operator:	Date:	Weather:	Remarks:	Location:
GB	04/10/2019	Cloudy/ Overcast		mE:
				mN:
Chkd by:	Start depth:	Surface layer:	Zero reading (mm):	Termination reason:
DD	98		98	mAOD:
				Grid:

Depth to top of increment:	Cumulative blows:	Cumulative pen (mm):	Increment blows:	Increment pen (mm):	mm per blow:	Layer CBR (%)
98	0	0	0	0		
132	1	34	1	34	34.00	
162	2	64	1	30	30.00	
190	3	92	1	28	28.00	
220	4	122	1	30	30.00	
254	5	156	1	34	34.00	8
309	6	211	1	55	55.00	
335	7	237	1	26	26.00	
356	8	258	1	21	21.00	
369	9	271	1	13	13.00	
381	10	283	1	12	12.00	
393	11	295	1	12	12.00	21
407	12	309	1	14	14.00	
422	13	324	1	15	15.00	
433	14	335	1	11	11.00	
459	15	361	1	26	26.00	10
483	16	385	1	24	24.00	
527	17	429	1	44	44.00	
570	18	472	1	43	43.00	
658	19	560	1	88	88.00	3
747	20	649	1	89	89.00	
879	21	781	1	132	#####	
1000	22	902	1	121	#####	





AGS

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths in meters.

Issue: Draft

Project: English Martyrs
Project No: 4738
Client: MAI Construction

Test reference:

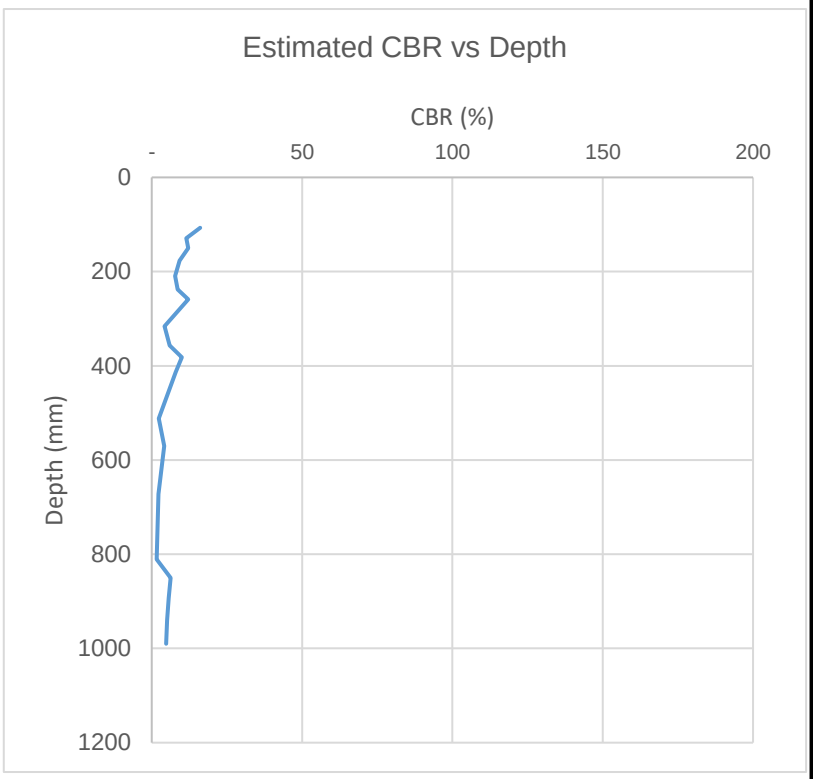
DCP4

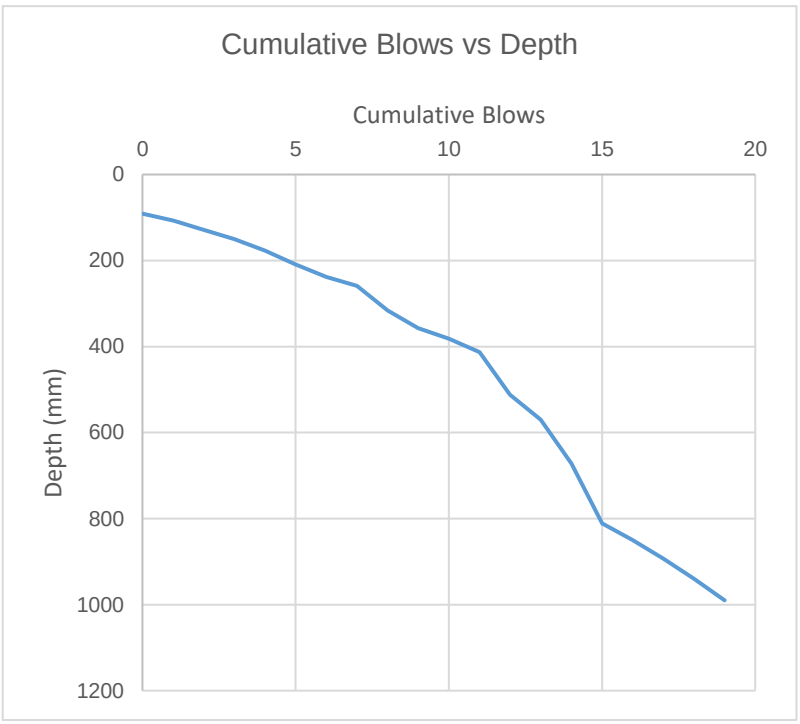
IN SITU CBR (TRRL DCP)

TerraConsult

Operator:	Date:	Weather:	Remarks:	Location:
GB	04/10/2019	Cloudy/ Overcast		mE:
				mN:
Chkd by:	Start depth:	Surface layer:	Zero reading (mm):	Termination reason:
DD	91		91	mAOD:
				Grid:

Depth to top of increment:	Cumulative blows:	Cumulative pen (mm):	Increment blows:	Increment pen (mm):	mm per blow:	Layer CBR (%)
91	0	0	0	0		
107	1	16	1	16	16.00	
129	2	38	1	22	22.00	
150	3	59	1	21	21.00	
177	4	86	1	27	27.00	
209	5	118	1	32	32.00	
238	6	147	1	29	29.00	10
259	7	168	1	21	21.00	
316	8	225	1	57	57.00	
357	9	266	1	41	41.00	
382	10	291	1	25	25.00	
413	11	322	1	31	31.00	
512	12	421	1	99	99.00	
570	13	479	1	58	58.00	
672	14	581	1	102	#####	
811	15	720	1	139	#####	4
850	16	759	1	39	39.00	
893	17	802	1	43	43.00	
940	18	849	1	47	47.00	
990	19	899	1	50	50.00	





AGS

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths in meters.

Issue: Draft

Project: English Martyrs
Project No: 4738
Client: MAI Construction

Test reference:

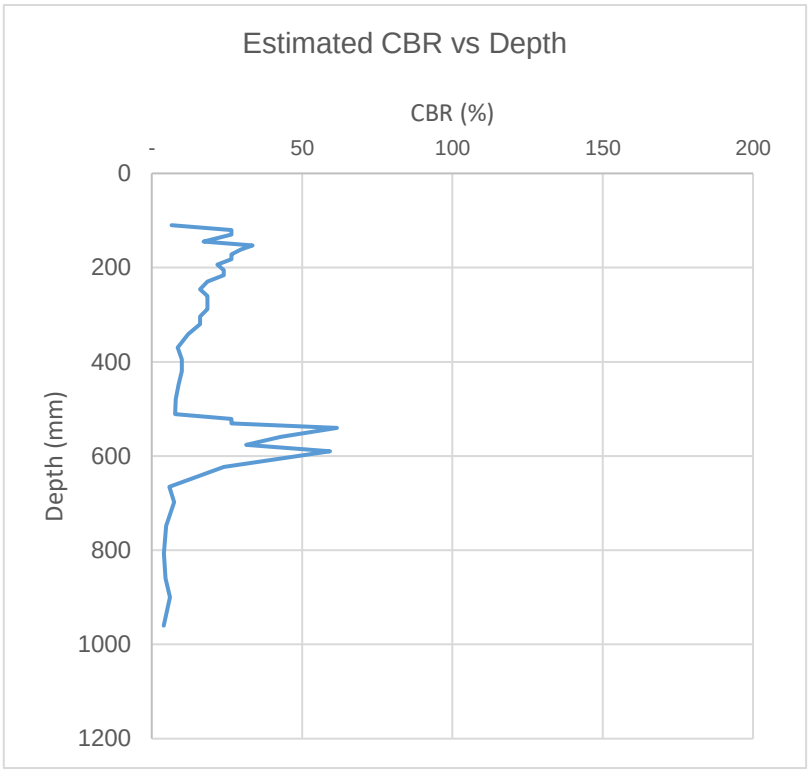
DCP5

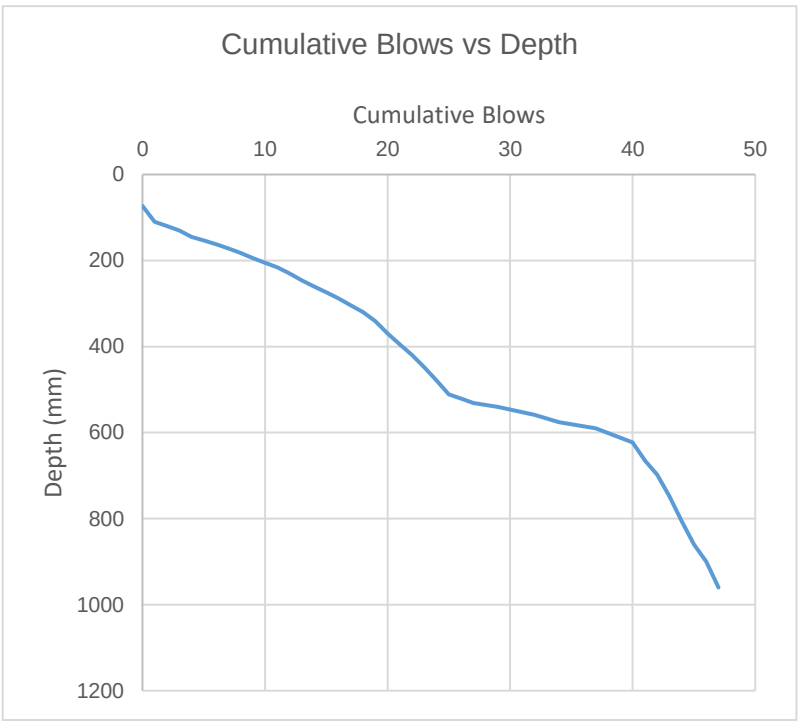
IN SITU CBR (TRRL DCP)

TerraConsult

Operator:	Date:	Weather:	Remarks:	Location:
GB	04/10/2019	Cloudy/ Overcast		mE:
				mN:
Chkd by:	Start depth:	Surface layer:	Zero reading (mm):	Termination reason:
DD	73		73	mAOD:
				Grid:

Depth to top of increment:	Cumulative blows:	Cumulative pen (mm):	Increment blows:	Increment pen (mm):	mm per blow:	Layer CBR (%)
73	0	0	0	0		
110	1	37	1	37	37.00	7
120	2	47	1	10	10.00	
130	3	57	1	10	10.00	
145	4	72	1	15	15.00	
153	5	80	1	8	8.00	
162	6	89	1	9	9.00	
172	7	99	1	10	10.00	26
182	8	109	1	10	10.00	
194	9	121	1	12	12.00	
205	10	132	1	11	11.00	
216	11	143	1	11	11.00	
230	12	157	1	14	14.00	
246	13	173	1	16	16.00	
260	14	187	1	14	14.00	
274	15	201	1	14	14.00	17
288	16	215	1	14	14.00	
304	17	231	1	16	16.00	
320	18	247	1	16	16.00	
341	19	268	1	21	21.00	
370	20	297	1	29	29.00	
395	21	322	1	25	25.00	
420	22	347	1	25	25.00	9
448	23	375	1	28	28.00	
479	24	406	1	31	31.00	
511	25	438	1	32	32.00	
521	26	448	1	10	10.00	
531	27	458	1	10	10.00	
540	29	467	2	9	4.50	
559	32	486	3	19	6.33	39
576	34	503	2	17	8.50	
590	37	517	3	14	4.67	
623	40	550	3	33	11.00	
665	41	592	1	42	42.00	
698	42	625	1	33	33.00	
748	43	675	1	50	50.00	
807	44	734	1	59	59.00	5
860	45	787	1	53	53.00	
900	46	827	1	40	40.00	
960	47	887	1	60	60.00	





AGS

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths in meters.

