TerraConsult

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Report No 2638/01 Issue 1

PRPOSED WASTE HANDLING DEPOT, GREENFIELD BUISNESS PARK, GREENFIELD, FLINSTHIRE

PHASE 2 SITE INVESTIGATION REPORT

Carried out for:

Flintshire County Council

PROPOSED WASTE HANDLING DEPOT, GREENFIELD BUISNESS PARK, GREENFIELD, FLINTSHIRE

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Date: 12/01/2016

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Prepared for:

Flintshire County council

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DISCLAIMER

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

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PROPOSED WASTE HANDLING DEPOT, GREENFIELD BUISNESS PARK, GREENFIELD, FLINTSHIRE

PHASE 2 INVESTIGATION REPORT

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APPENDICES

PROPOSED WASTE HANDLING DEPOT, GREENFIELD BUISNESS PARK, GREENFIELD, FLINSTHIRE

PHASE 2 SITE INVESTIGATION REPORT

1. INTRODUCTION

1.1 Background Information

1.1.1 TerraConsult Limited was commissioned by Flintshire County Council to carry out a Phase 2 geo-environmental site investigation for an area of land at Greenfield Business Park No 2, Greenfield, Flintshire. The purpose of the report is to provide preliminary information on conditions at the site for a proposed commercial development at the site (a proposed waste handling depot).

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, March 2012);
- BS5930:2015: “Code of practice for site investigations”;
- BS10175: 2011 +A1:2013 “Investigation of Potentially Contaminated Sites - Code of Practice”;
- DEFRA/Environment Agency (2004) Report CLR11 “Model Procedures for the Management of Land Contamination”;
- Environment Agency (2011) Report GPLC1 “Guiding Principles for Land Contamination”;
- Environment Agency (2013) Report GP3 “Groundwater protection: Principles and Practice” 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.

1.1.4 The proposed development of the site is understood to comprise:

- Area for the bulking up and transfer of domestic waste;
- Storage bays for bulking up and transfer of kerbside recycling material;
- A storage area and apparatus to treat gully emptying and sweeper arisings;
- Process facility to create biomass from wood stock provided from Household Waste Recycling Centres;

- Additional waste treatment activities including the processing / separation of metals and processing of construction and demolition wastes; and
- The removal from site or the treatment of any contaminated material encountered during the development.

1.2. Planning Status & Requirements

1.2.1 This report is designed to comply with the requirements of Planning Policy Wales (2012).

1.2.2 The site has been granted planning permission (No 053852) by Flintshire County Council.

1.2.3 There are four planning conditions relating to ground conditions and potential contaminated land which require to be discharged. These are as follows:

> Condition 17. A Phase 2 intrusive ground investigation shall be carried out and submitted to the local planning authority for approval to the construction period to develop a comprehensive conceptual ground model of the site.
>
> *REASON: In the interests of amenity and to comply with Policies STR1, GEN1 and EWP8 of the Flintshire Unitary Development Plan.*
>
> 18. Prior to the commencement of development approved by this planning permission (or such other date or stage in development as may be agreed in writing with the Local Planning Authority), the following components of a scheme to deal with the risks associated with contamination of the site shall each be submitted to and approved, in writing, by the Local Planning Authority:
>
> *1. A preliminary risk assessment which has identified:*
> *- all previous uses*
> *- potential contaminants associated with those uses*
> *- a conceptual model of the site indicating sources, pathways and receptors*
> *- potentially unacceptable risks arising from contamination at the site.*
> *2. A site investigation scheme, based on (1) to provide information for a detailed assessment of the risk to all receptors that may be affected, including those off site.*
> *3. The site investigation results and the detailed risk assessment (2) and, based on these, an options appraisal and remediation strategy giving full details of the remediation measures required and how they are to be undertaken.*
> *4. A verification plan providing details of the data that will be collected in order to demonstrate that the works set out in (3) are complete and identifying any requirements for longer-term monitoring of pollutant linkages, maintenance and arrangements for contingency action.*
>
> *Any changes to these components require the express consent of the Local Planning Authority. The scheme shall be implemented as approved.*

REASON: Natural Resources Wales considers that the controlled waters at this site are of high environmental sensitivity and contamination is known/strongly suspected at the site as a result of previous uses at the site, particularly associated with landfilling and to comply with Policies STR1, GEN1 and EWP8 of the Flintshire Unitary Development Plan.

19. Prior to commencement of development a verification report demonstrating completion of the works set out in the approved remediation strategy and the effectiveness of the remediation shall be submitted to and approved, in writing, by the Local Planning Authority. The report shall include results of sampling and monitoring carried out in accordance with the approved verification plan to demonstrate that the site remediation criteria have been met. It shall also include any plan (a "long-term monitoring and maintenance plan") for longer-term monitoring of pollutant linkages, maintenance and arrangements for contingency action, as identified in the verification plan, and for the reporting of this to the Local Planning Authority.

REASON: To demonstrate that the remediation criteria relating to controlled waters have been met, and (if necessary) to secure longer-term monitoring of groundwater quality. This will ensure that there are no longer remaining unacceptable risks to controlled waters following remediation of the site and to comply with Policies STR1, GEN1 and EWP8 of the Flintshire Unitary Development Plan.

20. Reports on monitoring, maintenance and any contingency action carried out in accordance with a long-term monitoring and maintenance plan shall be submitted to the Local Planning Authority as set out in that plan. On completion of the monitoring programme a final report demonstrating that all long- term site remediation criteria have been met and documenting the decision to cease monitoring shall be submitted to and approved in writing by the Local Planning Authority.

REASON: To ensure that longer term remediation criteria relating to controlled waters have been met. This will ensure that there are no longer remaining unacceptable risks to controlled waters following remediation of the site and to comply with Policies STR1, GEN1 and EWP8 of the Flintshire Unitary Development Plan.

1.2.4 This report has been designed to discharge Condition 17, 18 and 20, but Condition 19 will have to be discharged following completion of the remediation and verification work, if the findings of this report indicate that they are required.

1.3 Scope of the Investigation

1.3.1 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:

- carry out an intrusive investigation comprising dynamic sampling and trial pitting with associated sampling;
- ground gas and groundwater monitoring;
- laboratory testing for potential contaminants and geotechnical purposes;
- assess the general nature and extent of contamination at the site and carry out a contamination risk assessment to determine if the site poses a risk to potential receptors;
- to monitor the ground gas conditions at the site and undertake a ground gas risk assessment; and
- should the investigation indicate that remediation of contaminants be required, provide recommendations of feasible remedial measures to facilitate development of the site for residential end use.

1.4 Previous Investigations

1.4.1 TerraConsult have previously undertaken a Phase 1 report for the site, (Greenfield, Business Park No. 2, Greenfield, Flintshire, Phase 1 Site investigation Report, ref: 2169/01 Issue 1 of April 2015).

2 SITE LOCATION AND DESCRIPTION

2.1 Site Location

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

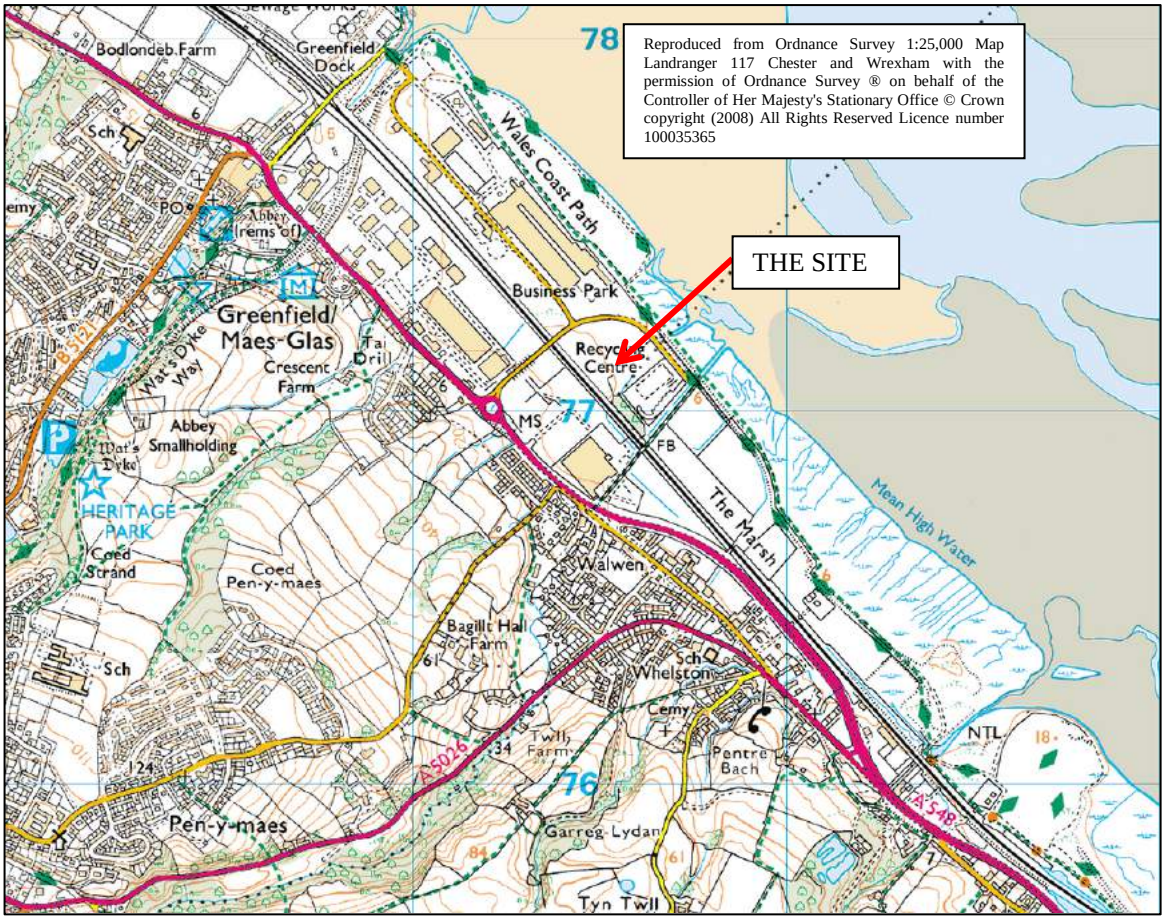


Figure 1: Site Location

Table 1: Summary of Site Location	
Location	900m to the east of Greenfield town centre, at Greenfield Business Park No 2, off Bagillt Road.
Grid Reference	320556, 377021
Post Code	CH8 7GJ
Site Area	1.82 ha (approx.)
Site Shape	The site is irregular in shape and has maximum plan dimensions of approximately 180 m by 200 m.
Topography	The elevation is at approximately 6 mOD.

2.2 Site Description

2.2.1 A site visit was originally undertaken as part of the Phase I Report in February 2015. The locations of various features and the appropriate photographs of the site are shown in appendices in the Phase I Report. At the time of the Phase II Ground Investigation, in December 2015, no major significant changes were noted. A selection of site photographs from December 2015, including the ground investigation locations, are shown in Appendix C.

Table 2: Summary of Description of the Site and its Environs	
Current Use:	The site is currently used for the storage of compost, construction waste, road salt storage and storage of ancillary items utilised on site for maintenance and general use.
Access	Via asphalt roadway direct from adjacent household waste and recycling centre off Bagillt Road
Existing Buildings& Structures	No buildings or structures present on site with the exception of roadways and barriers. Skips and various storage vessels located on site.
Site Surface	Partly asphalt/ concrete slabs or unmade up area. Some grassed areas. Some significant pooling water was noted in the centre and northwest corner of the site, restricting access, particularly in the northwest corner.
Vegetation	Vegetation largely absent with some grasses present on some compost stockpiles.
Storage Tanks	Below Ground Tanks: Oil/water separator located in the southern corner of the site Above Ground Tanks: Numerous storage vessel of unknown use located across the site in an *ad-hoc* manner.
Services	None known. Anticipated for site surface water drainage to be present.
Asbestos	No potential Asbestos Containing Materials (ACMs) noted in the buildings within the waste facility are to the southeast of eth site, or on the ground surface during the Ground Investigation.
Waste Disposal/ Materials Storage	Site is used for the storage of compost and construction rubble. Road salt stored adjacent to the eastern site boundary. Storage of materials ancillary to the site use occurs across the northern area of the site.
Surrounding Area	The site boundary partially bisects current site uses including compost stockpiles. A compost stockpile is located adjacent to the south with a household waste and recycling facility further to the south.
Ecology	There is no evidence of protected burrowing animals (e.g. badgers) or habitats suitable for protected amphibians (e.g. Great Crested Newts). The disused buildings on site could be suitable habitats for bats. Trees are present on the site and these should not be cut down during the nesting season. No evidence of invasive plant species were 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.*
Local / Background Knowledge	There is anecdotal information that the site is located with part of a former chemical works.

2.3 Site Ownership

2.3.1 The site is owned by Flintshire County Council.

2.4 History

2.4.1 The historical use of the site is described in detail in the Phase I Report, in Table 3, Section 2.4 and is summarised below.

2.4.2 The site was already partially developed in the earliest map, (1870), which showed the site as having various unnamed roads and embankments running across it. By 1910 a

structure labelled as a reservoir has been developed on the northern end of the site, with a marsh labelled to the south. Between 1912 and 1950 the site becomes significantly developed with a number of buildings and tanks/structures being located on site. After this time numerous railway lines are shown on site and the site is developed by industry related structures further until 1991 map, where none of the structures or buildings are shown. In 1994 the present day road is shown along the north and eastern site boundary. The remaining maps show no significant changes to present day.

2.4.3 The surrounding site shows similar development, then post 1994 the Greenfield Business Park around the site is developed until the present day.

2.5 Services Search

2.5.1 The client contact was asked to provide service information. We were informed that there were no active services within the site area being investigated. The onsite workers were also asked prior to the Phase II works commencing. They also confirmed that there were no active services in the area of the Phase II works.

3. ENVIRONMENTAL SETTING

3.1 Data Summary

3.1.1 A summary of the environmental background information (geology, hydrology, hydrogeology, database information etc.) and regulator consultation information has been tabulated and presented below. The source information for this table is presented in Appendix D of the Phase I Report or is referred to in Table 4 below. The table below represents the base data used to formulate the conceptual ground model.

3.2 Geology

3.2.1 The 1:50,000 scale BGS Bedrock and Superficial Map 096 Liverpool (2006) show the site to be underlain by Tidal Flat Deposits and Pennine Lower and Middle Coal Measures. The maps show geological faults from the north to the south through the centre of the site and to the east of the site, and faults running east-west to the north of the site.

3.3 Mining and Quarrying

3.3.1 The Coal Authority Mining Report for the site (see Appendix D of the Phase I Report) notes that “the property is in the likely zone of influence from workings in one seam of coal at 280m to 290m depth, and last worked in 1895. Any ground movement from these coal workings should have stopped by now”, although the report does later state there are no known faults or other lines of weakness due to coal mining which would have made the property unstable. The property is not in an area where any future coal working licences have been granted however. There are no records of mines or mine entrances within 20 metres of the site held by the Authority and the site is not within an area of influence of past or present open cast workings.

3.3.2 From the historic maps, there is no evidence of mineral extraction or quarrying at the site (e.g. brick pits, sand and gravel extraction etc.).

3.4 Hydrology, Flooding and Drainage

3.4.1 There are 75 detailed river network entries within 500 m of the site, the nearest being a secondary river 43m to the east of the site (The River Dee).

3.4.2 The site is located within a Zone 3 Floodplain with regards to fluvial flooding and a Zone 2 floodplain with regards to tidal flooding. Flood defences are located 25m to the north east but are not noted to be benefitting the site. There is potential at surface for the site to be susceptible to groundwater flooding via the Superficial Deposits. The confidence of the BGS with regards to this rating is moderate.

3.5 Hydrogeology

3.5.1 The Environment Agency and Natural Resources Wales have classified different types of aquifer from which groundwater can be extracted (see Appendix B for definitions). The bedrock (Pennine Lower Coal Measures and Pennine Middle Coal Measures) is classified as a Secondary A Aquifer. The Superficial Deposits (Tidal Flat Deposits) are classified as an unproductive aquifer. The site lies further than 1 km from the nearest SPZ.

4. HAZARD ASSESSMENT & PRELIMINARY CONCEPTUAL SITE MODEL

4.1 Preliminary Contamination Hazard Assessment

4.1.1 A preliminary hazard assessment was developed in the Phase I Report for the site and was based on current available guidance published by a number of sources. A preliminary conceptual site model for this site was established using the desk study information and has been used as a basis for the preliminary hazard assessment. The significant and possible potential pathways are only considered for the hazard assessment.

4.1.2 The preliminary hazard assessment is a qualitative assessment of the risks posed by each viable pollution link identified. The hazard assessment leads to a recommended subsequent activity that could be:

- Action Required (AR) in the short term to break existing contaminant-pathway-receptor (CPR) link;
- Site Investigation Required (SIR) with objectives for risk estimation, or
- No Action Required (NAR) at this stage.

4.1.3 The hazard assessment is summarised in Table 3 below.

Table 3: Preliminary Hazard Assessment

Hazard Identification				Hazard Assessment			
Link	**Contaminant**	**Pathway**	**Receptor**	**Probability**	**Conse-quence**	**Risk**	**Hazard Assessment**
1	Contaminated soil/groundwater	Ingestion (via soil dust) and inhalation (via soil dust and vapours), ingestion through dirty hands, dermal contact with soil/water.	A- Humans using the site during construction.	High Likelihood	Mild	**Medium/ Low**	SIR - Total soil concentration of relevant contaminants and ground gas vapours for contractors and designer's risk assessments.
2		Ingestion (via soil dust) and inhalation (via soil dust and vapours), ingestion through dirty hands, dermal contact with soil/water.	B- Humans using the site after development completion.	Medium/ Reasonably Foreseeable	Mild	**Low**	SIR- Total soil concentration of relevant contaminants for contractor's risk assessments.
3		Via service pipes	B- Humans using the site after construction. F- Building structures	Low/Unlikely	Medium	**Medium/ Low**	SIR - Total soil concentration of relevant contaminants and ground gas vapours and designer's risk assessments.
4		Downward migration	D- Perched groundwater	Medium/ Reasonably Foreseeable	Medium	**Medium**	SIR- Total soil concentration of relevant contaminants for contractor's risk assessments.
5		Downward migration	D - Secondary aquifer/water supply	Low/Unlikely	Medium	**Medium/ Low**	SIR
6	Gas – radon	Inhalation	B- Humans using the site after development completion.	High Likelihood	Severe	**Very High**	AR – Install radon protection measures in offices and enclosed structures
6	Gas – methane & carbon dioxide VOC vapours	Inhalation, explosion	A & B- Humans using the site during construction and after development completion.	High Likelihood	Severe	**Very High**	SIR – Gas monitoring wells and monitoring wells for methane and carbon dioxide
7	Contaminated soil/waste/ groundwater	Ingestion, inhalation, dermal/direct contact	E- Ecology (Flora/Fauna)	Medium/ Reasonably Foreseeable	Negligible	**Near Zero**	SIR – Additional analysis and assessment required due to lead concentrations in Made Ground.
8	Contaminated groundwater	Secondary Aquifer/ Surface water	E- Ecology (Flora/Fauna)	Low/Unlikely	Medium	**Medium/ Low**	SIR
9	Contaminated soil/groundwater	Direct contact.	F- Building structures.	Medium/ Reasonably Foreseeable	Mild	**Low**	SIR

4.1.4 The results of the risk assessments indicated that there are several potentially significant sources of contaminants present at the site. There could be unacceptable risks to receptors including humans, controlled waters and structures. Precautions are required with respect

to landfill type ground gases and radon for the development if offices and / or enclosed structures form part of the development.

4.1.5 The site history has shown that the site has been part of a former 'works' which is anecdotally understood to have been a chemical works. Historical maps have shown the presence of railway lines, process buildings, tanks and reservoirs / ponds on the site. The site itself and adjoining land is classified as a landfill. Nearby records of exploratory holes show the presence of Made Ground including ash, slag and black staining with organic odours. The potential for sources of contaminants in the solid, liquid and gaseous / vapour phases is considered significant.

4.1.6 The site investigation objectives and preliminary risk assessments described above should represent part of the detailed main stage investigation that should include overall characterisation of the ground in association with obtaining and analysing the information described above, which is described in this report.

4.2 Geotechnical Hazards Associated with the Development

4.2.1 In addition to the environmental hazards, there was also geotechnical hazards associated with the stability of the ground (including load bearing capacity, slope stability and effects of ground (mining) cavities). Local Authorities follow NPPF (2012) which requires that "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."

4.2.2 Table 9 of the Phase I Report (in Section 4.8) summarised the potential geotechnical hazards and geotechnical design considerations.

4.2.3 The geotechnical hazards associated with coal mining at the site are low and no special precautions are required to be made in relation to the proposed development. Made Ground of thickness greater than 1 m is anticipated, the underlying tidal flat deposits is also likely to be of high compressibility and moderate collapsible soils were predicted. No hazards were expected from swelling clay, running sands, landslips or ground dissolution.

4.2.4 Other geotechnical hazards are associated with the proposed development and include:

- In ground obstructions relating to historical land uses including a chemical works with numerous structures former shown on site, including railway lines;
- Tidal Flat Deposits (Silts, sands and clay) could be relatively compressible and of low strength; and
- The pH and sulphate content of the soils requires checking with respect to its potential attack of concrete and take appropriate action in terms of specifying a suitable mix in line with Building Research Establishment Special Digest 1 Concrete in Aggressive Ground (2005).

5. INVESTIGATION METHODOLOGY

5.1 Investigation Strategy

5.1.1 The determination of the excavation methods was based on observations during the site walkover and the former site usage. Due to the site coverage by existing stockpiles of materials in the southwest, west and northwest of the site, materials and equipment being stored in the north of the site, hardstanding/salt stockpile in the east and limited access due to these, it was considered that a combination of window sampling and trial pitting was most appropriate.

5.1.2 A number of exploratory hole locations were relocated due to access restrictions, principally due to stockpiles locally being located on intended areas, significant depth/extent of standing water at surface, particularly in the northwest and centre of the site) and due to various materials and equipment being stored in the northern portion of the site, as mentioned above.

5.1.3 The depth to the base of the trial pits was determined by the reach of the JCB excavator or where groundwater was struck and excavation was unsafe to continue (due to not being able to see the base of the excavation or potential stability issues). The window sample holes were intended to be sunk to a maximum depth of 5 m bgl with associated dynamic probes intended to reach a maximum depth of 10 m bgl.

5.1.4 The strategy included the installation of dual purpose ground gas and groundwater monitoring wells in seven of the window sample boreholes.

5.1.5 The purpose of the various exploratory holes are as follows:

Table 4: Purpose of Exploratory Holes

Exploratory Holes	Target Area
Dynamic Percussive (Window sampler) boreholes. (WS)	To assess shallow ground conditions and allow dynamic probes to be undertaken to assess geotechnical characterisation. To allow collection of samples for contamination and geotechnical testing. Located to gain a spread across the site, avoiding underground services. To install ground gas and groundwater monitoring installations.
All trial pits formed by mechanical excavator. (TP)	To assess shallow ground conditions both laterally and vertically. To allow collection of samples for contamination and geotechnical testing. Located to gain a spread across the site, avoiding underground services and inaccessible areas.

5.1.6 After inspection and sampling, the trial pits were back-filled with the as-dug excavated material. Installations were placed in selected window sample borehole locations.

5.1.7 The site investigation locations are shown on Figure 2 below which shows the locations overlying the existing layout.

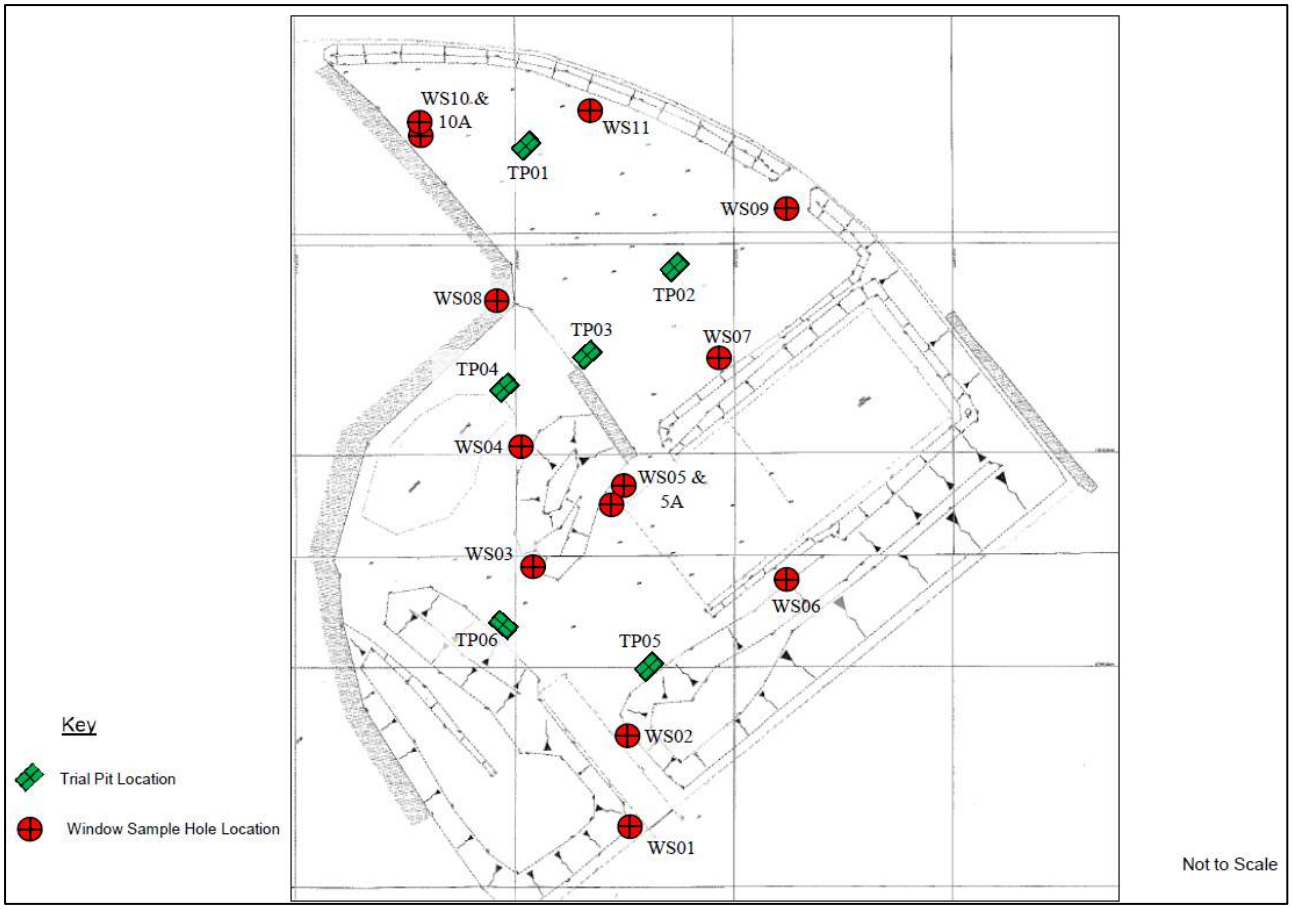


Figure 2: Exploratory Hole Plan using existing site layout as a base map.

5.2 Chemical and Geotechnical Testing Strategy

5.2.1 Based on previously available information and the desk based study, analysis of soil and groundwater grab samples was based on potential contaminants of concern. These include asbestos, heavy metals and inorganics (including cyanide and sulphate), petroleum hydrocarbons, Polycyclic Aromatic Hydrocarbons (PAH's), phenols, Volatile Organic Carbons (VOCs) and Semi-volatile Organic Carbons (SVOCs).

5.3 Monitoring Strategy

5.3.1 The ground gas monitoring will be in accordance with BS 8576 : 2013 and comprise three visits over one month. This monitoring period is in accordance with Table 5.5 of CIRIA C665 (2007) based on a Moderate Generation Potential of Source and a Low Sensitivity of Development.

5.3.2 Also review the TOC data in accordance with CL:AIRE document RB17 to assist in the ground gas assessment.

6 FIELDWORK

6.1 General Observations

6.1.1 The fieldwork was carried out between the 1st December and 2nd December 2015. TerraConsult personnel were present to supervise all work, describe the ground encountered, carry out in situ testing and decide on the depths and response zones of monitoring wells. A services search was carried out prior to the site work and a CAT scan performed at the location of each exploratory hole location. Fieldwork procedures were undertaken in accordance with the relevant sections of:

- British Drilling Association "Guidance for Safe Intrusive Activities on contaminated or Potentially Contaminated Land" (2008);
- BS EN 1997-2:2007 [Eurocode 7 Part 2];
- BS5930:2015 "Code of Practice for Site Investigations;"
- BS10175:2011 + A1:2013 "Investigation of potentially contaminated sites – Code of practice."

6.1.2 The investigation comprised the following fieldwork scope:

- 11 No. dynamic (window) sample holes with plastic liners;
- 11 No. dynamic probe positions (adjacent to window sample hole locations);
- 6 No. trial pits using a wheeled hydraulic excavator;
- Installation of 6 No. gas and groundwater monitoring wells (all 51 mm internal diameter HDPE with slotted sections having a 250 µm geotextile filter wrap);
- Sampling and testing of soils and groundwaters;
- Description of the ground encountered in accordance with BS5930:2015 "Code of Practice for Site Investigations"; and
- Gas and groundwater monitoring.

6.2 Trial Pits (and Trenches)

6.2.1 Six trial pits were excavated using a 12 tonne tracked excavator, where access permitted, across the site to depths of between 1.10 m (TP2) and 3.10 m bgl (TP6).

6.2.2 The trial pit logs and photographs are included as Appendix D.

6.3 Dynamic (Window) Sample Boreholes

6.3.1 Eleven dynamic sampling boreholes (WS1 to WS11) were carried out using a tracked Dando Competitor rig. These holes were excavated to depths of between 0.60 m bgl (WS10 & WS10A) to 5.00 m bgl in WS3. WS6 was not undertaken due to access issues during the ground investigation. WS10 was stopped at 0.60 m bgl twice (the second hole

recorded as WS10A) due to not being able to progress through the hardstanding/subsurface structures. It was moved several times, but no significant progress was achieved. WS5 was progressed to 0.80 m bgl until an obstruction was encountered. It was moved and WS5A progressed to 0.70 m bgl until another obstruction was encountered.

6.3.2 Six window sample boreholes (WS2, WS3, WS4, WS8, WS9 and WS11) have been installed with gas and groundwater monitoring wells. The monitoring wells are all installed using 51mm OD pipe with slotted sections using 250 µm geotextile filter wrap. The gravel used was washed 10mm gravel with hydrated bentonite pellets to seal the wells. They were installed with gas bung and flush headworks which are concreted. Response zone details are shown in Table 5 below.

Table 5: Exploratory Hole Response Zone Details

Location	Response Zone		Stratum Monitored
	Top	Bottom	
	m bgl	m bgl	
WS2	1.00	4.00	Made Ground: Sand & silt and sand strata
WS3	1.00	3.00	Sand silt & silty sand strata
WS4	1.00	2.00	Made Ground: Sandy gravel
WS8	2.00	4.00	Sandy clayey silt & silty sand strata
WS9	1.50	3.00	Sandy silt and silty sand strata
WS11	0.50	1.00	Made Ground: slightly clayey sandy gravel

6.3.3 The dynamic window sample logs are presented in Appendix D.

6.4 Dynamic Probing

6.4.1 Ten dynamic probes were completed across the site generally to depths of 5.0 to 7.0 m undertaken with a super heavy probe designation in accordance with BS EN ISO 22476-2: 2005 + A1 2011. DP6 was not undertaken due to access issues during the ground investigation. Pre-coring was not necessary. DP10 refused at a depth of 0.5om, with this hole repeated close by as DP10A and there was refusal at a depth of 0.70 m at this location. 5.0 to 7.0 m. All holes were stable. The holes were backfilled with bentonite pellets. The probe records and the Hammer Calibration Certificate are presented in Appendix D.

6.5 Samples and Sample Containers

6.5.1 Sampling was informed by visual and olfactory indicators of contamination and soil vapour headspace screening.

6.5.2 All soil samples were stored securely in cool boxes and transported to the nominated laboratory within 48 hours of collection, using the laboratory's chain of custody documentation. Sample scheduling was undertaken by TerraConsult's Engineers. Each chemical/environmental sample comprised a pair of containers: a plastic tub for metals and inorganics analysis, and an amber glass jar for organics analysis.

6.5.3 Perched water samples collected from trial pit excavations if collected comprised of a 1 litre plastic bottle and 1 litre glass bottle. They were extracted using dedicated disposable bailers (also called a grab sampler). A range of sample containers were used for sampling groundwater:

- 1 litre plastic bottles metals and inorganics;
- 1 litre glass bottles for SVOC's; and
- Amber glass vial for VOC's.

6.5.4 Water samples, like the soil samples, were stored in a cool box, before being dispatched directly to the accredited testing laboratory.

6.6 Monitoring

6.6.1 After completion of the fieldwork three monitoring visits have been made to carry out monitoring of groundwater levels and ground gas concentrations. Ground gas monitoring was carried out in accordance with BS8576:2013 and comprised measurement of landfill type gases using a GasData GFM435 infra-red meter to measure gas flow rate, methane, carbon dioxide, oxygen, carbon monoxide and hydrogen sulphide.

6.6.2 The depth of groundwater and installation depths were also recorded during the monitoring period.

6.6.3 The results of this monitoring are presented in Appendix E, together with details of the instrumentation specifications. It should be noted that no free phase hydrocarbons were encountered in any of the monitoring wells.

7. LABORATORY TESTING

7.1 Chemical Laboratory Testing

7.1.1 The samples were submitted to QTS Environmental of Lenham in Kent who are UKAS accredited in accordance with ISO17025 and are also MCERTS accredited for soil analysis in accordance with the Environment Agency's scheme. The laboratory carries out Quality Assurance and Quality Control in accordance with BS ISO 17025 and participate in external laboratory comparison and quality control schemes. Details of the accreditation and the methods of analysis are provided on the relevant test reports.

7.1.2 The selection of samples for laboratory testing and analytes to be determined were made based on the Phase 1 assessment, the excavation records and other observations during the investigations. The sample selection rational was as follows:

- to gain a good coverage across the site and of the various material types and strata encountered;
- to characterise samples which had visual or olfactory evidence of contamination;
- to characterise samples from the interface of permeable and less permeable horizons within the ground;
- to characterise soils samples located at groundwater level; and;
- to characterise the groundwater.

7.1.3 The selected soil and groundwater samples were tested for a range of typical contamination indicators including specific tests for contaminants suspected as being present from the desk study and from observations made on site. Tests were also performed which were used to support the modelling of contaminant transport and impacts (e.g. TOC) and for waste classification purposes.

7.1.4 Each of the soil samples were analysed for the 'total' concentration of a suite of potential contaminants.

7.1.5 The results of the Chemical laboratory analysis are presented in Appendix F. The various suites of analysis for the soil, leachate and water are shown in Table 6 below.

Table 6: Suites of Analysis for Soil and Water Samples

Determinand	Soil Suite 1	Soil Suite 2	WAC Suite	Water Suite 1	Water Suite 2
Number of Samples	7	7	2	2	5
Index Tests					
Asbestos Screen	-	✓	-	-	-
pH	✓	✓	✓ L	✓	✓
Electrical Conductivity	-	-	✓ L	✓	✓
TDS	-	-	✓ L	-	-
Hardness	-	-	-	-	✓
Alkalinity	-	-	-	-	✓
Metals			-		
As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Zn (totals)	✓	✓	✓ L	✓	✓
Ba, Mo, Sb	-	-	✓ L	-	-
Boron (water soluble on soil samples)	-	-	-	✓	✓
Inorganics					
Ammonium	✓	✓	-	-	✓
Cyanide - Total	✓	✓	-	✓	✓
Chloride (2:1 extract on soil samples)	✓	✓	✓ L	✓	✓
Sulphate(2:1 extract on soil samples)	✓	✓	-	-	-
Sulphate as SO_4	-	-	✓ L	-	✓
Nitrate as NO_2	-	-	-	-	✓
Organics					
Phenols - Total (monohydric)	✓	✓	✓ L	✓	✓
Total Organic Carbon (TOC)	-	✓	✓ L & S	-	-
Organic Matter	-	✓	-	-	-
PAH (Speciated USEPA 16)	✓	✓	✓ S	✓	✓
TPH (C_8 to C_{36}) TPH CWG (RBCA) Speciation	-	✓	-	-	✓
Mineral Oil (C_{10} to C_{40})	-	✓	✓ S	-	-
Benzene, Toluene, Ethyl Benzene, Xylenes (BTEX);	-	✓	✓ S	-	✓
Volatile Organic Compounds (VOCs) and Chlorinated Solvents	-	✓	-	-	-
Semi Volatile Organic Compounds (SVOCs)	-	✓	-	-	-
PCBs			✓ S		

NOTE

✓ = Test carried out on all samples **= Test required on selected samples only L = Leachate Tested, S = Solid Tested
2. All soil samples to be tested and reported in accordance with EA MCERTS for Soils Scheme
3.Asbestos Screen tested for the presence of Asbestos fibres. Quantification is only carried out is bulk samples were encountered or fibres detected.

7.2 Geotechnical Laboratory Testing

7.2.1 Samples were submitted to PSL Limited in Doncaster who are UKAS accredited in accordance with ISO17025. The following geotechnical testing was undertaken:

- 3 No. natural moisture contents;
- 3 No. liquid and plastic (Atterberg) limits;
- 3 No. analyses for sulfate and aggressive chemical environment classification for buried concrete (the full BRE SD1 suite, Building Research Establishment 2005);

- 3 No. particle size distribution wet sieve analyses, three with pipette analyses; and;
- 1 No. sedimentation by pipette.

7.2.2 The results of the geotechnical testing are included in Appendix G.

8 GROUND CONDITIONS

8.1 General

8.1.1 The site investigation has allowed the site specific ground conditions to be described and this information was used to provide an improved conceptual ground model.

8.1.2 The geology encountered during the site investigations was generally consistent with that anticipated from the desk study and is summarised below.

8.2 Ground Surface

8.2.1 The ground surface conditions encountered on-site generally consisted of compacted gravel across the majority of the site. The area surrounding TP3 in the centre of the site was covered by 0.10 m bgl of asphalt, the area in the south east corner of the site, from TP5 eastwards was predominantly concrete hardstanding. Stockpiles of construction waste are located in the south and southwest of the site, in this portion of the site, the ground surface is covered by Made Ground, comprising soft dark grey and mottled black gravelly clay to approximately 0.30 m bgl.

8.3 Anthropogenic Materials – Made Ground

8.3.1 Made Ground was encountered at every exploratory location across the site. It generally consisted of ashy sands and gravels which are composed of varying percentages of ash, clinker, brick fragments, concrete, sandstone and asphalt with lesser quantities of glass, wood, and ceramic material. The thickness of the Made Ground varies from 0.95 m bgl (WS08) to 2.10 m bgl (WS04). The Made Ground found on site is consistent with the historical information of the chemical work structures which once occupied the site.

8.3.2 In WS04, WS01, WS08, WS03, WS02, WS09 and all of the trial pits, with the exception of TP2, it has been proven that this material overlies natural strata of alluvial deposits. In TP2 the base of the Made Ground was not found. In TP06 at a depth ranging from 0.45 m bgl to 1.40 m bgl there was an odour of decomposing organic matter.

8.3.3 In WS05, WS05A, WS11, WS10 and WS10A sampling was obstructed by a concrete structure, possible foundations, varying in depth from 0.5 m bgl (WS10) and 1.00 m bgl (WS11).

8.4 Drift Deposits – Alluvial Deposits

8.4.1 The Alluvial Deposits (Tidal Flat Deposits) encountered in the trial pits and window sample holes mentioned previously, comprised of alternating beds of sands and silts with intermittent bands of silty clay. These deposits were proved to a maximum depth of 5.00 m bgl (WS03), where the base of the stratum was not encountered.

8.4.2 The layers of silt encountered in the exploratory holes vary in thickness from 0.50 m (WS02) to 1.90 m (WS09) and are sandy in composition.

8.4.3 The layers of fine sand encountered within the exploratory holes are light brown in colour and comprised of between 5% and 20% silt.

8.4.4 Based on the logs from the exploratory holes (e.g. WS08) the silt is typically overlying the sand. However the vertical extent of the alluvial deposits is not known.

8.4.5 The dynamic probe results indicate that the silt is generally very loose or loose with the density of the underlying sand increasing to being medium dense to dense below about 3.0 m depth.

8.5 Solid Geology

8.5.1 The exploratory holes undertaken during the Phase II investigation did not encounter bedrock/rock head within 5.00 to 7.00 m bgl. This is consistent information gathered in the Phase I Report for the site.

8.6 Groundwater

8.6.1 Groundwater was encountered in a number of exploratory holes at the site. A summary of the groundwater monitoring results are shown in Table 7 below.

Table 7: Groundwater Strike Information

Location	Depth (m bgl)	Strata
TP03	0.80	Made Ground.
TP04	1.60	Made Ground.
WS02	3.50	Silty fine to medium SAND.
WS04	1.50	Made Ground.
WS09	1.20	Sandy SILT.
WS11	0.70	Made Ground.

8.6.2 Groundwater levels during monitoring period (three visits) are presented below. These indicate that the water tables fluctuates slightly within perched water, with WS02 and WS09 varying the most. Groundwater levels in the remaining window sample holes are

relatively stable throughout the first two weeks of monitoring. The full monitoring results are presented in Appendix E.

Table 8: Groundwater Monitoring Information (first three rounds)

Location	Depth to Base m bgl	10/12/2015 Depth to Groundwater	16/12/2015 Depth to Groundwater	05/01/16 Depth to Groundwater
WS02	4.10	3.41	3.96	3.60
WS03	3.07	3.07	3.07	3.07
WS04	2.06	1.47	1.47	N/A*
WS08	3.96	3.96	3.96	3.96
WS09	2.78	1.27	1.20	0.87
WS11	0.96	0.68	0.70	0.70
* Installation flooded, unable to monitor				

8.7 Surface Water

8.7.1 During the Phase II site investigation there was a large volume of surface water present. The water pooled mainly on top of the Made Ground to the West of site near TP6, TP4, WS03 and WS04. The surface water was standing, however, during the excavations of TP4 and TP6 there was surface run off in to the pits. This pooling/flooding at surface was still at surface during the monitoring rounds. During the third round, WS04 location was covered by further surface water ponding. This indicates that the near surface layers of Made Ground are of low permeability because the groundwater level in the wells is not at or very close to ground level.

8.8 Live root depth

8.8.1 No tree roots were encountered during the Phase II site investigation.

8.9 Foundation Details

8.9.1 The sites history indicated that a number of buildings/structures were located on the site, which have been demolished and it is unlikely that the foundations and other below ground structures will have been removed. Therefore foundation obstructions are likely to be encountered within the ground. Concrete obstructions were encountered at locations WS05, WS05A, WS11, WS10 and WS10A. It was likely that the obstructions were foundations for the previous structure(s) which were once located in the area of the site.

9 GENERIC QUANTITATIVE RISK ASSESSMENT

9.1 Introduction

9.1.1 The assessment of contamination has been carried out in accordance with the overall guidance presented in CLR11 Model Procedures for the Management of Land Contamination using the procedures as indicated in Appendix B.

9.1.2 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 exceedance may be acceptable in the particular circumstances.

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

- human health;
- plant life;
- pollution of Controlled Waters;
- water supply pipes
- below ground concrete; and
- ground gases.

9.2 Assessment for the Protection of Human Health

9.2.1 The Generic Qualitative Risk Assessment (GQRA) is 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 commercial end use. A full summary of the chemical test results is presented in Appendix F. Exceedance of applicable Generic Assessment Criteria (GAC) concentrations are indicated in yellow, if present (note that the results highlighted in orange do not pose a risk to health bur relate to concrete design).

Soils

9.2.2 No contaminants for concern within the samples taken, exceeded their respective GAC values for commercial end use.

9.2.3 As no exceedances of SGVs were encountered, comparison to pC4SL GAC values were deemed not to be necessary. The full soil screening results are shown in Appendix H.

Asbestos

9.2.4 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 visually identified.

9.2.5 During laboratory analysis, out of six samples analysed one sample was detected positive for ACM. It was present in TP6 at 0.50 m bgl and identified as loose fibres of Amosite with a concentration of <0.001 % by weight (note that individual asbestos fibres can be positively identified in soils but if the quantity is very low there is insufficient asbestos to be able to determine the quantity other than it is present at a concentration below the quantification limit).

9.2.6 It is unlikely that any significant excavation activities will be undertaken at the location of TP6 as part of the redevelopment, the area is to be covered in concrete hardstanding, therefore it was not considered to pose a significant risk to the sites end users. The full soil screening results are shown in Appendix H.

Risks to Human Health (Construction Phase)

9.2.7 During the construction works there will be a risk from dust to on site workers and people occupying working on adjacent areas (the main waste facility to the southeast, industrial area to the northeast). Appropriate risk assessments should be carried out by the contractor to allow appropriate controls for the mitigation of risk to health of construction workers to be put in place. This risk can be controlled to within acceptable limits by:

- control of dust generation (see below);
- workers 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. The earthworks contractor should have a contingency plan in place before any works commence in case the presence of asbestos is suspected in groundworks;
- only permitting smoking or eating on site in appropriate pre-designated areas.

9.2.8 Given the proximity of the River Dee/Dee Estuary, 43m to the east of the site, industrial receptors both to the southeast and northeast and construction workers on site, 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 and that the following measures will be introduced to assist with control of dust generation:

- access roads and stockpiles should be regularly damped down with water;
- vehicles used to transport materials and aggregates should be enclosed or tarpaulined;
- local roads should be regularly cleaned;

- 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.

9.2.9 Due to the recorded ground gas conditions there is a potential risk during the re-development works for personnel entering excavations due to locally elevated concentrations of carbon dioxide. Entry into all below ground excavations should be carried out in accordance with The Confined Spaces Regulations (1997) and The Management of Health and Safety Regulations (1999).

9.2.10 It is recommended that the appointed Contractor consult with the Local Authority Air Quality Officer to determine whether a programme of particulate and nuisance dust monitoring is required for the duration of the works.

9.3 Risk to Plant Life

9.3.1 Concentrations of the phytotoxic metals zinc, copper and nickel have been recorded in Made Ground in excess of the guideline values for the protection of plants as presented in the MAFF document "Code of Good agricultural practice for the protection of soil"(1998). The results of the phytotoxic screening are presented in the tables below. It is acknowledged that the MAFF guidelines are based on the averaging area pH value, and that some pHs at the site have been recorded at significantly lower values than these.

Table 9: Phytotoxic Risk of Soils

Determinand	Number of Samples	Trigger Value* (mg/kg)	Results Exceeding Trigger Concentration (mg/kg)	Exceeds Tier 1 Screening (Y/N)
Copper	14	200	287 WS1, 476 TP2	Y
Chromium	14	400	-	N
Nickel	14	110	-	N
Zinc	14	300	7 out of 20 samples above 300 mg/kg – max 9550 TP3	N

***Trigger value from MAFF "Code of Good agricultural practice for the protection of soil" October 1998 at average pH 7.0**

9.3.2 The elevated concentrations of copper and zinc are all within material that will be placed under hardstanding, the proposed development is a commercial/industrial area of predominately concrete hardstanding and will not feature any soft cover areas. All concentrations are below human health screening values and therefore, based on all of this, it is unlikely that there will be a significant risk to plant life at the site.

9.3.3 If the development plan does change and landscaped areas are introduced to the site, then the elevated levels of contamination 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. The possibility of hazards to local flora and fauna arising from some of the levels of contamination cannot be precluded. Appropriate advice should be sought from the Local Authority Ecological Consultant.

9.4 Assessment for the Protection of Controlled Waters

9.4.1 The risks to controlled waters (groundwater and surface waters) from contaminants on-site have been assessed in accordance with the EA documents Groundwater Protection : Policy and Practice GP3 (2012) 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 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)).

9.4.2 The results of the remedial targets methodology assessment are presented in Appendix I and are summarised in the following Table 10.

Table 10: Summary of Exceedances of Generic Assessment Criteria for Controlled Waters

Chemical of Potential Concern	Water Quality Target (µg/l)	Basis for Water Quality Target	No. Water Samples Tested	Min. (µg/l)	Max. (µg/l)	No. Samples Exceeding WQT
Cadmium	5	EQS & DWS	3	2.5	25.1	2
Copper	10	EQS	3	<5	23	2
Nickel	20	DWS	3	11	81	2
Zinc	1000	EQS	3	99	3290	1
Zinc	3000	DWS	3	99	3290	1
Sulphate as SO_4	250	DWS	3	1150	1380	3
Sulphate as SO_4	400	EQS	3	1150	1380	3
Ammonium as NH_3	50	DWS	3	<50	1030	2
Mineral Oil (C_{10}–C_{40})	10	DWS	1	34	34	1

9.4.3 The data indicates that relevant water quality targets are exceeded in respect to a limited number of contaminants of concern.

9.4.4 Ammonium (as NH_4) was recorded above the detection limit and in exceedance of the DWS WQT value for two samples out of three of the samples. Unionised ammonia (NH_3) is of higher toxicity to ecological receptors than the ammonium ion (NH_4). The concentration of unionised ammonia (NH_3) can be calculated based on pH and temperature which have an influence on the partition coefficient. Calculation of unionised ammonia shows that all of the samples were below the EQS WQT value. Therefore, this indicates that it is unlikely to present a significant risk to ecological receptors.

9.4.5 It is likely that the perched groundwater encountered in TP4, WS4 and WS9 is not a continuous water body, as it was not encountered in other locations in the area between these locations (WS7 and TP2 for example), despite the groundwater strikes being all within a similar depth (1.20 – 1.60 m bgl – see Table 13). The probable flow of groundwater at the site is to the east, towards the River Dee, located approximately 43m

away. It is highly likely, due to the close proximity of this surface water body, that shallow and perched groundwater at the site is in hydraulic continuity with it.

9.4.6 The results from the hydraulically down gradient location, WS9 only had an exceedance for sulphate with no exceedances of the other analytes. This well is closest to the nearest major surface water receptor. It implies that the exceedances noted in TP4 and WS4 are not migrating across the site or towards the surface water receptors off-site and therefore it is unlikely that potential perched/shallow groundwater contamination with the same exceedance concentrations are migrating off-site.

9.4.7 It is also likely that if any potential shallow/perched groundwater contamination from the site reaches the River Dee/Dee Estuary, the concentrations are not sizeable enough that they would have a significant impact on this receptor. The process of diffusion, dissolution and dispersion would reduce any potential impact/concentrations further within the large surface water receptor of the River Dee/Dee Estuary. With regard to the risk to groundwater, the underlying bedrock (Pennine Lower Coal Measures and Pennine Middle Coal Measures) is classified as a Secondary A Aquifer and it is known that there are no SPZs within 2 km or the site and the aquifer's groundwater is not used for extraction for drinking water purposes.

9.4.8 It should also be noted that the site will be mostly hardstanding once redeveloped, in comparison to the mixture of ground cover currently present. This will decrease the potential for vertical migration of surface water etc and therefore vertical leaching of contaminants present in the Made Ground into the shallow/perched groundwater at the site.

9.4.9 With respect to the drinking water exceedances, for sulphate, ammonium as NH_4 and several heavy metals, these are all within an order of magnitude of the DWS or show limited exceedance of their respective WQT values.

9.4.10 The presence of silt and clay bands (as encountered in WS8, WS9, TP1, TP3, TP4, TP5 and TP6), and the likelihood of further deposits being present overlying the bedrock, would aid in the process of natural attenuation and reduce the relatively low concentration exceedances being reduced further. In the unlikely event of these reaching the underlying Secondary A Aquifer, dispersion, dissolution and dilution would likely occur to reduce concentrations further and ultimately to a point where it is unlikely that they will present a significant risk to the receptor.

9.4.11 Therefore it can be concluded that whilst there are elevated concentrations of Chemicals of Potential Concern, and subject to agreement with Natural Resources Wales, TerraConsult does not believe the site poses a significant risk to Controlled Waters because:

- The concentration of contaminants in soils are relatively low so there is no significant source in the soils (e.g. all BTEX, VOC and SVOC concentrations are less than the detection limits);
- the shallow/perched groundwaters at and in the vicinity of the site are not abstracted for human consumption;

- the sulphate concentrations are considered to be representative of general background concentrations and the deposits of ash/Made Ground;
- the DWS and the majority of the EQS exceedances are all within an order of magnitude of their respective GAC values;
- there are limited exceedances in the down gradient location (WS9 – sulphate only) compared to the rest of the site, implying that offsite migration is unlikely to pose a significant risk to the off-site surface water receptor (River Dee/Dee Estuary; and;
- The redevelopment includes a significant increase of hardstanding cover. This will reduce decrease the potential for vertical migration of surface water etc and therefore vertical leaching of contaminants present in the Made Ground into the shallow/perched groundwater at the site and eventually into the underlying Aquifer.

9.4.12 TerraConsult recommends that discussion with Natural Resources Wales is entered into at the earliest opportunity.

9.5 Water Supply Pipe Material Assessment

9.5.1 Plastic pipe materials are potentially vulnerable to attack from elevated levels 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 assessment has been completed in accordance with 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. This guidance provides threshold concentrations for different pipe material for various chemical groups.

9.5.2 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, and mineral oils. 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.

9.5.3 Table 11 summarises the relevant analytical results compared to pipeline threshold concentrations. An assessment of the chemical test results indicates that no exceedances for the PE water supply pipe are present across the site apart from TP1 and as such the use of PE pipe is deemed permissible. However, 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.

9.5.4 Following confirmation of the water supply pipe route, consideration of pipe materials for water supply pipes may be required, and/or protective measures such as the use of trenches backfilled with clean imported fill material may also be required. It is

recommended that discussions are commenced with the water supply company to confirm their requirements.

Table 11: Soil Data Compared to Pipeline Threshold Concentrations

Test Group	Testing Required	PE Threshold (mg/kg)	Maximum Site Concentrations (mg/kg)	Pass or Fail PE Threshold
Total VOCs	Where Preliminary Risk Assessment (PRA) has identified land potentially affected by contamination	0.5	<Detection Limits	Pass
Total BTEX & MTBE		0.1	<Detection limits	Pass
Total SVOCs (excluding PAHs and those Substances marked with an *)		2	<Detection limits	Pass
EC_5-EC_{10} aliphatic and aromatic hydrocarbons		2	<Detection limits	Pass
EC_{10}-EC_{16} aliphatic and Aromatic hydrocarbons		10	18 (TP1 @ 0.20) rest <Detection Limit	Pass except TP1
EC_{16}-EC_{40} aliphatic and aromatic hydrocarbons		500	1149 TP1 @ 0.20 rest <Detection Limit	Pass except TP1
Phenols* (from SVOC analysis)		2	<Detection limits	Pass
Cresols and chlorinated phenols*(from SVOC analysis)		2	<Detection limits	Pass
Ethers *	Only where identified	0.5	-	Not tested
Nitrobenzene *		0.5	<Detection limits	Pass
Ketones *		0.5	-	Not tested
Aldehydes *		0.5	-	Not tested
Amines *		0.5	-	Not tested
Corrosive	Conductivity, Redox and pH	See [1]	Pass	Pass

Notes

[1] Threshold: For wrapped steel, corrosive if pH<7 and conductivity >400 µS/cm. For wrapped ductile iron corrosive if pH<5, E_h not neutral and conductivity >400 µS/cm. For Copper, corrosive if pH<5 or >8 and Eh positive. For barrier pipe – Pass.

Highlighted where concentrations exceed the threshold for PE.

Where concentrations exceed the threshold for PE then Barrier pipe or Metal Pipe is required.

9.6 Chemical Attack on Below Ground Concrete

9.6.1 Below ground concrete structures are potentially at risk in areas of elevated sulphates and where there is low pH. An assessment of the soil and groundwater data (following the protocol established in BRE Special Digest 1, 2005) indicates that ACEC Class DS-2 – AC-2 conditions prevail.

9.6.2 Gross 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 hydrocarbons at the site there is no risk of these affecting the setting of concrete.

9.7 Permanent Ground Gases

Measured Gas Concentrations

9.7.1 Three rounds of gas monitoring carried were out by TerraConsult in the six gas monitoring wells with atmospheric conditions varying from 981 to 1020 mbar between the 10th December 2015 and 5th January 2016. One of the monitoring visits were carried out with atmospheric pressures less than 1000 mbar (pressures 981 mbar) with the other two readings were all taken with air pressured greater than 1000 mbar. It should also be noted that the first monitoring round was undertaken during falling pressure conditions. The highest VOC, flow rates, methane and carbon dioxide concentrations, together with the lowest oxygen levels (i.e. a combination of the worst case temporal conditions recorded) from the monitoring visits are summarised in the Table 12 below:

Table 12: Summary of Ground Gas Monitoring

Borehole	Response Zone mbgl	Contamination evidence	No. of monitoring occasions	Steady State Flow (l/hr)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (% v/v)	Carbon Monoxide (ppm)	Hydrogen sulphide (ppm)	Water Level mbgl	Atmospheric pressure readings mb
WS2	1.00 – 4.00	No	3	0.1*	0.1*– 0.20	6.8 – 8.9	2.6 – 4.7	1*	1*	3.41 – 3.96	981 - 1020
WS3	1.00 – 3.00	No	3	0.1*	0.1*	0.1* - 10.3	3.3 – 20.2	1*	1*	3.07	981 - 1020
WS4~	1.00 – 2.00	No	2~	0.1*	0.1*	3.4 – 4.1	13.0 – 14.1	1*	1*	1.47~	981 - 1020
WS8	2.00 – 4.00	No	3	0.1*	0.1*	1.3 – 4.7	14.0 – 18.3	1*	1*	3.96	981 - 1020
WS9	1.50 – 3.00	No	3	0.1*	0.1*	1.1 – 2.6	16.0 – 19.2	1*	1*	0.87 – 1.27	981 - 1020
WS11	0.50 – 1.00	No	3	0.1*	0.1*	0.1* - 0.3	16.9 – 19.5	1*	1*	0.68 – 0.70	981 - 1020

* Concentrations measured below the limits of detection (LOD) of the monitoring equipment. Assumed to be 0.1 for calculation purposes for all apart from CO and H2S, were the LOD is 1 ppm.
~ Installation flooded on third monitoring round, unable to monitor gas concentrations.

Ground Gas Assessment

9.7.2 Background information relating to the origin and production of landfill and ground gases are presented in Appendix J, together with current guidance on the assessment of ground gases. In accordance with this approach and the above measured ground gas levels, it is considered that the worst case temporal conditions may not have been measured during the monitoring period. However, as gas concentrations were measured at atmospheric pressures of 981 mbar and one in falling pressure conditions, it is anticipated that the worst case temporal conditions will not be significantly worse than those presented in Table 18 above. The gas flow rates measured across the whole of the site at all of the monitoring visits was less than the instrument detection limit of 0.1 l/hr. From Table 8.5 of CIRIA C665 the worst case Characteristic Situation for the two areas of the site are as follows:

Table 13: Characteristic Gas Situations							
Borehole Number	Steady State Flow	CH_4			CO_2		
	l/h	% v/v	GSV (l/hr)	Characteristic Situation	% v/v	GSV (l/hr)	Characteristic Situation
WS2	0.1*	0.1*–0.2	0.0002	CS1	6.8 – 8.9	0.0068 – 0.0089	CS2
WS3	0.1*	0.1*	0.0001	CS1	0.1* - 10.3	0.0001 – 0.0103	CS2
WS4	0.1*	0.1*	0.0001	CS1	3.4 – 4.1	0.0034 – 0.0041	CS1
WS8	0.1*	0.1*	0.0001	CS1	1.3 – 4.7	0.0013 – 0.0047	CS1
WS9	0.1*	0.1*	0.0001	CS1	1.1 – 2.6	0.0011 – 0.0026	CS1
WS11	0.1*	0.1*	0.0001	CS1	0.1* - 0.3	0.0001 – 0.0003	CS1
* Concentrations measured below the limits of detection of the monitoring equipment. Assumed to be 0.1 for calculation purposes.							

9.7.3 Based on the Ground Gas Assessment it can be seen that the carbon dioxide conditions at the site are the main risk driver regarding the gas conditions. The subsequent ground gas risk indicates that the majority of the site area would be classified as CS1 (Very low) with the area in the south west of the site (including WS2 and WS3 locations) being classified as CS2 (Low) and buildings would require to be designed taking into account the ground gas conditions. This is based on the carbon dioxide concentrations recorded in these two boreholes (6.8 – 8.9 % v/v in WS2 and up to 10.3 %v/v in WS3), as per Table 2 in BS 8485:2015 notes. This would indicate that any buildings in this portion of the site area would require CS2 gas protection measures, based on the worst case scenario in several of the individual wells. However it should be noted that no flows have been recorded during the three monitoring rounds undertaken at the site.

9.7.4 On the basis of the proposed redevelopment plan, the building (recycling/bulking facility) in the western/northwest portion of the site is unlikely to require gas protection measures based on the two readings from WS4 in this area. It should also be noted that no gas flows being recorded at the site, thus a significant risk from ground gas would be unlikely. However, to mitigate against any potential risk, it is suggested that CS2 protection is installed, to ensure that the end users/workers are not exposed to a significant risk.

9.7.5 There are a number of different combinations of design elements and verification which can be used or combined together in order to meet CS2 conditions for this development The design requires 1.5 points for CS2 protection for Type D buildings (large commercial/industrial buildings), as detailed in Table 4 of BS8485:2015. For a commercial/industrial building and the end use this can be achieved by a combination of the following:

- Cast in situ monolithic reinforced ground bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations cast in (up to 1.5 protection points if well reinforced to control cracking – Table 5 of BS

8485:2015) or a cast in situ ground-bearing floor slab (with only nominal mesh reinforcement at 0.5 protection points);

- Pressure relief pathway, usually low fine gavel or with a thin geocomposite blanket or strips terminating in a gravel trench external to the building. (up to 0.5 protection points - see Table 6 of BS 8485:2015 for further details).
- Gas resistant membrane meeting the criteria in Table 7 of BS 84585:2015 and meeting the criteria in BS ISO 15105-1 and verified according to CIRIA C735 (2 protection points) is unlikely to be required.

9.7.6 The Principal Contractor must ensure that the gas membrane (if used) is suitably protected from damage by follow on trades.

9.7.7 Based on the proposed end use of the site, it is envisaged that the floor slab of the building will need to be relatively heavy duty, due to vehicles tracking over it and weight of materials being placed on top of it. Therefore to achieve the full 1.5 points, it is recommended that a cast in situ monolithic reinforced ground bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations is used for the proposed building.

9.7.8 Note that no precautions are required due to radon.

9.8 Updated Conceptual Site Model

9.8.1 The conceptual site model initially developed from the desk study and walk-over survey (summarised in Section 4 of this report) has been updated using the findings of the Phase II ground investigation.

9.8.2 The site investigation revealed the following general downward succession:

Site surface: compacted gravel, asphalt, concrete and made Ground (compacted gravelly clay), varies across the site (see Section 9.2 for details).

Made Ground: The thickness of ashy sand and gravels and varies from 0.95 m bgl (WS08) to 2.10 m bgl (WS04).

Alluvium: comprised of alternating beds of sands and silts with intermittent bands of silty clay in some locations, below 3.0 m depth mainly a sand, proved to a maximum depth of 5.00 m bgl (WS03) and by dynamic probing to 7.0 m bgl.

Bedrock: Not encountered.

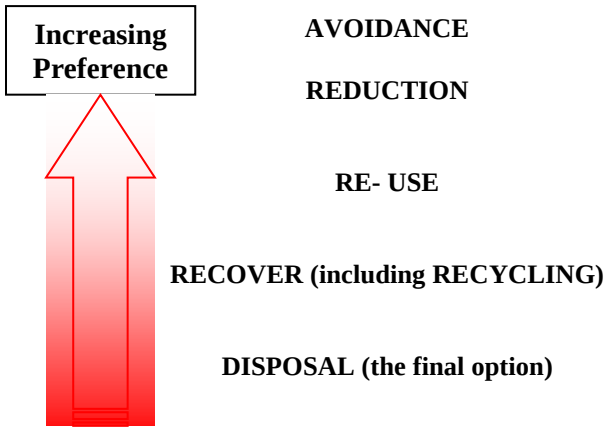
9.8.3 The updated contamination at the site has been assessed using the contaminant-pathway-receptor linkage approach. Following the site investigation, the plausible contaminant sources identified in Table 14 have been updated or confirmed as follows:

Table 14: Summary of Contaminant Linkages	
Receptor Group	**Pollution Source**
Human Health	No visual identification of asbestos containing materials were identified during the investigation. One out of six samples detected discrete asbestos fibres (Amosite) detected at 0.50 m bgl in TP6, which were determined to be less than laboratory detection limit (<0.001%) and unlikely to pose a significant risk. No exceedances with regards to commercial/industrial end use GAC values. Material is predominantly under hardstanding and will remain so, so limited pathways to receptors.
Plant Life / Ecological receptors	None, site will be covered in hardstanding, based on proposals at the time of writing
Controlled Waters	No unacceptable significant risk due to potential contamination, subject to confirmation from Natural Resources Wales.
Water Supply Pipe Material Assessment	No special precautions required, use of PE pipe is deemed permissible
Design of below ground concrete	Design of concrete to ACEC Class DS-2 – AC-2 conditions in terms of the durability and structural performance
Human health / property (from ground gases)	No radon protection is required under the current guidance. With regards to permanent ground gases, it is recommended that CS2 (Low risk) gas protection measures are required for the proposed commercial / industrial building located on the site. To achieve the full 1.5 points, it is recommended that a cast in situ monolithic reinforced ground bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations is used for the proposed building.

10 WASTE ASSESSMENT

10.1 Waste Hierarchy

10.1.1 In accordance with government guidance, it is required that the production and disposal of waste is managed in accordance with the following hierarchy of preference:



10.1.2 Site visits have indicated the presence of significant quantities of fly tipping across the site. It is recommended that that this material will require quantification, separation into a number of waste types on site so as to enable recovery/recycling of materials to minimise off-site disposal along the following lines:

- Metal – recover and sell as scrap.
- Timber, tree roots and vegetation – chip and use in landscaped areas.
- Plastic & polystyrene – send to landfill.
- Concrete, tarmac, bricks, gravel and tiles – crush and use as hardcore.
- Tyres – send off site to be shredded or incinerated.
- Soils - use in soft landscaping, if these have 'moderate' levels of contamination they can be capped with 'clean' materials from the site.
- Asbestos-cement board – if encountered, dispose at a suitably licensed landfill site in accordance with legislation and EA Guidance.

10.1.3 As with most developments, there will be waste materials produced from excavations for drainage/services if these are required. Where possible, these arisings should be incorporated into soft landscaping with the arisings being separated into Made Ground and alluvium as they are excavated in order to facilitate the re-use.

10.1.4 When soil is excavated it is technically a waste and can only be re-used if it fulfils the following requirements:

- There is a planned use for the material;
- There is planning permission for the proposed re-use;
- The material when re-used will not be a risk to flora, fauna or controlled waters;
- Appropriate procedures are followed to demonstrate the above criteria are met and the re-use of materials is recorded in a systematic way and appropriate permissions/permits are gained and relevant procedures followed.

10.2 Waste Characterisation and Classification

10.2.1 If there is a portion of excess soil this will then 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 K. A two phase approach is required comprising comprises:

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

Waste Characterisation

10.2.2 The results of the total concentrations form the chemical testing on soil samples have been assessed to determine their The samples were first assessed to determine whether they are non-hazardous or are hazardous in terms of waste classification. The results of this assessment indicate that none of the materials encountered during the investigation can be classified as hazardous.

10.2.3 An initial waste classification exercise of the Made Ground material analysed has been undertaken. Most of the samples tested are not hazardous in terms of waste disposal. Three samples have been classified as hazardous. These are samples of Made Ground from TP3 at 0.30 m bgl, TP1 at 0.20 m bgl and WS4 0.50 – 1.00 m bgl. These are classified as hazardous due their concentrations of heavy end hydrocarbons and zinc concentrations respectively. Hazardous material that is excavated, such as any Made Ground of soft clay that is also geotechnically unsuitable, will need to be removed from site. In accordance with the Waste Regulations, pre-treatment of hazardous materials is required prior to disposal. Due to the limited size of the site it is recommended that hazardous material be taken to a soil treatment centre for pre-treatment where the soils hazardous properties may be reduced. The site must register as a producer of Hazardous Waste with Natural Resources Wales and appropriate Duty of Care Waste Transfer procedures followed.

Waste Classification

10.2.4 In order to determine whether soils can be sent to a licensed landfill for disposal, further testing is required comprising landfill Waste Acceptance Criteria (WAC) analysis for both total concentrations for certain chemicals and for leachate analysis. Two WAC tests were carried out as part of this investigation in TP6 at 1.30 m bgl and TP4 at 1.60 m bgl. The samples tested were not hazardous but there were exceedances of the WAC criteria for inert waste so this material is likely to require to be disposed of at a landfill with a Permit for accepting non-hazardous landfill. Should it be proposed to dispose any excess soil at a landfill site then further WAC testing will have to be carried out to confirm the landfill waste classification.

10.2.5 Note that the above assessment should only be seen as an initial guide. Defining the class of waste is carried out on the actual waste being disposed of and the destination landfill site will have the final decision on acceptability of the waste. Therefore, it is recommended that if soils are to be removed from the site, the appointed contractor should approach a landfill site with the available chemical data and seek a formal waste characterisation.

10.3 Materials Management and Reuse of Arisings On-site

10.3.1 The reuse of excavated arisings on site should be maximised. Any material excavated on site may be classified as waste and it is the responsibility of the holder of a material to form their own view on whether or not it is waste. This includes determining when waste that has been treated in some way can cease to be classed as waste for a particular purpose.

10.3.2 As soil is technically a waste when it has been excavated, it cannot be re-used on site unless one of the following three procedures are implemented:

- the procedures are followed in the recently introduced CL:AIRE Code of Practice 'The Definition Of Waste: Development Industry Code of Practice Version 2 (2011).' If these procedures are followed, excavated arisings can be re-used without them being defined as waste "where it is certain that the material will be used for the purposes of construction in its natural state on the site from which it was excavated." or:
- the site applies for an Environmental Permit exemption from the Waste Management Regulations so the material can be placed without a permit (note that the rules for permit exemptions have been changed and the maximum quantity covered by a permit exemption for re-using soil is 1,000 T), or;
- the site applies for a full Environmental Permit (either a standard rules permit or a bespoke permit) from Natural Resources Wales under the Environmental Permitting Regulations 2007.

10.3.3 The length of time taken for the above three regimes also need to be considered:

- CL:AIRE Code of Practice takes 7 to 14 days to gain approval and fees of £0.01 per m^3 of soil move is payable to CL:AIRE (no charge for sites requiring reuse of up to 5,000 m^3 of soil);
- An Environmental Permit exemption takes 7 to 14 days to gain approval and there are no fees due;
- Allow a minimum of 12 weeks to develop a Waste Recovery Plan and gain approval or the Environmental Permit from Natural Resources Wales and there are significant fees payable to the Agency (typically £5,000) for the permit.

10.3.4 TerraConsult recommend that the CL:AIRE CoP is implemented for this development and a Materials Management Plan is used for the site to allow the re-use of soils at the site.

10.3.5 If the CL:AIRE procedures are followed, excavated arisings from other sites can be re-used on this site if the soil is natural uncontaminated soil; or Made Ground can be imported and reused if it has been treated to a required specification under an Environmental Permit. Note, untreated Made Ground cannot be imported in accordance with the CL:AIRE Code of Practice

11 DEVELOPMENT CONSIDERATIONS

11.1 Planning Conditions and other constraints imposed by the proposed development

Protected Habitats and Species (e.g. badgers, great crested newts, bats, nesting birds, Species of Principal Importance for Biodiversity)

11.1.1 The client informed TerraConsult, prior to the Phase 2 Ground Investigation, that a Badger set is present along the western edge of the site. This may impact the proposed redevelopment at the site. Specialist ecologists should be consulted prior to any works commencing on site.

Preservation Orders (e.g. Listed Buildings, TPOs)

11.1.2 It is not known if any tree preservation orders are in place at the site or within the immediate area of the site. Specialist ecologists should be consulted prior to any works commencing on site.

11.2 Environmental Assessment

11.2.1 Our previous report for the site presented a preliminary risk assessment has been made based on the contaminant-pathway-receptor model as defined in Part IIA of the Environment Protection Act, 1990, and in accordance with BS 10175: 2011+A1:2013 "Investigation of Potentially Contaminated Sites – Code of Practice". In order to make a more detailed assessment of the potential hazards, a more comprehensive conceptual ground model of the site was developed by carrying out a Phase 2 geo-environmental ground investigation. This detailed the characteristic ground conditions and elements of the surrounding environment and assisted with identifying the potential sources of contamination, the potential receptors of the contamination and the potential pathways between them.

11.2.2 The results of the human health risk assessment concluded that there was no exceedance of soil concentrations, on comparison to their respective contaminants of concern, when the site is considered for redevelopment for a commercial/industrial end use. If this changes then the elevated levels of contamination 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.

11.2.3 During the fieldwork no suspected ACMs were visually identified. One out of six samples analysed discrete identifiable asbestos containing materials (ACMs) was identified in one sample from TP6 at 0.50 m bgl and identified as loose fibres of Amosite. Subsequent quantification confirmed that the ACM fibres were <0.001 %, which is below the laboratory detection limit and therefore unlikely to present a significant risk to site end users (particularly as the site is due to be predominantly covered in concrete hardstanding.

11.2.4 No mitigation measures are required due to phytotoxic contaminants, primarily as the proposed site will be hardstanding. If this changes, the risk presented will need to re-evaluated.

11.2.5 The pH and sulphate content of the soils requires checking with respect to its potential attack of concrete and take appropriate action in terms of specifying a suitable mix in line with Building Research Establishment Special Digest 1 Concrete in Aggressive Ground (2001). An assessment of the soil and groundwater data (following the protocol established in BRE Special Digest 1, 2005) indicates that ACEC Class DS-2 – AC-2 conditions prevail.

11.2.6 An assessment of the chemical test results indicate that no special consideration of pipe materials for water supply pipes is required because there are no exceedances of criteria within 1.70 m of the current ground surface so PE pipework can be used. Failures were identified in the area around TP1, thus, following confirmation of the water supply pipe route (if there is one), consideration of pipe materials for water supply pipes may be required, and/or protective measures such as the use of trenches backfilled with clean imported fill material may also be required.

11.2.7 The assessment for the controlled waters risk assessment indicates that relevant water quality targets are exceeded in respect to a limited number of contaminants of concern. However, these are all within an order of magnitude or show limited exceedance of their respective GAC values. TerraConsult does not believe the site poses a significant risk to Controlled Waters because:

- The concentration of contaminants in soils are relatively low so there is no significant source in the soils (e.g. all BTEX, VOC and SVOC concentrations are less than the detection limits);
- the site is underlain by non-productive strata drift deposits (alluvium);
- the shallow/perched groundwaters at and in the vicinity of the site are not abstracted for human consumption;
- the sulphate concentrations are considered to be representative of general background concentrations and the deposits of ash/Made Ground;
- the DWS and the majority of the EQS exceedances are all within an order of magnitude of their respective GAC values and these exceedances are encountered in the wells within the central part of the site;
- at the down gradient location (WS9) the only exceedance is for sulphate indicating that off-site migration is unlikely to be occurring so there is no significant risk to the off-site surface water receptor (River Dee/Dee Estuary; and;
- The redevelopment includes a significant increase of hardstanding cover. This will reduce decrease the potential for vertical migration of surface water etc and therefore vertical leaching of contaminants present in the Made Ground into the shallow/perched groundwater at the site and eventually into the underlying Aquifer.