Issue: Draft

Project: English Martyrs
Project No: 4738
Client: MAI Construction

Test reference:

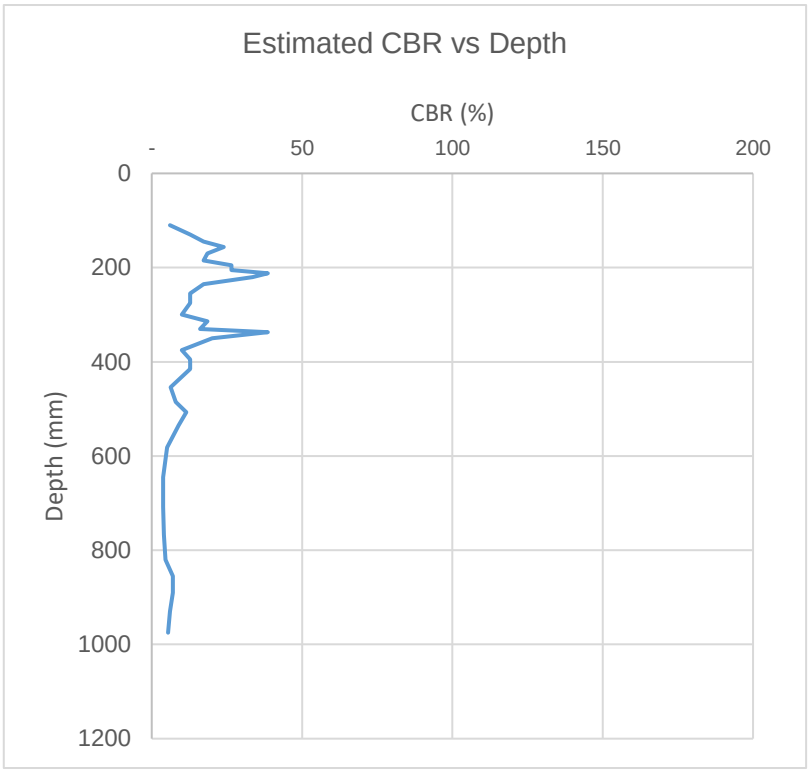
DCP6

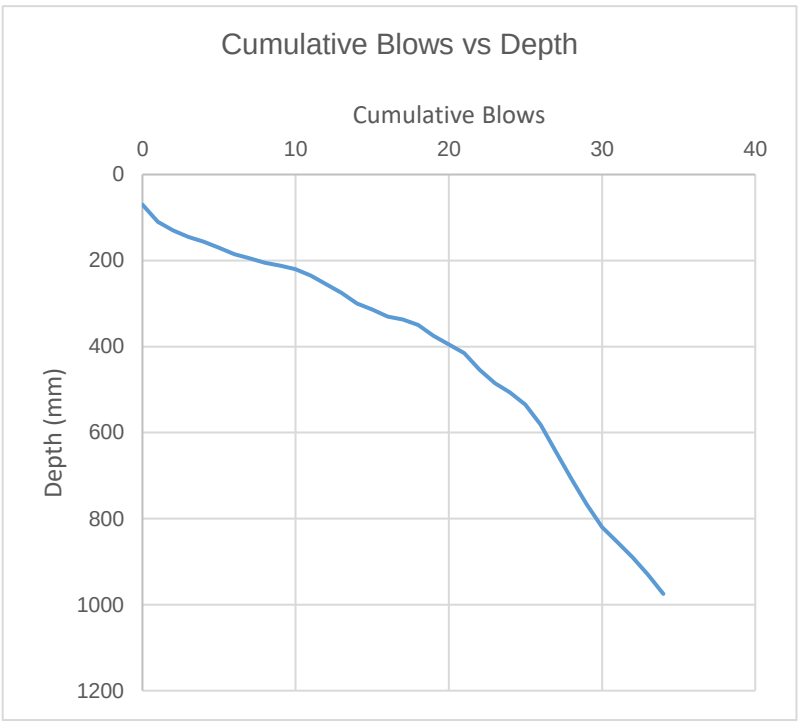
IN SITU CBR (TRRL DCP)

TerraConsult

Operator:	Date:	Weather:	Remarks:	Location:
GB	04/10/2019	Cloudy/ Overcast		mE:
				mN:
Chkd by:	Start depth:	Surface layer:	Zero reading (mm):	Termination reason:
DD	70		70	mAOD:
				Grid:

Depth to top of increment:	Cumulative blows:	Cumulative pen (mm):	Increment blows:	Increment pen (mm):	mm per blow:	Layer CBR (%)
70	0	0	0	0		
110	1	40	1	40	40.00	6
130	2	60	1	20	20.00	
145	3	75	1	15	15.00	
156	4	86	1	11	11.00	18
170	5	100	1	14	14.00	
185	6	115	1	15	15.00	
195	7	125	1	10	10.00	
205	8	135	1	10	10.00	31
212	9	142	1	7	7.00	
220	10	150	1	8	8.00	
235	11	165	1	15	15.00	
255	12	185	1	20	20.00	
275	13	205	1	20	20.00	
300	14	230	1	25	25.00	
314	15	244	1	14	14.00	
330	16	260	1	16	16.00	17
337	17	267	1	7	7.00	
350	18	280	1	13	13.00	
375	19	305	1	25	25.00	
395	20	325	1	20	20.00	
415	21	345	1	20	20.00	
454	22	384	1	39	39.00	
485	23	415	1	31	31.00	
507	24	437	1	22	22.00	
535	25	465	1	28	28.00	
582	26	512	1	47	47.00	
645	27	575	1	63	63.00	
708	28	638	1	63	63.00	6
767	29	697	1	59	59.00	
820	30	750	1	53	53.00	
855	31	785	1	35	35.00	
890	32	820	1	35	35.00	
930	33	860	1	40	40.00	
975	34	905	1	45	45.00	
-		(70)				





AGS

Notes: For explanation of symbols and abbreviations see Key Sheet.
All depths in meters.

Issue: Draft

Project: English Martyrs
Project No: 4738
Client: MAI Construction

Test reference:

DCP7

APPENDIX E

Summary of Chemical Test Results of Soil Samples

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TN38 9BY
Telephone: (01424) 718618

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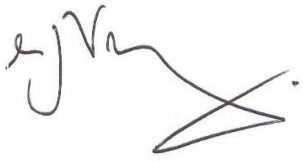
info@elab-uk.co.uk

THE ENVIRONMENTAL LABORATORY LTD

Analytical Report Number:	19-25184
Issue:	1
Date of Issue:	15/10/2019
Contact:	Derek Daniels
Customer Details:	TerraConsult Ltd Bold Business Centre Unit 34, Bold Lane St Helens MersevsideWA9 4TX
Quotation No:	Q18-01061
Order No:	PO-005909
Customer Reference:	4738
Date Received:	08/10/2019
Date Approved:	15/10/2019
Details:	English Martyrs
Approved by:	

Mike Varley, Technical Manager

Any comments, opinions or interpretations expressed herein are outside the scope of UKAS accreditation (Accreditation Number 2683

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Sample Summary

Report No.: 19-25184, issue number 1

Elab No.	Client's Ref.	Date Sampled	Date Scheduled	Description	Deviations
186140	TP1 0.20	04/10/2019	08/10/2019	Sandy silty loam	
186141	TP2 0.25	04/10/2019	08/10/2019		
186142	HP1 0.10	04/10/2019	08/10/2019	Sandy silty loam	

Results Summary

Report No.: 19-25184, issue number 1

			ELAB Reference	186140	186142
			Customer Reference		
			Sample ID		
			Sample Type	SOIL	SOIL
			Sample Location	TP1	HP1
			Sample Depth (m)	0.20	0.10
			Sampling Date	04/10/2019	04/10/2019
Determinand	**Codes**	**Units**	**LOD**		
Soil sample preparation parameters					
Moisture Content	N	%	0.1	28.8	25.4
Stones Content	N	%	0.1	44.4	43.3
Material removed	N	%	0.1	44.4	43.3
Description of Inert material removed	N		0	Stones,brick,clinker	Stones,brick,clinker
Metals					
Arsenic	M	mg/kg	1	179	43.7
Cadmium	M	mg/kg	0.5	2.5	0.8
Chromium	M	mg/kg	5	64.1	36.2
Copper	M	mg/kg	5	1530	169
Lead	M	mg/kg	5	2170	432
Mercury	M	mg/kg	0.5	< 0.5	< 0.5
Nickel	M	mg/kg	5	180	43.2
Selenium	M	mg/kg	1	< 1.0	1.4
Zinc	M	mg/kg	5	1580	595
Anions					
Water Soluble Sulphate	M	g/l	0.02	0.26	1.63
Inorganics					
Total Cyanide	M	mg/kg	1	< 1.0	< 1.0
Acid Soluble Sulphate (SO4)	U	%	0.02	0.26	0.88
Miscellaneous					
Acid Neutralisation Capacity	N	mol/kg	0.1	< 0.1	< 0.1
Loss On Ignition (450°C)	M	%	0.01	10.4	8.82
pH	M	pH units	0.1	6.7	7.8
Soil Organic Matter	U	%	0.1	4.4	5.3
Total Organic Carbon	N	%	0.01	11	4.0
Organics					
>C8-C10 BCB	N	mg/kg	1	< 1.0	3.3
>C10-C12 BCB	N	mg/kg	1	< 1.0	3.8
>C12-C16 BCB	N	mg/kg	1	< 1.0	< 1.0
>C16-C21 BCB	N	mg/kg	1	1.3	3.9
Diesel Range Organics (>C8-C21)	N	mg/kg	1	< 1	10
Phenols					
Phenol	M	mg/kg	1	< 1	< 1
M,P-Cresol	N	mg/kg	1	< 1	< 1
O-Cresol	N	mg/kg	1	< 1	< 1
3,4-Dimethylphenol	N	mg/kg	1	< 1	< 1
2,3-Dimethylphenol	M	mg/kg	1	< 1	< 1
2,3,5-trimethylphenol	M	mg/kg	1	< 1	< 1
Total Monohydric Phenols	N	mg/kg	5	< 5	< 5