11.2.8 Based on the Ground Gas Assessment it can be seen that the carbon dioxide conditions at the site are the main risk driver regarding the gas conditions. The subsequent ground gas risk indicates that the majority of the site area would be classified as CS1 (Very low) with

the area in the south west of the site (including WS2 and WS3 locations) would be classified as CS2 (Low) and buildings would require any gas protection measures.

11.2.9 On the basis of the proposed redevelopment plan, the building (recycling/bulking facility) in the western/northwest portion of the site is unlikely to require gas protection measures based on the two readings from WS4 in this area. It should also be noted that no gas flows being recorded at the site, thus a significant risk from ground gas would be unlikely. However, to mitigate against any potential risk, it is suggested that CS2 (Low risk) gas protection measures are required for the proposed commercial / industrial building located on the site. To achieve the full 1.5 points, it is recommended that a cast in situ monolithic reinforced ground bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations is used for the proposed building.

11.2.10 An initial waste characterisation exercise of the Made Ground material analysed has been undertaken. The majority of the soil samples tested were found to be not hazardous in terms of waste disposal. Three samples out of fourteen samples tested have been classified as hazardous for waste disposal purposes. These are all samples of Made Ground from TP3 at 0.30 m bgl, TP1 at 0.20 m bgl and WS4 0.50 – 1.00 m bgl. These are classified as hazardous due their concentrations of zinc, heavy end hydrocarbons and zinc concentrations respectively.

11.2.11 In terms of waste classification, to determine whether soils can be sent to a licensed landfill for disposal, two WAC tests were carried out as part of this investigation from samples which were not hazardous (TP6 at 1.30 m bgl and TP4 at 1.60 m bgl). The results indicate that the material will require disposal at a landfill with an Environmental Permit to take non-hazardous waste.

11.3 Remediation Strategy

11.3.1 Based on the Phase 2 Ground Investigation data and assessments, a Remediation Strategy will not be required in accordance with procedures in CLR 11 ‘Model Procedures for the Management of Land Contamination because the site is ‘suitable for use’ in its current state. The risk assessments have concluded that for the proposed development no remediation measures are required to address risks to human health, plants and controlled waters.

11.3.2 However, the building does require to be designed to incorporate ground gas protection measures to meet CS2 conditions due to the carbon dioxide conditions. This required 1.5 points of protection in accordance with Table 4 of BS8485:2015. To achieve the full 1.5 points, it is recommended that a cast in situ monolithic reinforced ground bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations is used for the proposed building.

11.3.3 Any proposals to remediate or develop the site should be agreed with the relevant authorities (e.g. local authority environmental health officer, Natural resources Wales etc) to obtain Planning Permission prior to commencement of the works and should be agreed with the local authority building control officer prior to commencement of the works. Where remediation works are required, a verification report should be submitted to the relevant authorities for approval in accordance with relevant Planning Conditions

11.4 Unforeseen Ground Contamination

11.4.1 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 Natural Resources Wales shall also be informed.
3. The suspected contaminated material will be investigated and tested appropriately in accordance 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 be placed either on a prepared surface of Glacial Till, 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 is will be surveyed, a photographic record kept and testing results incorporated into the Verification Report.
5. A photographic recorded will be made of relevant observations.
6. The testing suite will be determined by the independent geo-environmental specialist on the basis of visual and olfactory observations.
7. Test results will be compared against current assessment criteria suitable for the future use of the area of the site affected.
8. 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 Natural Resources Wales, 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.

9. Verification Report will be produced for the work.

Asbestos

11.4.2 Asbestos cement products and asbestos fibres have not been visually identified, although one sample out of six tested identified loose fibres of Amosite. Subsequent quantification confirmed that the ACM fibres were <0.001 %, which is below the laboratory detection limit and therefore unlikely to present a significant risk to site end users. If non-notifiable asbestos (e.g. chrysotile asbestos cement board) is encountered in any future excavations then it will be dealt with in accordance with the Control of Asbestos Regulations 2012 (CAR 2012) and the HSE's ACoP for asbestos (2013). Finding non-notifiable asbestos is a very common occurrence on brownfield sites and is a relatively low risk activity and can be dealt with as a matter of routine. Therefore it is not proposed that the Council will be notified but an appropriate record will be kept of confirmatory testing and disposal. This will be included in remediation verification reports.

11.4.3 If suspect notifiable asbestos is encountered then the Council and the HSE will be notified. An appropriate action plan will be agreed with the Council and the HSE in accordance with CAR 2012. The action plan will include the preparation of the Risk Assessment and Plan of Work in accordance with CAR and other statutory requirements including:

- Site mobilisation;
- Excavation methodology;
- Handling, movement and storage on site of excavation arisings;
- Any processing of excavation arisings containing ACMs;
- Movement and placement of arisings to final destination;
- Placing of cover system over soils with and ACMs remaining on site;
- Off-site disposal of ACMs;
- Licences;
- PPE & RPE;
- Dust and fibre monitoring.

11.4.4 Potential mitigation measures that would be required include:

- Site investigation and risk assessment;
- Removal or treatment of asbestos hotspots;
- Use of PPE and RPE by construction workers; and
- Compliance monitoring.

Unexpected Tanks

11.4.5 No buried underground fuel storage tanks have been encountered during the site investigation works, however, there remains a very low risk that tanks could be present on site, based on the site history. Should an underground tank be encountered during the redevelopment at the site, operations should cease in the area and TerraConsult informed. Degassing and removal of the tank by a suitably qualified contractor will be required, and a Naked Flame Certificate should be provided. Validation testing of remaining soil and water can be supervised by TerraConsult to confirm whether risks to human health remain.

12 CONCLUSION

12.1 Environmental Risk Assessment

12.1.1 The Phase 2 intrusive investigation has been carried out in order to develop a more comprehensive conceptual ground model of the site in order to assess the potential risks as set out in the Phase 1 report for the site. This report detailes the characteristic ground conditions and elements of the surrounding environment and has assisted with identifying the potential contaminants of contamination, the potential receptors of the contamination and the potential pathways between them.

12.1.2 The results of the risk assessments indicate that there is no significant source of contaminants of concern present at the site so there is a negligible risk to human health receptors, based on a commercial/industrial end use. There is a low risk to controlled waters and ecological receptors. No specific precautions are required with respect to radon gas or hydrocarbon vapours for the development. Therefore no Remedial Strategy is required for the development.

12.1.3 However, due to carbon dioxide concentrations recorded during the monitoring period, it is recommended that CS2 (Low risk) gas protection measures are required for the proposed commercial / industrial building located on the site. To achieve the full 1.5 points, it is recommended that a cast in situ monolithic reinforced ground bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations is used for the proposed building. The design drawings for the building floor slab and foundations should be agreed with the council environmental health officer to ensure that they approve that the design meets this criteria.

12.1.4 Notwithstanding the above, it is always possible that unexpected visual or olfactory ground contamination or buried tanks could be encountered in groundworks, particularly during excavation of material for the foundations of the proposed recycling/processing centre structures on site. If this occurs then the procedures set out in Section 11.4 should be implemented.

12.2 Recommendations for Further Works

Waste

12.2.1 As most developments require a portion of excess soil to be sent to a landfill sites. We have made a preliminary assessment of the chemical test data in this report but it is recommended that additional chemical and Landfill Waste Acceptance Criteria testing is carried out of any material to be sent to landfill in order that the landfill operator can correctly classify the waste.

Regulatory Liaison

12.2.2 This report should be issued to the relevant authorities (e.g. local authority environmental health officer, Natural Resources Wales etc) to discharge the relevant Planning Conditions.

Re-use of Soil on site and Importation of Fill

12.2.3 See Section 10.3 for full details. However, it should be noted that it is recommended that the development implements the procedures in the CL:AIRE document 'The Definition Of Waste: Development Industry Code of Practice,' Version 2 (2011) to enable legal re-use of arisings on site.

12.3 Health and Safety

12.3.1 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.

12.3.2 In accordance with the Construction Design and Management (CDM) Regulations 2015, TerraConsult has acted in the role of Contractor and as Designer for the site investigation works as described in this report. With issue of this report TerraConsult has discharged and completed all contractual and legal requirements for these positions and we have no further involvement with the project.

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Office of the Deputy Prime Minister: 2004 : The Building Regulations: Approved Document C.

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UK Technical Advisory Group on the Water Framework Directive: 2012 : Updated Recommendations on Environmental Standards River Basin Management (2015-21). Draft (SR3 – 2012), 26th April 2012

APPENDICES

List of Appendices

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 Flintshire County Council (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 January 2016 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.

Specific access constraints were imposed which meant that the full area of the site could not be investigated. No access was possible to some areas of the northwest portion and central areas of the site due to surface water flooding. Some subsurface obstructions in the north and central areas meant that hole could not be sunk. Lastly an area to the east/southeast was new concrete hardstanding and was in use as a salt stockpile. These areas could not be accessed at all.

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+A1 2013. 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+A1 2013. 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+A1 2013. 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.
Moderate 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) 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 Groundwater Protection: Policy and Practice GP3 (2012) 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 1.05) Handbook.
- Environment Agency : CLEA Software Version 1.071, September 2015
- 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.

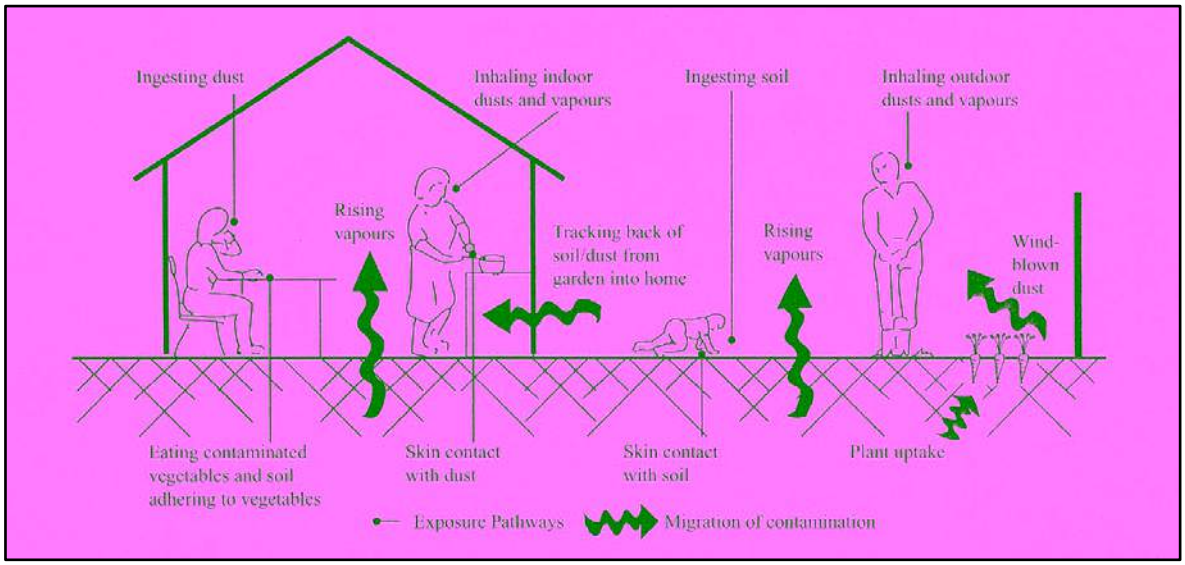
Soil Guideline Values

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 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.

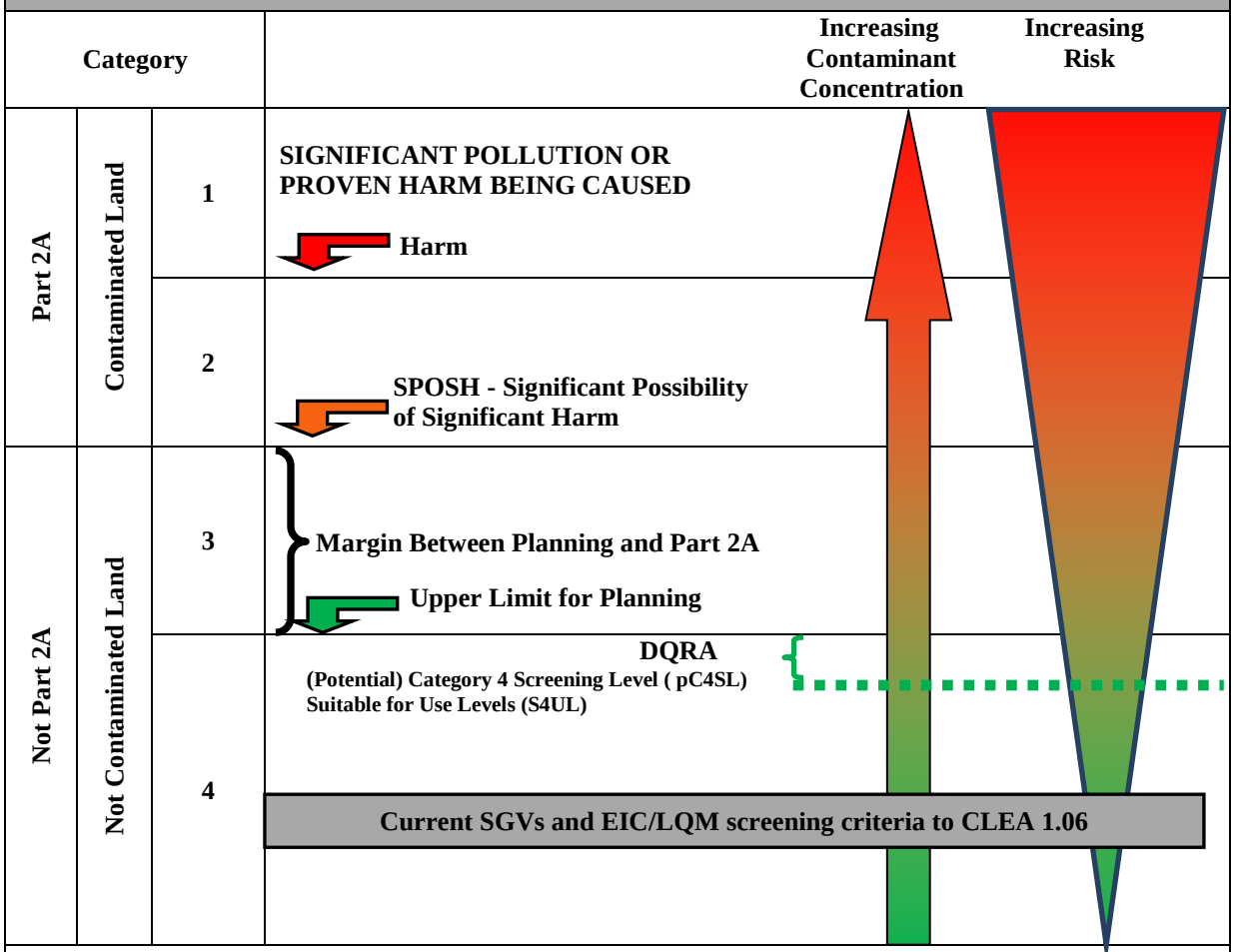
In March 2014, appendices to the main Defra report were published detailing the derivation of pC4SL for 6 contaminants and other appendices regarding a review of the CIEH/CL:AIRE statistics guidance and sensitivity analysis. For each contaminant, a range of pC4SL have been produced relating to modifying 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.							

CURRENT GUIDANCE FOR CONTROLLED WATERS RISK ASSESSMENT

Summary of Regulatory Context

Government 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. When considering the current use of land, Part IIA of the Environment Protection Act 1990 [4] (EPA 1990) provides the regulatory regime, which was introduced by Section 57 of the Environment Act 1995 [5], which came into force in England on 1 April 2000. 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, controlled waters 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."*

Part IIA provides a statutory definition of the pollution of controlled waters under Section 78A(9) as:

> *"the entry into controlled waters of **any** poisonous, noxious or polluting matter or **any** solid waste matter"*

Part IIA is supported by a substantial quantity of guidance and other Regulations, especially for England, The Contaminated Land (England) (Amendment) Regulations 2012 and Contaminated Land Statutory Guidance (DEFRA, 2012) which came into force in early April 2012. The document re-confirms the duties of Enforcing Authorities in dealing with contamination including the role of the Environment Agency which has powers under Part 7 of The Water Resources Act (1991) to take action to prevent or remedy the pollution of controlled waters, including circumstances where the pollution arises from contamination in the land.

Part IIA introduces the concept of a contaminant linkage; where for potential harm to exist there must be a connection between the source of the hazard and the receptor via a pathway. Risk assessment in contaminated land is therefore directed towards identifying the contaminants, pathways and receptors that can provide contaminant linkages. This is known as the contaminant-pathway-receptor link (CPR or contaminant linkage).

Part IIA places contaminated land responsibility as a part of the planning and redevelopment process rather than Local Authority or Environment Agency taking direct action except in situations of very high pollution risk or where harm is occurring. In the planning process guidance is provided by National Planning Policy Framework (NPPF) of March 2012. This requires that a site which has been developed shall not be capable of being determined "contaminated land" under Part IIA. Therefore, appropriate risk-based investigation is required to identify the contaminant linkages that can then be assessed, and then mitigated using methods that can be readily agreed with the planners.

Environment Agency Guidance

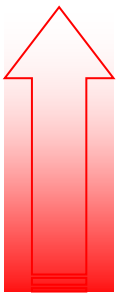
Legislation and guidance surrounding the protection of controlled waters in the UK is numerous and can be complex. The Environment Agency's overall position on groundwater is *"To protect and manage groundwater resources for present and future generation in ways that are appropriate for the risks that we identify"* (Groundwater Protection : Policy and Practice GP3, 2012). In brief, the core objectives of the existing legislation serve to enforce this position.

In 1992, the National Rivers Authority published their Policy and Practice for the Protection of Groundwater (PPPG), this document was influential as it provided a focus for key developments such as Source Protection Zones (SPZs) and Groundwater Vulnerability Maps. The Policy was then revised in 1998, since which there have been substantial changes in legislation, driven by Europe. Key European Directives relating to groundwater include the Groundwater Directive (80/68/EEC) and the Water Framework Directive (2000/60/EC). Aspects of these directives are controlled

by primary UK legislation such as the Water Resources Act 1991 as amended by the Water Act 2003. Further to legislative changes, gaps identified in the 1998 PPPG required addressing. These changes are reflected in the Environment Agency Policy document *Groundwater Protection: Policy and Practice (GP3), Version 1* of November 2012. The following diagram indicates the three main parts of GP3:

Structure of GP3

The Environment Agency follows a tiered, risk based approach to drinking water protection and this should be taken into account when carrying out controlled waters risk assessment:



Increasing Level of Protection

Water Protection Zones

Safeguard Zones

Source Protection Zones

Principal Aquifers

Secondary Aquifers

Tools available for Risk Assessment of Controlled Waters

In order for a developer of a potentially contaminated site to fulfil their obligations under the legislation, a site assessment would be required to be undertaken in order to identify any potential risks to controlled waters and to derive suitable clean-up criteria if necessary to ensure the protection of controlled waters. A number of tools are available for this purpose and the general approach is detailed further in Part 3 of GP3.

Three main stages apply to any risk assessment of controlled waters, these are:

i) Risk Screening (devise Conceptual Site Model, making reference to groundwater vulnerability maps, site setting etc)
ii) Generic Risk Assessment (using the EA Remedial Targets Methodology – Tier 1 - Comparison of groundwater data with relevant standards)
iii) Detailed Quantitative Risk Assessment (Consideration of aquifer properties and site specific parameters, using the EA Remedial Targets Methodology - Tiers 2 & 3)

The process is summarised below (Taken from the Environment Agency GP3 draft consultation document, 2006):

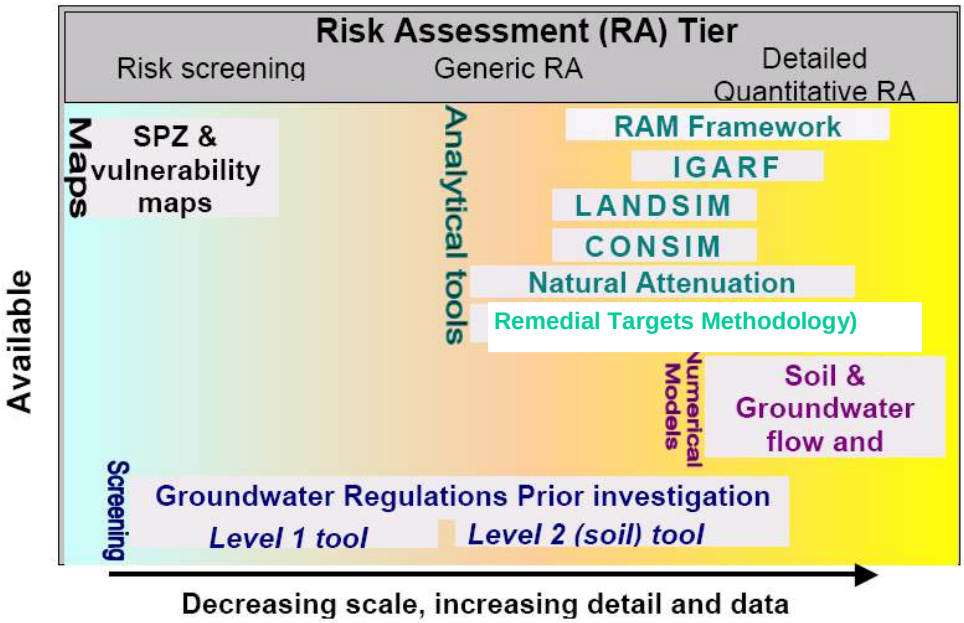


Figure 1-1 Environment Agency groundwater assessment tools, mapped against the different levels of risk assessment.

When assessing groundwater impact the Environment Agency advocate the application of their framework methodology "Remedial Targets Methodology – Hydrogeological Risk Assessment for Land Contamination" Environment Agency (2006). The methodology has four tiers of assessment:

Tier 1 utilises either a soil concentration (calculation of pore water concentrations based on partitioning calculations), leaching test or pore-water concentration of perched water as a source concentration input and these are contrasted directly to water quality standards. No dilution or attenuation is considered at Level 1.

Tier 2 (groundwater) considers dilution of the contaminant within the underlying receiving groundwater or surface water body. To determine a dilution factor the infiltration rate of pore water and the discharge of groundwater beneath the source must be determined. Level 2 Assessment is comprises a comparison between measured groundwater concentrations with to water quality standards.

Tier 3 considers natural attenuation in the form of dispersion, retardation and degradation of the contaminant. As the levels are progressed, the assessment becomes increasingly more detailed and less conservative as the data requirements are increased with each successive tier. The Environment Agency has released Excel Worksheets to carry out basic calculations using a conservative approach up to Tier 3. However, in this case the conceptual model is a simple one and assumes there is a simple migration of contaminants from the source zone into the aquifer receptor. Using these worksheets requires a sensitivity analysis showing how by varying each parameter, what effect it might have on the outcome of the assessment. Groundwater conceptual models are not always this simple.

Tier 4 is for more complex conceptual models where multiple sources, multiple pathways, multiple receptors and complex water balances can be assessed.

The Environment Agency developed a spreadsheet based code to support the Remedial Target Methodology, and the code is capable of undertaking assessments for Tiers 1 to 3. Tier 4 assessment is not supported by the spreadsheet based code.

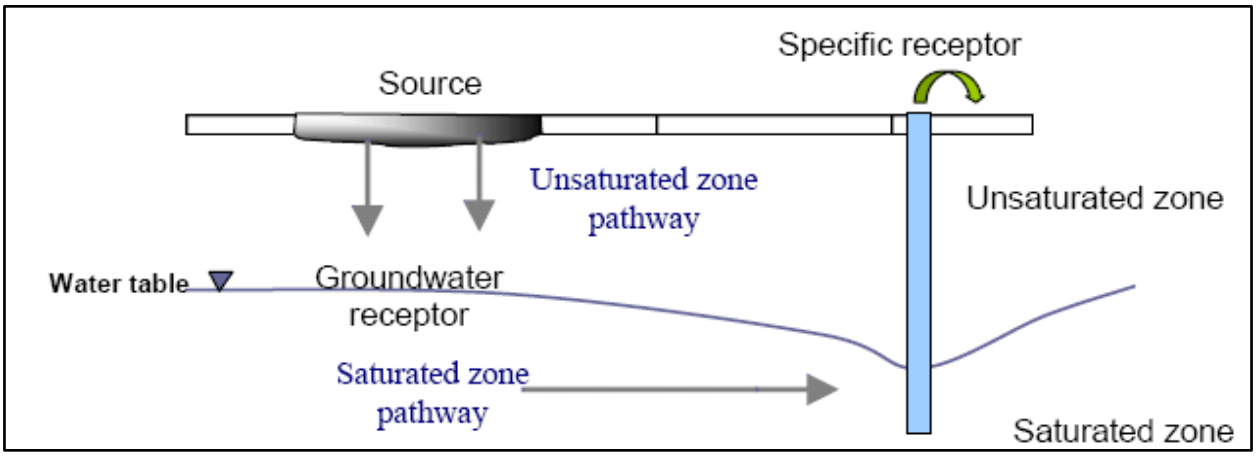
A more advanced code, ConSim 2, developed on behalf of the Environment Agency to support the Remedial Targets Methodology, allows for the introduction of additional geological horizons and is used mainly to determine the concentrations reaching a receptor and the timescales over which this may happen.

The codes assess only the dissolved phase contaminants. There are many further codes commercially available for use in controlled waters risk assessment, particularly for more complex situations, however, these should be used with caution and only once agreement has been obtained from the Environment Agency. All have the overall aim of the estimation of risk from contaminant linkages and the protection of controlled waters.

General notes on each stage of the controlled waters risk assessment process

Risk Screening

The understanding of the Conceptual Site Model (CSM) is the key to assessing any site. Using a robust CSM, potential pathways or receptors may be screened out from any further assessment at an early stage. For example if the pathway through the unsaturated zone is blocked by the presence of a significant thickness of low permeability clay. A greater understanding of the CSM is achieved with each tier of risk assessment. An example of a basic Source-Pathway-Receptor concept is given below (taken from the Environment Agency GP3, 2012):



Generic Risk Assessment

When undertaking the Generic Hydrogeological Risk Assessment (EA Remedial Targets Methodology Tier 1), comparison of chemical analytical results is made with screening criteria. Published values of screening criteria with which chemical test results can be compared are published in the following guidance:
There is a hierarchy of screening criteria which is as follows:

- Updated Recommendations on Environmental Technical Standards, River Basin Management (2015-21), April 2012 by the UK Technical Advisory Group on the Water Framework Directive;
- Environmental Quality Standards (EQS) for freshwaters based on The EC Dangerous Substances Directive (76/464/EEC and Daughter Directives);
- Surface Waters (Abstraction for Drinking Water)(Classification) Regulations (1996)
- Surface Waters (Fishlife) (Classification) Regulations (1997)
- UK Drinking Water Standards (DWS) (Water Supply (Water Quality) Regulations 2000);
- Dutch Ministry of Housing, Spatial Planning and Environment (2001) Intervention Values and Target Values – soil quality standards;
- World Health Organisation Guidelines for Drinking Water (2004)

Should the Level 1 or 2 assessments indicate threshold levels to be exceeded, then there are three alternative ways in which to proceed:

- To devise suitable remedial solutions;
- To carry out more investigation, sampling and analysis;
- To conduct a site-specific Detailed Quantitative Risk Assessment (DQRA) to whether or not the soil materials are suitable for their site-specific intended use or to devise a site-specific clean-up level.

Detailed Quantitative Risk Assessment (DQRA)

The decision to carry out a DQRA will be dependent on the extent and implications of the initial qualitative and generic assessment. The scope of any such assessment will be accurately defined by the outcomes of the former two stages. The CSM will be sufficiently refined by this stage that only certain contaminants of concern, certain pathways and certain receptors will require further assessment, the remainder having been screened out.

Additional site specific data is normally required for this stage of assessment, as explained above, more processes that are capable of affecting contaminant concentrations are considered (such as dilution and attenuation).

Remediation criteria derived will therefore be specific to each site and will be based on a detailed assessment of the potential impact at the identified receptor or *compliance point*. A greater level of confidence can be placed on the predicted impact on the compliance point following a DQRA.

Definition of Controlled Waters

The term 'controlled waters' is defined in Section 104 of the Water Resources Act 1991 as:

> *"Territorial Waters…which extend seawards for three miles…, coastal waters…, inland freshwaters, waters in any relevant lake or pond or of so much of any relevant river or watercourse as is above the freshwater limit, and ground waters, that is to say, any waters contained in underground strata."*

Note that the definition of groundwater under the Water Resources Act 1991 includes all water within underground strata (including soil / pore water in the unsaturated zone). The definition of groundwater under the Groundwater Directive however is limited to water in the saturated zone. For the purposes of Part IIA of the Environmental Protection Act 1990, the Environment Agency recommends that the groundwater within the saturated zone only is considered as the receptor (rather than soil / pore water).

Environment Agency's Aquifer Designations

The Environment Agency have classified different types of aquifer from which groundwater can be extracted. The aquifer designations reflect the importance of aquifers in terms of groundwater as a resource (drinking water supply) but also their role in supporting surface water flows and wetland ecosystems. The aquifer designation data is based on geological mapping provided by the British Geological Survey.

The maps are split into two different types of aquifer designation:

- **Superficial (Drift)** – permeable unconsolidated (loose) deposits.
- **Bedrock (Solid)**– solid permeable formations e.g. sandstone, chalk, limestone.

The aquifer designations displayed on the Environment Agency maps are as follows:

- **Principal Aquifers (formerly termed Major Aquifers) –** These are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as a major aquifer.
- **Secondary Aquifers (formerly termed Minor Aquifers) –** These include a wide range of rock layers or drift deposits with an equally wide range of water permeability and storage. Secondary aquifers are subdivided into two types:
  - **Secondary A** - permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers;
  - **Secondary B** - predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers.
  - **Secondary Undifferentiated** - has been assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.
- **Unproductive Strata (formerly termed Non-Aquifer) –** These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

Hazardous and Non Hazardous Substances

The Groundwater (England and Wales) Regulations 2009 control the disposal to the hydrogeological environment of potentially polluting substances which are divided into Hazardous Substances and Non-hazardous Contaminants (this roughly approximates to the former List 1 and List 2 substances).

Hazardous Substances are the most damaging and toxic and must be prevented from directly or indirectly entering the groundwater environment. Hazardous Substances include mineral oils and hydrocarbons, pesticides, biocides, herbicides, solvents and some metals. Discharge of Hazardous Substances to Controlled Waters must be prevented.

Non-hazardous Pollutants are any contaminants other than Hazardous Substances. Non-hazardous Pollutants are potentially toxic but are less harmful than Hazardous Substances, but their direct discharge to groundwater is generally not permitted and any indirect discharge to groundwater must be limited and be controlled by technical precautions in order to prevent pollution. Non-hazardous Pollutants include ammonia and nitrites, many metals and fluorides.

MANAGEMENT OF CONTAMINATED LAND

When risk assessment of the site has been completed and this indicates that remedial works are required, the main guidance in managing this process is set out in the DEFRA/EA publication CLR11 (2004) "Model Procedures for the Management of Land Contamination." The stages of managing remediation are as follows:

(a) Options Appraisal and develop Remediation Strategy;
(b) Develop Implementation Plan and Verification Plan;
(c) Remediation, Verification and Monitoring.

The Remediation Strategy sets out the remediation targets, identifies technically feasible remedial solutions and presents an evaluation of the options so that these can be assessed enabling that the most suitable solution is

adopted. An outline of the proposed remedial method should be presented. Agreement should be sought of the appropriate statutory bodies for the Remediation Strategy before proceeding to the next stage.

The Implementation Plan is a detailed method statement setting out how the remediation is to be carried out including stating how the site will be managed, welfare procedures, health and safety considerations together with practical measures such as details of temporary works, programme of works, waste management licences and regulatory consents required. Agreement should again be sought of the appropriate statutory bodies for this Plan.

The Verification Plan sets out the requirements for gathering data to demonstrate that the remediation has met the required remediation objectives and criteria. The Verification Plan presents the requirements for a wide range of issues including the level of supervision, sampling and testing regimes for treated materials, waste and imported materials, required monitoring works during and post remediation, how compliance with all licenses and consents will be checked etc. Agreement should again be sought of the appropriate statutory bodies for the Verification Plan. On completion of the remediation a Verification Report should be produced to provide a complete record of all remediation activities on site and the data collected as required in the Verification Plan. The Verification Report should demonstrate that the remediation has met the remedial targets to show that the site is suitable for the proposed use.

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	Megagram per metre cubed
GL	Ground Level	µg/m3	Microgram per metre cubed
GSV	Gas Screening Value	m bgl	Metres Below Ground Level
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	Kilo Pascal – same as kN/m^2
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

Site Photographs

Photograph	1
Description:	Site Area by WS3 looking northeast towards WS4 and TP4
Comments:	Surface area and locations restricted due to stockpile and surface water flooding.

Photograph	2
Description:	Looking northeast in the western side of the stockpile in northwest portion of site
Comments:	Surface area and locations restricted due to stockpile and surface water flooding.

Photograph	3
Description:	Photograph taken from the central area of site, adjacent to salt stockpile area hardstanding, looking northeast,
Comments:	The site area is restricted by surface water flooding.

Photograph	4
Description:	Photograph taken of TP4
Comments:	

Photograph	5
Description:	Photo of TP4 arisings
Comments:	

Photograph	6
Description:	Picture of TP6
Comments:	

Photograph	7
Description:	Picture of TP6 arisings
Comments:	

Photograph	8
Description:	Picture of TP2
Comments:	

Photograph	9
Description:	Picture of TP2 arisings
Comments:	

Photograph	10
Description:	Picture of TP3
Comments:	

Photograph	11
Description:	Picture of TP5
Comments:	

APPENDIX D

Exploratory Hole Records

Dynamic Probe

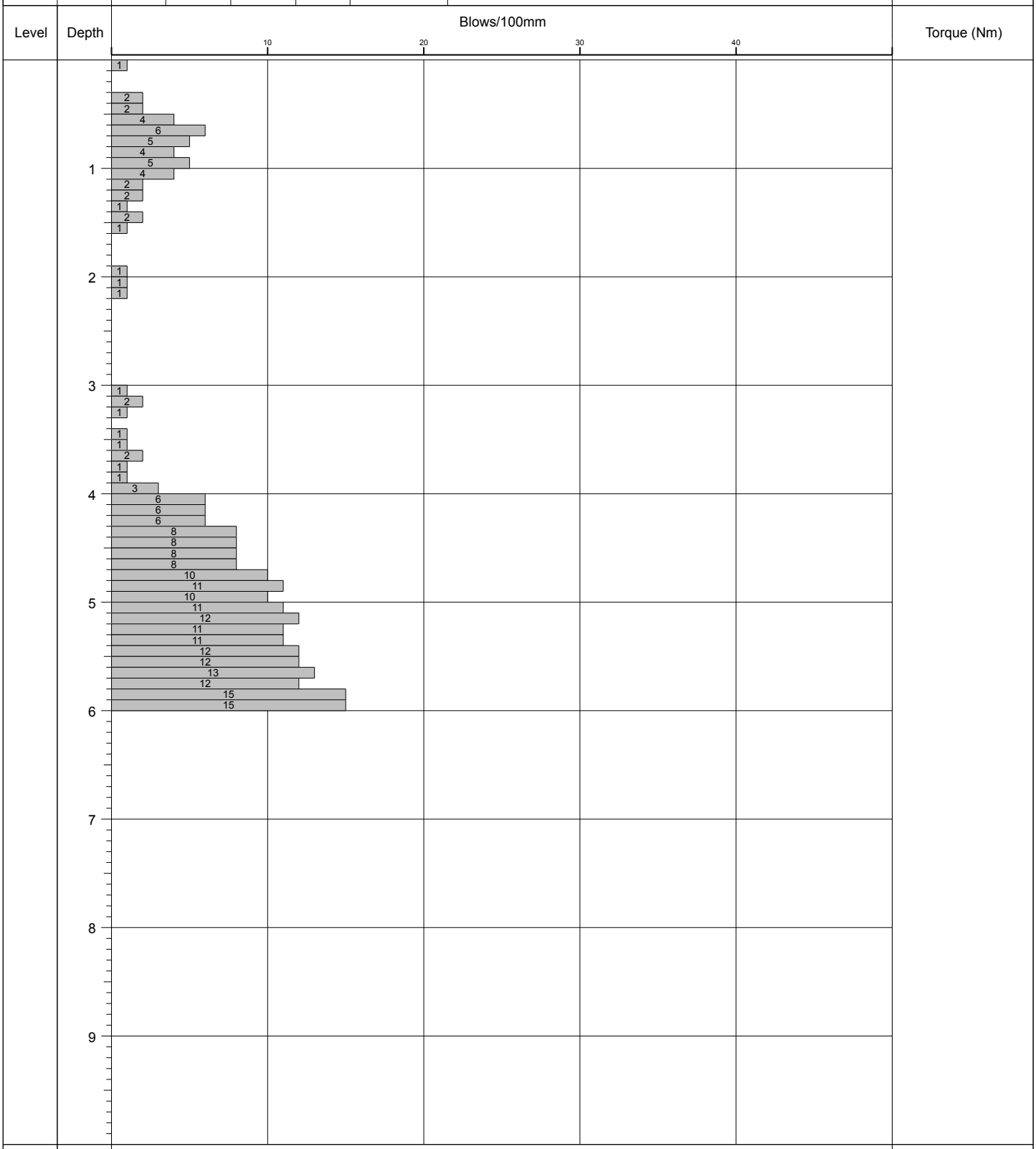
TerraConsult

Dynamic probe formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Remarks:
DP	0.00	6.00	01-12-15	01-12-15	DP Drilling	Archway Dart 331	

Location details:

mE:
mN:
mAOD:
Grid:



Probe type	Hammer mass (kg)	Standard drop (mm)	Diameter cone (mm)	Cone angle	Rod diameter (mm)	Rod mass (kg)	Groundwater	Abort reason
DPSH-B	63.5	760	49		35	8.0		

Weather	Pre drilling	Remarks

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

Log issue: DRAFT
Scale: 1:50

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.
Project No: 2638
Client: Flintshire County Council

Exploratory position reference:

DP1

Sheet 1 of 1

Dynamic Probe

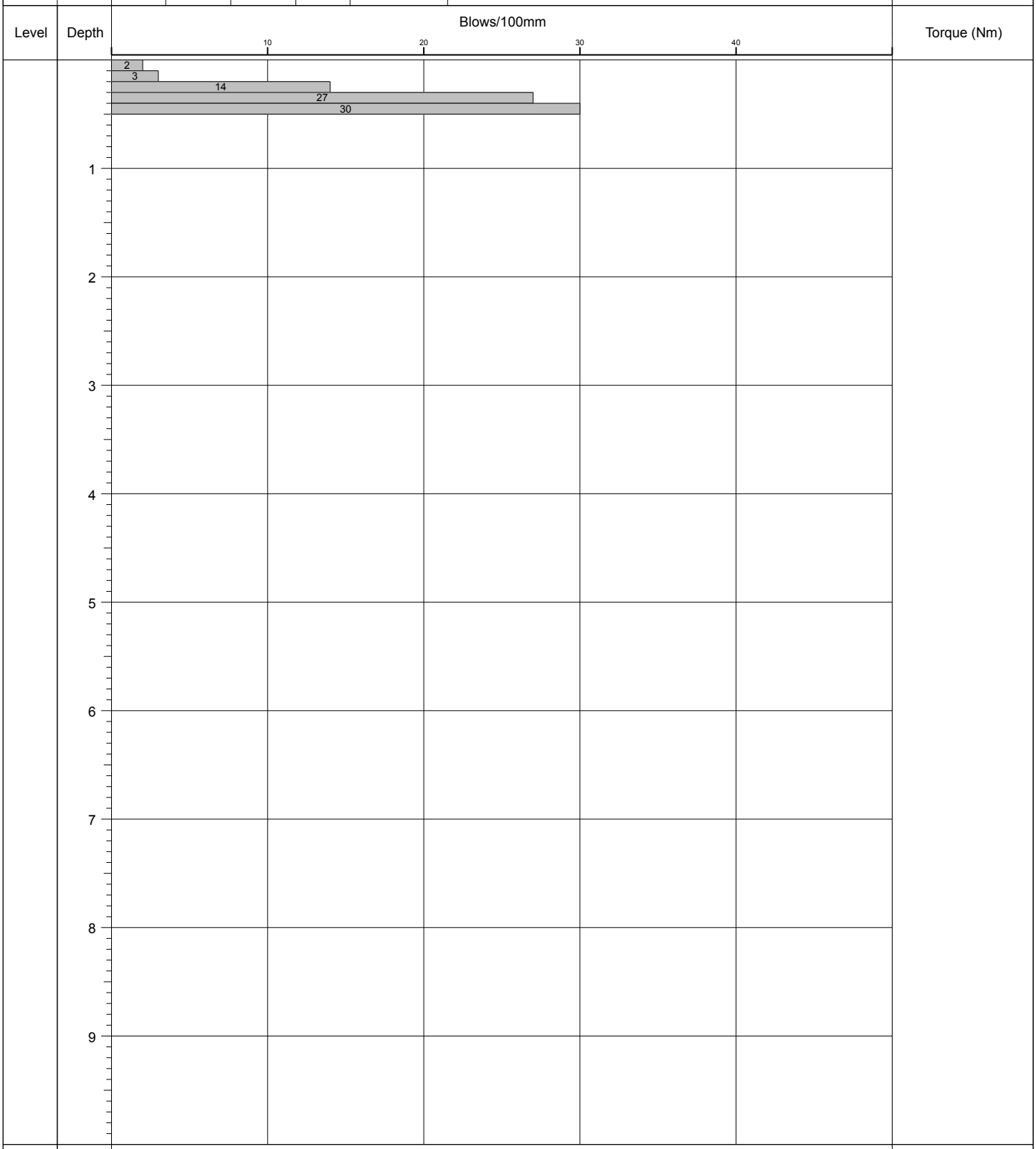
TerraConsult

Dynamic probe formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Remarks:
DP	0.00	0.50	01-12-15	01-12-15	DP Drilling	Archway Dart 331	

Location details:

mE:
mN:
mAOD:
Grid:



Probe type	Hammer mass (kg)	Standard drop (mm)	Diameter cone (mm)	Cone angle	Rod diameter (mm)	Rod mass (kg)	Groundwater	Abort reason
DPSH-B	63.5	760	49		35	8.0		

Weather	Pre drilling	Remarks

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

Log issue: DRAFT
Scale: 1:50

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.
Project No: 2638
Client: Flintshire County Council

Exploratory position reference:

DP10

Sheet 1 of 1

Dynamic Probe

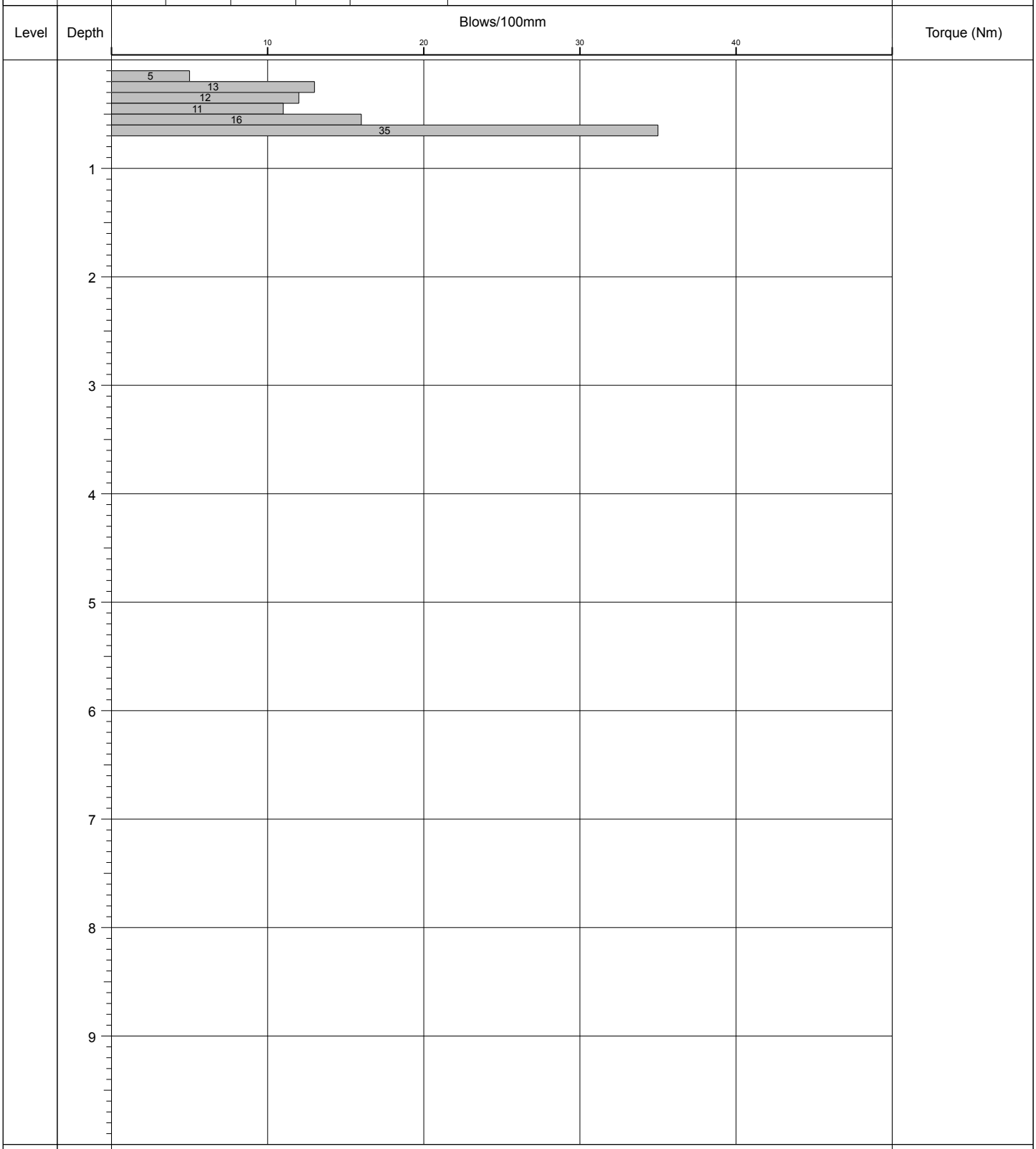
TerraConsult

Dynamic probe formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Remarks:
DP	0.00	0.60	01-12-15	01-12-15	DP Drilling	Archway Dart 331	

Location details:

mE:
mN:
mAOD:
Grid:



Probe type	Hammer mass (kg)	Standard drop (mm)	Diameter cone (mm)	Cone angle	Rod diameter (mm)	Rod mass (kg)	Groundwater	Abort reason
DPSH-B	63.5	760	49		35	8.0		

Weather	Pre drilling	Remarks

AGS

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

Log issue: DRAFT
Scale: 1:50

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.
Project No: 2638
Client: Flintshire County Council

Exploratory position reference:

DP10A

Sheet 1 of 1

Dynamic Probe

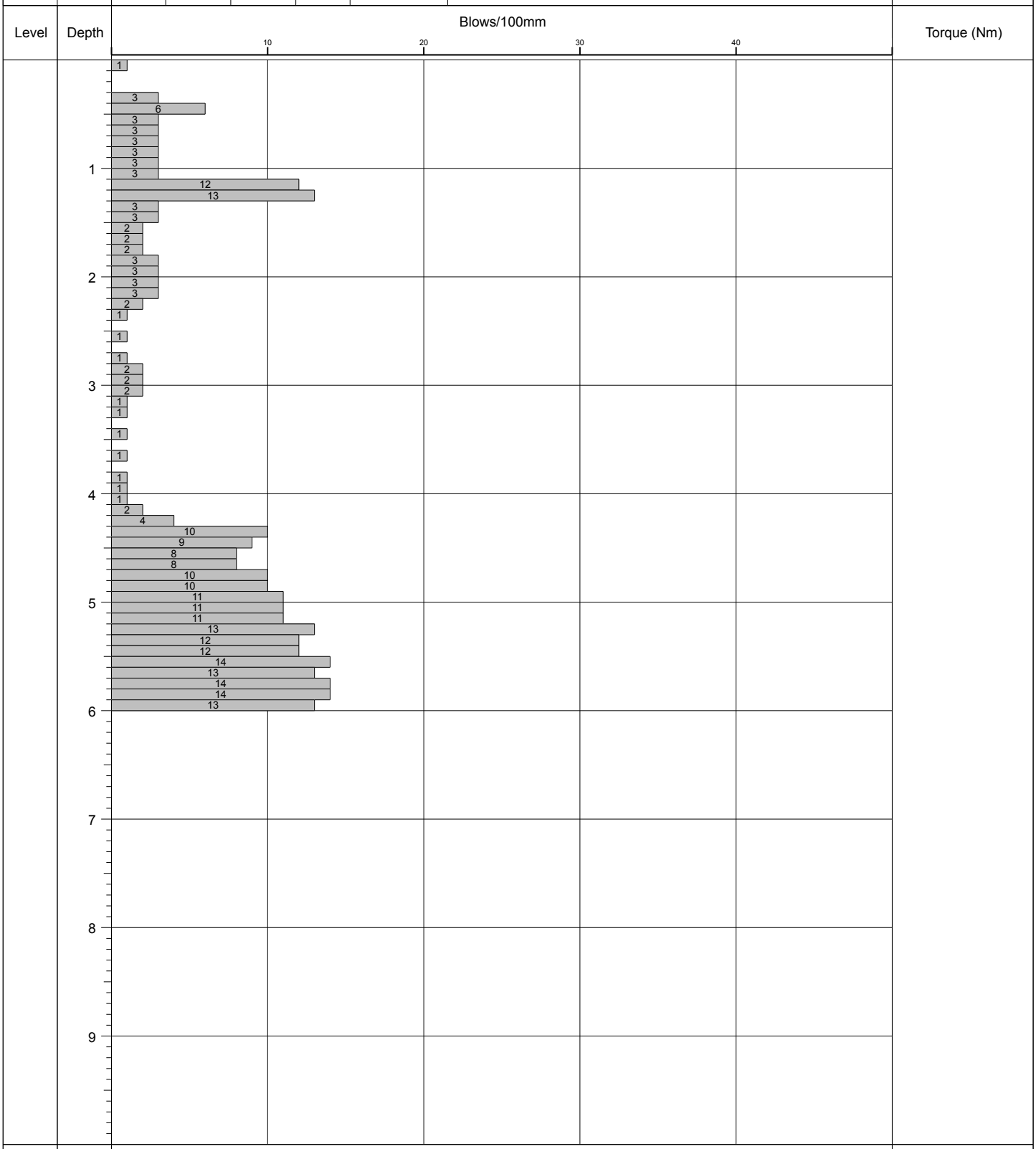
TerraConsult

Dynamic probe formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Remarks:
DP	0.00	0.62	01-12-15	01-12-15	DP Drilling	Archway Dart 331	

Location details:

mE:
mN:
mAOD:
Grid:



Probe type	Hammer mass (kg)	Standard drop (mm)	Diameter cone (mm)	Cone angle	Rod diameter (mm)	Rod mass (kg)	Groundwater	Abort reason
DPSH-B	63.5	760	49		35	8.0		

Weather	Pre drilling	Remarks

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

Log issue: DRAFT
Scale: 1:50

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.
Project No: 2638
Client: Flintshire County Council

Exploratory position reference:

DP11

Sheet 1 of 1

Dynamic Probe

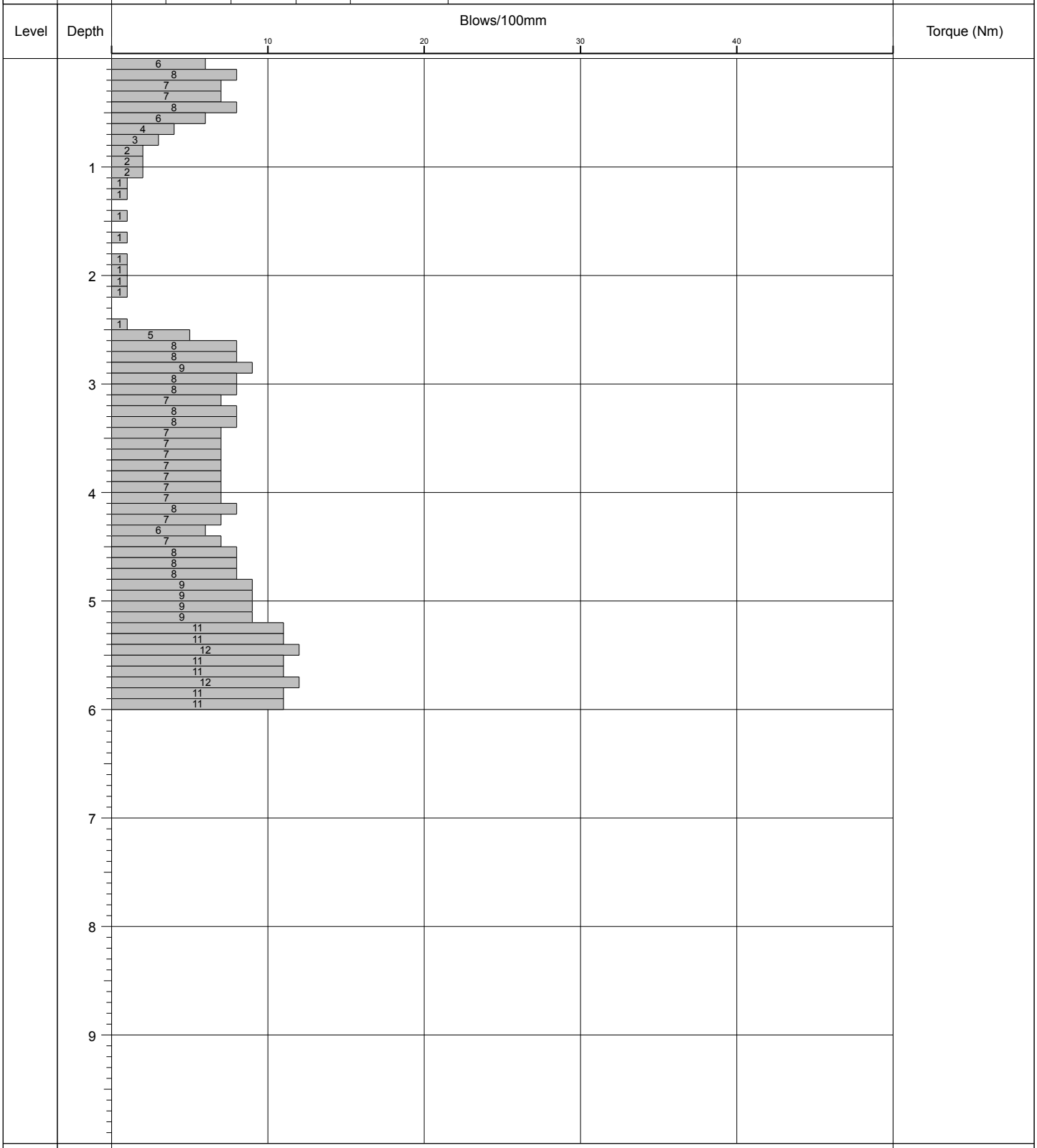
TerraConsult

Dynamic probe formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Remarks:
DP	0.00	6.00	01-12-15	01-12-15	DP Drilling	Archway Dart 331	

Location details:

mE:
mN:
mAOD:
Grid:



Probe type	Hammer mass (kg)	Standard drop (mm)	Diameter cone (mm)	Cone angle	Rod diameter (mm)	Rod mass (kg)	Groundwater	Abort reason
DPSH-B	63.5	760	49		35	8.0		

Weather	Pre drilling	Remarks

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

Log issue: DRAFT
Scale: 1:50

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.
Project No: 2638
Client: Flintshire County Council

Exploratory position reference:

DP2

Sheet 1 of 1

Dynamic Probe

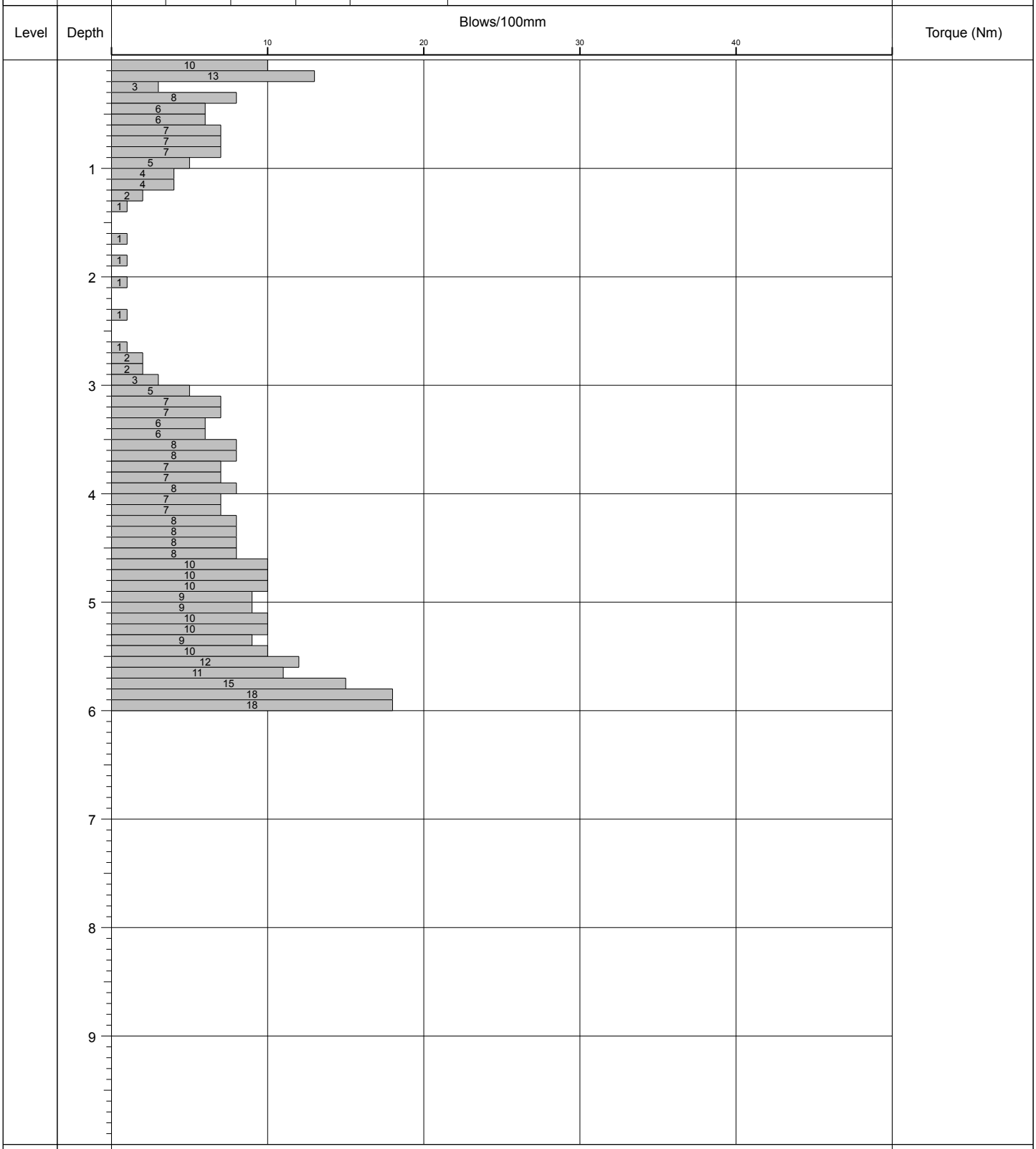
TerraConsult

Dynamic probe formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Remarks:
DP	0.00	6.00	01-12-15	01-12-15	DP Drilling	Archway Dart 331	

Location details:

mE:
mN:
mAOD:
Grid:



Probe type	Hammer mass (kg)	Standard drop (mm)	Diameter cone (mm)	Cone angle	Rod diameter (mm)	Rod mass (kg)	Groundwater	Abort reason
DPSH-B	63.5	760	49		35	8.0		

Weather	Pre drilling	Remarks

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

Log issue: DRAFT
Scale: 1:50

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.
Project No: 2638
Client: Flintshire County Council

Exploratory position reference:

DP3

Sheet 1 of 1

Dynamic Probe

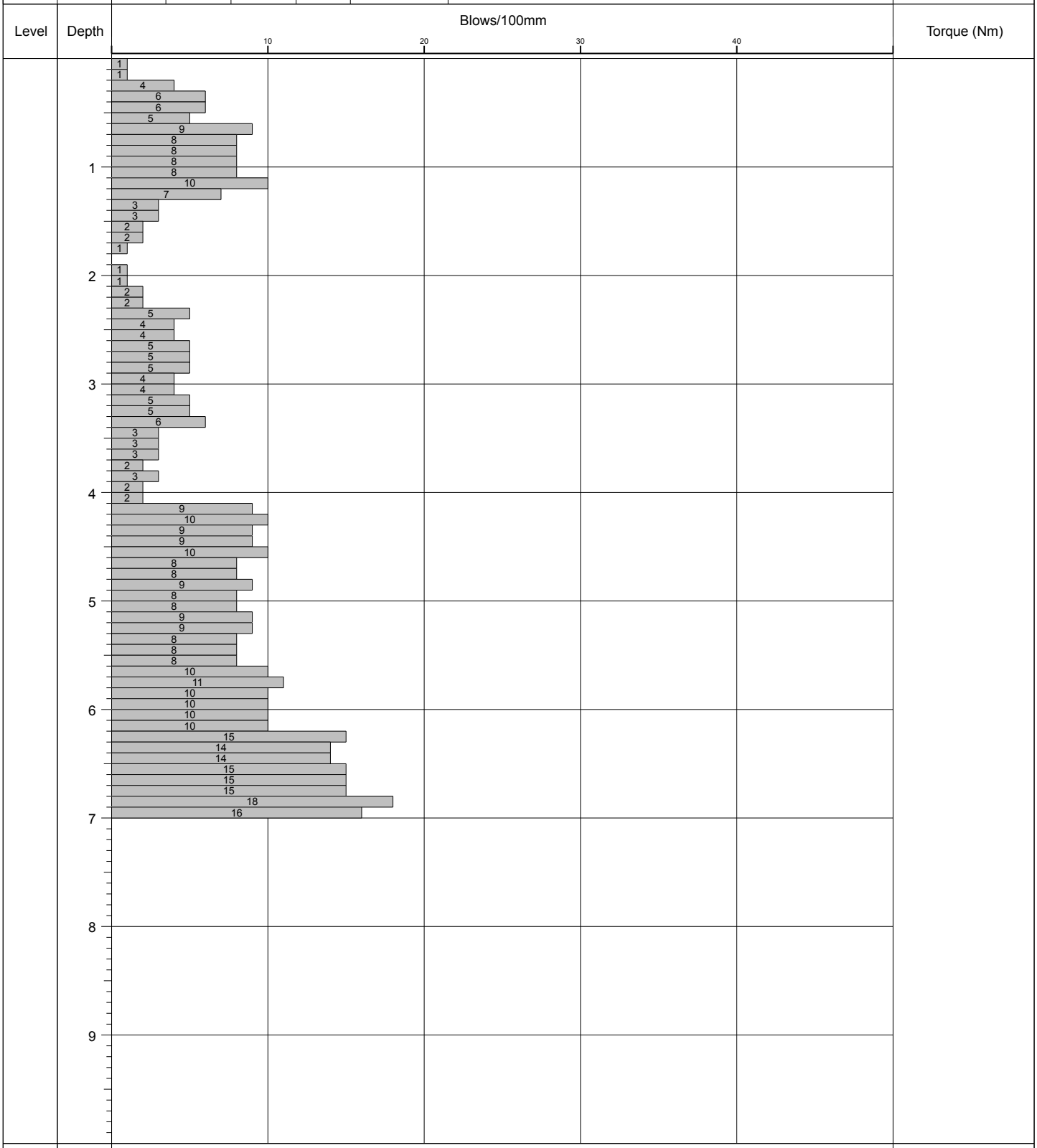
TerraConsult

Dynamic probe formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Remarks:
DP	0.00	7.00	01-12-15	01-12-15	DP Drilling	Archway Dart 331	

Location details:

mE:
mN:
mAOD:
Grid:



Probe type	Hammer mass (kg)	Standard drop (mm)	Diameter cone (mm)	Cone angle	Rod diameter (mm)	Rod mass (kg)	Groundwater	Abort reason
DPSH-B	63.5	760	49		35	8.0		

Weather	Pre drilling	Remarks

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

Log issue: DRAFT
Scale: 1:50

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.
Project No: 2638
Client: Flintshire County Council

Exploratory position reference:

DP4

Sheet 1 of 1

Dynamic Probe

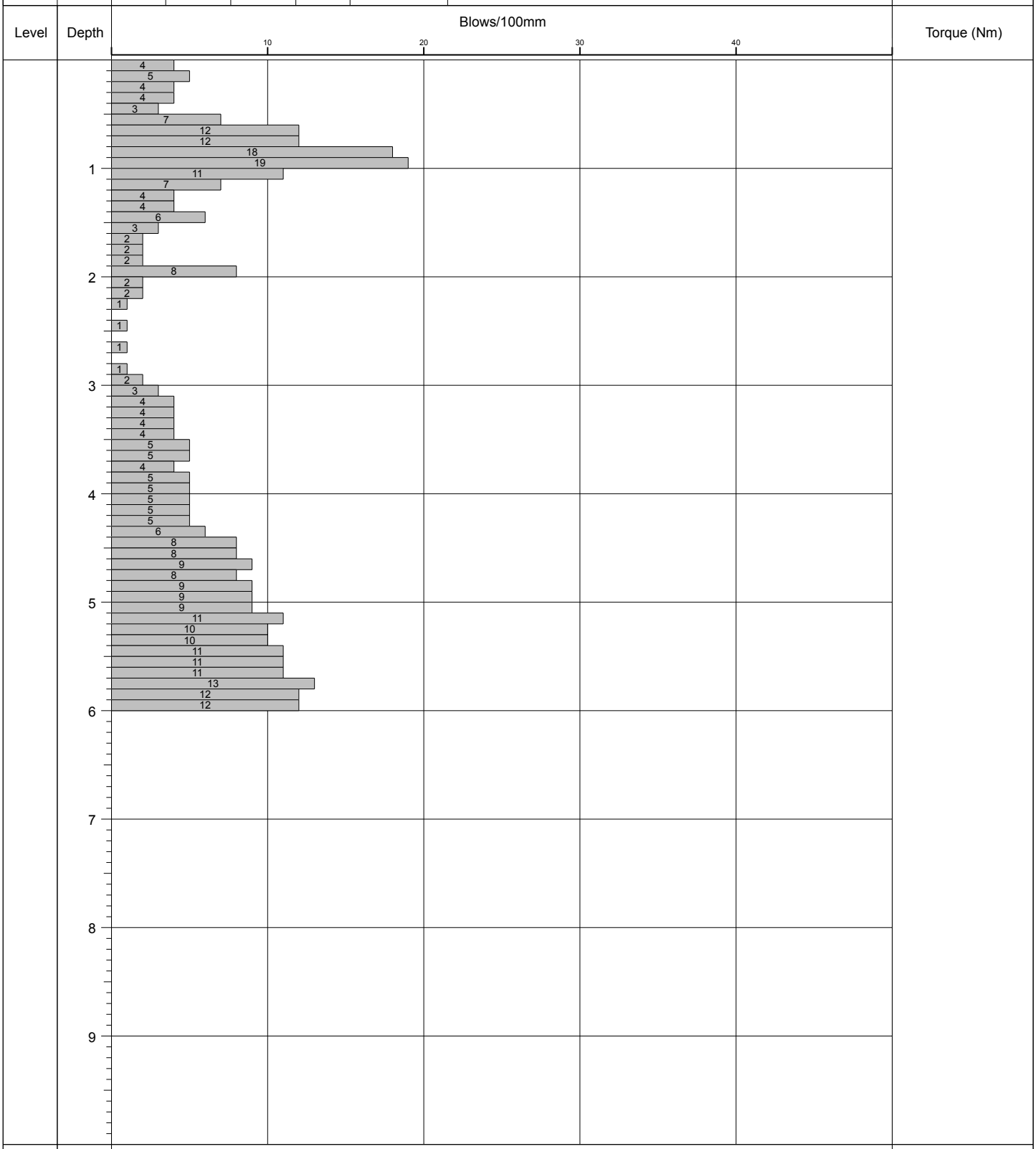
TerraConsult

Dynamic probe formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Remarks:
DP	0.00	6.00	01-12-15	01-12-15	DP Drilling	Archway Dart 331	

Location details:

mE:
mN:
mAOD:
Grid:



Probe type	Hammer mass (kg)	Standard drop (mm)	Diameter cone (mm)	Cone angle	Rod diameter (mm)	Rod mass (kg)	Groundwater	Abort reason
DPSH-B	63.5	760	49		35	8.0		

Weather	Pre drilling	Remarks

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

Log issue: DRAFT
Scale: 1:50

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.
Project No: 2638
Client: Flintshire County Council

Exploratory position reference:

DP5

Sheet 1 of 1

Dynamic Probe

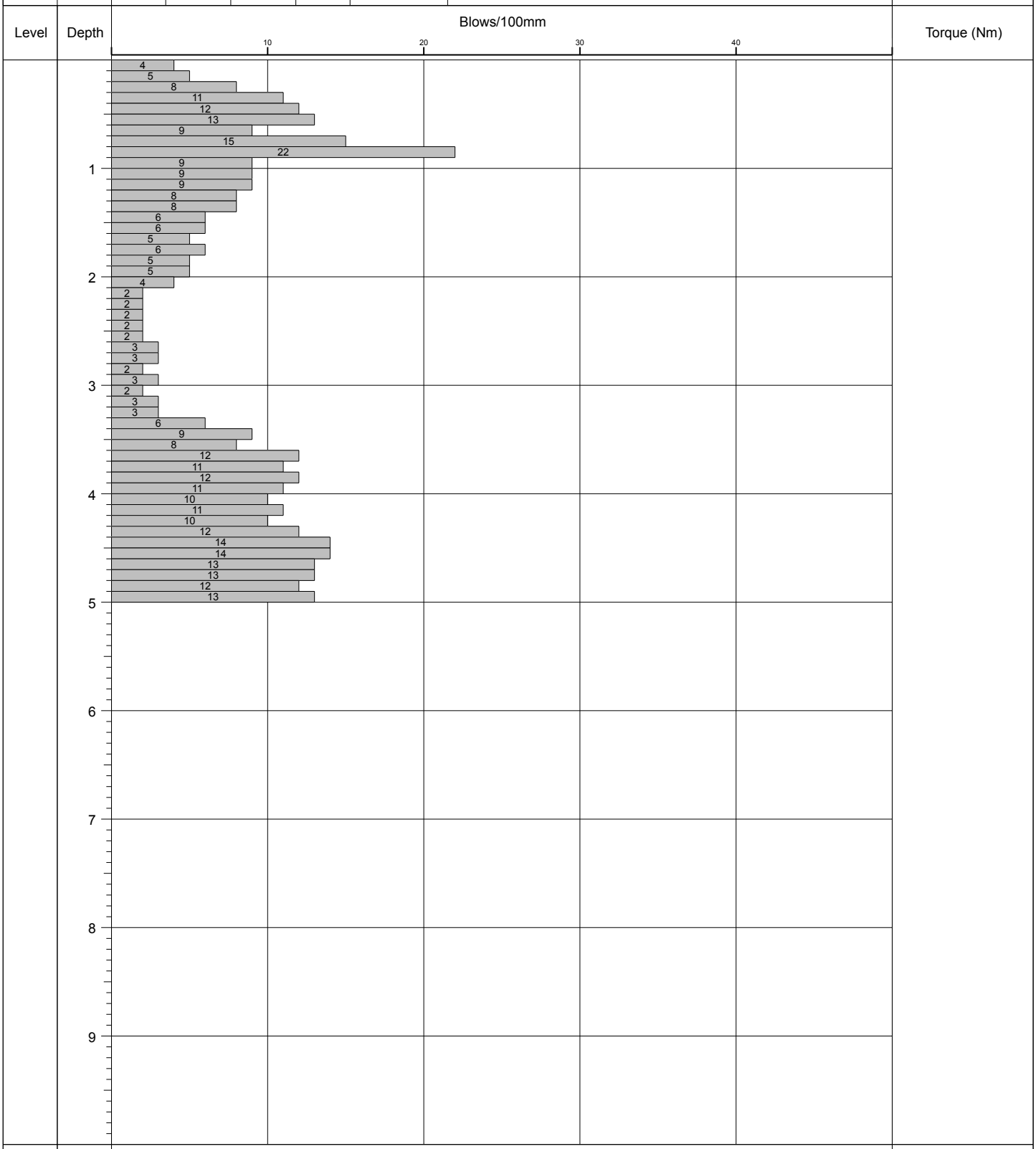
TerraConsult

Dynamic probe formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Remarks:
DP	0.00	5.00	01-12-15	01-12-15	DP Drilling	Archway Dart 331	

Location details:

mE:
mN:
mAOD:
Grid:



Probe type	Hammer mass (kg)	Standard drop (mm)	Diameter cone (mm)	Cone angle	Rod diameter (mm)	Rod mass (kg)	Groundwater	Abort reason
DPSH-B	63.5	760	49		35	8.0		

Weather	Pre drilling	Remarks

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

Log issue: DRAFT
Scale: 1:50

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.
Project No: 2638
Client: Flintshire County Council

Exploratory position reference:

DP7

Sheet 1 of 1

Dynamic Probe

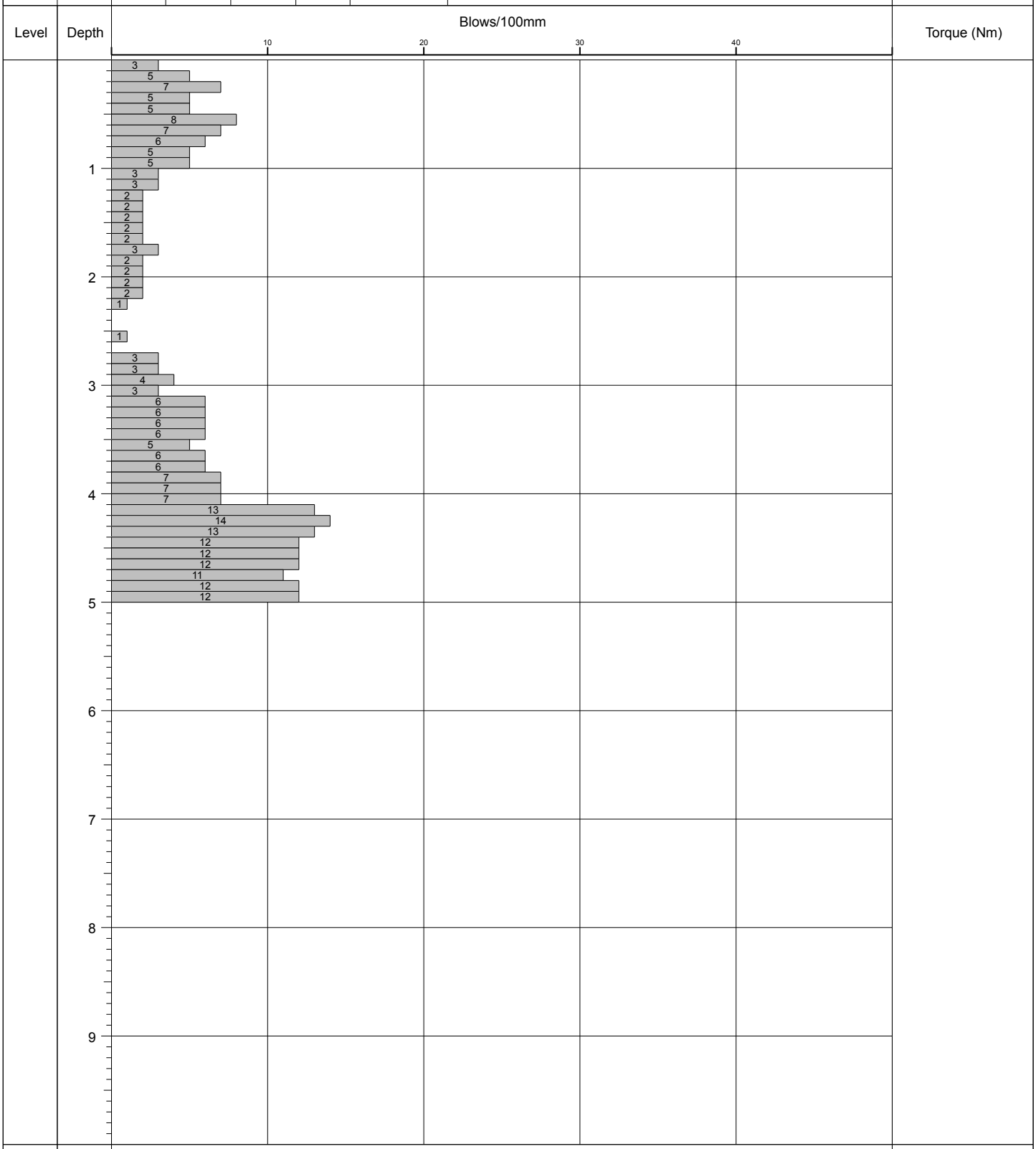
TerraConsult

Dynamic probe formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Remarks:
DP	0.00	5.00	01-12-15	01-12-15	DP Drilling	Archway Dart 331	