Results Summary

Report No.: 19-25184, issue number 1

			ELAB Reference	186140	186142
			Customer Reference		
			Sample ID		
			Sample Type	SOIL	SOIL
			Sample Location	TP1	HP1
			Sample Depth (m)	0.20	0.10
			Sampling Date	04/10/2019	04/10/2019
Determinand	**Codes**	**Units**	**LOD**		
Polyaromatic hydrocarbons					
Naphthalene	M	mg/kg	0.1	0.6	< 0.1
Acenaphthylene	M	mg/kg	0.1	0.1	< 0.1
Acenaphthene	M	mg/kg	0.1	1.9	< 0.1
Fluorene	M	mg/kg	0.1	1.0	< 0.1
Phenanthrene	M	mg/kg	0.1	8.2	0.8
Anthracene	M	mg/kg	0.1	1.7	0.2
Fluoranthene	M	mg/kg	0.1	10.2	1.1
Pyrene	M	mg/kg	0.1	9.3	1.1
Benzo(a)anthracene	M	mg/kg	0.1	4.4	0.4
Chrysene	M	mg/kg	0.1	5.2	0.7
Benzo(b)fluoranthene	M	mg/kg	0.1	3.8	0.6
Benzo(k)fluoranthene	M	mg/kg	0.1	3.9	0.7
Benzo(a)pyrene	M	mg/kg	0.1	4.0	0.5
Indeno(1,2,3-cd)pyrene	M	mg/kg	0.1	2.5	0.4
Dibenzo(a,h)anthracene	M	mg/kg	0.1	0.5	< 0.1
Benzo[g,h,i]perylene	M	mg/kg	0.1	2.4	0.4
Coronene	N	mg/kg	0.1	1.0	0.3
Total PAH(16)	M	mg/kg	0.4	59.6	7.2
Total PAH (Including Coronene GC-FID)	N	mg/kg	2	61	7
BTEX					
Benzene	M	ug/kg	10	< 10.0	< 10.0
Toluene	M	ug/kg	10	< 10.0	< 10.0
Ethylbenzene	M	ug/kg	10	< 10.0	< 10.0
Xylenes	M	ug/kg	10	< 10.0	< 10.0
MTBE	N	ug/kg	10	< 10.0	< 10.0
Total BTEX	M	mg/kg	0.01	< 0.01	< 0.01
TPH CWG					
>C5-C6 Aliphatic	N	mg/kg	0.01	< 0.01	< 0.01
>C6-C8 Aliphatic	N	mg/kg	0.01	< 0.01	< 0.01
>C8-C10 Aliphatic	N	mg/kg	1	< 1.0	3.5
>C10-C12 Aliphatic	N	mg/kg	1	< 1.0	3.8
>C12-C16 Aliphatic	N	mg/kg	1	< 1.0	< 1.0
>C16-C21 Aliphatic	N	mg/kg	1	< 1.0	1.6
>C21-C35 Aliphatic	N	mg/kg	1	< 1.0	127
>C35-C40 Aliphatic	N	mg/kg	1	< 1.0	71.2
>C5-C7 Aromatic	N	mg/kg	0.01	< 0.01	< 0.01
>C7-C8 Aromatic	N	mg/kg	0.01	< 0.01	< 0.01
>C8-C10 Aromatic	N	mg/kg	1	< 1.0	2.1
>C10-C12 Aromatic	N	mg/kg	1	< 1.0	2.5
>C12-C16 Aromatic	N	mg/kg	1	< 1.0	< 1.0
>C16-C21 Aromatic	N	mg/kg	1	1.6	1.8
>C21-C35 Aromatic	N	mg/kg	1	10.2	159
>C35-C40 Aromatic	N	mg/kg	1	1.8	100
Total (>C5-C40) Ali/Aro	N	mg/kg	1	13.7	472
Total Petroleum Hydrocarbons					
Mineral Oil	M	mg/kg	5	^ < 5	^ 334
PCB (ICES 7 congeners)					
PCB (Total of 7 Congeners)	M	mg/kg	0.03	< 0.03	< 0.03

Tests marked N are not UKAS accredited.

Results Summary

Report No.: 19-25184, issue number 1

WAC Analysis								
Elab Ref:	186142					**Landfill Waste Acceptance Criteria Limits***		
Sample Date:	04/10/2019					**Inert Waste Landfill**	**Stable Non-reactive Hazardous waste in non-hazardous Landfill**	**Hazardous Waste Landfill**
Sample ID:	HP1							
Depth (m)	0.1							
Site:	English Martyrs							
Determinand		**Code**	**Units**					
Total Organic Carbon		N	%		4.00	3	5	6
Loss on Ignition		M	%		8.8	--	--	10
Total BTEX		M	mg/kg		< 0.01	6	--	--
Total PCBs (7 congeners)		M	mg/kg		< 0.03	1	--	--
TPH Total WAC		M	mg/kg		334	500	--	--
Total (of 17) PAHs		N	mg/kg		7.0	100	--	--
pH		M			7.8	--	>6	--
Acid Neutralisation Capacity		N	mol/kg		< 0.1	--	To evaluate	To evaluate
Eluate Analysis			**10:1**		**10:1**	**Limit values for compliance leaching test using BS EN 12457-2 at L/S 10 l/kg**		
			mg/l		**mg/kg**			
Arsenic		N	< 0.005		< 0.05	0.5	2	25
Barium		N	0.192		1.92	20	100	300
Cadmium		N	< 0.001		< 0.01	0.04	1	5
Chromium		N	< 0.005		< 0.05	0.5	10	70
Copper		N	0.007		0.07	2	50	100
Mercury		N	< 0.005		< 0.01	0.01	0.2	2
Molybdenum		N	< 0.005		< 0.05	0.5	10	30
Nickel		N	0.001		< 0.05	0.4	10	40
Lead		N	< 0.001		< 0.05	0.5	10	50
Antimony		N	< 0.005		< 0.05	0.06	0.7	5
Selenium		N	< 0.005		< 0.05	0.1	0.5	7
Zinc		N	0.016		0.16	4	50	200
Chloride		N	9		93.00	800	15000	25000
Fluoride		N	< 5		< 10	10	150	500
Sulphate		N	626		6260.00	1000	20000	50000
Total Dissolved Solids		N	892		8920.00	4000	60000	100000
Phenol Index		N	< 0.01		< 0.10	1	-	-
Dissolved Organic Carbon		N	14.700		147.00	500	800	1000
Leach Test Information								
pH		N	7.7					
Conductivity (uS/cm)		N	1330					
Dry mass of test portion (g)			100.000					
Dry Matter (%)			77					
Moisture (%)			30					
Eluent Volume (ml)			932					

Results are expressed on a dry weight basis, after correction for moisture content where applicable

* Stated limits are for guidance only, and not for conformity assessment.

Results Summary

Report No.: 19-25184, issue number 1

WAC Analysis								
Elab Ref:	186140					**Landfill Waste Acceptance Criteria Limits***		
Sample Date:	04/10/2019					**Inert Waste Landfill**	**Stable Non-reactive Hazardous waste in non-hazardous Landfill**	**Hazardous Waste Landfill**
Sample ID:	TP1							
Depth (m)	0.2							
Site:	English Martyrs							
Determinand		**Code**	**Units**					
Total Organic Carbon		N	%		11.00	3	5	6
Loss on Ignition		M	%		10.4	--	--	10
Total BTEX		M	mg/kg		< 0.01	6	--	--
Total PCBs (7 congeners)		M	mg/kg		< 0.03	1	--	--
TPH Total WAC		M	mg/kg		< 5	500	--	--
Total (of 17) PAHs		N	mg/kg		61.0	100	--	--
pH		M			6.7	--	>6	--
Acid Neutralisation Capacity		N	mol/kg		< 0.1	--	To evaluate	To evaluate
Eluate Analysis			**10:1**		**10:1**	**Limit values for compliance leaching test using BS EN 12457-2 at L/S 10 l/kg**		
			mg/l		**mg/kg**			
Arsenic		N	< 0.005		< 0.05	0.5	2	25
Barium		N	0.058		0.58	20	100	300
Cadmium		N	< 0.001		< 0.01	0.04	1	5
Chromium		N	< 0.005		< 0.05	0.5	10	70
Copper		N	0.010		0.10	2	50	100
Mercury		N	< 0.005		< 0.01	0.01	0.2	2
Molybdenum		N	< 0.005		< 0.05	0.5	10	30
Nickel		N	0.002		< 0.05	0.4	10	40
Lead		N	0.008		0.08	0.5	10	50
Antimony		N	0.006		0.06	0.06	0.7	5
Selenium		N	< 0.005		< 0.05	0.1	0.5	7
Zinc		N	0.020		0.20	4	50	200
Chloride		N	< 5		< 50	800	15000	25000
Fluoride		N	< 5		< 10	10	150	500
Sulphate		N	14		137.00	1000	20000	50000
Total Dissolved Solids		N	49		489.00	4000	60000	100000
Phenol Index		N	< 0.01		< 0.10	1	-	-
Dissolved Organic Carbon		N	9.760		98.00	500	800	1000
Leach Test Information								
pH		N	7.3					
Conductivity (uS/cm)		N	73					
Dry mass of test portion (g)			100.000					
Dry Matter (%)			76					
Moisture (%)			31					
Eluent Volume (ml)			940					

Results are expressed on a dry weight basis, after correction for moisture content where applicable

* Stated limits are for guidance only, and not for conformity assessment.

Unit A2, Windmill Road, Ponswood Industrial Estate, St Leonards on Sea, East Sussex, TN38 9BY
Tel: +44 (0)1424 718618, Email: info@elab-uk.co.uk, Web: www.elab-uk.co.uk

Results Summary

Report No.: 19-25184, issue number 1

Asbestos Results

Analytical result only applies to the sample as submitted by the client. Any comments, opinions or interpretations (marked #)
in this report are outside UKAS accreditation (Accreditation No2683). They are subjective comments only which must be verified by the client.

Elab No	Depth (m)	Clients Reference	Description of Sample Matrix #	Asbestos Identification	Gravimetric Analysis Total (%)	Gravimetric Analysis by ACM Type (%)	Free Fibre Analysis (%)	Total Asbestos (%)
186140	0.20	TP1	Brown Sandy Soil,Stonres,Pottery,Clinker	No asbestos detected	n/t	n/t	n/t	n/t
186142	0.10	HP1	Brown Sandy Soil,Stones,Brick,Twigs	No asbestos detected	n/t	n/t	n/t	n/t

Method Summary

Report No.: 19-25184, issue number 1

Parameter	Codes	Analysis Undertaken On	Date Tested	Method Number	Technique
Soil					
TOT PAH (GC-FID)	N	As submitted sample	11/10/2019		GC-FID
pH	M	Air dried sample	15/10/2019	113	Electromeric
Acid Soluble Sulphate	U	Air dried sample	11/10/2019	115	Ion Chromatography
Total Petroleum Hydrocarbons in solids	M	As submitted sample	10/10/2019	117	GC-FID
Aqua regia extractable metals	M	Air dried sample	10/10/2019	118	ICPMS
PCB (ICES 7 congeners)	M	Air dried sample	10/10/2019	120	GC-MS
Phenols in solids	M	As submitted sample	10/10/2019	121	HPLC
Loss on ignition at 450 deg C	M	Air dried sample	11/10/2019	129	Gravimetry
PAH (GC-FID)	M	As submitted sample	10/10/2019	133	GC-FID
Water soluble anions	M	Air dried sample	10/10/2019	172	Ion Chromatography
Low range Aliphatic hydrocarbons soil	N	As submitted sample	11/10/2019	181	GC-MS
Low range Aromatic hydrocarbons soil	N	As submitted sample	11/10/2019	181	GC-MS
BTEX in solids	M	As submitted sample	11/10/2019	181A	GC-MS
Total cyanide	M	As submitted sample	10/10/2019	204	Colorimetry
Total organic carbon/Total sulphur	N	Air dried sample	11/10/2019	210	IR
Aliphatic hydrocarbons in soil	N	As submitted sample	10/10/2019	214	GC-FID
Aliphatic/Aromatic hydrocarbons in soil	N	As submitted sample	11/10/2019	214	GC-FID
Aromatic hydrocarbons in soil	N	As submitted sample	10/10/2019	214	GC-FID
Basic carbon banding in soil	N	As submitted sample	10/10/2019	218	GC-FID
Diesel range organics in soil	N	As submitted sample	14/10/2019	257	GC-FID
Soil organic matter	U	Air dried sample	14/10/2019	BS1377:P3	Titrimetry
Acid neutralisation capacity	N	Air dried sample	15/10/2019	737	
Asbestos identification	U	Air dried sample	10/10/2019	PMAN	Microscopy