Location details:

mE:
mN:
mAOD:
Grid:



Probe type	Hammer mass (kg)	Standard drop (mm)	Diameter cone (mm)	Cone angle	Rod diameter (mm)	Rod mass (kg)	Groundwater	Abort reason
DPSH-B	63.5	760	49		35	8.0		

Weather	Pre drilling	Remarks

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

Log issue: DRAFT
Scale: 1:50

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.
Project No: 2638
Client: Flintshire County Council

Exploratory position reference:

DP8

Sheet 1 of 1

Dynamic Probe

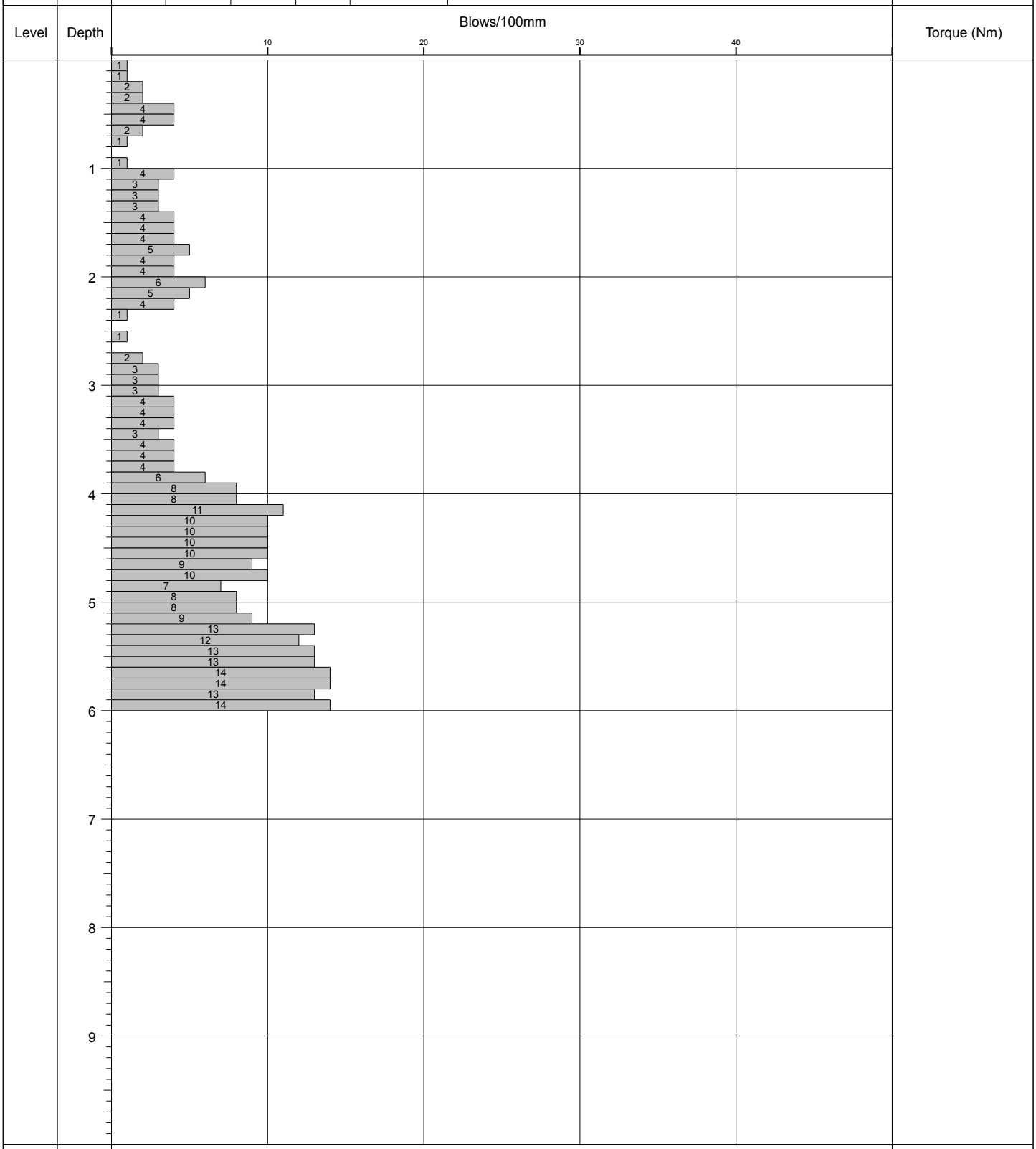
TerraConsult

Dynamic probe formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Remarks:
DP	0.00	6.00	01-12-15	01-12-15	DP Drilling	Archway Dart 331	

Location details:

mE:
mN:
mAOD:
Grid:



Probe type	Hammer mass (kg)	Standard drop (mm)	Diameter cone (mm)	Cone angle	Rod diameter (mm)	Rod mass (kg)	Groundwater	Abort reason
DPSH-B	63.5	760	49		35	8.0		

Weather	Pre drilling	Remarks

AGS

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

Log issue: DRAFT
Scale: 1:50

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.
Project No: 2638
Client: Flintshire County Council

Exploratory position reference:

DP9

Sheet 1 of 1

Dynamic Sample Log

TerraConsult

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Logger:	Logged:	Remarks:
WLS	0.00	4.50	01-12-15	01-12-15	DP Drilling	Archway Dart 331	IOB	01-12-15	

Location details:

mE:
mN:
mAOD:
Grid:

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (thick-ness)	Stratum Description	Samples & In Situ Testing: Water	Casing	Depth	Type & No	Results
				(0.30)	MADE GROUND: Soft dark grey mottled black slightly gravelly CLAY with frequent rootlets. Gravel is angular fine to coarse of clinker, brick and concrete with occasional plastic.					
				0.30	MADE GROUND: Dark grey mottled orange and black clayey gravelly fine to coarse SAND. Gravel is angular fine to coarse of clinker, brick and concrete.			0.50 - 1.00	ES	
				(1.46)						
				1.76	Soft greyish brown slightly sandy SILT with occasional pockets of grey brown silty fine to coarse SAND.			2.00 - 3.00	ES	
				(2.14)						
				3.90	Brownish grey silty fine to medium SAND.			4.00 - 4.50	ES	
				(0.60)						
				4.50	Dynamic sample terminated at 4.50m					

Water	Casing	Depth	Type & No	Results

Groundwater entries:

Struck:	Rose to:	Casing:	Sealed:

Diameter & casing:

From:	to:	Dia:	Casing:
0.00	1.00	85	
1.00	2.00	75	
2.00	3.00	60	
3.00	4.00	60	
4.00	5.00	60	

Depth related remarks:

From	to:	Remarks

Run details:

From:	to:	Duration:	Recovery:
0.00	1.00		85
1.00	2.00		90
2.00	3.00		50
3.00	4.00		90
4.00	5.00		100

AGS

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

Log issue: DRAFT
Scale: 1:50

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.
Project No: 2638
Client: Flintshire County Council

Exploratory position reference:
WS1

Dynamic Sample Log

TerraConsult

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Logger:	Logged:	Remarks:
WLS	0.00	0.50	02-12-15	02-12-15	DP Drilling	Archway Dart 331	IOB	02-12-15	

Location details:

mE:
mN:
mAOD:
Grid:

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (thick-ness)	Stratum Description	Samples & In Situ Testing: Water	Casing	Depth	Type & No	Results
				(0.50)	MADE GROUND: Dark brown slightly clayey sandy angular fine to coarse GRAVEL of Brick, concrete, clinker, limestone, glass.					
				0.50	Dynamic sample terminated at 0.50m					

Water	Casing	Depth	Type & No	Results

Groundwater entries:

Struck:	Rose to:	Casing:	Sealed:

Diameter & casing:

From:	to:	Dia:	Casing:
0.00	0.50	85	

Depth related remarks:

From	to:	Remarks

Run details:

From:	to:	Duration:	Recovery:
0.00	0.50		100

AGS

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

Log issue: DRAFT
Scale: 1:50

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.
Project No: 2638
Client: Flintshire County Council

Exploratory position reference:

WS10

Dynamic Sample Log

TerraConsult

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Logger:	Logged:	Remarks:
WLS	0.00	0.60	02-12-15	02-12-15	DP Drilling	Archway Dart 331	IOB	02-12-15	

Location details:

mE:
mN:
mAOD:
Grid:

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (thick-ness)	Stratum Description	Samples & In Situ Testing: Water	Casing	Depth	Type & No	Results
				(0.60)	MADE GROUND: Dark brown slightly clayey sandy angular fine to coarse GRAVEL of Brick, concrete, clinker, limestone, glass.					
				0.60	Dynamic sample terminated at 0.60m					

Water	Casing	Depth	Type & No	Results

Groundwater entries:

Struck:	Rose to:	Casing:	Sealed:

Diameter & casing:

From:	to:	Dia:	Casing:
0.00	0.50	85	

Depth related remarks:

From	to:	Remarks

Run details:

From:	to:	Duration:	Recovery:
0.00	0.50		100

AGS

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

Log issue: DRAFT
Scale: 1:50

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.
Project No: 2638
Client: Flintshire County Council

Exploratory position reference:

WS10A

Dynamic Sample Log

TerraConsult

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Logger:	Logged:	Remarks:
WLS	0.00	1.00	01-12-15	01-12-15	DP Drilling	Archway Dart 331	IOB	01-12-15	

Location details:

mE:
mN:
mAOD:
Grid:

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (thick-ness)	Stratum Description	Samples & In Situ Testing: Water	Casing	Depth	Type & No	Results
	SP			(1.00)	MADE GROUND: Dark brown slightly clayey sandy angular fine to coarse GRAVEL of brick, concrete, clinker, limestone and glass.					
				1.00	Dynamic sample terminated at 1.00m					

Water	Casing	Depth	Type & No	Results

Groundwater entries:

Struck:	Rose to:	Casing:	Sealed:

Diameter & casing:

From:	to:	Dia:	Casing:
0.00	1.00	85	

Depth related remarks:

From	to:	Remarks

Run details:

From:	to:	Duration:	Recovery:
0.00	1.00		45

AGS

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

Log issue: DRAFT
Scale: 1:50

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.
Project No: 2638
Client: Flintshire County Council

Exploratory position reference:
WS11

Dynamic Sample Log

TerraConsult

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Logger:	Logged:	Remarks:
WLS	0.00	4.80	01-12-15	01-12-15	DP Drilling	Archway Dart 331	IOB	01-12-15	

Location details:

mE:
mN:
mAOD:
Grid:

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (thick-ness)	Stratum Description	Samples & In Situ Testing: Water	Casing	Depth	Type & No	Results
				(0.30)	MADE GROUND: Dark grey mottled black clayey gravelly fine to coarse SAND. Gravel is angular fine to coarse of brick, clinker, concrete, glass and timber.					
				0.30						
				(0.35)	MADE GROUND: Black mottled dark grey gravelly SAND. Gravel is angular fine to coarse of brick, clinker, concrete, glass and timber.					
				0.65						
	SP				Firm dark brown mottled light brown sandy CLAY.					
				(1.45)				1.50 - 2.00	ES	
				2.10						
				(0.50)	Dark brown sandy SILT.					
				2.60						
					Light brown silty fine to medium SAND.					
				(2.20)				4.00 - 4.50	ES	
				4.80						
					Dynamic sample terminated at 4.80m					

Water	Casing	Depth	Type & No	Results

Groundwater entries:

Struck:	Rose to:	Casing:	Sealed:

Diameter & casing:

From:	to:	Dia:	Casing:
0.00	1.00	85	
1.00	2.00	85	
2.00	3.00	75	
3.00	4.00	60	
4.00	4.80	60	

Depth related remarks:

From	to:	Remarks

Run details:

From:	to:	Duration:	Recovery:
0.00	1.00		100
1.00	2.00		70
2.00	3.00		90
3.00	4.00		100
4.00	4.80		100

AGS

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

Log issue: DRAFT
Scale: 1:50

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.
Project No: 2638
Client: Flintshire County Council

Exploratory position reference:

WS2

Dynamic Sample Log

TerraConsult

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Logger:	Logged:	Remarks:
WLS	0.00	5.00	01-12-15	01-12-15	DP Drilling	Archway Dart 331	IOB	01-12-15	

Location details:

mE:
mN:
mAOD:
Grid:

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (thick-ness)	Stratum Description	Samples & In Situ Testing: Water	Casing	Depth	Type & No	Results
				(0.49)	MADE GROUND: Dark grey mottled black clayey gravelly fine to coarse SAND. Gravel is angular fine to coarse of brick, clinker, concrete, glass and timber.					
				0.49	MADE GROUND: Black mottled dark grey gravelly SAND. Gravel is angular fine to coarse of brick, clinker, concrete, glass and timber.			0.50 - 1.00	ES	
	SP			(0.56)						
				1.05	Firm light grey brown silty sandy CLAY.					
				(0.33)						
				1.38	Light yellowish brown sandy SILT with occasional pockets of silty fine to medium SAND.			1.50 - 2.00	ES	
				(1.37)						
				2.75	Light yellowish brown silty fine to medium SAND with occasional pockets of light yellow sandy SILT.					
								3.50 - 4.00	ES	
				(2.25)						
				5.00	Dynamic sample terminated at 5.00m					

Water	Casing	Depth	Type & No	Results

Groundwater entries:

Struck:	Rose to:	Casing:	Sealed:

Diameter & casing:

From:	to:	Dia:	Casing:
0.00	1.00	85	
1.00	2.00	75	
2.00	3.00	60	
3.00	4.00	60	
4.00	5.00	60	

Depth related remarks:

From	to:	Remarks

Run details:

From:	to:	Duration:	Recovery:
0.00	1.00		100
1.00	2.00		100
2.00	3.00		100
3.00	4.00		85
4.00	5.00		100

AGS

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

Log issue: DRAFT
Scale: 1:50

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.
Project No: 2638
Client: Flintshire County Council

Exploratory position reference:

WS3

Dynamic Sample Log

TerraConsult

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Logger:	Logged:	Remarks:
WLS	0.00	4.00	01-12-15	01-12-15	DP Drilling	Archway Dart 331	IOB	01-12-15	

Location details:

mE:
mN:
mAOD:
Grid:

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (thick-ness)	Stratum Description	Samples & In Situ Testing: Water	Casing	Depth	Type & No	Results
				(0.30)	MADE GROUND: Dark brownish grey clayey gravelly fine to coarse SAND. Gravel is angular fine to coarse of concrete, clinker, brick, glass and limestone.					
				0.30	MADE GROUND: Dark grey mottled black very sandy angular fine to coarse GRAVEL of concrete, clinker, brick, limestone and glass.			0.50 - 1.00	ES	
	SP			(1.80)						
				2.10	Light yellowish brown fine to medium SAND.			2.50 - 3.00	ES	
				(1.90)						
				4.00	Dynamic sample terminated at 4.00m					

Stratum continues next page

Water	Casing	Depth	Type & No	Results

Groundwater entries:

Struck:	Rose to:	Casing:	Sealed:

Diameter & casing:

From:	to:	Dia:	Casing:
0.00	0.70	85	
0.00	1.00	85	
1.00	2.00	85	
2.00	3.00	75	
3.00	4.00	60	

Depth related remarks:

From	to:	Remarks

Run details:

From:	to:	Duration:	Recovery:
0.00	0.70		90
0.00	1.00		100
1.00	2.00		20
2.00	3.00		100
3.00	4.00		40

AGS

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

Log issue: DRAFT

Scale: 1:50

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.

Project No: 2638

Client: Flintshire County Council

Exploratory position reference:

WS4

Dynamic Sample Log

TerraConsult

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Logger:	Logged:	Remarks:
WLS	0.00	4.00	01-12-15	01-12-15	DP Drilling	Archway Dart 331	IOB	01-12-15	

Location details:

mE:
mN:
mAOD:
Grid:

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (thick-ness)	Stratum Description	Samples & In Situ Testing: Water	Casing	Depth	Type & No	Results

Groundwater entries:

Struck:	Rose to:	Casing:	Sealed:

Diameter & casing:

From:	to:	Dia:	Casing:
0.00	0.70	85	
0.00	1.00	85	
1.00	2.00	85	
2.00	3.00	75	
3.00	4.00	60	

Depth related remarks:

From	to:	Remarks

Run details:

From:	to:	Duration:	Recovery:
4.00	5.00		0

AGS

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

Log issue: DRAFT
Scale: 1:50

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.
Project No: 2638
Client: Flintshire County Council

Exploratory position reference:

WS4

Dynamic Sample Log

TerraConsult

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Logger:	Logged:	Remarks:
WLS	0.00	0.80	01-12-15	01-12-15	DP Drilling	Archway Dart 331	IOB	01-12-15	

Location details:

mE:
mN:
mAOD:
Grid:

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (thick-ness)	Stratum Description	Samples & In Situ Testing: Water	Casing	Depth	Type & No	Results
				(0.80)	MADE GROUND: Dark grey mottled black subangular fine to coarse GRAVEL of concrete, brick, clinker, tiles, glass and limestone.					
				0.80	Dynamic sample terminated at 0.80m					

Water	Casing	Depth	Type & No	Results

Groundwater entries:

Struck:	Rose to:	Casing:	Sealed:

Diameter & casing:

From:	to:	Dia:	Casing:
0.00	0.80	85	

Depth related remarks:

From	to:	Remarks

Run details:

From:	to:	Duration:	Recovery:
0.00	0.80		100

AGS

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

Log issue: DRAFT

Scale: 1:50

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.

Project No: 2638

Client: Flintshire County Council

Exploratory position reference:

WS5

Dynamic Sample Log

TerraConsult

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Logger:	Logged:	Remarks:
WLS	0.00	0.70	01-12-15	01-12-15	DP Drilling	Archway Dart 331	IOB	01-12-15	

Location details:

mE:
mN:
mAOD:
Grid:

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (thick-ness)	Stratum Description	Samples & In Situ Testing: Water	Casing	Depth	Type & No	Results
				(0.70)	MADE GROUND: Dark grey mottled black subangular fine to coarse GRAVEL of concrete, brick, clinker, tiles, glass and limestone.					
				0.70	Dynamic sample terminated at 0.70m					

Water	Casing	Depth	Type & No	Results

Groundwater entries:

Struck:	Rose to:	Casing:	Sealed:

Diameter & casing:

From:	to:	Dia:	Casing:
0.00	0.70	85	

Depth related remarks:

From	to:	Remarks

Run details:

From:	to:	Duration:	Recovery:
0.00	0.70		90

AGS

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

Log issue: DRAFT
Scale: 1:50

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.
Project No: 2638
Client: Flintshire County Council

Exploratory position reference:

WS5A

Dynamic Sample Log

TerraConsult

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Logger:	Logged:	Remarks:
WLS	0.00	2.00	01-12-15	01-12-15	DP Drilling	Archway Dart 331	IOB	01-12-15	

Location details:

mE:
mN:
mAOD:
Grid:

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (thick-ness)	Stratum Description	Samples & In Situ Testing: Water	Casing	Depth	Type & No	Results
				(0.30)	MADE GROUND: Soft dark brown slightly gravelly CLAY. Gravel is angular fine to coarse of brick, clinker, concrete and limestone.					
				0.30	MADE GROUND: Dark brown mottled light brown sandy angular fine to coarse GRAVEL of brick, concrete, sandstone and limestone.					
				(1.70)						
				2.00	Dynamic sample terminated at 2.00m					

Water	Casing	Depth	Type & No	Results

Groundwater entries:

Struck:	Rose to:	Casing:	Sealed:

Diameter & casing:

From:	to:	Dia:	Casing:
0.00	1.00	85	
1.00	2.00	75	

Depth related remarks:

From	to:	Remarks

Run details:

From:	to:	Duration:	Recovery:
0.00	1.00		60
1.00	2.00		100

AGS

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

Log issue: DRAFT
Scale: 1:50

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.
Project No: 2638
Client: Flintshire County Council

Exploratory position reference:

WS7

Dynamic Sample Log

TerraConsult

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Logger:	Logged:	Remarks:
WLS	0.00	4.50	01-12-15	01-12-15	DP Drilling	Archway Dart 331	IOB	01-12-15	

Location details:

mE:
mN:
mAOD:
Grid:

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (thick-ness)	Stratum Description	Samples & In Situ Testing: Water	Casing	Depth	Type & No	Results
				0.10	MADE GROUND: Dark brown clayey gravelly fine to coarse SAND. Gravel is subangular fine to coarse of brick, concrete, limestone, tiles and clinker.					
				(0.70)	MADE GROUND: Black mottled dark grey medium coarse SAND and angular fine to coarse GRAVEL of clinker, concrete, brick and limestone.			0.40 - 0.80	ES	
				0.80						
				0.95	MADE GROUND: Red very sandy fine to coarse subangular GRAVEL of brick.					
	SP			(1.43)	Light brown mottled dark brown slightly sandy clayey SILT.					
				2.38	Light brown silty fine to medium SAND.					
				(2.12)				3.00 - 4.00	ES	
				4.50	Dynamic sample terminated at 4.50m					

Water	Casing	Depth	Type & No	Results

Groundwater entries:

Struck:	Rose to:	Casing:	Sealed:

Diameter & casing:

From:	to:	Dia:	Casing:
0.00	1.00	85	
1.00	2.00	75	
2.00	3.00	75	
3.00	4.00	60	
4.00	4.50	60	

Depth related remarks:

From	to:	Remarks

Run details:

From:	to:	Duration:	Recovery:
0.00	1.00		100
1.00	2.00		95
2.00	3.00		100
3.00	4.00		100
4.00	4.50		100

AGS

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

Log issue: DRAFT

Scale: 1:50

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.

Project No: 2638

Client: Flintshire County Council

Exploratory position reference:

WS8

Dynamic Sample Log

TerraConsult

Borehole formation details:

Type:	From:	To:	Start date:	End date:	Crew:	Plant:	Logger:	Logged:	Remarks:
WLS	0.00	3.90	01-12-15	01-12-15	DP Drilling	Archway Dart 331	IOB	01-12-15	

Location details:

mE:
mN:
mAOD:
Grid:

Backfill/ Instal'n	Water-strike	Legend	Level	Depth (thick-ness)	Stratum Description	Samples & In Situ Testing: Water	Casing	Depth	Type & No	Results
				(1.10)	MADE GROUND: Light yellowish brown slightly sandy slightly gravelly CLAY. Gravel is fine to coarse angular of brick, concrete and limestone.			0.50 - 1.00	ES	
				1.10						
	SP			(1.90)	Light yellowish brown sandy SILT.			1.50 - 2.00	ES	
				3.00						
				(0.90)	Light yellowish brown silty fine to medium SAND.					
				3.90	Dynamic sample terminated at 3.90m					

Water	Casing	Depth	Type & No	Results

Groundwater entries:

Struck:	Rose to:	Casing:	Sealed:

Diameter & casing:

From:	to:	Dia:	Casing:
0.00	1.00	85	
1.00	2.00	75	
2.00	3.00	60	
3.00	3.90	60	

Depth related remarks:

From	to:	Remarks

Run details:

From:	to:	Duration:	Recovery:
0.00	1.00		55
1.00	2.00		100
2.00	3.00		40
3.00	3.90		30

AGS

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

Log issue: DRAFT

Scale: 1:50

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.

Project No: 2638

Client: Flintshire County Council

Exploratory position reference:

WS9

Trial Pit Log

TerraConsult

Personnel:		Equipment & methods:		Dimensions:		Coordinates & level:		Dates:	
Logged by:	IOB	Method:		Width:	0.60	mE:		Start:	01/12/2015
Checked by:	LM			Length:	2.40	mN:		End:	01/12/2015
		Plant:	JCB 3CX	**Orientation:**		mAOD:		Logged:	01/12/2015
		Shoring:	N/A	Bearing =		Grid:			

Backfill/ Instal'n	Water-strike	Legend	Level & Depth (Thickness)	Stratum Description	Samples & In Situ Testing		
					Depth	Type & No	Results
			(0.70)	MADE GROUND: Dark grey slightly clayey sandy angular to subrounded fine to coarse GRAVEL of concrete, limestone, clinker and brick with occasional rootlets and pottery fragments.	0.20	ES	
			0.70	MADE GROUND: Light grey clayey sandy angular to subangular fine to coarse GRAVEL of sandstone and limestone with a low cobble content of limestone.	0.80	ES	
			0.90	MADE GROUND: Light grey sandy angular to subangular predominantly medium to coarse GRAVEL of sandstone and limestone.			
			(0.40)		1.10	B	
					1.10	ES	
			1.30	Stiff light reddish brown mottled grey sandy SILT.			
					1.70	ES	
			(1.30)	*Becomes greyish brown and clayey*			
			2.60	Trial pit terminated at 2.60m			
					Depth	Type & No	Results

Groundwater entries:			Depth related remarks:			General remarks:	
Depth:	Rose to:	Remarks:	From	to:	Remarks:	Weather:	
0.80	0.00					Stability:	Stable
						Remarks:	
						Termination:	

Notes: For explanation of symbols and abbreviations see Key Sheet. All depths and reduced levels are in meters.	Project:	Waste Handling Depot, Greenfields Business Park, Flintshire.	Exploratory position reference:
Log issue: DRAFT	Project No:	2638	**TP1**
Scale: 1:25	Client:	Flintshire County Council	Sheet 1 of 1

Trial Pit Log

TerraConsult

Personnel:		Equipment & methods:		Dimensions:		Coordinates & level:		Dates:	
Logged by:	IOB	Method:		Width:	0.60	mE:		Start:	01/12/2015
Checked by:	LM			Length:	2.20	mN:		End:	01/12/2015
		Plant:	JCB 3CX	**Orientation:**		mAOD:		Logged:	01/12/2015
		Shoring:	N/A	Bearing =		Grid:			

Backfill/ Instal'n	Water-strike	Legend	Level & Depth (Thickness)	Stratum Description	Samples & In Situ Testing		
					Depth	Type & No	Results
			0.20	MADE GROUND: Dark grey slightly clayey sandy angular to subrounded fine to coarse GRAVEL of concrete, limestone, clinker and brick with occassional rootlets and pottery fragments.			
			0.25	MADE GROUND: Dark grey mottled black sandy GRAVEL. Gravel is angular to subrounded fine to coarse of concrete, clinker and limestone.	0.30	ES	
			0.40	MADE GROUND: Light yellowish brown sandy fine to medium angular to subangular GRAVEL of limestone, concrete and brick.	0.50	ES	
			(0.30)	MADE GROUND: Greyish brown mottled black sandy angular to subrounded fine to coarse GRAVEL of clinker, brick and limestone.			
			0.70	MADE GROUND: Dark grey mottled black sandy angular to subrounded fine to coarse GRAVEL of sandstone with a low cobble content of brick.	0.80	ES	
			(0.40)				
				Boulder encountered (approx: 32cm x 39cm x 63cm)			
			1.10	Trial pit terminated at 1.10m			
					Depth	Type & No	Results

Groundwater entries:			Depth related remarks:			General remarks:
Depth:	Rose to:	Remarks:	From	to:	Remarks:	Weather:
0.80	0.00					Stability: Stable
						Remarks:
						Termination:

Notes: For explanation of symbols and abbreviations see Key Sheet. All depths and reduced levels are in meters.	Project: Waste Handling Depot, Greenfields Business Park, Flintshire.	Exploratory position reference:
Log issue: DRAFT	Project No: 2638	**TP2**
Scale: 1:25	Client: Flintshire County Council	Sheet 1 of 1

Trial Pit Log

TerraConsult

Personnel:		Equipment & methods:		Dimensions:		Coordinates & level:		Dates:	
Logged by:	IOB	Method:		Width:	0.52	mE:		Start:	01/12/2015
Checked by:	LM			Length:	1.20	mN:		End:	01/12/2015
		Plant:	JCB 3CX	**Orientation:**		mAOD:		Logged:	01/12/2015
		Shoring:	N/A	Bearing =		Grid:			

Backfill/ Instal'n	Water-strike	Legend	Level & Depth (Thickness)	Stratum Description	Samples & In Situ Testing		
					Depth	Type & No	Results
			0.10	MADE GROUND: Asphalt.			
			(0.40)	MADE GROUND: Brownish grey sandy angular to subrounded fine to coarse GRAVEL of limestone with a medium cobble content of limestone.	0.30 0.30	B ES	
			0.50	MADE GROUND: Dark grey mottled black sandy angular to subrounded fine to coarse GRAVEL of clinker, concrete and brick with a low to medium cobble content of limestone and concrete.			
			0.70	MADE GROUND: Light grey sandy angular to subrounded fine to coarse GRAVEL of concrete and limestone with a mediumcobble content and high boulder content of concrete and limestone.	0.70 0.70	B ES	
			(0.50)				
			1.20	Soft dark grey slightly sandy silty CLAY.	1.30 1.30	B ES	
			1.40	Trial pit terminated at 1.40m			

			Depth	Type & No	Results
			Depth	Type & No	Results

Groundwater entries:			Depth related remarks:			General remarks:	
Depth:	Rose to:	Remarks:	From	to:	Remarks:	Weather:	
0.80	0.00					Stability:	Stable
						Remarks:	
						Termination:	

Notes: For explanation of symbols and abbreviations see Key Sheet. All depths and reduced levels are in meters.	Project:	Waste Handling Depot, Greenfields Business Park, Flintshire.	Exploratory position reference:
Log issue: DRAFT	Project No:	2638	**TP3**
Scale: 1:25	Client:	Flintshire County Council	Sheet 1 of 1

Trial Pit Log

TerraConsult

Personnel:		Equipment & methods:		Dimensions:		Coordinates & level:		Dates:	
Logged by:	IOB	Method:		Width:	0.55	mE:		Start:	01/12/2015
Checked by:	LM			Length:	2.15	mN:		End:	01/12/2015
		Plant:	JCB 3CX	**Orientation:**		mAOD:		Logged:	01/12/2015
		Shoring:	N/A	Bearing =		Grid:			

Backfill/ Instal'n	Water-strike	Legend	Level & Depth (Thickness)	Stratum Description	Samples & In Situ Testing		
					Depth	Type & No	Results
			0.05	MADE GROUND: Soft dark brown slightly sandy gravelly CLAY with occasional rootlets. Gravel is angular to subrounded fine to coarse concrete, limestone, clinker and brick.			
			(0.30)				
			0.35	MADE GROUND: Light grey clayey sandy angular to subangular fine to coarse GRAVEL of brick, concrete, limestone, asphalt and pottery.			
			(0.35)	MADE GROUND: Brownish grey fine to coarse SAND and angular to subrounded fine to coarse GRAVEL of concrete, brick, asphalt and limestone with a low cobble content of brick and concrete.	0.50	ES	
			0.70				
			(1.00)	MADE GROUND: Light grey clayey sandy angular to subangular fine to coarse GRAVEL of brick, concrete, limestone, asphalt and pottery with occasional plastic bottles, wire and timber.	0.80 0.80	B ES	
			1.70	Stiff light grey slightly clayey slightly sandy SILT.	1.60 1.60	B ES	
			1.90	Trial pit terminated at 1.90m	1.90 1.90	B ES	

Depth	Type & No	Results

Groundwater entries:

Depth:	Rose to:	Remarks:
1.60	0.00	

Depth related remarks:

From to: Remarks:

General remarks:

Weather:

Stability: Stable

Remarks:

Termination:

AGS

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

Log issue: DRAFT

Scale: 1:25

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.

Project No: 2638

Client: Flintshire County Council

Exploratory position reference:

TP4

Trial Pit Log

TerraConsult

Personnel:		Equipment & methods:		Dimensions:		Coordinates & level:		Dates:	
Logged by:	IOB	Method:		Width:	0.60	mE:		Start:	01/12/2015
Checked by:	LM			Length:	2.20	mN:		End:	01/12/2015
		Plant:	JCB 3CX	**Orientation:**		mAOD:		Logged:	01/12/2015
		Shoring:	N/A	Bearing =		Grid:			

Backfill/ Instal'n	Water-strike	Legend	Level & Depth (Thickness)	Stratum Description	Samples & In Situ Testing		
					Depth	Type & No	Results
			(0.30)	MADE GROUND: Dark grey mottled black sandy GRAVEL with a low cobble content. Gravel is angular to subrounded fine to coarse concrete, limestone, clinker, brick and ash. Cobbles are subrounded of clinker.			
			0.30				
			(1.30)	MADE GROUND: Stiff dark greyish brown slightly sandy gravelly CLAY. Gravel is angular to subrounded fine to coarse of concrete, limestone, clinker and brick.	0.40	ES	
			1.60				
			(1.00)	Stiff light grey slightly clayey slightly sandy SILT.	1.70	ES	
			2.60		2.50	ES	
				Trial pit terminated at 2.60m			
					Depth	Type & No	Results

Groundwater entries:
Depth: Rose to: Remarks:

Depth related remarks:
From to: Remarks:

General remarks:
Weather:
Stability: Stable
Remarks:

Termination:

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

Log issue: DRAFT
Scale: 1:25

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.
Project No: 2638
Client: Flintshire County Council

Exploratory position reference:
TP5

Trial Pit Log

TerraConsult

Personnel:		Equipment & methods:		Dimensions:		Coordinates & level:		Dates:	
Logged by:	IOB	Method:		Width:	0.58	mE:		Start:	01/12/2015
Checked by:	LM			Length:	2.10	mN:		End:	01/12/2015
		Plant:	JCB 3CX	**Orientation:**		mAOD:		Logged:	01/12/2015
		Shoring:	N/A	Bearing =		Grid:			

Backfill/ Instal'n	Water-strike	Legend	Level & Depth (Thickness)	Stratum Description	Samples & In Situ Testing		
					Depth	Type & No	Results
			0.05	MADE GROUND: Soft dark grey slightly sandy gravelly CLAY with occasional rootlets. Gravel is angular to subrounded fine to coarse of concrete, limestone, clinker and brick with occasional pottery.			
			(0.40)	MADE GROUND: Light grey clayey sandy angular to subangular fine to coarse GRAVEL of brick, concrete, limestone, asphalt and occasional glass bottles and timber.			
			0.45	MADE GROUND: Dark greyish brown sandy slightly gravelly CLAY with frequent rootlets and occasional glass bottles. Gravel is angular medium to coarse of concrete, pottery, asphalt and sandstone.	0.50	ES	
			(0.95)				
				Slight organic odour.	1.30 1.30	B ES	
			1.40	Soft light grey slightly clayey slightly sandy SILT.			
					1.60 1.60	B ES	
			(0.90)				
			2.30	Light yellowish brown silty fine SAND with occasional roots.			
					2.40 2.40	B ES	
			(0.80)				
			3.10	Trial pit terminated at 3.10m			

Depth	Type & No	Results

Groundwater entries:			Depth related remarks:			General remarks:	
Depth:	Rose to:	Remarks:	From	to:	Remarks:	Weather:	
						Stability:	Stable
						Remarks:	
						Termination:	

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

Log issue: DRAFT
Scale: 1:25

Project: Waste Handling Depot, Greenfields Business Park, Flintshire.
Project No: 2638
Client: Flintshire County Council

Exploratory position reference:

TP6

Sheet 1 of 1

SPT Hammer Calibration Certificate

SPT Hammer Energy Test Report

in accordance with BSEN ISO 22476-3:2005

ARCHWAY ENGINEERING (UK) LTD
AINLEYS INDUSTRIAL ESTATE
ELLAND
WEST YORKSHIRE
HX5 9JP

SPT Hammer Ref:	AR812
Test Date:	10/02/2015
Report Date:	2/10/2015
File Name:	AR812.spt
Test Operator:	SH

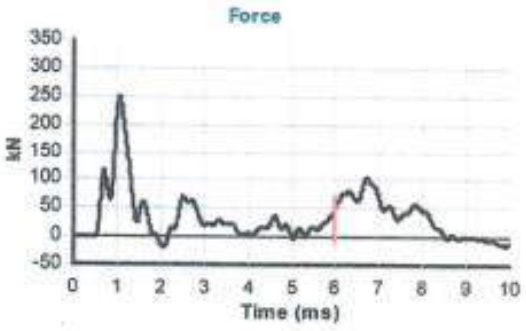
Instrumented Rod Data

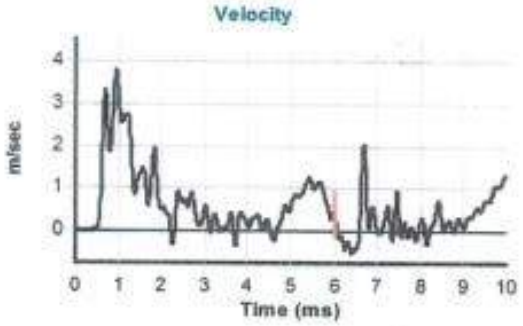
Diameter d_r (mm):	54
Wall Thickness t_r (mm):	6.1
Assumed Modulus E_a (GPa):	200
Accelerometer No.1:	7079
Accelerometer No.2:	7080

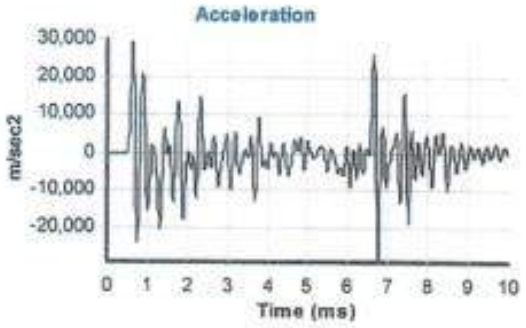
SPT Hammer Information

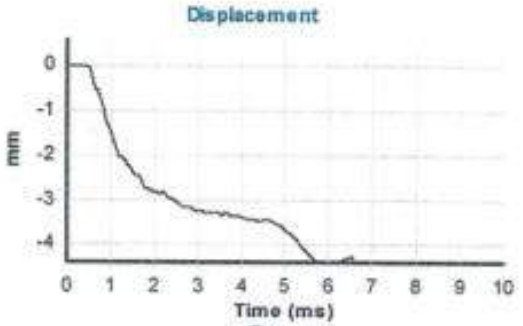
Hammer Mass m (kg):	63.5
Falling Height h (mm):	760
SPT String Length L (m):	13.0

Comments / Location
CALIBRATION









Calculations

Area of Rod A (mm2):	918
Theoretical Energy E_{theor} (J):	473
Measured Energy E_{meas} (J):	336

Energy Ratio E_r (%): **71**

Signed: S. HOWARTH
Title: FITTER

The recommended calibration interval is 12 months

Key To Exploratory Hole Records

SAMPLES

Undisturbed

U	Driven tube sample
TW	Pushed thin wall tube sample } nominally 100 mm diameter and full recovery unless otherwise stated
P	Pushed piston sample
L	Liner sample (from windowless or similar sampler), full recovery unless otherwise stated
CBR	CBR mould sample
BLK	Block sample
CS	Core sample (from rotary core) taken for laboratory testing
AMAL	Amalgamated sample

Disturbed

D	Small sample
B	Bulk sample

Other

W	Water sample
G	Gas sample
	Environmental chemistry samples (in more than one container where appropriate)
ES	Soil sample
EW	Water sample

Comments Sample reference numbers are assigned to every sample taken. A sample reference of 'NR' indicates that attempt was made to take a tube sample; however, there was no recovery.