Leachate

Tests marked N are not UKAS accredited

Report Information

Report No.: 19-25184, issue number 1

Key

U	hold UKAS accreditation
M	hold MCERTS and UKAS accreditation
N	do not currently hold UKAS accreditation
^	MCERTS accreditation not applicable for sample matrix
*	UKAS accreditation not applicable for sample matrix
S	Subcontracted to approved laboratory UKAS Accredited for the test
SM	Subcontracted to approved laboratory MCERTS/UKAS Accredited for the test
NS	Subcontracted to approved laboratory. UKAS accreditation is not applicable.
I/S	Insufficient Sample
U/S	Unsuitable sample
n/t	Not tested
<	means "less than"
>	means "greater than"

Soil sample results are expressed on an air dried basis (dried at < 30°C), and are uncorrected for inert material removed.
ELAB are unable to provide an interpretation or opinion on the content of this report.
The results relate only to the sample received.
PCB congener results may include any coeluting PCBs
Uncertainty of measurement for the determinands tested are available upon request
Unless otherwise stated, sample information has been provided by the client

Deviation Codes

a	No date of sampling supplied
b	No time of sampling supplied (Waters Only)
c	Sample not received in appropriate containers
d	Sample not received in cooled condition
e	The container has been incorrectly filled
f	Sample age exceeds stability time (sampling to receipt)
g	Sample age exceeds stability time (sampling to analysis)

Where a sample has a deviation code, the applicable test result may be invalid.

Sample Retention and Disposal

All soil samples will be retained for a period of one month
All water samples will be retained for 7 days following the date of the test report
Charges may apply to extended sample storage

APPENDIX F

Current Guidance for Ground Gas Risk Assessment

Site: English Martyrs

CHEMICAL STATISTICAL ANALYSIS - based on CLEA v1.06 (Sandy Loam 1% SOM)

TerraConsult

Job No: 4738

Analyte	Limit of Detection	TerraConsult Stone, Bricks, Clinker 04/10/19 TP1 Depth	TerraConsult Stone, Bricks, Clinker 04/10/19 HP1 Depth	Statistical Analysis n	Standard Deviation	Minimum	Average	Maximum	SGV / GAC Statistical Results Maximum	Residential With Veg. Uptake Tier I Screening Criteria	Pass/ Fail	SGV / GAC Criteria Source Source of Screening Criteria	Source of Toxicological Data	pC4SL Screening Criteria Residential with Home Grown Produce	Pass / Fail	pC4SL Criteria Source Source of Screening Criteria	Source of Toxicological Data	LQM/CIEH S4UL Screening Criteria Residential with Home Grown Produce	Pass / Fail	LQM/CIEH S4UL Criteria Source Source of Screening Criteria	Source of Toxicological Data
Stone Content	<0.1 %	44.4	43.3		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Asbestos Screen	Positive / Negative	Negative	Negative		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Metals																					
Arsenic (total)	<1 mg/kg	179	43.7	2	95.67	44	111	179	179.0	32	Fail	SC050021*	SC050021	37	Fail	CLEA v1.06	Defra 2014	37	Fail	CLEA v1.06	LQM/CIEH 2014
Cadmium (total)	<0.5 mg/kg	2.5	0.8	2	1.20	1	2	3	2.5	10	Pass	SC050021*	SC050021	22	Pass	CLEA v1.06	Defra 2014	11	Pass	CLEA v1.06	LQM/CIEH 2014
Chromium (hexavalent)	<2 mg/kg	0.0	0.0	2	0.00	0	0	0	0.0	4.3	Pass	CLEA v1.06	LQM 2009	21	Pass	CLEA v1.06	Defra 2014	6	Pass	CLEA v1.06	LQM/CIEH 2014
Chromium (total) (III for S4ULs)	<5 mg/kg	64.1	36.2	2	19.73	36	50	64	64.1	3010	Pass	CLEA v1.06	LQM 2009	-	-	-	-	910	Pass	CLEA v1.06	LQM/CIEH 2014
Copper (total)	<5 mg/kg	1530	169	2	962.37	169	850	1530	1530.0	2330	Pass	CLEA v1.06	LQM 2009	-	-	-	-	2400	Pass	CLEA v1.06	LQM/CIEH 2014
Lead (total)	<5 mg/kg	2170	432	2	1228.95	432	1301	2170	2170.0	N/A	-	-	-	210	Fail	CLEA v1.06	Defra 2014	-	-	-	-
Mercury (total inorganic)	<0.5 mg/kg	0.5	0.5	2	0.00	1	1	1	0.5	170	Pass	SC050021*	SC050021	-	-	-	-	40	Pass	CLEA v1.06	LQM/CIEH 2014
Nickel (total)	<5 mg/kg	180	43.2	2	96.73	43	112	180	180.0	43	Fail	CLEA v1.071	EFSA	-	-	-	-	180	Fail	CLEA v1.06	LQM/CIEH 2014
Selenium (total)	<1 mg/kg	1	1.4	2	0.28	1	1	1	1.4	350	Pass	SC050021*	SC050021	-	-	-	-	250	Pass	CLEA v1.06	LQM/CIEH 2014
Zinc (total)	<5 mg/kg	1580	595	2	696.50	595	1088	1580	1580.0	3740	Pass	CLEA v1.06	LQM 2009	-	-	-	-	3700	Pass	CLEA v1.06	LQM/CIEH 2014
Inorganic														-	-	-	-	-	-		
pH Value	pH Units	6.7	7.8	2	0.78	6.7	7	7.8	7.80	-	-	-	-	-	-	-	-	-	-	-	-
Cyanide (total)	<1 mg/kg	1.0	1.0	2	0.00	1	1	1.0	1.00	-	-	-	-	-	-	-	-	-	-	-	-
Sulphate (2:1)	<0.02 g/l	0.26	1.63	2	0.97	0.26	1	2	2	-	-	-	-	-	-	-	-	-	-	-	-
Organic														-	-	-	-	-	-		
Soil Organic Matter	<0.1 %	4.4	5.3	2	0.64	4.4	5	5.30	5.30	-	-	-	-	-	-	-	-	-	-	-	-
TOC	<0.1 %	11	4	2	4.95	4.0	8	11.00	11.00	-	-	-	-	-	-	-	-	-	-	-	-
Loss On Ignition (450°C)	%	10.4	8.8																		
Cresol	<1 mg/kg	1	1	2	0.00	1	1	1.0	1.00	-	-	-	-	-	-	-	-	-	-	-	-
Phenol (Total Monohydric)	<1 mg/kg	1	1	2	0.00	1	1	1.0	1.00	210	Pass	CLEA v1.06	SC050021	-	-	-	-	280	Pass	CLEA v1.06	LQM/CIEH 2014
PAH																					
Naphthalene	<0.1 mg/kg	0.6	0.1	2	0.35	0.1	0	0.6	0.6	1.54	Pass	CLEA v1.06	LQM 2009	-	-	-	-	2.3	Pass	CLEA v1.06	LQM/CIEH 2014
Acenaphthylene	<0.1 mg/kg	0.1	0.1	2	0.00	0.1	0	0.1	0.1	168	Pass	CLEA v1.06	LQM 2009	-	-	-	-	170	Pass	CLEA v1.06	LQM/CIEH 2014
Acenaphthene	<0.1 mg/kg	1.9	0.1	2	1.27	0.1	1	1.9	1.9	205	Pass	CLEA v1.06	LQM 2009	-	-	-	-	210	Pass	CLEA v1.06	LQM/CIEH 2014
Fluorene	<0.1 mg/kg	1	0.1	2	0.64	0.1	1	1.0	1.0	163	Pass	CLEA v1.06	LQM 2009	-	-	-	-	170	Pass	CLEA v1.06	LQM/CIEH 2014
Phenanthrene	<0.1 mg/kg	8.2	0.8	2	5.23	0.8	5	8.2	8.2	92	Pass	CLEA v1.06	LQM 2009	-	-	-	-	95	Pass	CLEA v1.06	LQM/CIEH 2014
Anthracene	<0.1 mg/kg	1.7	0.2	2	1.06	0.2	1	1.7	1.7	2260	Pass	CLEA v1.06	LQM 2009	-	-	-	-	2400	Pass	CLEA v1.06	LQM/CIEH 2014
Fluoranthene	<0.1 mg/kg	10.2	1.1	2	6.43	1.1	6	10.2	10.2	257	Pass	CLEA v1.06	LQM 2009	-	-	-	-	280	Pass	CLEA v1.06	LQM/CIEH 2014
Pyrene	<0.1 mg/kg	9.3	1.1	2	5.80	1.1	5	9.3	9.3	563	Pass	CLEA v1.06	LQM 2009	-	-	-	-	620	Pass	CLEA v1.06	LQM/CIEH 2014
Benz(a)anthracene	<0.1 mg/kg	4.4	0.4	2	2.83	0.4	2	4.4	4.4	3.1	Fail	CLEA v1.06	LQM 2009	-	-	-	-	7.2	Pass	CLEA v1.06	LQM/CIEH 2014
Chrysene	<0.1 mg/kg	5.2	0.7	2	3.18	0.7	3	5.2	5.2	6	Pass	CLEA v1.06	LQM 2009	-	-	-	-	15	Pass	CLEA v1.06	LQM/CIEH 2014
Benzo(b)fluoranthene	<0.1 mg/kg	3.8	0.6	2	2.26	0.6	2	3.8	3.8	5.6	Pass	CLEA v1.06	LQM 2009	-	-	-	-	2.6	Fail	CLEA v1.06	LQM/CIEH 2014
Benzo(k)fluoranthene	<0.1 mg/kg	3.9	0.7	2	2.26	0.7	2	3.9	3.9	8.5	Pass	CLEA v1.06	LQM 2009	-	-	-	-	77	Pass	CLEA v1.06	LQM/CIEH 2014
Benzo(a)pyrene	<0.1 mg/kg	4	0.5	2	2.47	0.5	2	4.0	4.0	0.83	Fail	CLEA v1.06	LQM 2009	5.0	Pass	CLEA v1.06	Defra 2014	2.2	Fail	CLEA v1.06	LQM/CIEH 2014
Indeno(123cd)pyrene	<0.1 mg/kg	2.5	0.4	2	1.48	0.4	1	2.5	2.5	3.2	Pass	CLEA v1.06	LQM 2009	-	-	-	-	27	Pass	CLEA v1.06	LQM/CIEH 2014
Dibenzo(ah)anthracene	<0.1 mg/kg	0.5	0.1	2	0.28	0.1	0	0.5	0.5	0.76	Pass	CLEA v1.06	LQM 2009	-	-	-	-	0.24	Fail	CLEA v1.06	LQM/CIEH 2014
Benzo(ghi)perylene	<0.1 mg/kg	2.4	0.4	2	1.41	0.4	1	2.4	2.4	44	Pass	CLEA v1.06	LQM 2009	-	-	-	-	320	Pass	CLEA v1.06	LQM/CIEH 2014
Coronene	<0.1 mg/kg	1	0.3	2	0.49	0.3	1	1.0	1.0	88.1	Pass	CLEA v1.06	LQM 2009	-	-	-	-	-	-	-	-
Total EPA-16 PAHs	<0.4 mg/kg	59.6	7.2	2	37.05	7.2	33	59.6	59.6	-	-	-	-	-	-	-	-	-	-	-	-
Total WAC-17 PAHs	<1.7 mg/kg	61.00	7.0	2	38.18	7.0	34	61.0	61.0	-	-	-	-	-	-	-	-	-	-	-	-
BTEX Benzene	<10 ug/kg	10	10	2	0.00	10.000	10	10.000	10.00	0.078	Fail	CLEA v1.06	SC050021	0.87	Fail	CLEA v1.06	Defra 2014	0.087	Fail	CLEA v1.06	LQM/CIEH 2014
Toluene	<10 ug/kg	10	10	2	0.00	10.000	10	10.000	10.00	119	Pass	CLEA v1.06	SC050021	-	-	-	-	130	Pass	CLEA v1.06	LQM/CIEH 2014
Ethyl Benzene	<10 ug/kg	10	10	2	0.00	10.000	10	10.000	10.00	65.2	Pass	CLEA v1.06	SC050021	-	-	-	-	47	Pass	CLEA v1.06	LQM/CIEH 2014
Xylene (o, m & p)	<10 ug/kg	10	10	2	0.00	10.000	10	10.000	10.00	45.2	Pass	CLEA v1.06	SC050021	-	-	-	-	60	Pass	CLEA v1.06	LQM/CIEH 2014
MTBE	<10 ug/kg	10	10	2	0.00	10.000	10	10.000	-	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons																					
DRO (C_{10} - C_{28})	<1 mg/kg	1	10	2	6.36	1	6	10	10	-	-	-	-	-	-	-	-	-	-	-	-
Mineral Oil (C_{10} - C_{40})	<5 mg/kg	5	334	2	232.64	5	170	334	334	-	-	-	-	-	-	-	-	-	-	-	-
TPH (C_6 - C_{40})	<10 mg/kg	13.7	472	2	324.07	14	243	472.0	472.00	-	-	-	-	-	-	-	-	-	-	-	-
Aliphatic >C_5 - C_6	<0.01 mg/kg	0.01	0.01	2	0.00	0.01	0	0.0	0.01	30	Pass	CLEA v1.06	LQM 2009	-	-	-	-	42	Pass	CLEA v1.06	LQM/CIEH 2014
Aliphatic >C_6 - C_8	<0.01 mg/kg	0.01	0.01	2	0.00	0.01	0	0.0	0.01	73	Pass	CLEA v1.06	LQM 2009	-	-	-	-	100	Pass	CLEA v1.06	LQM/CIEH 2014
Aliphatic >C_8 - C_{10}	<1 mg/kg	1	3.5	2	1.77	1	2	3.5	3.50	19	Pass	CLEA v1.06	LQM 2009	-	-	-	-	27	Pass	CLEA v1.06	LQM/CIEH 2014
Aliphatic >C_{10} - C_{12}	<1 mg/kg	1	3.8	2	1.98	1	2	3.8	3.80	93	Pass	CLEA v1.06	LQM 2009	-	-	-	-	130	Pass	CLEA v1.06	LQM/CIEH 2014
Aliphatic >C_{12} - C_{16}	<1 mg/kg	1	1	2	0.00	1	1	1.0	1.00	740	Pass	CLEA v1.06	LQM 2009	-	-	-	-	1100	Pass	CLEA v1.06	LQM/CIEH 2014
Aliphatic >C_{16} - C_{21}	<1 mg/kg	1	1.6	2	0.42	1	1	1.6	1.60	45000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	65000	Pass	CLEA v1.06	LQM/CIEH 2014
Aliphatic >C_{21} - C_{35}	<1 mg/kg	1	127	2	89.10	1	64	127.0	127.00	45000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	65000	Pass	CLEA v1.06	LQM/CIEH 2014
Aliphatic >C_{35} - C_{44}	<1 mg/kg	1	71.2	2	49.64	1	36	71.2	71.20	45000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	65000	Pass	CLEA v1.06	LQM/CIEH 2014
Aromatic C_5 - C_7	<0.01 mg/kg	0.01	0.01	2	0.00	0	0	0.01	0.01	65	Pass	CLEA v1.06	LQM 2009	-	-	-	-	70	Pass	CLEA v1.06	LQM/CIEH 2014
Aromatic C_7 - C_8	<0.05 mg/kg	0.01	0.01	2	0.00	0	0	0.01	0.01	120	Pass	CLEA v1.06	LQM 2009	-	-	-	-	130	Pass	CLEA v1.06	LQM/CIEH 2014
Aromatic >C_8 - C_{10}	<1 mg/kg	1	2.1	2	0.78	1	2	2.1	2.10	27	Pass	CLEA v1.06	LQM 2009	-	-	-	-	34	Pass	CLEA v1.06	LQM/CIEH 2014
Aromatic >C_{10} - C_{12}	<1 mg/kg	1	2.5	2	1.06	1	2	2.5	2.50	69	Pass	CLEA v1.06	LQM 2009	-	-	-	-	74	Pass	CLEA v1.06	LQM/CIEH 2014
Aromatic >C_{12} - C_{16}	<1 mg/kg	1	1	2	0.00	1	1	1.0	1.00	140	Pass	CLEA v1.06	LQM 2009	-	-	-	-	140	Pass	CLEA v1.06	LQM/CIEH 2014
Aromatic >C_{16} - C_{21}	<1 mg/kg	1.6	1.8	2	0.14	2	2	1.8	1.80	250	Pass	CLEA v1.06	LQM 2009	-	-	-	-	260	Pass	CLEA v1.06	LQM/CIEH 2014
Aromatic >C_{21} - C_{35}	<6 mg/kg	10.2	159	2	105.22	10	85	159.0	159.00	890	Pass	CLEA v1.06	LQM 2009	-	-	-	-	1100	Pass	CLEA v1.06	LQM/CIEH 2014
Aromatic >C_{35} - C_{44}	<10 mg/kg	1.8	100	2	69.44	2	51	100.0	100.00	890	Pass	CLEA v1.06	LQM 2009	-	-	-	-	1100	Pass	CLEA v1.06	LQM/CIEH 2014