Monitoring samples taken after completion of hole construction are not shown on the exploratory hole logs.

TESTS

SPT S or SPT C Standard Penetration Test, open shoe (S) or solid cone (C)

The Standard Penetration Test is defined in BS EN ISO 22476-3 (2005). The incremental blow counts are given in the Field Records column; each increment is 75 mm unless stated otherwise and any penetration under self-weight in mm (SW) is noted. Where the full 300 mm test drive is achieved the total number of blows for the test drive is presented as N = ** in the Test column. Where the test drive blows reach 50 (either in total or for a single increment) the total blow count beyond the seating drive is given (without the N = prefix).

IV	*in situ* Vane shear strength, peak (p) and remoulded (r), kPa
HV	Hand vane shear strength, peak (p) and remoulded (r), kPa
PP	Pocket penetrometer test, converted to shear strength, kPa
KFH, KRH, KPI	Variable head permeability tests (KFH = falling head test, KRH = rising head test, KPI = packer test), permeability value
	Test results provided in Field Records column

DRILLING RECORDS

The mechanical indices (TCR/SCR/RQD & If) are defined in BS 5930 (1999) and BS EN ISO 22575-1 (2006)

TCR	Total Core Recovery, %
SCR	Solid Core Recovery, %
RQD	Rock Quality Designation, %
If	Fracture spacing, mm. Minimum, typical and maximum spacings are presented.
NI	Non-intact is used where the core is fragmented.

Flush returns, estimated percentage with colour where relevant, are given in the Records column

CRF	Core recovered (length in m) in the following run
AZCL	Assessed zone of core loss
NR	Not recovered

GROUNDWATER

▼	Groundwater strike
▽	Groundwater level after standing period

INSTALLATION

Standpipe/ piezometer

Details of standpipe/piezometer installations are given on the Record. Legend column shows installed instrument depths including slotted pipe section or tip depth, response zone filter material type and layers of backfill.

The type of instrument installed is indicated by a code in the Legend column at the depth of the response zone:

SP	Standpipe
SPIE	Standpipe piezometer
PPIE	Pneumatic piezometer
EPIE	Electronic piezometer

Inclinometer or Slip Indicator

The installation of vertical profiling instruments is indicated on the Record. The base of tubing is shown in the Legend column.

The type of instrument installed is indicated by a code in the Legend column at the base of the tubing:

ICE	Biaxial inclinometer
ICM	Inclinometer tubing for use with probe
SLIP	Slip indicator

Settlement Points or Pressure Cells

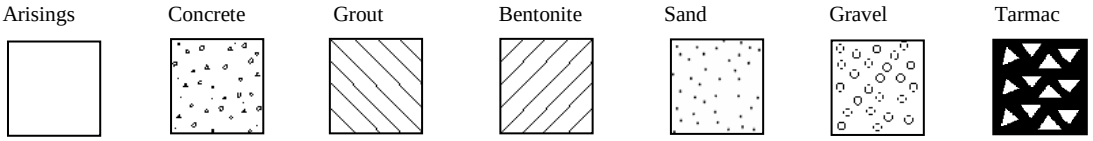
The installation of single point instruments is indicated on the Record. The location of the measuring device is shown in the Legend column.

The type of instrument installed is indicated by a code in the Legend column:

ESET	Electronic settlement cell/gauge
ETM	Magnetic extensometer settlement point
EPCE	Electronic embedment pressure cell
PPCE	Electronic push in pressure cell

INSTALLATION LEGENDS

A legend describing the installation is shown in the rightmost column. Legends additional to BS5930 are used to describe the backfill materials as indicated below.



NOTES

1. Soils and rocks are described in accordance with BS 5930:2015.

2. Strata legends are in accordance with BS 5930:1999.

3. Water level observations of discernible entries during the advancing of the exploratory hole are given at the foot of the log and in the Legend column. The term "none observed" is used where no discrete entries are identified although this does not necessarily indicate that the hole has not been advanced below groundwater level. Under certain conditions groundwater cannot be observed, for instance, drilling with water flush or overwater, or boring at a rate much faster than water can make its way into the borehole (ref BS5930:2015, Clause 47.2.7). In addition, where appropriate, water levels in the hole at the time of recovering individual samples or carrying out in situ tests and at shift changes are given in the Records column.

4. Evidence of the occurrence of very coarse particles (cobbles and boulders) is presented on the logs, however, because of their size in relation to the exploratory hole these records may not be fully representative of their size and frequency in the ground mass.

5. The borehole logs present the results of Standard Penetration Tests recorded in the field without correction or interpretation. However, in certain ground conditions (e.g. high hydraulic head or where very coarse particles are present) some judgement may be necessary in considering whether the results are representative of in situ mass conditions.

6. The declination of bedding and joints is given with respect to the normal to the core axis. Thus in a vertical borehole this will be the dip.

7. The assessment of SCR, RQD and Fracture Spacing excludes artificial (non in situ) fractures.

8. Where “tarmac” is referred to in descriptions, this refers to bound bituminous paving materials which could be blacktop, asphalt, mastic asphalt, tarmac or other type of materials. The word “tarmac” is not intended to covey that tar has been used in the material.

APPENDIX E

Gas and Groundwater Monitoring

No: 2638

GROUNDWATER AND GROUND GAS MONITORING

TerraConsult

Site: Greenfields Waste, Flintshire

Location	Date	Monitored by	Well Details		Groundwater				Gas												Weather	
			Standpipe diameter (mm)	Depth to Base (m bgl)	Water Depth (m bgl)	Groundwater Level (mOD)	Purged (Y/N)	Water Sample Taken?	Atmospheric Pressure (mbar)	Atmospheric Pressure Comment	Relative Pressure	Steady Flow (l/h)	Peak Flow (l/h)	CH_4 (% v/v)	GSV CH_4 (l/hr)	CO_2 (% v/v)	GSV CO_2 (l/hr)	O_2 (% v/v)	CO (ppm)	H_2S (ppm)	VOC (ppm)	Conditions	Ambient Temp °C
WS2	10/12/15	AC	50	4.10	3.41	1.85	N	N	1020	Falling	0.1	0.1	0.1	0.1	0.0001	8.9	0.0089	2.6	1	1	-	Overcast (high tide) Flooded-Bung removed to drain water, reading taken after 30mins	10
	16/12/15	AC	50	4.10	3.96	1.30	Y	Purged Dry (Water in BH is drained surface water)	1008	Rising	0.1	0.1	0.1	0.1	0.0001	6.8	0.0068	4.7	1	1	-	Overcast (high tide) Flooded-Bung removed to drain water, reading taken after 30mins	12
	05/01/16	AC	50	4.10	3.60	1.66	N	N	981	Rising	0.1	0.1	0.1	0.2	0.0002	7.4	0.0074	4.7	1	1	-	Overcast Flooded-Bung removed to drain water, reading taken after 30mins	7
WS3	10/12/15	AC	50	3.07	3.07	2.34	N	N	1020	Falling	0.1	0.1	0.1	0.1	0.0001	10.3	0.0103	3.3	1	1	-	Overcast (high tide)	10
	16/12/15	AC	50	3.07	3.07	2.34	N	N	1008	Rising	0.1	0.1	0.1	0.1	0.0001	8.8	0.0088	4.3	1	1	-	Overcast (high tide)	12
	05/01/16	AC	50	3.07	3.07	2.34	N	N	981	Rising	0.1	0.1	0.1	0.1	0.0001	0.1	0.0001	20.2	1	1	-	Overcast	7
WS4	10/12/15	AC	50	2.06	1.47	3.68	N	N	1020	Falling	0.1	0.1	0.1	0.1	0.0001	4.1	0.0041	13.0	1	1	-	Overcast (high tide)	10
	16/12/15	AC	50	2.06	1.47	3.68	Y	Y	1008	Rising	0.1	0.1	0.1	0.1	0.0001	3.4	0.0034	14.1	1	1	-	Overcast (high tide) Water-GREY and SANDY	12
	05/01/16	AC	50	FLOODED																		Overcast	7
WS8	10/12/15	AC	50	3.96	3.96	1.11	N	N	1019	Falling	0.1	0.1	0.1	0.1	0.0001	4.7	0.0047	14.0	1	1	-	Overcast (high tide)	10
	16/12/15	AC	50	3.96	3.96	1.11	N	N	1008	Rising	0.1	0.1	0.1	0.1	0.0001	4.0	0.0040	14.8	1	1	-	Overcast (high tide)	12
	05/01/16	AC	50	3.96	3.96	1.11	N	N	981	Rising	0.1	0.1	0.1	0.1	0.0001	1.3	0.0013	18.3	1	1	-	Overcast	7
WS9	10/12/15	AC	50	2.78	1.27	3.66	N	N	1019	Falling	0.1	0.1	0.1	0.1	0.0001	2.6	0.0026	16.0	1	1	-	Overcast (high tide)	10
	16/12/15	AC	50	2.78	1.20	3.73	Y	Y	1008	Rising	0.1	0.1	0.1	0.1	0.0001	2.1	0.0021	16.8	1	1	-	Overcast (high tide) Water-LIGHT BROWN and SANDY	12
	05/01/16	AC	50	2.78	0.87	4.06	N	N	981	Rising	0.1	0.1	0.1	0.1	0.0001	1.1	0.0011	19.2	1	1	-	Overcast	7
WS11	10/12/15	AC	50	0.96	0.68	4.05	N	N	1019	Falling	0.1	0.1	0.1	0.1	0.0001	0.1	0.0001	19.3	1	1	-	Overcast (high tide)	10
	16/12/15	AC	50	0.96	0.70	4.03	Y	Purged Dry	1008	Rising	0.1	0.1	0.1	0.1	0.0001	0.1	0.0001	19.5	1	1	-	Overcast (high tide)	12
	05/01/16	AC	50	0.96	0.70	4.23	N	N	981	Rising	0.1	0.1	0.1	0.1	0.0001	0.3	0.0003	16.9	1	1	-	Overcast	7

Note: * = flow rate maximum indicate, flow rate reduced down to less than detection limit of 0.1 l/hr within 10 to 60 seconds of opening gas tap.

Indicates reading less than the detection limit indicated

NOTES:
NM = Not Measured.
(x) = Peak value recorded.
[grey] = Below detection limit.

GSV (l/HR) = [gas concentration (%v/v)] x [gas well flow rate (l/hr)]
100

Instrumentation Specifications

Gas Monitoring – Permanent Gases

Gas monitoring for permanent gases (e.g. methane, carbon dioxide, oxygen etc) at TerraConsult is carried out using a GasData GFM 400 series gas analyser with flow meter which measures borehole flow rates, bulk gas concentrations (methane, carbon dioxide and oxygen), barometric and differential pressure.

The specification range of the GFM 400 series is as follows:

Feature	Method/Type	Range	Resolution
Methane	Infrared	0 - 100%v/v	0.1%
Lower Detection Limit (LEL)	Infrared	0 - 100%v/v	0.1%
Carbon Dioxide	Infrared	0 - 100%v/v	0.1%
Oxygen	Electrochemical	0 - 25%v/v	0.1%
Hydrogen Sulphide	Electrochemical	0 - 5,000ppm	1ppm
Carbon monoxide	Electrochemical	0 – 2,000ppm	1ppm
Atmospheric Pressure	Absolute Pressure Sensor	800 – 1,200mb	1mb
Differential Pressure	Thermal Dissipation	±1,250Pa	0.1Pa
Temperature	Bi-metal	-10ºC to +100ºC	1ºC
Flow	Thermal Dissipation	-60 – 100 l/hr	0.1 l/hr

Volatile Organic Compounds

TerraConsult uses a PhoCheck Tiger Photo Ionisation Detector (PID) to detect a large range of Volatile Organic Compounds (VOCs) which are potentially dangerous from both a poisoning and/or an explosive perspective.

The sensor specification is as follows:

Feature	Method/Type	Range	Resolution
Total VOCs	PID	1ppb – 10,000ppm & 1ppb to 20,000ppm for specific gases	+/- 5% displayed reading +/- one digit

Calibration

Measuring equipment owned by TerraConsult is maintained in good condition and regularly inspected to ensure that it is capable of accurate and effective operation and is calibrated in line with the manufacturer's recommendations. When equipment is hired for use, the hirer will be required to provide a calibration certificate with the equipment.

In accordance with TerraConsult's ISO 9001:2008 accreditation, the process of calibrating and maintenance of TerraConsult's own measuring equipment is carried out in accordance with our quality system procedures and a register of all measuring equipment is maintained and calibration certificates collated and stored accordingly.

Prior to the use of any measuring equipment, the user will undertake suitable checks to ensure that it is fit for use and within the calibration tolerances specified.

Should a copy of the relevant calibration certificate be required, please contact TerraConsult directly to request a copy.
.

APPENDIX F

Laboratory Chemical Test Results

Richard Colin
TerraConsult Ltd
Bold Business Centre
Bold Lane
Sutton
St Helens
Merseyside
WA9 4TX

QTS Environmental Ltd
Unit 1
Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Kent
ME17 2JN
t: 01622 850410
russell.jarvis@qtsenvironmental.com

QTS Environmental Report No: 15-38508

Site Reference:	Greenfields, Fintshire
Project / Job Ref:	2638
Order No:	14915
Sample Receipt Date:	04/12/2015
Sample Scheduled Date:	07/12/2015
Report Issue Number:	1
Reporting Date:	11/12/2015

Authorised by:

Russell Jarvis
Associate Director of Client Services
On behalf of QTS Environmental Ltd

Authorised by:

Kevin Old
Associate Director of Laboratory
On behalf of QTS Environmental Ltd

QTS Environmental Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

4480

Soil Analysis Certificate							
QTS Environmental Report No: 15-38508	**Date Sampled**	01/12/15	01/12/15	01/12/15	01/12/15	01/12/15
TerraConsult Ltd	**Time Sampled**	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Greenfields, Fintshire	**TP / BH No**	TP4	TP4	TP4	TP6	TP6
Project / Job Ref: 2638	**Additional Refs**	1	2	4	1	2
Order No: 14915	**Depth (m)**	0.50	0.70	1.60	0.50	1.30
Reporting Date: 11/12/2015	**QTSE Sample No**	181564	181565	181566	181569	181570

Determinand	Unit	RL	Accreditation					
Asbestos Screen	N/a	N/a	ISO17025		Not Detected		Detected	
Sample Matrix	Material Type	N/a	NONE				Loose fibres	
Asbestos Type	PLM Result	N/a	ISO17025				Chrysotile	
pH	pH Units	N/a	MCERTS	7.7	7.9	7.6	7.4	7.6
Total Cyanide	mg/kg	< 2	NONE		< 2	< 2	< 2	
Total Sulphate as SO_4	mg/kg	< 200	NONE	9120	1675		2962	2159
Total Sulphate as SO_4	%	< 0.02	NONE	0.91	0.17		0.30	0.22
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	MCERTS	1530	393	1690	1000	735
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	MCERTS	1.53	0.39	1.69	1	0.73
Total Sulphur	%	< 0.02	NONE	0.29				0.13
Organic Matter	%	< 0.1	MCERTS		0.8		4.1	
Total Organic Carbon (TOC)	%	< 0.1	MCERTS		0.5		2.4	
Ammonium as NH_4	mg/kg	< 0.5	NONE	22.1				82.1
Ammonium as NH_4	mg/l	< 0.05	NONE	2.21				8.21
W/S Chloride (2:1)	mg/kg	< 1	MCERTS	181	194		42	60
W/S Chloride (2:1)	mg/l	< 0.5	MCERTS	90.6	96.8		21.1	29.8
Water Soluble Nitrate (2:1) as NO_3	mg/kg	< 3	MCERTS	12				< 3
Water Soluble Nitrate (2:1) as NO_3	mg/l	< 1.5	MCERTS	6.2				< 1.5
Arsenic (As)	mg/kg	< 2	MCERTS		19	24	18	
Cadmium (Cd)	mg/kg	< 0.2	MCERTS		0.5	0.4	1.1	
Chromium (Cr)	mg/kg	< 2	MCERTS		19	20	22	
Copper (Cu)	mg/kg	< 4	MCERTS		76	111	132	
Lead (Pb)	mg/kg	< 3	MCERTS		35	44	259	
W/S Magnesium	mg/l	< 0.1	NONE	1.8				10
Mercury (Hg)	mg/kg	< 1	NONE		< 1	< 1	< 1	
Nickel (Ni)	mg/kg	< 3	MCERTS		44	47	32	
Selenium (Se)	mg/kg	< 3	NONE		< 3	< 3	< 3	
Zinc (Zn)	mg/kg	< 3	MCERTS		89	119	401	
Total Phenols (monohydric)	mg/kg	< 2	NONE		< 2	< 2	< 2	
DRO (C10 - C24)	mg/kg	< 6	MCERTS		< 6	< 6	< 6	
Oil (C25 - C40)	mg/kg	< 6	MCERTS		< 6	< 6	18	
EPH (C10 - C40)	mg/kg	< 6	MCERTS			< 6		
Mineral Oil (C10 - C40)	mg/kg	< 10	MCERTS		< 10	< 10	< 10	

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C
Analysis carried out on the dried sample is corrected for the stone content

The samples have been examined to identify the presence of asbestiform minerals by polarising light microscopy and dispersion staining technique to In-House Procedures QTSE600 Determination of Asbestos in Bulk Materials; Asbestos in Soils/Sediments (fibre screening and identification)

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Asbestos Analyst: Wioletta Goral

RL: Reporting Limit

Pinch Test: Where pinch test is positive it is reported "Loose Fibres - PT" with type(s).

Subcontracted analysis $^{(S)}$

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Soil Analysis Certificate							
QTS Environmental Report No: 15-38508	**Date Sampled**	01/12/15	01/12/15	01/12/15	01/12/15	01/12/15
TerraConsult Ltd	**Time Sampled**	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Greenfields, Fintshire	**TP / BH No**	TP6	TP3	TP1	TP2	TP2
Project / Job Ref: 2638	**Additional Refs**	5	1	1	1	2
Order No: 14915	**Depth (m)**	1.60	0.50	0.20	0.30	0.50
Reporting Date: 11/12/2015	**QTSE Sample No**	181572	181573	181574	181575	181576

Determinand	Unit	RL	Accreditation					
Asbestos Screen	N/a	N/a	ISO17025		Not Detected	Not Detected	Not Detected	
Sample Matrix	Material Type	N/a	NONE					
Asbestos Type	PLM Result	N/a	ISO17025					
pH	pH Units	N/a	MCERTS	7.8	7.1	7.9	7.5	7.8
Total Cyanide	mg/kg	< 2	NONE	< 2	< 2	< 2		< 2
Total Sulphate as SO_4	mg/kg	< 200	NONE			1829	6895	109400
Total Sulphate as SO_4	%	< 0.02	NONE			0.18	0.69	10.90
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	MCERTS	76	1720	340	1380	1630
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	MCERTS	0.08	1.72	0.34	1.38	1.63
Total Sulphur	%	< 0.02	NONE				0.28	
Organic Matter	%	< 0.1	MCERTS			5		2.1
Total Organic Carbon (TOC)	%	< 0.1	MCERTS			2.9		1.2
Ammonium as NH_4	mg/kg	< 0.5	NONE				6.3	
Ammonium as NH_4	mg/l	< 0.05	NONE				0.63	
W/S Chloride (2:1)	mg/kg	< 1	MCERTS			15	18	12
W/S Chloride (2:1)	mg/l	< 0.5	MCERTS			7.5	9.2	5.8
Water Soluble Nitrate (2:1) as NO_3	mg/kg	< 3	MCERTS				< 3	
Water Soluble Nitrate (2:1) as NO_3	mg/l	< 1.5	MCERTS				< 1.5	
Arsenic (As)	mg/kg	< 2	MCERTS	7	20	6		94
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	< 0.2	8.1	1.3		< 0.2
Chromium (Cr)	mg/kg	< 2	MCERTS	16	20	18		14
Copper (Cu)	mg/kg	< 4	MCERTS	11	131	27		476
Lead (Pb)	mg/kg	< 3	MCERTS	24	358	332		178
W/S Magnesium	mg/l	< 0.1	NONE				4.5	
Mercury (Hg)	mg/kg	< 1	NONE	< 1	< 1	< 1		< 1
Nickel (Ni)	mg/kg	< 3	MCERTS	13	29	12		12
Selenium (Se)	mg/kg	< 3	NONE	< 3	< 3	< 3		42.1
Zinc (Zn)	mg/kg	< 3	MCERTS	63	9550	349		735
Total Phenols (monohydric)	mg/kg	< 2	NONE	< 2	< 2	< 2		< 2
DRO (C10 - C24)	mg/kg	< 6	MCERTS	< 6	79	447		< 6
Oil (C25 - C40)	mg/kg	< 6	MCERTS	< 6	636	1520		< 6
EPH (C10 - C40)	mg/kg	< 6	MCERTS	< 6	737			
Mineral Oil (C10 - C40)	mg/kg	< 10	MCERTS	< 10	182	283		< 10

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

Analysis carried out on the dried sample is corrected for the stone content

The samples have been examined to identify the presence of asbestiform minerals by polarising light microscopy and dispersion staining technique to In-House Procedures QTSE600 Determination of Asbestos in Bulk Materials; Asbestos in Soils/Sediments (fibre screening and identification)

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Asbestos Analyst: Wioletta Goral

RL: Reporting Limit

Pinch Test: Where pinch test is positive it is reported "Loose Fibres - PT" with type(s).

Subcontracted analysis $^{(S)}$

QTS Environmental Ltd
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Soil Analysis Certificate							
QTS Environmental Report No: 15-38508	Date Sampled	01/12/15					
TerraConsult Ltd	Time Sampled	None Supplied					
Site Reference: Greenfields, Fintshire	TP / BH No	TP5					
Project / Job Ref: 2638	Additional Refs	1					
Order No: 14915	Depth (m)	0.40					
Reporting Date: 11/12/2015	QTSE Sample No	181577					

Determinand	Unit	RL	Accreditation					
Asbestos Screen	N/a	N/a	ISO17025	Not Detected				
Sample Matrix	Material Type	N/a	NONE					
Asbestos Type	PLM Result	N/a	ISO17025					
pH	pH Units	N/a	MCERTS	7.4				
Total Cyanide	mg/kg	< 2	NONE	< 2				
Total Sulphate as SO_4	mg/kg	< 200	NONE	5344				
Total Sulphate as SO_4	%	< 0.02	NONE	0.53				
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	MCERTS	1670				
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	MCERTS	1.67				
Total Sulphur	%	< 0.02	NONE					
Organic Matter	%	< 0.1	MCERTS	2.2				
Total Organic Carbon (TOC)	%	< 0.1	MCERTS	1.3				
Ammonium as NH_4	mg/kg	< 0.5	NONE					
Ammonium as NH_4	mg/l	< 0.05	NONE					
W/S Chloride (2:1)	mg/kg	< 1	MCERTS	79				
W/S Chloride (2:1)	mg/l	< 0.5	MCERTS	39.7				
Water Soluble Nitrate (2:1) as NO_3	mg/kg	< 3	MCERTS					
Water Soluble Nitrate (2:1) as NO_3	mg/l	< 1.5	MCERTS					
Arsenic (As)	mg/kg	< 2	MCERTS	15				
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	< 0.2				
Chromium (Cr)	mg/kg	< 2	MCERTS	24				
Copper (Cu)	mg/kg	< 4	MCERTS	33				
Lead (Pb)	mg/kg	< 3	MCERTS	268				
W/S Magnesium	mg/l	< 0.1	NONE					
Mercury (Hg)	mg/kg	< 1	NONE	< 1				
Nickel (Ni)	mg/kg	< 3	MCERTS	21				
Selenium (Se)	mg/kg	< 3	NONE	< 3				
Zinc (Zn)	mg/kg	< 3	MCERTS	250				
Total Phenols (monohydric)	mg/kg	< 2	NONE	< 2				
DRO (C10 - C24)	mg/kg	< 6	MCERTS	< 6				
Oil (C25 - C40)	mg/kg	< 6	MCERTS	< 6				
EPH (C10 - C40)	mg/kg	< 6	MCERTS					
Mineral Oil (C10 - C40)	mg/kg	< 10	MCERTS	< 10				

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C
Analysis carried out on the dried sample is corrected for the stone content

The samples have been examined to identify the presence of asbestiform minerals by polarising light microscopy and dispersion staining technique to In-House Procedures QTSE600 Determination of Asbestos in Bulk Materials; Asbestos in Soils/Sediments (fibre screening and identification)

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Asbestos Analyst: Wioletta Goral

RL: Reporting Limit

Pinch Test: Where pinch test is positive it is reported "Loose Fibres - PT" with type(s).

Subcontracted analysis $^{(S)}$

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Soil Analysis Certificate - Speciated PAHs							
QTS Environmental Report No: 15-38508	Date Sampled	01/12/15	01/12/15	01/12/15	01/12/15	01/12/15
TerraConsult Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Greenfields, Fintshire	TP / BH No	TP4	TP4	TP6	TP6	TP3
Project / Job Ref: 2638	Additional Refs	2	4	1	5	1
Order No: 14915	Depth (m)	0.70	1.60	0.50	1.60	0.50
Reporting Date: 11/12/2015	QTSE Sample No	181565	181566	181569	181572	181573

Determinand	Unit	RL	Accreditation					
Naphthalene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluorene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Phenanthrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.15	< 0.1	0.22
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.26	< 0.1	0.35
Pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.20	< 0.1	0.32
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.12	< 0.1	0.16
Chrysene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.14	< 0.1	0.22
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.15	< 0.1	0.27
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	0.22
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	0.19
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	0.20
Coronene	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Total Oily Waste PAHs	mg/kg	< 1	MCERTS	< 1	< 1	< 1	< 1	1.1
Total Dutch 10 PAHs	mg/kg	< 1	MCERTS	< 1	< 1	< 1	< 1	1.6
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	< 1.6	< 1.6	< 1.6	< 1.6	2.2
Total WAC-17 PAHs	mg/kg	< 1.7	NONE	< 1.7	< 1.7	< 1.7	< 1.7	2.2

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

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Soil Analysis Certificate - Speciated PAHs							
QTS Environmental Report No: 15-38508	Date Sampled	01/12/15	01/12/15	01/12/15		
TerraConsult Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: Greenfields, Fintshire	TP / BH No	TP1	TP2	TP5		
Project / Job Ref: 2638	Additional Refs	1	2	1		
Order No: 14915	Depth (m)	0.20	0.50	0.40		
Reporting Date: 11/12/2015	QTSE Sample No	181574	181576	181577		

Determinand	Unit	RL	Accreditation					
Naphthalene	mg/kg	< 0.1	MCERTS	0.53	< 0.1	< 0.1		
Acenaphthylene	mg/kg	< 0.1	MCERTS	0.20	< 0.1	< 0.1		
Acenaphthene	mg/kg	< 0.1	MCERTS	1.38	< 0.1	< 0.1		
Fluorene	mg/kg	< 0.1	MCERTS	1.26	< 0.1	< 0.1		
Phenanthrene	mg/kg	< 0.1	MCERTS	18	< 0.1	< 0.1		
Anthracene	mg/kg	< 0.1	MCERTS	5.18	< 0.1	< 0.1		
Fluoranthene	mg/kg	< 0.1	MCERTS	30.50	< 0.1	< 0.1		
Pyrene	mg/kg	< 0.1	MCERTS	23.90	< 0.1	< 0.1		
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	12.20	< 0.1	< 0.1		
Chrysene	mg/kg	< 0.1	MCERTS	11.60	< 0.1	< 0.1		
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	12.30	< 0.1	< 0.1		
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	5.59	< 0.1	< 0.1		
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	11	< 0.1	< 0.1		
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	6.41	< 0.1	< 0.1		
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	0.95	< 0.1	< 0.1		
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	5.73	< 0.1	< 0.1		
Coronene	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1		
Total Oily Waste PAHs	mg/kg	< 1	MCERTS	60	< 1	< 1		
Total Dutch 10 PAHs	mg/kg	< 1	MCERTS	107	< 1	< 1		
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	147	< 1.6	< 1.6		
Total WAC-17 PAHs	mg/kg	< 1.7	NONE	147	< 1.7	< 1.7		

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

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Soil Analysis Certificate - TPH CWG Banded							
QTS Environmental Report No: 15-38508	Date Sampled	01/12/15	01/12/15	01/12/15	01/12/15	01/12/15
TerraConsult Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Greenfields, Fintshire	TP / BH No	TP4	TP6	TP1	TP2	TP5
Project / Job Ref: 2638	Additional Refs	2	1	1	2	1
Order No: 14915	Depth (m)	0.70	0.50	0.20	0.50	0.40
Reporting Date: 11/12/2015	QTSE Sample No	181565	181569	181574	181576	181577

Determinand	Unit	RL	Accreditation					
Aliphatic >C5 - C6	mg/kg	< 0.01	NONE	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Aliphatic >C6 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Aliphatic >C8 - C10	mg/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
Aliphatic >C10 - C12	mg/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
Aliphatic >C12 - C16	mg/kg	< 3	MCERTS	< 3	< 3	< 3	< 3	< 3
Aliphatic >C16 - C21	mg/kg	< 3	MCERTS	< 3	< 3	4	< 3	< 3
Aliphatic >C21 - C34	mg/kg	< 10	MCERTS	< 10	< 10	208	< 10	< 10
Aliphatic (C5 - C34)	mg/kg	< 21	NONE	< 21	< 21	213	< 21	< 21
Aromatic >C5 - C7	mg/kg	< 0.01	NONE	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Aromatic >C7 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Aromatic >C8 - C10	mg/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
Aromatic >C10 - C12	mg/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
Aromatic >C12 - C16	mg/kg	< 2	MCERTS	< 2	< 2	18	< 2	< 2
Aromatic >C16 - C21	mg/kg	< 3	MCERTS	< 3	3	166	< 3	< 3
Aromatic >C21 - C35	mg/kg	< 10	MCERTS	< 10	< 10	771	< 10	< 10
Aromatic (C5 - C35)	mg/kg	< 21	NONE	< 21	< 21	955	< 21	< 21
Total >C5 - C35	mg/kg	< 42	NONE	< 42	< 42	1168	< 42	< 42

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

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Soil Analysis Certificate - BTEX / MTBE							
QTS Environmental Report No: 15-38508	Date Sampled	01/12/15	01/12/15	01/12/15	01/12/15	01/12/15
TerraConsult Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Greenfields, Fintshire	TP / BH No	TP4	TP4	TP6	TP6	TP3
Project / Job Ref: 2638	Additional Refs	2	4	1	5	1
Order No: 14915	Depth (m)	0.70	1.60	0.50	1.60	0.50
Reporting Date: 11/12/2015	QTSE Sample No	181565	181566	181569	181572	181573

Determinand	Unit	RL	Accreditation					
Benzene	ug/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
Toluene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
Ethylbenzene	ug/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
p & m-xylene	ug/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
o-xylene	ug/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
MTBE	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

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Soil Analysis Certificate - BTEX / MTBE							
QTS Environmental Report No: 15-38508	Date Sampled	01/12/15	01/12/15	01/12/15		
TerraConsult Ltd	Time Sampled	None Supplied	None Supplied	None Supplied		
Site Reference: Greenfields, Fintshire	TP / BH No	TP1	TP2	TP5		
Project / Job Ref: 2638	Additional Refs	1	2	1		
Order No: 14915	Depth (m)	0.20	0.50	0.40		
Reporting Date: 11/12/2015	QTSE Sample No	181574	181576	181577		

Determinand	Unit	RL	Accreditation					
Benzene	ug/kg	< 2	MCERTS	< 2	< 2	< 2		
Toluene	ug/kg	< 5	MCERTS	< 5	< 5	< 5		
Ethylbenzene	ug/kg	< 2	MCERTS	< 2	< 2	< 2		
p & m-xylene	ug/kg	< 2	MCERTS	< 2	< 2	< 2		
o-xylene	ug/kg	< 2	MCERTS	< 2	< 2	< 2		
MTBE	ug/kg	< 5	MCERTS	< 5	< 5	< 5		

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

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Soil Analysis Certificate - Volatile Organic Compounds (VOC)								
QTS Environmental Report No: 15-38508	Date Sampled	01/12/15	01/12/15	01/12/15	01/12/15	01/12/15		
TerraConsult Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied		
Site Reference: Greenfields, Fintshire	TP / BH No	TP4	TP6	TP3	TP1	TP2		
Project / Job Ref: 2638	Additional Refs	2	1	1	1	1		
Order No: 14915	Depth (m)	0.70	0.50	0.50	0.20	0.30		
Reporting Date: 11/12/2015	QTSE Sample No	181565	181569	181573	181574	181575		

Determinand	Unit	RL	Accreditation					
Dichlorodifluoromethane	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
Vinyl Chloride	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
Chloromethane	ug/kg	< 10	MCERTS	< 10	< 10	< 10	< 10	< 10
Chloroethane	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
Bromomethane	ug/kg	< 10	MCERTS	< 10	< 10	< 10	< 10	< 10
Trichlorofluoromethane	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
1,1-Dichloroethene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
MTBE	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
trans-1,2-Dichloroethene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
1,1-Dichloroethane	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
cis-1,2-Dichloroethene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
2,2-Dichloropropane	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
Chloroform	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
Bromochloromethane	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
1,1,1-Trichloroethane	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
1,1-Dichloropropene	ug/kg	< 10	MCERTS	< 10	< 10	< 10	< 10	< 10
Carbon Tetrachloride	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
1,2-Dichloroethane	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
Benzene	ug/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
1,2-Dichloropropane	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
Trichloroethene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
Bromodichloromethane	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
Dibromomethane	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
TAME	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
cis-1,3-Dichloropropene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
Toluene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
trans-1,3-Dichloropropene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
1,1,2-Trichloroethane	ug/kg	< 10	MCERTS	< 10	< 10	< 10	< 10	< 10
1,3-Dichloropropane	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
Tetrachloroethene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
Dibromochloromethane	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
1,2-Dibromoethane	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
Chlorobenzene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
1,1,1,2-Tetrachloroethane	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
Ethyl Benzene	ug/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
m,p-Xylene	ug/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
o-Xylene	ug/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
Styrene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
Bromoform	ug/kg	< 10	MCERTS	< 10	< 10	< 10	< 10	< 10
Isopropylbenzene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
1,1,2,2-Tetrachloroethane	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
1,2,3-Trichloropropane	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
n-Propylbenzene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
Bromobenzene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
2-Chlorotoluene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
1,3,5-Trimethylbenzene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
4-Chlorotoluene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
tert-Butylbenzene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
1,2,4-Trimethylbenzene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
sec-Butylbenzene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
p-Isopropyltoluene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
1,3-Dichlorobenzene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
1,4-Dichlorobenzene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
n-Butylbenzene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
1,2-Dichlorobenzene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
,2-Dibromo-3-chloropropane	ug/kg	< 10	MCERTS	< 10	< 10	< 10	< 10	< 10
Hexachlorobutadiene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

QTS Environmental Ltd
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4480

Soil Analysis Certificate - Volatile Organic Compounds (VOC)							
QTS Environmental Report No: 15-38508	Date Sampled	01/12/15					
TerraConsult Ltd	Time Sampled	None Supplied					
Site Reference: Greenfields, Fintshire	TP / BH No	TP5					
Project / Job Ref: 2638	Additional Refs	1					
Order No: 14915	Depth (m)	0.40					
Reporting Date: 11/12/2015	QTSE Sample No	181577					

Determinand	Unit	RL	Accreditation					
Dichlorodifluoromethane	ug/kg	< 5	MCERTS	< 5				
Vinyl Chloride	ug/kg	< 5	MCERTS	< 5				
Chloromethane	ug/kg	< 10	MCERTS	< 10				
Chloroethane	ug/kg	< 5	MCERTS	< 5				
Bromomethane	ug/kg	< 10	MCERTS	< 10				
Trichlorofluoromethane	ug/kg	< 5	MCERTS	< 5				
1,1-Dichloroethene	ug/kg	< 5	MCERTS	< 5				
MTBE	ug/kg	< 5	MCERTS	< 5				
trans-1,2-Dichloroethene	ug/kg	< 5	MCERTS	< 5				
1,1-Dichloroethane	ug/kg	< 5	MCERTS	< 5				
cis-1,2-Dichloroethene	ug/kg	< 5	MCERTS	< 5				
2,2-Dichloropropane	ug/kg	< 5	MCERTS	< 5				
Chloroform	ug/kg	< 5	MCERTS	< 5				
Bromochloromethane	ug/kg	< 5	MCERTS	< 5				
1,1,1-Trichloroethane	ug/kg	< 5	MCERTS	< 5				
1,1-Dichloropropene	ug/kg	< 10	MCERTS	< 10				
Carbon Tetrachloride	ug/kg	< 5	MCERTS	< 5				
1,2-Dichloroethane	ug/kg	< 5	MCERTS	< 5				
Benzene	ug/kg	< 2	MCERTS	< 2				
1,2-Dichloropropane	ug/kg	< 5	MCERTS	< 5				
Trichloroethene	ug/kg	< 5	MCERTS	< 5				
Bromodichloromethane	ug/kg	< 5	MCERTS	< 5				
Dibromomethane	ug/kg	< 5	MCERTS	< 5				
TAME	ug/kg	< 5	MCERTS	< 5				
cis-1,3-Dichloropropene	ug/kg	< 5	MCERTS	< 5				
Toluene	ug/kg	< 5	MCERTS	< 5				
trans-1,3-Dichloropropene	ug/kg	< 5	MCERTS	< 5				
1,1,2-Trichloroethane	ug/kg	< 10	MCERTS	< 10				
1,3-Dichloropropane	ug/kg	< 5	MCERTS	< 5				
Tetrachloroethene	ug/kg	< 5	MCERTS	< 5				
Dibromochloromethane	ug/kg	< 5	MCERTS	< 5				
1,2-Dibromoethane	ug/kg	< 5	MCERTS	< 5				
Chlorobenzene	ug/kg	< 5	MCERTS	< 5				
1,1,1,2-Tetrachloroethane	ug/kg	< 5	MCERTS	< 5				
Ethyl Benzene	ug/kg	< 2	MCERTS	< 2				
m,p-Xylene	ug/kg	< 2	MCERTS	< 2				
o-Xylene	ug/kg	< 2	MCERTS	< 2				
Styrene	ug/kg	< 5	MCERTS	< 5				
Bromoform	ug/kg	< 10	MCERTS	< 10				
Isopropylbenzene	ug/kg	< 5	MCERTS	< 5				
1,1,2,2-Tetrachloroethane	ug/kg	< 5	MCERTS	< 5				
1,2,3-Trichloropropane	ug/kg	< 5	MCERTS	< 5				
n-Propylbenzene	ug/kg	< 5	MCERTS	< 5				
Bromobenzene	ug/kg	< 5	MCERTS	< 5				
2-Chlorotoluene	ug/kg	< 5	MCERTS	< 5				
1,3,5-Trimethylbenzene	ug/kg	< 5	MCERTS	< 5				
4-Chlorotoluene	ug/kg	< 5	MCERTS	< 5				
tert-Butylbenzene	ug/kg	< 5	MCERTS	< 5				
1,2,4-Trimethylbenzene	ug/kg	< 5	MCERTS	< 5				
sec-Butylbenzene	ug/kg	< 5	MCERTS	< 5				
p-Isopropyltoluene	ug/kg	< 5	MCERTS	< 5				
1,3-Dichlorobenzene	ug/kg	< 5	MCERTS	< 5				
1,4-Dichlorobenzene	ug/kg	< 5	MCERTS	< 5				
n-Butylbenzene	ug/kg	< 5	MCERTS	< 5				
1,2-Dichlorobenzene	ug/kg	< 5	MCERTS	< 5				
,2-Dibromo-3-chloropropane	ug/kg	< 10	MCERTS	< 10				
Hexachlorobutadiene	ug/kg	< 5	MCERTS	< 5				

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

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Soil Analysis Certificate - Semi Volatile Organic Compounds (SVOC)							
QTS Environmental Report No: 15-38508	Date Sampled	01/12/15	01/12/15	01/12/15	01/12/15	01/12/15
TerraConsult Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Greenfields, Fintshire	TP / BH No	TP4	TP6	TP3	TP1	TP2
Project / Job Ref: 2638	Additional Refs	2	1	1	1	1
Order No: 14915	Depth (m)	0.70	0.50	0.50	0.20	0.30
Reporting Date: 11/12/2015	QTSE Sample No	181565	181569	181573	181574	181575

Determinand	Unit	RL	Accreditation					
Phenol	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
1,2,4-Trichlorobenzene	mg/kg	< 0.1	ISO17025	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2-Nitrophenol	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Nitrobenzene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
0-Cresol	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
bis(2-chloroethoxy)methane	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
bis(2-chloroethyl)ether	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2,4-Dichlorophenol	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2-Chlorophenol	mg/kg	< 0.1	ISO17025	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
1,3-Dichlorobenzene	mg/kg	< 0.1	ISO17025	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
1,4-Dichlorobenzene	mg/kg	< 0.1	ISO17025	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
1,2-Dichlorobenzene	mg/kg	< 0.1	ISO17025	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2,4-Dimethylphenol	mg/kg	< 0.15	ISO17025	< 0.15	< 0.15	< 0.15	< 0.15	< 0.15
Isophorone	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Hexachloroethane	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
p-Cresol	mg/kg	< 0.15	MCERTS	< 0.15	< 0.15	< 0.15	< 0.15	< 0.15
2,4,6-Trichlorophenol	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2,4,5-Trichlorophenol	mg/kg	< 0.15	MCERTS	< 0.15	< 0.15	< 0.15	< 0.15	< 0.15
2-Nitroaniline	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
4-Chloro-3-methylphenol	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2-Methylnaphthalene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	0.5	< 0.1
Hexachlorocyclopentadiene	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Hexachlorobutadiene	mg/kg	< 0.1	ISO17025	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2,6-Dinitrotoluene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Dimethyl phthalate	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2-Chloronaphthalene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
4-Chloroanaline	mg/kg	< 0.15	NONE	< 0.15	< 0.15	< 0.15	< 0.15	< 0.15
4-Nitrophenol	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
4-Chlorophenyl phenyl ether	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
3-Nitroaniline	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
4-Nitroaniline	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
4-Bromophenyl phenyl ether	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Hexachlorobenzene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2,4-Dinitrotoluene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Diethyl phthalate	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Dibenzofuran	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	0.5	< 0.1
Azobenzene	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Dibutyl phthalate	mg/kg	< 0.1	ISO17025	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Carbazole	mg/kg	< 0.1	ISO17025	< 0.1	< 0.1	< 0.1	0.4	< 0.1
bis(2-ethylhexyl)phthalate	mg/kg	< 0.15	MCERTS	< 0.15	< 0.15	< 0.15	< 0.15	< 0.15
Benzyl butyl phthalate	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Di-n-octyl phthalate	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

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Soil Analysis Certificate - Semi Volatile Organic Compounds (SVOC)							
QTS Environmental Report No: 15-38508	Date Sampled	01/12/15					
TerraConsult Ltd	Time Sampled	None Supplied					
Site Reference: Greenfields, Fintshire	TP / BH No	TP5					
Project / Job Ref: 2638	Additional Refs	1					
Order No: 14915	Depth (m)	0.40					
Reporting Date: 11/12/2015	QTSE Sample No	181577					

Determinand	Unit	RL	Accreditation					
Phenol	mg/kg	< 0.1	NONE	< 0.1				
1,2,4-Trichlorobenzene	mg/kg	< 0.1	ISO17025	< 0.1				
2-Nitrophenol	mg/kg	< 0.1	NONE	< 0.1				
Nitrobenzene	mg/kg	< 0.1	MCERTS	< 0.1				
0-Cresol	mg/kg	< 0.1	NONE	< 0.1				
bis(2-chloroethoxy)methane	mg/kg	< 0.1	MCERTS	< 0.1				
bis(2-chloroethyl)ether	mg/kg	< 0.1	MCERTS	< 0.1				
2,4-Dichlorophenol	mg/kg	< 0.1	MCERTS	< 0.1				
2-Chlorophenol	mg/kg	< 0.1	ISO17025	< 0.1				
1,3-Dichlorobenzene	mg/kg	< 0.1	ISO17025	< 0.1				
1,4-Dichlorobenzene	mg/kg	< 0.1	ISO17025	< 0.1				
1,2-Dichlorobenzene	mg/kg	< 0.1	ISO17025	< 0.1				
2,4-Dimethylphenol	mg/kg	< 0.15	ISO17025	< 0.15				
Isophorone	mg/kg	< 0.1	NONE	< 0.1				
Hexachloroethane	mg/kg	< 0.1	MCERTS	< 0.1				
p-Cresol	mg/kg	< 0.15	MCERTS	< 0.15				
2,4,6-Trichlorophenol	mg/kg	< 0.1	MCERTS	< 0.1				
2,4,5-Trichlorophenol	mg/kg	< 0.15	MCERTS	< 0.15				
2-Nitroaniline	mg/kg	< 0.1	NONE	< 0.1				
4-Chloro-3-methylphenol	mg/kg	< 0.1	NONE	< 0.1				
2-Methylnaphthalene	mg/kg	< 0.1	MCERTS	< 0.1				
Hexachlorocyclopentadiene	mg/kg	< 0.1	NONE	< 0.1				
Hexachlorobutadiene	mg/kg	< 0.1	ISO17025	< 0.1				
2,6-Dinitrotoluene	mg/kg	< 0.1	MCERTS	< 0.1				
Dimethyl phthalate	mg/kg	< 0.1	NONE	< 0.1				
2-Chloronaphthalene	mg/kg	< 0.1	MCERTS	< 0.1				
4-Chloroanaline	mg/kg	< 0.15	NONE	< 0.15				
4-Nitrophenol	mg/kg	< 0.1	NONE	< 0.1				
4-Chlorophenyl phenyl ether	mg/kg	< 0.1	MCERTS	< 0.1				
3-Nitroaniline	mg/kg	< 0.1	NONE	< 0.1				
4-Nitroaniline	mg/kg	< 0.1	NONE	< 0.1				
4-Bromophenyl phenyl ether	mg/kg	< 0.1	MCERTS	< 0.1				
Hexachlorobenzene	mg/kg	< 0.1	MCERTS	< 0.1				
2,4-Dinitrotoluene	mg/kg	< 0.1	MCERTS	< 0.1				
Diethyl phthalate	mg/kg	< 0.1	MCERTS	< 0.1				
Dibenzofuran	mg/kg	< 0.1	MCERTS	< 0.1				
Azobenzene	mg/kg	< 0.1	NONE	< 0.1				
Dibutyl phthalate	mg/kg	< 0.1	ISO17025	< 0.1				
Carbazole	mg/kg	< 0.1	ISO17025	< 0.1				
bis(2-ethylhexyl)phthalate	mg/kg	< 0.15	MCERTS	< 0.15				
Benzyl butyl phthalate	mg/kg	< 0.1	MCERTS	< 0.1				
Di-n-octyl phthalate	mg/kg	< 0.1	MCERTS	< 0.1				

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

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UKAS TESTING
4480

Water Analysis Certificate							
QTS Environmental Report No: 15-38508	Date Sampled	01/12/15					
TerraConsult Ltd	Time Sampled	None Supplied					
Site Reference: Greenfields, Fintshire	TP / BH No	TP4					
Project / Job Ref: 2638	Additional Refs	9					
Order No: 14915	Depth (m)	1.90					
Reporting Date: 11/12/2015	QTSE Sample No	181568					

Determinand	Unit	RL	Accreditation					
pH	pH Units	N/a	ISO17025	7.2				
Electrical Conductivity	uS/cm	< 5	NONE	5910				
Total Cyanide	ug/l	< 5	NONE	< 5				
Sulphate as SO_4	mg/l	< 1	ISO17025	1150				
Ammonium as NH_4	ug/l	< 50	NONE	1030				
Ammonium as NH_4	mg/l	< 0.05	NONE	1.03				
Arsenic (dissolved)	ug/l	< 5	ISO17025	< 5				
Boron (dissolved)	ug/l	< 5	ISO17025	327				
Cadmium (dissolved)	ug/l	< 0.4	ISO17025	7				
Chromium (dissolved)	ug/l	< 5	ISO17025	< 5				
Copper (dissolved)	ug/l	< 5	ISO17025	14				
Lead (dissolved)	ug/l	< 5	ISO17025	< 5				
Mercury (dissolved)	ug/l	< 0.05	ISO17025	< 0.05				
Nickel (dissolved)	ug/l	< 5	ISO17025	46				
Selenium (dissolved)	ug/l	< 5	ISO17025	< 5				
Zinc (dissolved)	ug/l	< 2	ISO17025	3290				
Total Phenols (monohydric)	ug/l	< 10	NONE	< 10				
EPH (C10 - C40)	ug/l	< 10	NONE	34				

Subcontracted analysis (S)
Insufficient sample I/S
Unsuitable Sample U/S

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Water Analysis Certificate - Speciated PAH							
QTS Environmental Report No: 15-38508	**Date Sampled**	01/12/15					
TerraConsult Ltd	**Time Sampled**	None Supplied					
Site Reference: Greenfields, Fintshire	**TP / BH No**	TP4					
Project / Job Ref: 2638	**Additional Refs**	9					
Order No: 14915	**Depth (m)**	1.90					
Reporting Date: 11/12/2015	**QTSE Sample No**	181568					

Determinand	**Unit**	**RL**	**Accreditation**					
Naphthalene	ug/l	< 0.01	NONE	0.03				
Acenaphthylene	ug/l	< 0.01	NONE	< 0.01				
Acenaphthene	ug/l	< 0.01	NONE	0.01				
Fluorene	ug/l	< 0.01	NONE	< 0.01				
Phenanthrene	ug/l	< 0.01	NONE	0.03				
Anthracene	ug/l	< 0.01	NONE	< 0.01				
Fluoranthene	ug/l	< 0.01	NONE	0.01				
Pyrene	ug/l	< 0.01	NONE	0.01				
Benzo(a)anthracene	ug/l	< 0.01	NONE	< 0.01				
Chrysene	ug/l	< 0.01	NONE	< 0.01				
Benzo(b)fluoranthene	ug/l	< 0.01	NONE	< 0.01				
Benzo(k)fluoranthene	ug/l	< 0.01	NONE	< 0.01				
Benzo(a)pyrene	ug/l	< 0.01	NONE	< 0.01				
Indeno(1,2,3-cd)pyrene	ug/l	< 0.01	NONE	< 0.01				
Dibenz(a,h)anthracene	ug/l	< 0.01	NONE	< 0.01				
Benzo(ghi)perylene	ug/l	< 0.01	NONE	< 0.01				
Total EPA-16 PAHs	ug/l	< 0.01	NONE	0.09				

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UKAS TESTING
4480

Water Analysis Certificate - BTEX / MTBE							
QTS Environmental Report No: 15-38508	**Date Sampled**	01/12/15					
TerraConsult Ltd	**Time Sampled**	None Supplied					
Site Reference: Greenfields, Fintshire	**TP / BH No**	TP4					
Project / Job Ref: 2638	**Additional Refs**	9					
Order No: 14915	**Depth (m)**	1.90					
Reporting Date: 11/12/2015	**QTSE Sample No**	181568					

Determinand	Unit	RL	Accreditation					
Benzene	ug/l	< 1	**ISO17025**	< 1				
Toluene	ug/l	< 5	**ISO17025**	< 5				
Ethylbenzene	ug/l	< 5	**ISO17025**	< 5				
p & m-xylene	ug/l	< 10	**ISO17025**	< 10				
o-xylene	ug/l	< 5	**ISO17025**	< 5				
MTBE	ug/l	< 10	**ISO17025**	< 10				

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mCERTS THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

UKAS TESTING 4480

Waste Acceptance Criteria Analytical Certificate - BS EN 12457/3

QTS Environmental Report No: 15-38508	**Date Sampled**	01/12/15	
TerraConsult Ltd	**Time Sampled**	None Supplied	
Site Reference: Greenfields, Fintshire	**TP / BH No**	TP4	
Project / Job Ref: 2638	**Additional Refs**	6	
Order No: 14915	**Depth (m)**	1.60	
Reporting Date: 11/12/2015	**QTSE Sample No**	181567	

Determinand	**Unit**	**MDL**		**Landfill Waste Acceptance Criteria Limits**		
				Inert Waste Landfill	**Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill**	**Hazardous Waste Landfill**
TOC[MU]	%	< 0.1	1.1	3%	5%	6%
Loss on Ignition	%	< 0.01	3.20	--	--	10%
BTEX[MU]	mg/kg	< 0.05	< 0.05	6	--	--
Sum of PCBs	mg/kg	< 0.1	< 0.1	1	--	--
Mineral Oil[MU]	mg/kg	< 10	< 10	500	--	--
Total PAH[MU]	mg/kg	< 1.7	< 1.7	100	--	--
pH[MU]	pH Units	N/a	7.7	--	>6	--
Acid Neutralisation Capacity	mol/kg (+/-)	< 1	1.2	--	To be evaluated	To be evaluated

Eluate Analysis	**2:1 mg/l**	**8:1 mg/l**		**Cumulative 10:1 mg/kg**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg (mg/kg)**		
Arsenic[U]	< 0.01	< 0.01		< 0.2	0.5	2	25
Barium[U]	0.12	0.08		0.8	20	100	300
Cadmium[U]	< 0.0005	< 0.0005		< 0.02	0.04	1	5
Chromium[U]	< 0.005	< 0.005		< 0.20	0.5	10	70
Copper[U]	< 0.01	< 0.01		< 0.5	2	50	100
Mercury[U]	< 0.005	< 0.005		< 0.01	0.01	0.2	2
Molybdenum[U]	0.068	0.021		0.3	0.5	10	30
Nickel[U]	< 0.007	< 0.007		< 0.2	0.4	10	40
Lead[U]	< 0.005	< 0.005		< 0.2	0.5	10	50
Antimony[U]	< 0.005	< 0.005		< 0.06	0.06	0.7	5
Selenium[U]	< 0.005	< 0.005		< 0.1	0.1	0.5	7
Zinc[U]	0.010	< 0.005		< 0.2	4	50	200
Chloride[U]	14	2		35	800	15000	25000
Fluoride[U]	< 0.5	< 0.5		< 1	10	150	500
Sulphate[U]	1043	117		2273	**1000**	20000	50000
TDS	890	164		2507	4000	60000	100000
Phenol Index	< 0.01	< 0.01		< 0.5	1	-	-
DOC	2.6	1.9		19.8	500	800	1000
Leach Test Information							
Sample Mass (kg)	0.21						
Dry Matter (%)	84.2						
Moisture (%)	18.8						
Stage 1							
Volume Eluate L2 (litres)	0.32						
Filtered Eluate VE1 (litres)	0.21						

Results are expressed on a dry weight basis, after correction for moisture content where applicable
Stated limits are for guidance only and QTS Environmental cannot be held responsible for any discrepencies with current legislation
M Denotes MCERTS accredited test
U Denotes ISO17025 accredited test

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UKAS TESTING 4480

Waste Acceptance Criteria Analytical Certificate - BS EN 12457/3

QTS Environmental Report No: 15-38508	**Date Sampled**	01/12/15	
TerraConsult Ltd	**Time Sampled**	None Supplied	
Site Reference: Greenfields, Fintshire	**TP / BH No**	TP6	
Project / Job Ref: 2638	**Additional Refs**	4	
Order No: 14915	**Depth (m)**	1.30	
Reporting Date: 11/12/2015	**QTSE Sample No**	181571	

Determinand	**Unit**	**MDL**		**Landfill Waste Acceptance Criteria Limits**		
				Inert Waste Landfill	**Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill**	**Hazardous Waste Landfill**
TOC[MU]	%	< 0.1	2.7	3%	5%	6%
Loss on Ignition	%	< 0.01	6.20	--	--	10%
BTEX[MU]	mg/kg	< 0.05	< 0.05	6	--	--
Sum of PCBs	mg/kg	< 0.1	< 0.1	1	--	--
Mineral Oil[MU]	mg/kg	< 10	< 10	500	--	--
Total PAH[MU]	mg/kg	< 1.7	2.1	100	--	--
pH[MU]	pH Units	N/a	7.6	--	>6	--
Acid Neutralisation Capacity	mol/kg (+/-)	< 1	1.3	--	To be evaluated	To be evaluated

Eluate Analysis	**2:1 mg/l**	**8:1 mg/l**		**Cumulative 10:1 mg/kg**	**Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg (mg/kg)**		
Arsenic[U]	0.01	< 0.01		< 0.2	0.5	2	25
Barium[U]	0.17	0.07		0.9	20	100	300
Cadmium[U]	0.0009	0.0008		< 0.02	0.04	1	5
Chromium[U]	< 0.005	< 0.005		< 0.20	0.5	10	70
Copper[U]	0.05	0.03		< 0.5	2	50	100
Mercury[U]	< 0.005	< 0.005		< 0.01	0.01	0.2	2
Molybdenum[U]	0.183	0.054		0.7	**0.5**	10	30
Nickel[U]	0.013	< 0.007		< 0.2	0.4	10	40
Lead[U]	0.019	0.021		0.2	0.5	10	50
Antimony[U]	0.100	0.066		0.70	0.06	**0.7**	5
Selenium[U]	< 0.005	< 0.005		< 0.1	0.1	0.5	7
Zinc[U]	0.098	0.043		0.5	4	50	200
Chloride[U]	19	2		42	800	15000	25000
Fluoride[U]	0.9	0.6		6.5	10	150	500
Sulphate[U]	44	11		151	1000	20000	50000
TDS	231	110		1250	4000	60000	100000
Phenol Index	< 0.01	< 0.01		< 0.5	1	-	-
DOC	42.1	15.6		189	500	800	1000

Leach Test Information				
Sample Mass (kg)	0.20			
Dry Matter (%)	85.7			
Moisture (%)	16.8			
Stage 1				
Volume Eluate L2 (litres)	0.32			
Filtered Eluate VE1 (litres)	0.22			

Results are expressed on a dry weight basis, after correction for moisture content where applicable
Stated limits are for guidance only and QTS Environmental cannot be held responsible for any discrepencies with current legislation
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Soil Analysis Certificate - Sample Descriptions	
QTS Environmental Report No: 15-38508	
TerraConsult Ltd	
Site Reference: Greenfields, Fintshire	
Project / Job Ref: 2638	
Order No: 14915	
Reporting Date: 11/12/2015	

QTSE Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
181564	TP4	1	0.50	12.5	Brown sandy clay with vegetation and concrete
181565	TP4	2	0.70	19.3	Light brown sandy clay with stones
181566	TP4	4	1.60	14.8	Light brown sandy clay with concrete
181567	TP4	6	1.60	15.8	Light brown sand with concrete
181569	TP6	1	0.50	16.4	Brown sandy clay with vegetation
181570	TP6	2	1.30	16.4	Brown sandy clay with vegetation and stones
181571	TP6	4	1.30	14.3	Brown sandy clay with vegetation
181572	TP6	5	1.60	15.8	Brown sandy clay
181573	TP3	1	0.50	13.8	Blue sandy clay with concrete
181574	TP1	1	0.20	6.1	Brown sandy clay with stones
181575	TP2	1	0.30	11.6	Grey sandy clay with concrete and stones
181576	TP2	2	0.50	12.8	Grey sandy clay with concrete
181577	TP5	1	0.40	15.8	Brown sandy clay

Moisture content is part of procedure E003 & is not an accredited test

Insufficient Sample I/S

Unsuitable Sample U/S

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Soil Analysis Certificate - Methodology & Miscellaneous Information
QTS Environmental Report No: 15-38508
TerraConsult Ltd
Site Reference: Greenfields, Fintshire
Project / Job Ref: 2638
Order No: 14915
Reporting Date: 11/12/2015

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 – C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10 C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received

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Soil Analysis Certificate - Methodology & Miscellaneous Information
QTS Environmental Report No: 15-38508
TerraConsult Ltd
Site Reference: Greenfields, Fintshire
Project / Job Ref: 2638
Order No: 14915
Reporting Date: 11/12/2015

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Water	UF	Alkalinity	Determination of alkalinity by titration against hydrochloric acid using bromocresol green as the end point	E103
Water	UF	BTEX	Determination of BTEX by headspace GC-MS	E101
Water	F	Cations	Determination of cations by filtration followed by ICP-MS	E102
Water	UF	Chemical Oxygen Demand (COD)	Determination using a COD reactor followed by colorimetry	E112
Water	F	Chloride	Determination of chloride by filtration & analysed by ion chromatography	E109
Water	F	Chromium - Hexavalent	Determination of hexavalent chromium by acidification, addition of 1,5 diphenylcarbazide followed by co	E116
Water	UF	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E115
Water	UF	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E115
Water	UF	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E115
Water	UF	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through liquid:liquid extraction with cyclohexane	E111
Water	F	Diesel Range Organics (C10 - C24)	Determination of liquid:liquid extraction with hexane followed by GC-FID	E104
Water	F	Dissolved Organic Content (DOC)	Determination of DOC by filtration followed by low heat with persulphate addition followed by IR detect	E110
Water	UF	Electrical Conductivity	Determination of electrical conductivity by electrometric measurement	E123
Water	F	EPH (C10 – C40)	Determination of liquid:liquid extraction with hexane followed by GC-FID	E104
Water	F	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of liquid:liquid extraction with hexane followed by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E104
Water	F	Fluoride	Determination of Fluoride by filtration & analysed by ion chromatography	E109
Water	F	Hardness	Determination of Ca and Mg by ICP-MS followed by calculation	E102
Leachate	F	Leachate Preparation - NRA	Based on National Rivers Authority leaching test 1994	E301
Leachate	F	Leachate Preparation - WAC	Based on BS EN 12457 Pt1, 2, 3	E302
Water	F	Metals	Determination of metals by filtration followed by ICP-MS	E102
Water	F	Mineral Oil (C10 - C40)	Determination of liquid:liquid extraction with hexane followed by GI-FID	E104
Water	F	Nitrate	Determination of nitrate by filtration & analysed by ion chromatography	E109
Water	UF	Monohydric Phenol	Determination of phenols by distillation followed by colorimetry	E121
Water	F	PAH - Speciated (EPA 16)	Determination of PAH compounds by concentration through SPE cartridge, collection in dichloromethane followed by GC-MS	E105
Water	F	PCB - 7 Congeners	Determination of PCB compounds by concentration through SPE cartridge, collection in dichloromethane	E108
Water	UF	Petroleum Ether Extract (PEE)	Gravimetrically determined through liquid:liquid extraction with petroleum ether	E111
Water	UF	pH	Determination of pH by electrometric measurement	E107
Water	F	Phosphate	Determination of phosphate by filtration & analysed by ion chromatography	E109
Water	UF	Redox Potential	Determination of redox potential by electrometric measurement	E113
Water	F	Sulphate (as SO4)	Determination of sulphate by filtration & analysed by ion chromatography	E109
Water	UF	Sulphide	Determination of sulphide by distillation followed by colorimetry	E118
Water	F	SVOC	Determination of semi-volatile organic compounds by concentration through SPE cartridge, collection in dichloromethane followed by GC-MS	E106
Water	UF	Toluene Extractable Matter (TEM)	Gravimetrically determined through liquid:liquid extraction with toluene	E111
Water	UF	Total Organic Carbon (TOC)	Low heat with persulphate addition followed by IR detection	E110
Water	F	TPH CWG (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of liquid:liquid extraction with hexane, fractionating with SPE followed by GC-FID for C8 to C35. C5 to C8 by headspace GC-MS	E104
Water	F	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of liquid:liquid extraction with hexane, fractionating with SPE followed by GC-FID for C8 to C44. C5 to C8 by headspace GC-MS	E104
Water	UF	VOCs	Determination of volatile organic compounds by headspace GC-MS	E101
Water	UF	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E101

Key

F Filtered
UF Unfiltered

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QTS Environmental Report No: 15-38758

Site Reference:	Greenfields, Flintshire
Project / Job Ref:	2638
Order No:	14915
Sample Receipt Date:	04/12/2015
Sample Scheduled Date:	14/12/2015
Report Issue Number:	1
Reporting Date:	17/12/2015

Authorised by:

Russell Jarvis
Associate Director of Client Services
On behalf of QTS Environmental Ltd

Authorised by:

Kevin Old
Associate Director of Laboratory
On behalf of QTS Environmental Ltd

QTS Environmental Ltd
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Soil Analysis Certificate							
QTS Environmental Report No: 15-38758	**Date Sampled**	01/12/15					
TerraConsult Ltd	**Time Sampled**	None Supplied					
Site Reference: Greenfields, Flintshire	**TP / BH No**	TP6					
Project / Job Ref: 2638	**Additional Refs**	1					
Order No: 14915	**Depth (m)**	0.50					
Reporting Date: 17/12/2015	**QTSE Sample No**	182769					

Determinand	**Unit**	**RL**	**Accreditation**					
Asbestos Quantification	%	< 0.001	NONE	< 0.001				

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C
Analysis carried out on the dried sample is corrected for the stone content
Subcontracted analysis $^{(S)}$

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Soil Analysis Certificate - Methodology & Miscellaneous Information
QTS Environmental Report No: 15-38758
TerraConsult Ltd
Site Reference: Greenfields, Flintshire
Project / Job Ref: 2638
Order No: 14915
Reporting Date: 17/12/2015

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 – C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10 C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received

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QTS Environmental Report No: 15-38764

Site Reference:	Greenfields, Flintshire
Project / Job Ref:	2638
Order No:	14915
Sample Receipt Date:	04/12/2015
Sample Scheduled Date:	15/12/2015
Report Issue Number:	1
Reporting Date:	17/12/2015

Authorised by:

Russell Jarvis
Associate Director of Client Services
On behalf of QTS Environmental Ltd

Authorised by:

Kevin Old
Associate Director of Laboratory
On behalf of QTS Environmental Ltd

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Soil Analysis Certificate							
QTS Environmental Report No: 15-38764	Date Sampled	01/12/15	01/12/15	01/12/15	02/12/15	02/12/15
TerraConsult Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Greenfields, Flintshire	TP / BH No	WS1	WS3	WS4	WS2	WS8
Project / Job Ref: 2638	Additional Refs	1	1	1	1	1
Order No: 14915	Depth (m)	0.50 - 1.00	0.50 - 1.00	0.50 - 1.00	1.50 - 2.00	0.40 - 0.80
Reporting Date: 17/12/2015	QTSE Sample No	182802	182803	182804	182805	182806

Determinand	Unit	RL	Accreditation					
pH	pH Units	N/a	MCERTS	7.9	7.8	7.6	7.7	6.0
Total Cyanide	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2
Total Sulphate as SO_4	mg/kg	< 200	NONE		1605			3271
Total Sulphate as SO_4	%	< 0.02	NONE		0.16			0.33
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	MCERTS	344	258	1560	381	318
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	MCERTS	0.34	0.26	1.56	0.38	0.32
Organic Matter	%	< 0.1	MCERTS		1.8			2.1
Total Organic Carbon (TOC)	%	< 0.1	MCERTS		1			1.2
W/S Chloride (2:1)	mg/kg	< 1	MCERTS		133			26
W/S Chloride (2:1)	mg/l	< 0.5	MCERTS		66.3			12.9
Arsenic (As)	mg/kg	< 2	MCERTS	26	31	32	10	14
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	2.9	3.1	4.5	0.2	< 0.2
Chromium (Cr)	mg/kg	< 2	MCERTS	24	25	26	22	23
Copper (Cu)	mg/kg	< 4	MCERTS	287	160	194	18	176
Lead (Pb)	mg/kg	< 3	MCERTS	467	135	225	179	47
Mercury (Hg)	mg/kg	< 1	NONE	2.5	1.1	1.3	< 1	< 1
Nickel (Ni)	mg/kg	< 3	MCERTS	35	75	72	19	64
Selenium (Se)	mg/kg	< 3	NONE	6.1	< 3	< 3	< 3	< 3
Zinc (Zn)	mg/kg	< 3	MCERTS	798	852	1750	196	135
Total Phenols (monohydric)	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2
DRO (C10 - C24)	mg/kg	< 6	MCERTS	20	< 6	< 6	< 6	< 6
Oil (C25 - C40)	mg/kg	< 6	MCERTS	53	16	< 6	< 6	< 6
EPH (C10 - C40)	mg/kg	< 6	MCERTS	77		< 6	< 6	
Mineral Oil (C10 - C40)	mg/kg	< 10	MCERTS	< 10	< 10	< 10	< 10	< 10

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C
Analysis carried out on the dried sample is corrected for the stone content
Subcontracted analysis $^{(S)}$

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Soil Analysis Certificate							
QTS Environmental Report No: 15-38764	**Date Sampled**	02/12/15					
TerraConsult Ltd	**Time Sampled**	None Supplied					
Site Reference: Greenfields, Flintshire	**TP / BH No**	WS9					
Project / Job Ref: 2638	**Additional Refs**	1					
Order No: 14915	**Depth (m)**	0.50 - 1.00					
Reporting Date: 17/12/2015	**QTSE Sample No**	182807					

Determinand	Unit	RL	Accreditation					
pH	pH Units	N/a	MCERTS	3.0				
Total Cyanide	mg/kg	< 2	NONE	< 2				
Total Sulphate as SO_4	mg/kg	< 200	NONE					
Total Sulphate as SO_4	%	< 0.02	NONE					
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	MCERTS	1580				
W/S Sulphate as SO_4 (2:1)	g/l	< 0.01	MCERTS	1.58				
Organic Matter	%	< 0.1	MCERTS					
Total Organic Carbon (TOC)	%	< 0.1	MCERTS					
W/S Chloride (2:1)	mg/kg	< 1	MCERTS					
W/S Chloride (2:1)	mg/l	< 0.5	MCERTS					
Arsenic (As)	mg/kg	< 2	MCERTS	7				
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	< 0.2				
Chromium (Cr)	mg/kg	< 2	MCERTS	21				
Copper (Cu)	mg/kg	< 4	MCERTS	52				
Lead (Pb)	mg/kg	< 3	MCERTS	63				
Mercury (Hg)	mg/kg	< 1	NONE	< 1				
Nickel (Ni)	mg/kg	< 3	MCERTS	9				
Selenium (Se)	mg/kg	< 3	NONE	< 3				
Zinc (Zn)	mg/kg	< 3	MCERTS	78				
Total Phenols (monohydric)	mg/kg	< 2	NONE	< 2				
DRO (C10 - C24)	mg/kg	< 6	MCERTS	< 6				
Oil (C25 - C40)	mg/kg	< 6	MCERTS	< 6				
EPH (C10 - C40)	mg/kg	< 6	MCERTS	< 6				
Mineral Oil (C10 - C40)	mg/kg	< 10	MCERTS	< 10				

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C
Analysis carried out on the dried sample is corrected for the stone content
Subcontracted analysis $^{(S)}$

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Soil Analysis Certificate - Speciated PAHs							
QTS Environmental Report No: 15-38764	Date Sampled	01/12/15	01/12/15	01/12/15	02/12/15	02/12/15
TerraConsult Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Greenfields, Flintshire	TP / BH No	WS1	WS3	WS4	WS2	WS8
Project / Job Ref: 2638	Additional Refs	1	1	1	1	1
Order No: 14915	Depth (m)	0.50 - 1.00	0.50 - 1.00	0.50 - 1.00	1.50 - 2.00	0.40 - 0.80
Reporting Date: 17/12/2015	QTSE Sample No	182802	182803	182804	182805	182806

Determinand	Unit	RL	Accreditation					
Naphthalene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluorene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Phenanthrene	mg/kg	< 0.1	MCERTS	0.48	< 0.1	< 0.1	< 0.1	< 0.1
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluoranthene	mg/kg	< 0.1	MCERTS	1.49	0.30	< 0.1	< 0.1	< 0.1
Pyrene	mg/kg	< 0.1	MCERTS	1.30	0.24	< 0.1	< 0.1	< 0.1
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	0.91	0.16	< 0.1	< 0.1	< 0.1
Chrysene	mg/kg	< 0.1	MCERTS	0.93	0.24	< 0.1	< 0.1	< 0.1
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	1.15	0.24	< 0.1	< 0.1	< 0.1
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	0.50	0.13	< 0.1	< 0.1	< 0.1
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	0.82	0.16	< 0.1	< 0.1	< 0.1
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	0.49	< 0.1	< 0.1	< 0.1	< 0.1
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	0.44	< 0.1	< 0.1	< 0.1	< 0.1
Coronene	mg/kg	< 0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Total Oily Waste PAHs	mg/kg	< 1	MCERTS	4.8	< 1	< 1	< 1	< 1
Total Dutch 10 PAHs	mg/kg	< 1	MCERTS	6	< 1	< 1	< 1	< 1
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	8.5	< 1.6	< 1.6	< 1.6	< 1.6
Total WAC-17 PAHs	mg/kg	< 1.7	NONE	8.5	< 1.7	< 1.7	< 1.7	< 1.7

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

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Soil Analysis Certificate - Speciated PAHs							
QTS Environmental Report No: 15-38764	Date Sampled	02/12/15					
TerraConsult Ltd	Time Sampled	None Supplied					
Site Reference: Greenfields, Flintshire	TP / BH No	WS9					
Project / Job Ref: 2638	Additional Refs	1					
Order No: 14915	Depth (m)	0.50 - 1.00					
Reporting Date: 17/12/2015	QTSE Sample No	182807					