Below Detection Limits.
Exceeded GAC/SGV
Exceeded pC4SL / S4ULs
Assessment criteria for pH, Sulphide and Sulphate are not based on human health. Sulphate criteria assumes DS-1 ACEC classification for concrete.

Notes

1. Generic Qualitative Assessment Criteria have been used where appropriate based on the current CLEA 1.06 Model (default values, sandy loam 1%SOM). Where no CLEA generic guideline value has been calculated no assessment has been made. The results presented show maximum and mean concentrations. This is to provide a reasonable prediction of the
2. Results lower than detection limit are shaded in grey.
3. When the test result is recorded as being less than the detection limit, the result used for the analysis is the detection limit.
4. Cyanide (total)*, in the absence of a GQAC based on current CLEA 1.06 Model, the Atrisk Soil Value for Cyanide (free) has been used.
5. For metals, where an SGV has been published, this value has been used. Note that the published SGVs do not include the residential without plant uptake scenario. CLEA v1.06 has therefore been used to derive GACs for this scenario. For organics, CLEA v1.06 has been used (as the SGV assumes 6% SOM)
6. pC4SL based on adjusted toxicology and expsoure assumptions
7. pC4SL for benzene assumes 6% SOM

APPENDIX G

Summary of Guidance for Classification of Soil as a Waste Material

Guidance for Classification of Soil for Off Site Disposal at a Landfill Site

Many site developments create a portion of excess soils and Made Ground which if not re-usable, are required to be disposed off-site at a suitably licensed landfill site. The regulations and associated guidance published by the Environment Agency is relatively complex and lengthy. This guidance provides a summary of the following documents which should be referred to when assessing soil (and common constituents found within Made Ground on remediation sites) for off-site disposal:

- Guidance for Waste destined for disposal in landfills: Interpretation of the Waste Acceptance Requirements of the Landfill (England and Wales) Regulations 2002 (as amended) (EA, 2004);
- Guidance on Sampling and Testing of Wastes to Meet Landfill Waste Acceptance Procedures (EA, April 2005);
- WM3 - Hazardous Waste: Interpretation of the Definition and Classification of Hazardous Wastes (EA, May 2015);
- European Regulation No 1272/2008 on Classification, Labelling and Packaging of substances 2015 (CLP 2015);
- Guidance on Waste Destined for Disposal in Landfill (EA, June 2006);
- Treatment of Non-hazardous wastes for Landfill (EA, February 2007).

It is important to distinguish between the waste classification system and the designation of materials as “suitable for use” on site. A material may be retained on site for an appropriate end use if that end-use is clearly designated and that a site-specific risk assessment ensures that it does not pose a risk to human health or controlled waters. However, if this material is excavated and sent for disposal, the material is then subject to waste management regulations and the two systems cannot be directly correlated. It is therefore important to note that classifying a material as hazardous (should it be excavated and become a waste) does not necessarily indicate that it might not be suitable to be kept on site for re-use. Separate guidance in the form of a Code of Practice (CL:AIRE Version 2, 2011) has been developed jointly between the development industry and the Environment Agency to provide best practice when assessing whether materials are wastes or not, and for determining when waste can cease to be waste for a particular use.

In accordance with the current waste regulations (or Landfill Directive, as they are more commonly known), from 30th October 2007 all waste materials produced from construction sites have to be pre-treated prior to disposal. Pre-treatment includes waste minimisation, recovery (e.g. separation of demolition waste to be used as hardcore) and separation of materials into different waste categories (e.g. separate inert waste from hazardous waste etc). Mixing of different waste types shall be avoided and intentional mixing of inert materials with hazardous waste to ‘dilute it’ and hence change its waste classification, is illegal.

The current waste regulations (based on the EU landfill directive) introduced a two tier classification system for waste materials, defining them as either being hazardous or non-hazardous. Landfills are licensed to take wastes based on a three tier classification system with the non- hazardous waste divided into two sub-categories:

- Non-Hazardous - inert;
- Non-Hazardous - non-hazardous;
- Hazardous.

Waste materials are categorised with a six figure numeric code in the European Waste Catalogue. Commonly found construction and demolition wastes including excavated soil from contaminated sites and Made Ground with their waste codes are summarised below (this is not a comprehensive list):

Waste Code	What is it?	Likely Waste Category–		
		Inert Waste	Non-Hazardous	Hazardous Waste
17 01 01 Concrete	Concrete, possibly with reinforcement (from Construction & Demolition)	✓		
17 01 02 Bricks		✓		
17 01 06* Mixtures of concrete, bricks, tiles & ceramics containing dangerous substances	These are not normally considered hazardous but if they are contaminated (e.g. by asbestos) then could be hazardous – see comment above			✓
17 01 07 Mixtures of concrete, bricks, tiles & ceramics other than those in 17 01 06	This is mixed inerts c.f. 17 09 04	✓		
17 05 03* soils and stones containing dangerous substances				✓
17 05 04 soils and stones other than those mentioned in 17 05 03	Soil and stones only (excluding top soil, peat, soil and stones from contaminated sites)	✓		
17 06 05* Construction materials containing asbestos	e.g. corrugated asbestos sheeting			✓
17 08 02 Gypsum-based construction materials other than those mentioned in 17 08 01	Plaster & plasterboard (although specific disposal requirements are required for high sulphate waste – see EA guidance 'Understanding the Landfill Directive' version 1.0 March 2010.		✓	
17 09 01* Construction & demolition wastes containing mercury				✓
17 09 02* Construction & demolition wastes containing PCBs	Waste with more than 50 mg/kg of PCB's are hazardous			✓
17 09 03* Other mixed construction & demolition wastes containing dangerous substances	Broad range of potentially (see notes below – if asterix the waste is hazardous) hazardous wastes			✓
17 09 04 Mixed construction & demolition wastes other than those mentioned in 17 09 01, 17 09 02 & 17 09 03	Mixed inerts with soil, tarmac, cables, vegetation, plaster, etc. (this waste can only be considered inert if it passes the waste acceptance criteria	✓	✓	

	identified in the regulations).			

Note: all wastes with an asterix code are hazardous regardless of whether they are mirror or absolute entries in the EWC list the decision to with regard to composition must come before applying the code for mirror entries.

Some materials are classified as Inert Waste based in its origin (e.g. 17 01 01 Concrete, or glass) without any requirement for laboratory chemical analysis.

However, most soils will require laboratory testing to confirm whether they are classified as Hazardous Waste. The protocol for assessing these materials and the appropriate threshold values is complicated and are set out in the Environment Agency's "Technical Guidance *WM3* Hazardous Waste – Interpretation of the Definition and Classification of Hazardous Waste" (2015). If the test results for the waste indicates that it is not hazardous then further analysis of the waste is required to determine whether it is Inert Waste. If the waste does not meet the criteria for either Hazardous or Inert, then it is by default classified as Non-hazardous Waste.

As an alternative location to landfills for off-site disposal of inert and non-hazardous waste, there are a number of sites which have Waste Permit Exemptions that can accept certain categories of inert and non-hazardous wastes. Additionally some quarries can accept certain types of wastes to be used for quarry restoration material. For both alternatives to disposal at landfill sites the material still requires chemical testing as these sites have site specific acceptance criteria for wastes. It should also be noted that these types of site do not incur landfill tax which in the 2018/19 tax year is £2.80 for inactive waste (inert and some types of non-hazardous waste) and £88.95/Tonne for active waste (some types of non-hazardous waste and hazardous waste. Note that the Inland Revenue uses a different classification scheme for waste for tax purposes to the European Waste Classification scheme.

Waste Categorisation

The process of determining the category of wastes is a three stage process:

- Stage 1 – is the waste either Hazardous or Inert by definition without the requirement for chemical analysis (if it is then Stages 2 and 3 are not required);
- Stage 2 - Waste characterisation;
- Stage 3 - WAC classification.

Waste characterisation determines if a waste is hazardous or not. Excavated soil is characterised using a system based on the contaminants present and their hazardous properties. The system uses total concentrations of the contaminants. Thresholds (as a percentage of the waste) have been set for the various hazardous properties.

Fourteen hazardous properties together with other scenarios where material could cause a hazard have been defined:

- Hazardous properties: explosive, oxidising, highly flammable/flammable, irritant, harmful, toxic, carcinogenic, corrosive, infectious, toxic for reproduction, mutagenic and ecotoxic;
- Substances which can release toxic/very toxic gases in contact with water, acid or air;
- Substances which, after disposal, can yield another substance, e.g. a leachate, which possesses any of the above hazardous properties.

Some of the hazardous properties are sub-divided e.g. there are three categories of carcinogenic, mutagenic and toxic for reproduction substances. The hazardous properties were originally defined in the European Hazardous Waste Directive 91/689/EC. Should a waste contain a contaminant with one or more of the listed hazardous properties at a concentration equal to or above the threshold value for the particular property, then the waste is hazardous. The hazardous properties of a wide range of chemicals are sourced from CLP 2015.

There are many reasons why waste soil is classified as being hazardous but the majority of reasons can be divided into the following four groups:

- Hydrocarbons – this is probably the most common reason for the hazardous classification of soils. For most soils hydrocarbon analysis will be required for both Polycyclic Aromatic Hydrocarbons (PAH) and speciated Petroleum Hydrocarbons (PHCs) but depending on the site's history other groups of organic contaminants may also be is included in any analysis suite for soil samples;
- Metals – Particularly sites from former metal processing or mining sites and also some types of ash have metal concentrations that are sufficiently high to characterise materials requiring disposal as hazardous waste.
- Asbestos;
- Anions – e.g. sulphate in plasterboard (there are special disposal requirements for high sulphate waste and specific WAC requirements); it is possible that sulphate salts of metals and semi-metals could make the waste hazardous – the sulphate concentration could possibly be significant under H12, H13 and H14.

The characterisation of wastes with significant metal concentrations involves some processing of the analysis data. The chemical analysis results for inorganic substances are generally reported as total concentrations e.g. total lead, total arsenic, total sulphate etc. However, CLP 2015 deals with the hazardous properties of actual compounds e.g. lead sulphate, arsenic pentoxide, nickel carbonate. Therefore, the total metal results have to be converted into assessed chemical analysis results for the compound most likely to be present in the soil samples. For example, if the sample contains high total lead concentrations and high sulphate concentrations, then the lead is likely to be present in the soil as lead sulphate. The most likely compounds can often be determined from a desk study or previous site uses. If the site has been derelict for a number of years, consideration should be given as to whether water soluble compounds should or should not be chosen, as rainfall could have removed them from the soil (this does not apply if the soil has been taken from below under a concrete slab etc). Chemical knowledge and common sense needs to be used in choosing a suitable compound.

If no data is available, then a worst case scenario has to be assumed and the most hazardous compound likely to be present has to be chosen. For example, metal chromates (lead chromate, nickel chromate) are often the most hazardous compounds formed by many metals, but if the chromium concentrations in the soil are low, chromates are unlikely to be present. It should also be noted that for many of the hazard categories, the cumulative hazard from different compounds is added (e.g. add the concentrations of the copper, lead and zinc compounds together to assess the Hazard Category H14 Ecotoxicity).

If the results of the above assessment determine that the waste is hazardous, it must then be analysed for the Waste Acceptance Criteria (WAC) analysis contained within appropriate Environmental Permitting Regulations (this comprises mainly leachate but also analysis for TOC

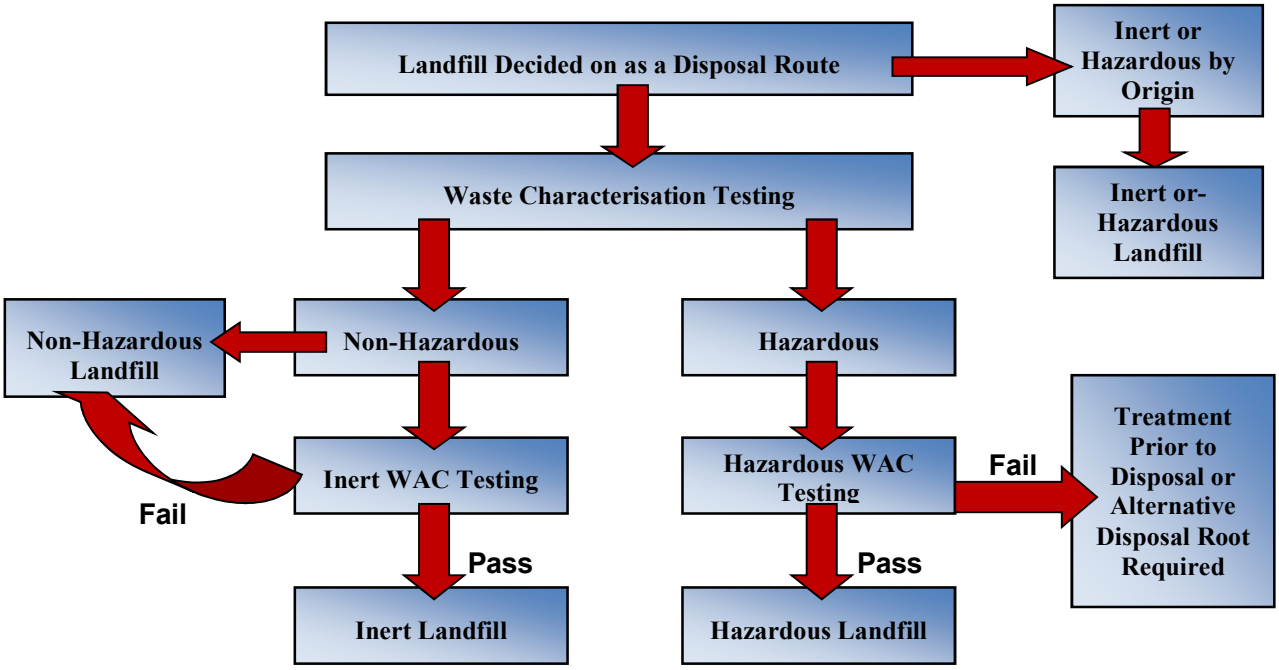
and Loss on ignition). WAC limit values have been set for the listed determinands. If any of the determinands exceed their limit value, the waste must be pre-treated to reduce concentrations to below the limit values before the waste may be disposed of at a landfill site licensed to take hazardous waste.

For waste classified as not being hazardous, then there are two options available. Currently, waste correctly characterised as not being hazardous may be disposed of without WAC testing to a non-hazardous landfill. Alternatively WAC testing for Inert Waste can be carried out (this is similar to the list for hazardous waste with the addition of PAH's, BTEX and Mineral Oil). If the results pass the Inert WAC criteria it can be disposed of at an Inert Waste Landfill. If any of the WAC test results exceed the Inert WAC criteria the waste has to be disposed at a non- hazardous landfill. There are WAC limits for non-hazardous waste set for pH and TOC. If these two criteria are not met then the waste must be pre-treated to so that it meets the criteria before it can be disposed.

If materials fail the WAC criteria it may be possible to pre-treat the waste on-site or be taken to a soil treatment centre for pre-treatment to reduce the soil's hazardous properties (e.g. by bioremediation of hydrocarbons).

It should be noted that in order to dispose of Hazardous Waste, the site must register as a producer of Hazardous Waste with the Environment Agency. When disposing of waste materials to landfill sites the appropriate Duty of Care Waste Transfer procedures must be followed.

Landfilled Waste Decision Tree



Landfill Tax

It should be noted that HM Revenue and Customs (HMRC) classify wastes for tax purposes using a different scheme to the three fold landfill EU Landfill Directive scheme (i.e. the hazardous, non-hazardous and inert). HMRC have a two-fold system for landfill tax. The Standard Landfill Tax is currently £88.95/T and applies to all wastes unless they qualify for the reduced rate of landfill tax

of £2.80/T. The wastes that qualify for the reduced rate of Landfill Tax are set out in The Landfill Tax (Qualifying Material) Order 2011 with supplementary information on the interpretation of these regulations in HMRS "Notice LFT1 – A General Guide to Landfill Tax" (May 2012) and HMRC Briefing Notes 15/12 and 18/12.

APPENDIX H

Unforeseen Ground Contamination

Unforeseen Ground Contamination

There is the potential for areas of previously unexpected contamination to be present, as is the case with any "brownfield" site. Any significant quantities of asbestos, significant ashy soils, unusual, brightly coloured or significantly oily or odorous material should be considered in this category. If unexpected contamination is found the following procedures should be adhered to:

1. All site works at the position of the suspected contamination will cease.
2. A suitably trained geo-environmental specialist should assess the visual and olfactory observations of the condition of the ground and the extent of contamination and the Client and the Local Authority should be informed of the discovery. Should the contamination be likely to affect controlled waters the Environment Agency shall also be informed.
3. The suspected contaminated material will be investigated and tested appropriately in accordance with the assessed risks. The investigation works will be carried out in the presence of a suitably qualified geo-environmental engineer. The investigation works shall commence to recover samples for testing and, using visual and olfactory observations of the condition of the ground, delineate the area over which contaminated materials are present.
4. The unexpected contaminated material will either be left in situ or be stockpiled whilst testing is carried out and suitable assessments completed to determine whether the material can be re-used on site or requires to be disposed as appropriate.
5. Where the material is left in situ awaiting results it will be reburied or covered with plastic sheeting.
6. Where the potentially contaminated material is to be temporarily stockpiled it will either be placed either on a prepared surface of clayey Alluvium, or on 2000 gauge Visqueen sheeting (or other impermeable surface) and covered to prevent dust and odour emissions.
7. Any areas where unexpected visual or olfactory ground contamination will be surveyed, a photographic record kept and testing results incorporated into the Verification Report.
8. A photographic recorded will be made of relevant observations.
9. The testing suite will be determined by the independent geo-environmental specialist on the basis of visual and olfactory observations.
10. Test results will be compared against current assessment criteria suitable for the future use of the area of the site affected.
11. The results of the investigation and testing of any suspect unexpected contamination will be used to determine the relevant actions. After consultation with the Local Authority and if necessary the Environment Agency, materials should either be:
    - re-used in areas where test results indicate that it meets compliance targets so it can be reused without treatment; or
    - treatment of material on site to meet compliance targets so it can be reused; or

- removal from site to a treatment centre or to a suitably licensed landfill or permitted treatment facility.

12. Verification Report will be produced for the work.

Asbestos

Asbestos fibres and ACMs have been encountered in the soils at the site. An Asbestos Working Plan is present in Appendix J which covers procedures which need to be followed if asbestos, or suspected asbestos, is encountered.

Unexpected Tanks

No buried underground fuel storage tanks have been encountered during the site investigation works; however, there remains a low risk that tanks are present on site. Should an underground tank be encountered, operations should cease in the area. Additionally there may be pipework associated with these tanks which could have oily residues. The following procedures are to be adhered to if tanks and pipework are identified:

1. All site works at the position of the tanks/pipework should stop.
2. A description of the tank should be made by the geo-environmental engineer including; condition and surround, along with visual and olfactory observations should any contents in the tank be apparent. A photographic recorded will also be made of relevant observations.
3. The tank's position and depth should be determined and marked on a plan of the site.
4. The independent geo-environmental engineer will inform Client and the Local Authority.
5. During the presence of the independent geo-environmental engineer, investigation works should be undertaken to obtain samples of any liquid or sludge contents and to establish dimensions of the tank.
6. Testing will be determined on the basis of visual and olfactory observations by independent geo-environmental engineer.
7. Test results will be compared against current assessment criteria and proposals for disposal of any contents determined in agreement with the appropriate Regulatory Parties.
8. Emptying the tank and disposal of contents to a suitable licenced disposal facility.
9. Degassing and removal of the tank by a suitably qualified contractor will be required, and a Naked Flame Certificate should be provided.
10. Once the tank has been emptied in accordance with the above proposals, it is to be removed for disposal to a licensed waste management facility. Copies of the relevant waste consignment notes are to be kept and included in the Verification Report.
11. Excavation and remediation of any contaminated soils around the tank will be carried out.
12. Samples of the base and sides of the resultant hole will be sampled and supervised by the independent geo-environmental engineer to confirm whether risks to human health or controlled waters.

All of the above information will be incorporated into the Verification Report and submitted to the regulatory parties, the Local Authority and the Environment Agency where groundwater may potentially have been impacted.

APPENDIX G

Summary of Guidance for Classification of Soil as a Waste Material

Guidance for Classification of Soil for Off Site Disposal at a Landfill Site

Many site developments create a portion of excess soils and Made Ground which if not re-usable, are required to be disposed off-site at a suitably licensed landfill site. The regulations and associated guidance published by the Environment Agency is relatively complex and lengthy. This guidance provides a summary of the following documents which should be referred to when assessing soil (and common constituents found within Made Ground on remediation sites) for off-site disposal:

- Guidance for Waste destined for disposal in landfills: Interpretation of the Waste Acceptance Requirements of the Landfill (England and Wales) Regulations 2002 (as amended) (EA, 2004);
- Guidance on Sampling and Testing of Wastes to Meet Landfill Waste Acceptance Procedures (EA, April 2005);
- WM3 - Hazardous Waste: Interpretation of the Definition and Classification of Hazardous Wastes (EA, May 2015);
- European Regulation No 1272/2008 on Classification, Labelling and Packaging of Substances 2015 (CLP 2015);
- Guidance on Waste Destined for Disposal in Landfill (EA, June 2006);
- Treatment of Non-hazardous wastes for Landfill (EA, February 2007).

It is important to distinguish between the waste classification system and the designation of materials as "suitable for use" on site. A material may be retained on site for an appropriate end use if that end-use is clearly designated and that a site-specific risk assessment ensures that it does not pose a risk to human health or controlled waters. However, if this material is excavated and sent for disposal, the material is then subject to waste management regulations and the two systems cannot be directly correlated. It is therefore important to note that classifying a material as hazardous (should it be excavated and become a waste) does not necessarily indicate that it might not be suitable to be kept on site for re-use. Separate guidance in the form of a Code of Practice (CL:AIRE Version 2, 2011) has been developed jointly between the development industry and the Environment Agency to provide best practice when assessing whether materials are wastes or not, and for determining when waste can cease to be waste for a particular use.

In accordance with the current waste regulations (or Landfill Directive, as they are more commonly known), from 30th October 2007 all waste materials produced from construction sites have to be pre-treated prior to disposal. Pre-treatment includes waste minimisation, recovery (e.g. separation of demolition waste to be used as hardcore) and separation of materials into different waste categories (e.g. separate inert waste from hazardous waste etc.). Mixing of different waste types shall be avoided and intentional mixing of inert materials with hazardous waste to 'dilute it' and hence change its waste classification, is illegal.

The current waste regulations (based on the EU landfill directive) introduced a two tier classification system for waste materials, defining them as either being hazardous or non-hazardous. Landfills are licensed to take wastes based on a three tier classification system with the non- hazardous waste divided into two sub-categories:

- Non-Hazardous - inert;
- Non-Hazardous - non-hazardous;
- Hazardous.

Waste materials are categorised with a six figure numeric code in the European Waste Catalogue. Commonly found construction and demolition wastes including excavated soil from contaminated sites and Made Ground with their waste codes are summarised below (this is not a comprehensive list):

Waste Code	What is it?	Likely Waste Category–		
		1. Inert Waste	2. Non-Hazardous	Hazardous Waste
17 01 01 Concrete	3. Concrete, possibly with reinforcement (from Construction & Demolition)	✓		
4. 17 01 02 Bricks		✓		
5. 17 01 06* Mixtures of concrete, bricks, tiles & ceramics containing dangerous substanc	6. These are not normally considered hazardous but if they are contaminated (e.g. by asbestos) then could be hazardous – see comment above			✓

es				
7. **17 01 07** Mixtures of concrete, bricks, tiles & ceramics other than those in 17 01 06	8. This is mixed inerts c.f. 17 09 04	✓		
9. 17 05 03* soils and stones containing dangerous substances				✓
10. 17 05 04 soils	11. Soil and stones only (excluding	✓		

and stones other than those mentioned in 17 05 03	top soil, peat, soil and stones from contaminated sites)			
12. 17 06 05* Construction materials containing asbestos	13. e.g. corrugated asbestos sheeting			✓
14. **17 08 02** Gypsum-based construction materials other than those	15. Plaster & plasterboard (although specific disposal requirements are required for high sulphate waste – see EA guidance 'Understanding the		✓	

mentioned in 17 08 01	Landfill Directive' version 1.0 March 2010.			
16. **17 09 01*** Construction & demolition wastes containing mercury				✓
17. **17 09 02*** Construction & demolition wastes containing PCBs	18. Waste with more than 50 mg/kg of PCB's are hazardous			✓
19. **17 09 03*** Othe	20. Broad range of potentially (see			✓

r mixed construction & demolition wastes containing dangerous substances	notes below – if asterisk the waste is hazardous) hazardous wastes			
21. **17 09 04** Mixed construction & demolition wastes other than those mentioned in 17 09	22. Mixed inerts with soil, tarmac, cables, vegetation, plaster, etc. (this waste can only be considered inert if it passes the waste acceptance criteria identified in the regulations).	✓	✓	

01, 17 09 02 & 17 09 03				
23. **Note**: all wastes with an asterisk code are hazardous regardless of whether they are mirror or absolute entries in the EWC list the decision to with regard to composition must come before applying the code for mirror entries.				

Some materials are classified as Inert Waste based in its origin (e.g. 17 01 01 Concrete, or glass) without any requirement for laboratory chemical analysis.

However, most soils will require laboratory testing to confirm whether they are classified as Hazardous Waste. The protocol for assessing these materials and the appropriate threshold values is complicated and are set out in the Environment Agency's "Technical Guidance *WM3* Hazardous Waste – Interpretation of the Definition and Classification of Hazardous Waste" (2015). If the test results for the waste indicates that it is not hazardous then further analysis of the waste is required to determine whether it is Inert Waste. If the waste does not meet the criteria for either Hazardous or Inert, then it is by default classified as Non-hazardous Waste.

As an alternative location to landfills for off-site disposal of inert and non-hazardous waste, there are a number of sites which have Waste Permit Exemptions that can accept certain categories of inert and non-hazardous wastes. Additionally some quarries can accept certain types of wastes to be used for quarry restoration material. For both alternatives to disposal at landfill sites the material still requires chemical testing as these sites have site specific acceptance criteria for wastes. It should also be noted that these types of site do not incur landfill tax which in the 2018/19 tax year is £2.80 for inactive waste (inert and some types of non-hazardous waste) and £88.95/Tonne for active waste (some types of non-hazardous waste and hazardous waste. Note that the Inland Revenue uses a different classification scheme for waste for tax purposes to the European Waste Classification scheme.

Waste Categorisation

The process of determining the category of wastes is a three stage process:

- Stage 1 – is the waste either Hazardous or Inert by definition without the requirement for chemical analysis (if it is then Stages 2 and 3 are not required);
- Stage 2 - Waste characterisation;
- Stage 3 - WAC classification.

Waste characterisation determines if a waste is hazardous or not. Excavated soil is characterised using a system based on the contaminants present and their hazardous properties. The system uses total concentrations of the contaminants. Thresholds (as a percentage of the waste) have been set for the various hazardous properties.

Fourteen hazardous properties together with other scenarios where material could cause a hazard have been defined:

- Hazardous properties: explosive, oxidising, highly flammable/flammable, irritant, harmful, toxic, carcinogenic, corrosive, infectious, toxic for reproduction, mutagenic and ecotoxic;
- Substances which can release toxic/very toxic gases in contact with water, acid or air;
- Substances which, after disposal, can yield another substance, e.g. a leachate, which possesses any of the above hazardous properties.

Some of the hazardous properties are sub-divided e.g. there are three categories of carcinogenic, mutagenic and toxic for reproduction substances. The hazardous properties were originally defined in the European Hazardous Waste Directive 91/689/EC. Should a waste contain a contaminant with one or more of the listed hazardous properties at a concentration equal to or above the threshold value for the particular property, then the waste is hazardous. The hazardous properties of a wide range of chemicals are sourced from CLP 2015.

There are many reasons why waste soil is classified as being hazardous but the majority of reasons can be divided into the following four groups:

- Hydrocarbons – this is probably the most common reason for the hazardous classification of soils. For most soils hydrocarbon analysis will be required for both Polycyclic Aromatic Hydrocarbons (PAH) and speciated Petroleum Hydrocarbons (PHCs) but depending on the site's history other groups of organic contaminants may also be is included in any analysis suite for soil samples;
- Metals – Particularly sites from former metal processing or mining sites and also some types of ash have metal concentrations that are sufficiently high to characterise materials requiring disposal as hazardous waste.

- Asbestos;
- Anions – e.g. sulphate in plasterboard (there are special disposal requirements for high sulphate waste and specific WAC requirements); it is possible that sulphate salts of metals and semi-metals could make the waste hazardous – the sulphate concentration could possibly be significant under H12, H13 and H14.

The characterisation of wastes with significant metal concentrations involves some processing of the analysis data. The chemical analysis results for inorganic substances are generally reported as total concentrations e.g. total lead, total arsenic, total sulphate etc. However, CLP 2015 deals with the hazardous properties of actual compounds e.g. lead sulphate, arsenic pentoxide, nickel carbonate. Therefore, the total metal results have to be converted into assessed chemical analysis results for the compound most likely to be present in the soil samples. For example, if the sample contains high total lead concentrations and high sulphate concentrations, then the lead is likely to be present in the soil as lead sulphate. The most likely compounds can often be determined from a desk study or previous site uses. If the site has been derelict for a number of years, consideration should be given as to whether water soluble compounds should or should not be chosen, as rainfall could have removed them from the soil (this does not apply if the soil has been taken from below under a concrete slab etc). Chemical knowledge and common sense needs to be used in choosing a suitable compound.

If no data is available, then a worst case scenario has to be assumed and the most hazardous compound likely to be present has to be chosen. For example, metal chromates (lead chromate, nickel chromate) are often the most hazardous compounds formed by many metals, but if the chromium concentrations in the soil are low, chromates are unlikely to be present. It should also be noted that for many of the hazard categories, the cumulative hazard from different compounds is added (e.g. add the concentrations of the copper, lead and zinc compounds together to assess the Hazard Category H14 Ecotoxicity).

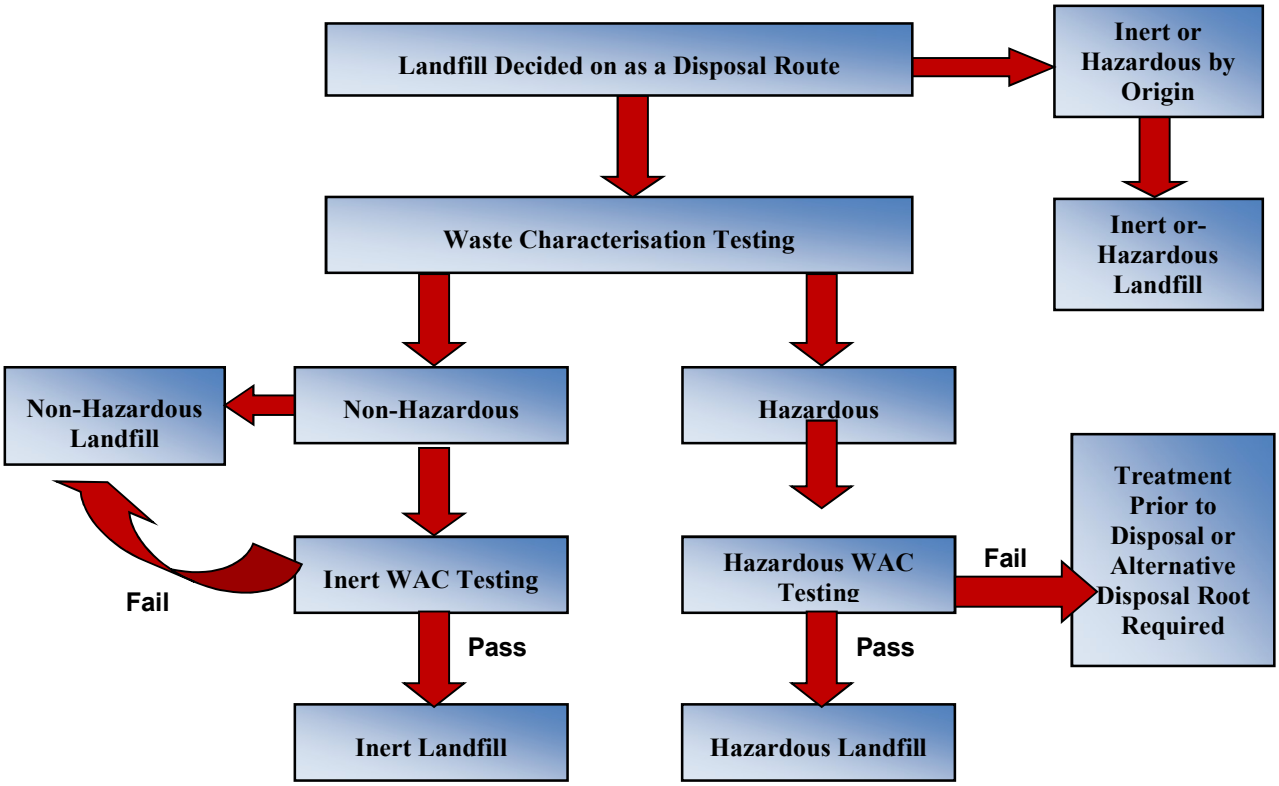
If the results of the above assessment determine that the waste is hazardous, it must then be analysed for the Waste Acceptance Criteria (WAC) analysis contained within appropriate Environmental Permitting Regulations (this comprises mainly leachate but also analysis for TOC and Loss on ignition). WAC limit values have been set for the listed determinands. If any of the determinands exceed their limit value, the waste must be pre-treated to reduce concentrations to below the limit values before the waste may be disposed of at a landfill site licensed to take hazardous waste.

For waste classified as not being hazardous, then there are two options available. Currently, waste correctly characterised as not being hazardous may be disposed of without WAC testing to a non-hazardous landfill. Alternatively WAC testing for Inert Waste can be carried out (this is similar to the list for hazardous waste with the addition of PAH's, BTEX and Mineral Oil). If the results pass the Inert WAC criteria it can be disposed of at an Inert Waste Landfill. If any of the WAC test results exceed the Inert WAC criteria the waste has to be disposed at a non- hazardous landfill. There are WAC limits for non-hazardous waste set for pH and TOC. If these two criteria are not met then the waste must be pre-treated to so that it meets the criteria before it can be disposed.

If materials fail the WAC criteria it may be possible to pre-treat the waste on-site or be taken to a soil treatment centre for pre-treatment to reduce the soil's hazardous properties (e.g. by bioremediation of hydrocarbons).

It should be noted that in order to dispose of Hazardous Waste, the site must register as a producer of Hazardous Waste with the Environment Agency. When disposing of waste materials to landfill sites the appropriate Duty of Care Waste Transfer procedures must be followed.

Landfilled Waste Decision Tree



Landfill Tax

It should be noted that HM Revenue and Customs (HMRC) classify wastes for tax purposes using a different scheme to the three fold landfill EU Landfill Directive scheme (i.e. the hazardous, non-hazardous and inert). HMRC have a two-fold system for landfill tax. The Standard Landfill Tax is currently £88.95/T and applies to all wastes unless they qualify for the reduced rate of landfill tax of £2.80/T. The wastes that qualify for the reduced rate of Landfill Tax are set out in The Landfill Tax (Qualifying Material) Order 2011 with supplementary information on the interpretation of these regulations in HMRS "Notice LFT1 – A General Guide to Landfill Tax" (May 2012) and HMRC Briefing Notes 15/12 and 18/12.

APPENDIX H

Protocol for Dealing with Unexpected Contamination

General Unexpected Contamination

There is the potential for areas of previously unexpected contamination to be present, as is the case with any "brownfield" site. Any significant quantities of asbestos, significant ashy soils, unusual, brightly coloured or significantly oily or odorous material should be considered in this category. If unexpected contamination is found the following procedures should be adhered to:

1. All site works at the position of the suspected contamination will cease.
2. Visual and olfactory observations of the condition of the ground and the extent of contamination will be made and notification will be made to the independent suitably trained specialist for instance the Local Authority not later than 24 hours after discovery. Should the contamination be likely to affect controlled waters then the Environment Agency shall also be informed.
3. The suspected contaminated material will be investigated and tested appropriately in accordance with the assessed risks. The investigation works will be carried out in the presence of a suitably qualified geo-environmental engineer. The investigation works shall commence to recover samples for testing and, using visual and olfactory observations of the condition of the ground, delineate the area over which contaminated materials are present.
4. The unexpected contaminated material will either be left in situ or be excavated and stockpiled whilst testing is carried out. Suitable assessments will then be completed to determine whether the material can be re-used on site or removed as appropriate.
5. Where the material is left in situ, awaiting results, it will be covered with plastic sheeting or soil.
6. Where any quarantined material is to be temporarily stockpiled it will be placed either on concrete hard standing or on minimum 2000 gauge plastic sheeting (or other impermeable surface) and suitably covered to prevent dust and odour emissions.
7. Any areas where unexpected visual or olfactory ground contamination are encountered will be surveyed. A photographic record will be kept and testing results incorporated into the Verification Report.
8. A photographic recorded will be made of all relevant observations.
9. The testing suite will be determined by the independent geo-environmental specialist on the basis of visual and olfactory observations.
10. Test results will be compared against current assessment criteria suitable for the future use of the area of the site affected.
11. The results of the investigation and testing of any suspect unexpected contamination will be used to determine the relevant actions. After

consultation with the Local Authority and if necessary the Environment Agency, materials should either be:

- re-used in areas where test results indicate that it meets compliance targets so it can be reused without treatment; or
- treatment of material on site to meet compliance targets so it can be reused; or
- removal from site to a treatment centre or to a suitably licensed landfill or permitted treatment facility.

12. A Verification Report will be produced for any areas of unexpected contamination encountered and this shall be incorporated into the main verification report for each area of the Phase 1B area.

The assessment of the site and laboratory data will be carried out in accordance with current guidance and good practice and if any remedial action is required then the regulators will be provided with the data, assessment and recommendations for their approval prior to carrying out the remediation.

Note that if asbestos is unexpectedly encountered in the earthworks then specific procedures will need to be implemented, including utilisation of a Safe Working Plan as per CAR 2012 Guidance documentation and notification to the Local Authority and Environment Agency.

Unexpected Tanks

It is considered extremely unlikely that underground fuel storage tanks are encountered during the earthworks. If encountered, then the following procedures are to be adhered to if tanks and pipework are identified:

1. All site works at the position of the tanks/pipework should stop.
2. A description of the tank should be made by the geo-environmental engineer including; condition and surround, along with visual and olfactory observations should any contents in the tank be apparent. A photographic record will also be made of relevant observations.
3. The tank's position and depth should be determined and marked on a plan of the site.
4. The independent geo-environmental engineer will inform the Client and the Local Authority.
5. Investigation works should be undertaken by the geo-environmental engineer to obtain samples of any liquid or sludge contents and to establish dimensions of the tank.

6. Testing will be determined on the basis of visual and olfactory observations by the independent geo-environmental engineer.
7. Test results will be compared against current assessment criteria and proposals for disposal of any contents determined in agreement with the appropriate Regulatory Parties.
8. Emptying the tank and disposal of contents to a suitable licenced disposal facility.
9. Degassing and removal of the tank by a suitably qualified contractor will be required, and a Naked Flame Certificate should be provided.
10. Once the tank has been emptied and degassed in accordance with the above proposals, it is to be removed for disposal to a licensed waste management facility. Copies of the relevant waste consignment notes are to be kept and included in the Verification Report.
11. Breaking out and removal of any tank cradle structure.
12. Excavation and remediation of any contaminated soils around the tank will be carried out.
13. Samples of the base and sides of the resultant hole will be taken and supervised by the independent geo-environmental engineer to confirm whether risks to human health or controlled waters exist.

All of the above information will be incorporated into the Verification Report and submitted to the regulatory parties and the Environment Agency where groundwater may potentially have been impacted.









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