Determinand	Unit	RL	Accreditation					
Naphthalene	mg/kg	< 0.1	MCERTS	< 0.1				
Acenaphthylene	mg/kg	< 0.1	MCERTS	< 0.1				
Acenaphthene	mg/kg	< 0.1	MCERTS	< 0.1				
Fluorene	mg/kg	< 0.1	MCERTS	< 0.1				
Phenanthrene	mg/kg	< 0.1	MCERTS	< 0.1				
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1				
Fluoranthene	mg/kg	< 0.1	MCERTS	0.24				
Pyrene	mg/kg	< 0.1	MCERTS	0.18				
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	< 0.1				
Chrysene	mg/kg	< 0.1	MCERTS	0.20				
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	0.22				
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1				
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	< 0.1				
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	< 0.1				
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	< 0.1				
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	< 0.1				
Coronene	mg/kg	< 0.1	NONE	< 0.1				
Total Oily Waste PAHs	mg/kg	< 1	MCERTS	< 1				
Total Dutch 10 PAHs	mg/kg	< 1	MCERTS	< 1				
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	< 1.6				
Total WAC-17 PAHs	mg/kg	< 1.7	NONE	< 1.7				

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

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Soil Analysis Certificate - TPH CWG Banded							
QTS Environmental Report No: 15-38764	Date Sampled	01/12/15	02/12/15				
TerraConsult Ltd	Time Sampled	None Supplied	None Supplied				
Site Reference: Greenfields, Flintshire	TP / BH No	WS3	WS8				
Project / Job Ref: 2638	Additional Refs	1	1				
Order No: 14915	Depth (m)	0.50 - 1.00	0.40 - 0.80				
Reporting Date: 17/12/2015	QTSE Sample No	182803	182806				

Determinand	Unit	RL	Accreditation					
Aliphatic >C5 - C6	mg/kg	< 0.01	NONE	< 0.01	< 0.01			
Aliphatic >C6 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05			
Aliphatic >C8 - C10	mg/kg	< 2	MCERTS	< 2	< 2			
Aliphatic >C10 - C12	mg/kg	< 2	MCERTS	< 2	< 2			
Aliphatic >C12 - C16	mg/kg	< 3	MCERTS	< 3	< 3			
Aliphatic >C16 - C21	mg/kg	< 3	MCERTS	< 3	< 3			
Aliphatic >C21 - C34	mg/kg	< 10	MCERTS	< 10	< 10			
Aliphatic (C5 - C34)	mg/kg	< 21	NONE	< 21	< 21			
Aromatic >C5 - C7	mg/kg	< 0.01	NONE	< 0.01	< 0.01			
Aromatic >C7 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05			
Aromatic >C8 - C10	mg/kg	< 2	MCERTS	< 2	< 2			
Aromatic >C10 - C12	mg/kg	< 2	MCERTS	< 2	< 2			
Aromatic >C12 - C16	mg/kg	< 2	MCERTS	< 2	< 2			
Aromatic >C16 - C21	mg/kg	< 3	MCERTS	3	< 3			
Aromatic >C21 - C35	mg/kg	< 10	MCERTS	< 10	< 10			
Aromatic (C5 - C35)	mg/kg	< 21	NONE	< 21	< 21			
Total >C5 - C35	mg/kg	< 42	NONE	< 42	< 42			

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

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Soil Analysis Certificate - BTEX / MTBE							
QTS Environmental Report No: 15-38764	Date Sampled	01/12/15	01/12/15	01/12/15	02/12/15	02/12/15
TerraConsult Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Greenfields, Flintshire	TP / BH No	WS1	WS3	WS4	WS2	WS8
Project / Job Ref: 2638	Additional Refs	1	1	1	1	1
Order No: 14915	Depth (m)	0.50 - 1.00	0.50 - 1.00	0.50 - 1.00	1.50 - 2.00	0.40 - 0.80
Reporting Date: 17/12/2015	QTSE Sample No	182802	182803	182804	182805	182806

Determinand	Unit	RL	Accreditation					
Benzene	ug/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
Toluene	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5
Ethylbenzene	ug/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
p & m-xylene	ug/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
o-xylene	ug/kg	< 2	MCERTS	< 2	< 2	< 2	< 2	< 2
MTBE	ug/kg	< 5	MCERTS	< 5	< 5	< 5	< 5	< 5

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

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Soil Analysis Certificate - BTEX / MTBE							
QTS Environmental Report No: 15-38764	Date Sampled	02/12/15					
TerraConsult Ltd	Time Sampled	None Supplied					
Site Reference: Greenfields, Flintshire	TP / BH No	WS9					
Project / Job Ref: 2638	Additional Refs	1					
Order No: 14915	Depth (m)	0.50 - 1.00					
Reporting Date: 17/12/2015	QTSE Sample No	182807					

Determinand	Unit	RL	Accreditation					
Benzene	ug/kg	< 2	MCERTS	< 2				
Toluene	ug/kg	< 5	MCERTS	< 5				
Ethylbenzene	ug/kg	< 2	MCERTS	< 2				
p & m-xylene	ug/kg	< 2	MCERTS	< 2				
o-xylene	ug/kg	< 2	MCERTS	< 2				
MTBE	ug/kg	< 5	MCERTS	< 5				

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

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Soil Analysis Certificate - Volatile Organic Compounds (VOC)							
QTS Environmental Report No: 15-38764	Date Sampled	01/12/15	02/12/15			
TerraConsult Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Greenfields, Flintshire	TP / BH No	WS4	WS8			
Project / Job Ref: 2638	Additional Refs	1	1			
Order No: 14915	Depth (m)	0.50 - 1.00	0.40 - 0.80			
Reporting Date: 17/12/2015	QTSE Sample No	182804	182806			

Determinand	Unit	RL	Accreditation					
Dichlorodifluoromethane	ug/kg	< 5	MCERTS	< 5	< 5			
Vinyl Chloride	ug/kg	< 5	MCERTS	< 5	< 5			
Chloromethane	ug/kg	< 10	MCERTS	< 10	< 10			
Chloroethane	ug/kg	< 5	MCERTS	< 5	< 5			
Bromomethane	ug/kg	< 10	MCERTS	< 10	< 10			
Trichlorofluoromethane	ug/kg	< 5	MCERTS	< 5	< 5			
1,1-Dichloroethene	ug/kg	< 5	MCERTS	< 5	< 5			
MTBE	ug/kg	< 5	MCERTS	< 5	< 5			
trans-1,2-Dichloroethene	ug/kg	< 5	MCERTS	< 5	< 5			
1,1-Dichloroethane	ug/kg	< 5	MCERTS	< 5	< 5			
cis-1,2-Dichloroethene	ug/kg	< 5	MCERTS	< 5	< 5			
2,2-Dichloropropane	ug/kg	< 5	MCERTS	< 5	< 5			
Chloroform	ug/kg	< 5	MCERTS	< 5	< 5			
Bromochloromethane	ug/kg	< 5	MCERTS	< 5	< 5			
1,1,1-Trichloroethane	ug/kg	< 5	MCERTS	< 5	< 5			
1,1-Dichloropropene	ug/kg	< 10	MCERTS	< 10	< 10			
Carbon Tetrachloride	ug/kg	< 5	MCERTS	< 5	< 5			
1,2-Dichloroethane	ug/kg	< 5	MCERTS	< 5	< 5			
Benzene	ug/kg	< 2	MCERTS	< 2	< 2			
1,2-Dichloropropane	ug/kg	< 5	MCERTS	< 5	< 5			
Trichloroethene	ug/kg	< 5	MCERTS	< 5	< 5			
Bromodichloromethane	ug/kg	< 5	MCERTS	< 5	< 5			
Dibromomethane	ug/kg	< 5	MCERTS	< 5	< 5			
TAME	ug/kg	< 5	MCERTS	< 5	< 5			
cis-1,3-Dichloropropene	ug/kg	< 5	MCERTS	< 5	< 5			
Toluene	ug/kg	< 5	MCERTS	< 5	< 5			
trans-1,3-Dichloropropene	ug/kg	< 5	MCERTS	< 5	< 5			
1,1,2-Trichloroethane	ug/kg	< 10	MCERTS	< 10	< 10			
1,3-Dichloropropane	ug/kg	< 5	MCERTS	< 5	< 5			
Tetrachloroethene	ug/kg	< 5	MCERTS	< 5	< 5			
Dibromochloromethane	ug/kg	< 5	MCERTS	< 5	< 5			
1,2-Dibromoethane	ug/kg	< 5	MCERTS	< 5	< 5			
Chlorobenzene	ug/kg	< 5	MCERTS	< 5	< 5			
1,1,1,2-Tetrachloroethane	ug/kg	< 5	MCERTS	< 5	< 5			
Ethyl Benzene	ug/kg	< 2	MCERTS	< 2	< 2			
m,p-Xylene	ug/kg	< 2	MCERTS	< 2	< 2			
o-Xylene	ug/kg	< 2	MCERTS	< 2	< 2			
Styrene	ug/kg	< 5	MCERTS	< 5	< 5			
Bromoform	ug/kg	< 10	MCERTS	< 10	< 10			
Isopropylbenzene	ug/kg	< 5	MCERTS	< 5	< 5			
1,1,2,2-Tetrachloroethane	ug/kg	< 5	MCERTS	< 5	< 5			
1,2,3-Trichloropropane	ug/kg	< 5	MCERTS	< 5	< 5			
n-Propylbenzene	ug/kg	< 5	MCERTS	< 5	< 5			
Bromobenzene	ug/kg	< 5	MCERTS	< 5	< 5			
2-Chlorotoluene	ug/kg	< 5	MCERTS	< 5	< 5			
1,3,5-Trimethylbenzene	ug/kg	< 5	MCERTS	< 5	< 5			
4-Chlorotoluene	ug/kg	< 5	MCERTS	< 5	< 5			
tert-Butylbenzene	ug/kg	< 5	MCERTS	< 5	< 5			
1,2,4-Trimethylbenzene	ug/kg	< 5	MCERTS	< 5	< 5			
sec-Butylbenzene	ug/kg	< 5	MCERTS	< 5	< 5			
p-Isopropyltoluene	ug/kg	< 5	MCERTS	< 5	< 5			
1,3-Dichlorobenzene	ug/kg	< 5	MCERTS	< 5	< 5			
1,4-Dichlorobenzene	ug/kg	< 5	MCERTS	< 5	< 5			
n-Butylbenzene	ug/kg	< 5	MCERTS	< 5	< 5			
1,2-Dichlorobenzene	ug/kg	< 5	MCERTS	< 5	< 5			
,2-Dibromo-3-chloropropane	ug/kg	< 10	MCERTS	< 10	< 10			
Hexachlorobutadiene	ug/kg	< 5	MCERTS	< 5	< 5			

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

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Soil Analysis Certificate - Semi Volatile Organic Compounds (SVOC)							
QTS Environmental Report No: 15-38764	Date Sampled	01/12/15	02/12/15			
TerraConsult Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Greenfields, Flintshire	TP / BH No	WS4	WS8			
Project / Job Ref: 2638	Additional Refs	1	1			
Order No: 14915	Depth (m)	0.50 - 1.00	0.40 - 0.80			
Reporting Date: 17/12/2015	QTSE Sample No	182804	182806			

Determinand	Unit	RL	Accreditation					
Phenol	mg/kg	< 0.1	NONE	< 0.1	< 0.1			
1,2,4-Trichlorobenzene	mg/kg	< 0.1	ISO17025	< 0.1	< 0.1			
2-Nitrophenol	mg/kg	< 0.1	NONE	< 0.1	< 0.1			
Nitrobenzene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1			
0-Cresol	mg/kg	< 0.1	NONE	< 0.1	< 0.1			
bis(2-chloroethoxy)methane	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1			
bis(2-chloroethyl)ether	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1			
2,4-Dichlorophenol	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1			
2-Chlorophenol	mg/kg	< 0.1	ISO17025	< 0.1	< 0.1			
1,3-Dichlorobenzene	mg/kg	< 0.1	ISO17025	< 0.1	< 0.1			
1,4-Dichlorobenzene	mg/kg	< 0.1	ISO17025	< 0.1	< 0.1			
1,2-Dichlorobenzene	mg/kg	< 0.1	ISO17025	< 0.1	< 0.1			
2,4-Dimethylphenol	mg/kg	< 0.15	ISO17025	< 0.15	< 0.15			
Isophorone	mg/kg	< 0.1	NONE	< 0.1	< 0.1			
Hexachloroethane	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1			
p-Cresol	mg/kg	< 0.15	MCERTS	< 0.15	< 0.15			
2,4,6-Trichlorophenol	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1			
2,4,5-Trichlorophenol	mg/kg	< 0.15	MCERTS	< 0.15	< 0.15			
2-Nitroaniline	mg/kg	< 0.1	NONE	< 0.1	< 0.1			
4-Chloro-3-methylphenol	mg/kg	< 0.1	NONE	< 0.1	< 0.1			
2-Methylnaphthalene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1			
Hexachlorocyclopentadiene	mg/kg	< 0.1	NONE	< 0.1	< 0.1			
Hexachlorobutadiene	mg/kg	< 0.1	ISO17025	< 0.1	< 0.1			
2,6-Dinitrotoluene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1			
Dimethyl phthalate	mg/kg	< 0.1	NONE	< 0.1	< 0.1			
2-Chloronaphthalene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1			
4-Chloroanaline	mg/kg	< 0.15	NONE	< 0.15	< 0.15			
4-Nitrophenol	mg/kg	< 0.1	NONE	< 0.1	< 0.1			
4-Chlorophenyl phenyl ether	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1			
3-Nitroaniline	mg/kg	< 0.1	NONE	< 0.1	< 0.1			
4-Nitroaniline	mg/kg	< 0.1	NONE	< 0.1	< 0.1			
4-Bromophenyl phenyl ether	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1			
Hexachlorobenzene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1			
2,4-Dinitrotoluene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1			
Diethyl phthalate	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1			
Dibenzofuran	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1			
Azobenzene	mg/kg	< 0.1	NONE	< 0.1	< 0.1			
Dibutyl phthalate	mg/kg	< 0.1	ISO17025	< 0.1	< 0.1			
Carbazole	mg/kg	< 0.1	ISO17025	< 0.1	< 0.1			
bis(2-ethylhexyl)phthalate	mg/kg	< 0.15	MCERTS	< 0.15	< 0.15			
Benzyl butyl phthalate	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1			
Di-n-octyl phthalate	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1			

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30^{O}C

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Soil Analysis Certificate - Sample Descriptions	
QTS Environmental Report No: 15-38764	
TerraConsult Ltd	
Site Reference: Greenfields, Flintshire	
Project / Job Ref: 2638	
Order No: 14915	
Reporting Date: 17/12/2015	

QTSE Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
$ 182802	WS1	1	0.50 - 1.00	16.1	Brown clayey sand with stones
$ 182803	WS3	1	0.50 - 1.00	15.6	Brown clayey gravel with stones
$ 182804	WS4	1	0.50 - 1.00	13.2	Brown gravelly sand with stones
$ 182805	WS2	1	1.50 - 2.00	19.6	Brown clay
$ 182806	WS8	1	0.40 - 0.80	18	Brown sandy gravel with stones
$ 182807	WS9	1	0.50 - 1.00	20.3	Light brown clay

Moisture content is part of procedure E003 & is not an accredited test

Insufficient Sample I/S

Unsuitable Sample U/S

$ samples exceeded recommended holding times

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Soil Analysis Certificate - Methodology & Miscellaneous Information
QTS Environmental Report No: 15-38764
TerraConsult Ltd
Site Reference: Greenfields, Flintshire
Project / Job Ref: 2638
Order No: 14915
Reporting Date: 17/12/2015

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 – C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10 C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received

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QTS Environmental Report No: 15-39027

Site Reference:	Greenfields
Project / Job Ref:	None Supplied
Order No:	None Supplied
Sample Receipt Date:	18/12/2015
Sample Scheduled Date:	21/12/2015
Report Issue Number:	1
Reporting Date:	04/01/2016

Authorised by:

Russell Jarvis
Associate Director of Client Services
On behalf of QTS Environmental Ltd

Authorised by:

Kevin Old
Associate Director of Laboratory
On behalf of QTS Environmental Ltd

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UKAS TESTING
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Water Analysis Certificate						
QTS Environmental Report No: 15-39027	**Date Sampled**	16/12/15	16/12/15			
TerraConsult Ltd	**Time Sampled**	None Supplied	None Supplied			
Site Reference: Greenfields	**TP / BH No**	WS4	WS9			
Project / Job Ref: None Supplied	**Additional Refs**	None Supplied	None Supplied			
Order No: None Supplied	**Depth (m)**	None Supplied	None Supplied			
Reporting Date: 04/01/2016	**QTSE Sample No**	184041	184042			

Determinand	**Unit**	**RL**	**Accreditation**					
pH	pH Units	N/a	**ISO17025**	7.0	7.3			
Electrical Conductivity	uS/cm	< 5	NONE	1360	2270			
Total Cyanide	ug/l	< 5	NONE	17	< 5			
Sulphate as SO_4	mg/l	< 1	**ISO17025**	1220	1380			
Ammonium as NH_4	ug/l	< 50	NONE	107	< 50			
Ammonium as NH_4	mg/l	< 0.05	NONE	0.11	< 0.05			
Chloride	mg/l	< 1	**ISO17025**	1710	34			
Nitrate as NO_3	mg/l	< 0.5	**ISO17025**	71.2	4.5			
Alkalinity	mgCaCO3/l	< 20	NONE	370	290			
Hardness - Total	mgCaCO3/l	< 1	NONE	1520	1340			
Arsenic (dissolved)	ug/l	< 5	**ISO17025**	< 5	< 5			
Boron (dissolved)	ug/l	< 5	**ISO17025**	354	66			
Cadmium (dissolved)	ug/l	< 0.4	**ISO17025**	25.1	2.5			
Chromium (dissolved)	ug/l	< 5	**ISO17025**	< 5	< 5			
Copper (dissolved)	ug/l	< 5	**ISO17025**	23	< 5			
Lead (dissolved)	ug/l	< 5	**ISO17025**	< 5	< 5			
Mercury (dissolved)	ug/l	< 0.05	**ISO17025**	< 0.05	< 0.05			
Nickel (dissolved)	ug/l	< 5	**ISO17025**	81	11			
Selenium (dissolved)	ug/l	< 5	**ISO17025**	< 5	24			
Zinc (dissolved)	ug/l	< 2	**ISO17025**	890	99			
Total Phenols (monohydric)	ug/l	< 10	NONE	< 10	< 10			

Subcontracted analysis (S)
Insufficient sample I/S
Unsuitable Sample U/S

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Water Analysis Certificate - Speciated PAH						
QTS Environmental Report No: 15-39027	**Date Sampled**	16/12/15	16/12/15			
TerraConsult Ltd	**Time Sampled**	None Supplied	None Supplied			
Site Reference: Greenfields	**TP / BH No**	WS4	WS9			
Project / Job Ref: None Supplied	**Additional Refs**	None Supplied	None Supplied			
Order No: None Supplied	**Depth (m)**	None Supplied	None Supplied			
Reporting Date: 04/01/2016	**QTSE Sample No**	184041	184042			

Determinand	**Unit**	**RL**	**Accreditation**					
Naphthalene	ug/l	< 0.01	NONE	1.74	1.35			
Acenaphthylene	ug/l	< 0.01	NONE	< 0.01	< 0.01			
Acenaphthene	ug/l	< 0.01	NONE	0.06	0.03			
Fluorene	ug/l	< 0.01	NONE	0.08	0.04			
Phenanthrene	ug/l	< 0.01	NONE	0.17	0.08			
Anthracene	ug/l	< 0.01	NONE	0.02	0.02			
Fluoranthene	ug/l	< 0.01	NONE	0.05	0.03			
Pyrene	ug/l	< 0.01	NONE	0.04	0.03			
Benzo(a)anthracene	ug/l	< 0.01	NONE	< 0.01	< 0.01			
Chrysene	ug/l	< 0.01	NONE	< 0.01	< 0.01			
Benzo(b)fluoranthene	ug/l	< 0.01	NONE	< 0.01	< 0.01			
Benzo(k)fluoranthene	ug/l	< 0.01	NONE	< 0.01	< 0.01			
Benzo(a)pyrene	ug/l	< 0.01	NONE	< 0.01	< 0.01			
Indeno(1,2,3-cd)pyrene	ug/l	< 0.01	NONE	< 0.01	< 0.01			
Dibenz(a,h)anthracene	ug/l	< 0.01	NONE	< 0.01	< 0.01			
Benzo(ghi)perylene	ug/l	< 0.01	NONE	< 0.01	< 0.01			
Total EPA-16 PAHs	ug/l	< 0.01	NONE	2.16	1.58			

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Water Analysis Certificate - TPH CWG Banded						
QTS Environmental Report No: 15-39027	**Date Sampled**	16/12/15	16/12/15			
TerraConsult Ltd	**Time Sampled**	None Supplied	None Supplied			
Site Reference: Greenfields	**TP / BH No**	WS4	WS9			
Project / Job Ref: None Supplied	**Additional Refs**	None Supplied	None Supplied			
Order No: None Supplied	**Depth (m)**	None Supplied	None Supplied			
Reporting Date: 04/01/2016	**QTSE Sample No**	184041	184042			

Determinand	**Unit**	**RL**	**Accreditation**					
Aliphatic >C5 - C6	ug/l	< 10	NONE	< 10	< 10			
Aliphatic >C6 - C8	ug/l	< 10	NONE	< 10	< 10			
Aliphatic >C8 - C10	ug/l	< 10	NONE	< 10	< 10			
Aliphatic >C10 - C12	ug/l	< 10	NONE	< 10	< 10			
Aliphatic >C12 - C16	ug/l	< 10	NONE	< 10	< 10			
Aliphatic >C16 - C21	ug/l	< 10	NONE	< 10	< 10			
Aliphatic >C21 - C34	ug/l	< 10	NONE	< 10	< 10			
Aliphatic (C5 - C34)	ug/l	< 70	NONE	< 70	< 70			
Aromatic >C5 - C7	ug/l	< 10	NONE	< 10	< 10			
Aromatic >C7 - C8	ug/l	< 10	NONE	< 10	< 10			
Aromatic >C8 - C10	ug/l	< 10	NONE	< 10	< 10			
Aromatic >C10 - C12	ug/l	< 10	NONE	< 10	< 10			
Aromatic >C12 - C16	ug/l	< 10	NONE	< 10	< 10			
Aromatic >C16 - C21	ug/l	< 10	NONE	< 10	< 10			
Aromatic >C21 - C35	ug/l	< 10	NONE	< 10	< 10			
Aromatic (C5 - C35)	ug/l	< 70	NONE	< 70	< 70			
Total >C5 - C35	ug/l	< 140	NONE	< 140	< 140			

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Water Analysis Certificate - BTEX / MTBE						
QTS Environmental Report No: 15-39027	**Date Sampled**	16/12/15	16/12/15			
TerraConsult Ltd	**Time Sampled**	None Supplied	None Supplied			
Site Reference: Greenfields	**TP / BH No**	WS4	WS9			
Project / Job Ref: None Supplied	**Additional Refs**	None Supplied	None Supplied			
Order No: None Supplied	**Depth (m)**	None Supplied	None Supplied			
Reporting Date: 04/01/2016	**QTSE Sample No**	184041	184042			

Determinand	Unit	RL	Accreditation					
Benzene	ug/l	< 1	**ISO17025**	< 1	< 1			
Toluene	ug/l	< 5	**ISO17025**	< 5	< 5			
Ethylbenzene	ug/l	< 5	**ISO17025**	< 5	< 5			
p & m-xylene	ug/l	< 10	**ISO17025**	< 10	< 10			
o-xylene	ug/l	< 5	**ISO17025**	< 5	< 5			
MTBE	ug/l	< 10	**ISO17025**	< 10	< 10			

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Soil Analysis Certificate - Methodology & Miscellaneous Information
QTS Environmental Report No: 15-39027
TerraConsult Ltd
Site Reference: Greenfields
Project / Job Ref: None Supplied
Order No: None Supplied
Reporting Date: 04/01/2016

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Water	UF	Alkalinity	Determination of alkalinity by titration against hydrochloric acid using bromocresol green as the end point	E103
Water	UF	BTEX	Determination of BTEX by headspace GC-MS	E101
Water	F	Cations	Determination of cations by filtration followed by ICP-MS	E102
Water	UF	Chemical Oxygen Demand (COD)	Determination using a COD reactor followed by colorimetry	E112
Water	F	Chloride	Determination of chloride by filtration & analysed by ion chromatography	E109
Water	F	Chromium - Hexavalent	Determination of hexavalent chromium by acidification, addition of 1,5 diphenylcarbazide followed by	E116
Water	UF	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E115
Water	UF	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E115
Water	UF	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E115
Water	UF	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through liquid:liquid extraction with cyclohexane	E111
Water	F	Diesel Range Organics (C10 - C24)	Determination of liquid:liquid extraction with hexane followed by GC-FID	E104
Water	F	Dissolved Organic Content (DOC)	Determination of DOC by filtration followed by low heat with persulphate addition followed by IR dete	E110
Water	UF	Electrical Conductivity	Determination of electrical conductivity by electrometric measurement	E123
Water	F	EPH (C10 – C40)	Determination of liquid:liquid extraction with hexane followed by GC-FID	E104
Water	F	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of liquid:liquid extraction with hexane followed by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E104
Water	F	Fluoride	Determination of Fluoride by filtration & analysed by ion chromatography	E109
Water	F	Hardness	Determination of Ca and Mg by ICP-MS followed by calculation	E102
Leachate	F	Leachate Preparation - NRA	Based on National Rivers Authority leaching test 1994	E301
Leachate	F	Leachate Preparation - WAC	Based on BS EN 12457 Pt1, 2, 3	E302
Water	F	Metals	Determination of metals by filtration followed by ICP-MS	E102
Water	F	Mineral Oil (C10 - C40)	Determination of liquid:liquid extraction with hexane followed by GI-FID	E104
Water	F	Nitrate	Determination of nitrate by filtration & analysed by ion chromatography	E109
Water	UF	Monohydric Phenol	Determination of phenols by distillation followed by colorimetry	E121
Water	F	PAH - Speciated (EPA 16)	Determination of PAH compounds by concentration through SPE cartridge, collection in dichloromethane followed by GC-MS	E105
Water	F	PCB - 7 Congeners	Determination of PCB compounds by concentration through SPE cartridge, collection in dichlorometha	E108
Water	UF	Petroleum Ether Extract (PEE)	Gravimetrically determined through liquid:liquid extraction with petroleum ether	E111
Water	UF	pH	Determination of pH by electrometric measurement	E107
Water	F	Phosphate	Determination of phosphate by filtration & analysed by ion chromatography	E109
Water	UF	Redox Potential	Determination of redox potential by electrometric measurement	E113
Water	F	Sulphate (as SO4)	Determination of sulphate by filtration & analysed by ion chromatography	E109
Water	UF	Sulphide	Determination of sulphide by distillation followed by colorimetry	E118
Water	F	SVOC	Determination of semi-volatile organic compounds by concentration through SPE cartridge, collection in dichloromethane followed by GC-MS	E106
Water	UF	Toluene Extractable Matter (TEM)	Gravimetrically determined through liquid:liquid extraction with toluene	E111
Water	UF	Total Organic Carbon (TOC)	Low heat with persulphate addition followed by IR detection	E110
Water	F	TPH CWG (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of liquid:liquid extraction with hexane, fractionating with SPE followed by GC-FID for C8 to C35. C5 to C8 by headspace GC-MS	E104
Water	F	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of liquid:liquid extraction with hexane, fractionating with SPE followed by GC-FID for C8 to C44. C5 to C8 by headspace GC-MS	E104
Water	UF	VOCs	Determination of volatile organic compounds by headspace GC-MS	E101
Water	UF	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E101

Key

F Filtered
UF Unfiltered

APPENDIX G

Laboratory Geotechnical Test Results

PSL
Professional Soils Laboratory

LABORATORY REPORT

UKAS TESTING
4043

Contract Number: PSL15/6086

Report Date: 05 January 2016

Client's Reference: 2638

Client Name: Terra Consult
Bold Business Centre
Bold Lane, Sutton
St Helens
Merseyside
WA9 4TX

For the attention of: Chris Eccles

Contract Title: Greenfields, Flintshire

Date Received: 17/12/2015
Date Commenced: 17/12/2015
Date Completed: 5/1/2016

Notes: Opinions and Interpretations are outside the UKAS Accreditation

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

R Gunson (Director)
A Watkins (Director)
M Beastall (Laboratory Manager)

D Lambe (Senior Technician)
S Royle (Senior Technician)

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SUMMARY OF LABORATORY SOIL DESCRIPTIONS

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Description of Sample
TP1		B	1.10		MADE GROUND dark brown slightly sandy clayey gravel with cobbles.
TP3		B	0.30		MADE GROUND grey sandy clayey gravel.
TP3		B	1.30		MADE GROUND brown gravelly very sandy very silty clay.
TP4		B	0.80		MADE GROUND brown very sandy clayey gravel.
TP4		B	1.90		MADE GROUND brown very gravelly very sandy very silty clay.

UKAS TESTING
4043

PSL
Professional Soils Laboratory

Checked / Approved		Date	05/01/16	Contract No:
Greenfields, Flintshire				PSL15/6086
				Client Ref:
				2638

SUMMARY OF SOIL CLASSIFICATION TESTS

(BS1377 : PART 2 : 1990)

Hole Number	Sample Number	Sample Type	Top Depth m	Base Depth m	Moisture Content % Clause 3.2	Linear Shrinkage % Clause 6.5	Particle Density Mg/m^3 Clause 8.2	Liquid Limit % Clause 4.3/4	Plastic Limit % Clause 5.3	Plasticity Index % Clause 5.4	Passing .425mm %	Remarks
TP3		B	1.30		24			38	20	18	81	Intermediate plasticity CI.
TP4		B	1.90		26			39	21	18	70	Intermediate plasticity CI.

SYMBOLS : **NP : Non Plastic** *** : Liquid Limit and Plastic Limit Wet Sieved.**

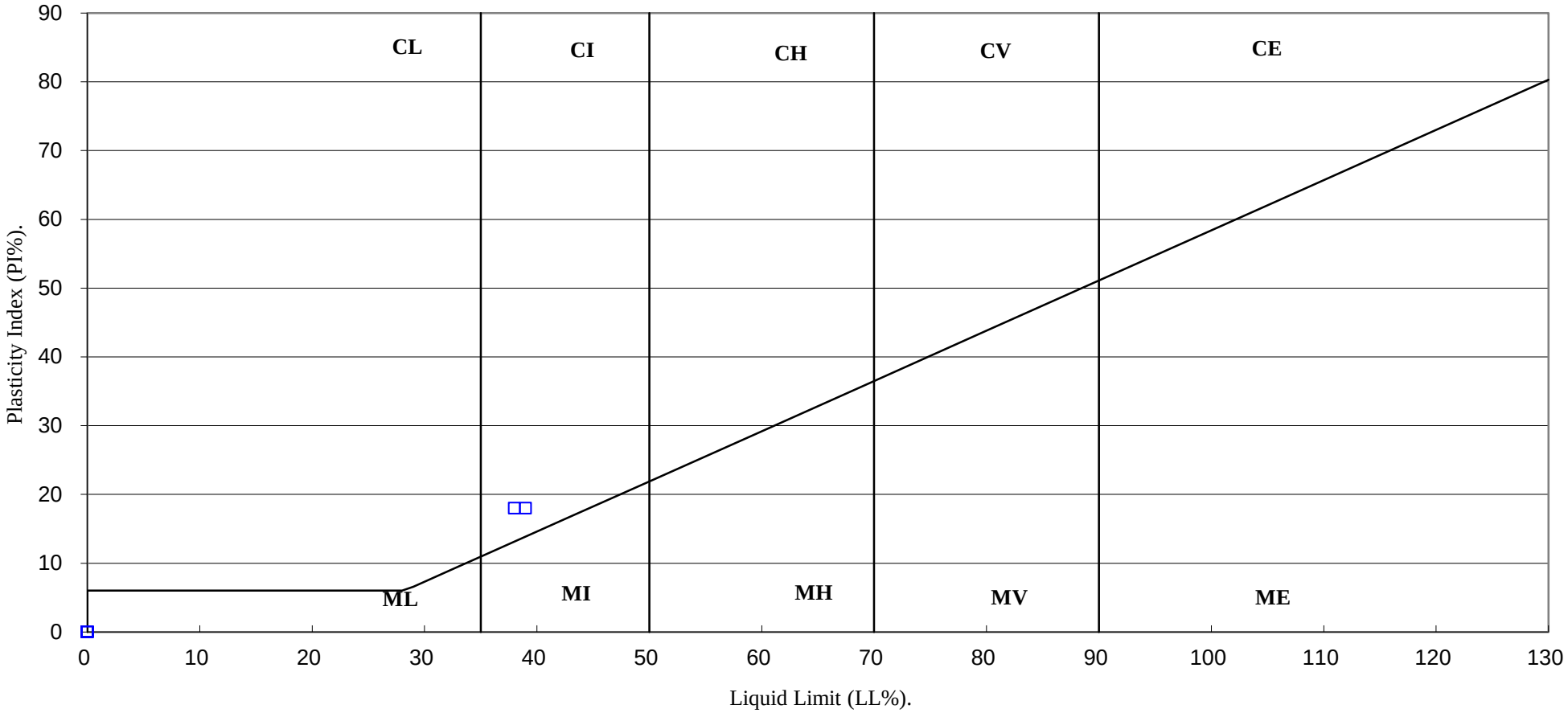
UKAS TESTING 4043

PSL Professional Soils Laboratory

Checked / Approved		Date	05/01/16	Contract No:
Greenfields, Flintshire				PSL15/6086
				Client Ref:
				2638

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.

(BS5930 :2015)



UKAS TESTING 4043	PSL Professional Soils Laboratory	**Checked /Approved**		**Date**	05/01/16	**Contract No:**
		Greenfields, Flintshire				**PSL15/6086**
						Client Ref:
						2638

PARTICLE SIZE DISTRIBUTION TEST

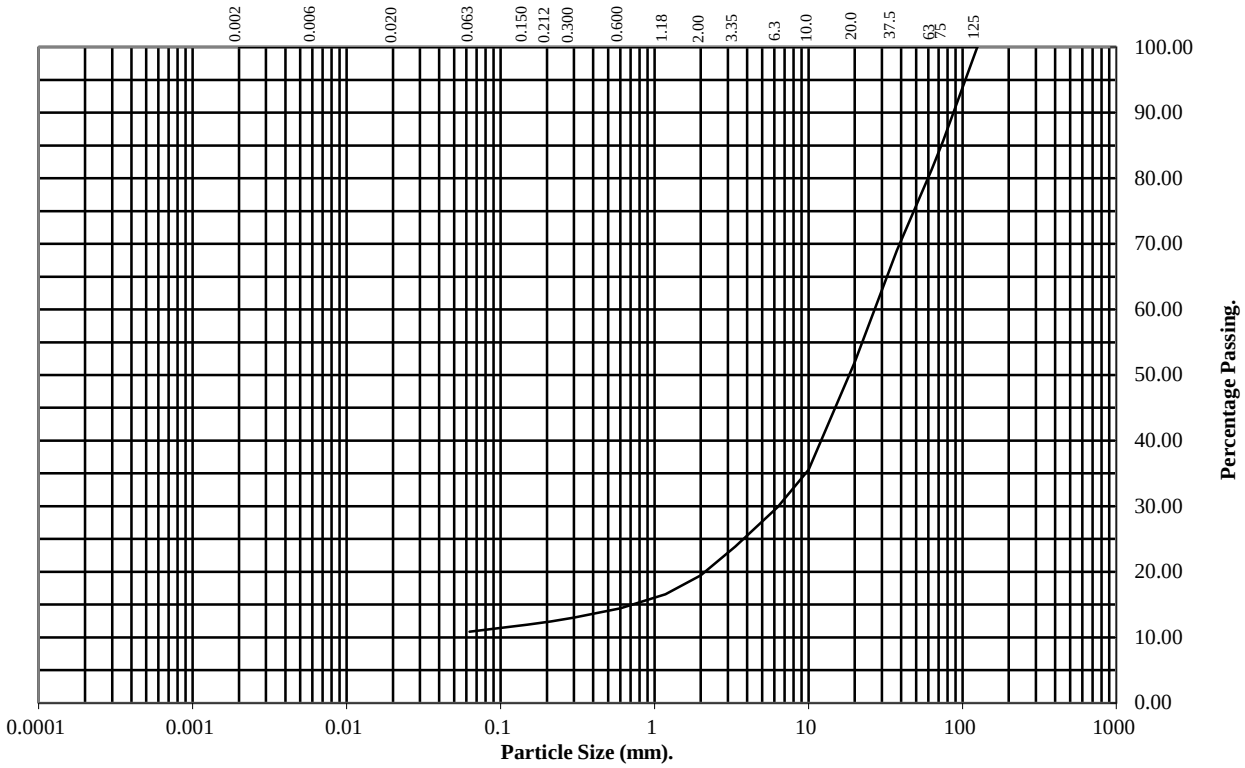
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **TP1** **Top Depth (m):** **1.10**

Sample Number: **Base Depth(m):**

Sample Type: **B**



BS Test Sieve	Percentage Passing
125	100
75	86
63	81
37.5	69
20	52
10	36
6.3	30
3.35	24
2	19
1.18	17
0.6	14
0.3	13
0.212	12
0.15	12
0.063	11

Soil Fraction	Total Percentage
Cobbles	19
Gravel	62
Sand	8
Silt/Clay	11

Remarks:

See summary of soil descriptions.

UKAS TESTING 4043	PSL Professional Soils Laboratory	**Checked / Approved**	**Date** 05/01/16	**Contract No:** PSL15/6086
		Greenfields, Flintshire		**Client Ref:** 2638

PARTICLE SIZE DISTRIBUTION TEST

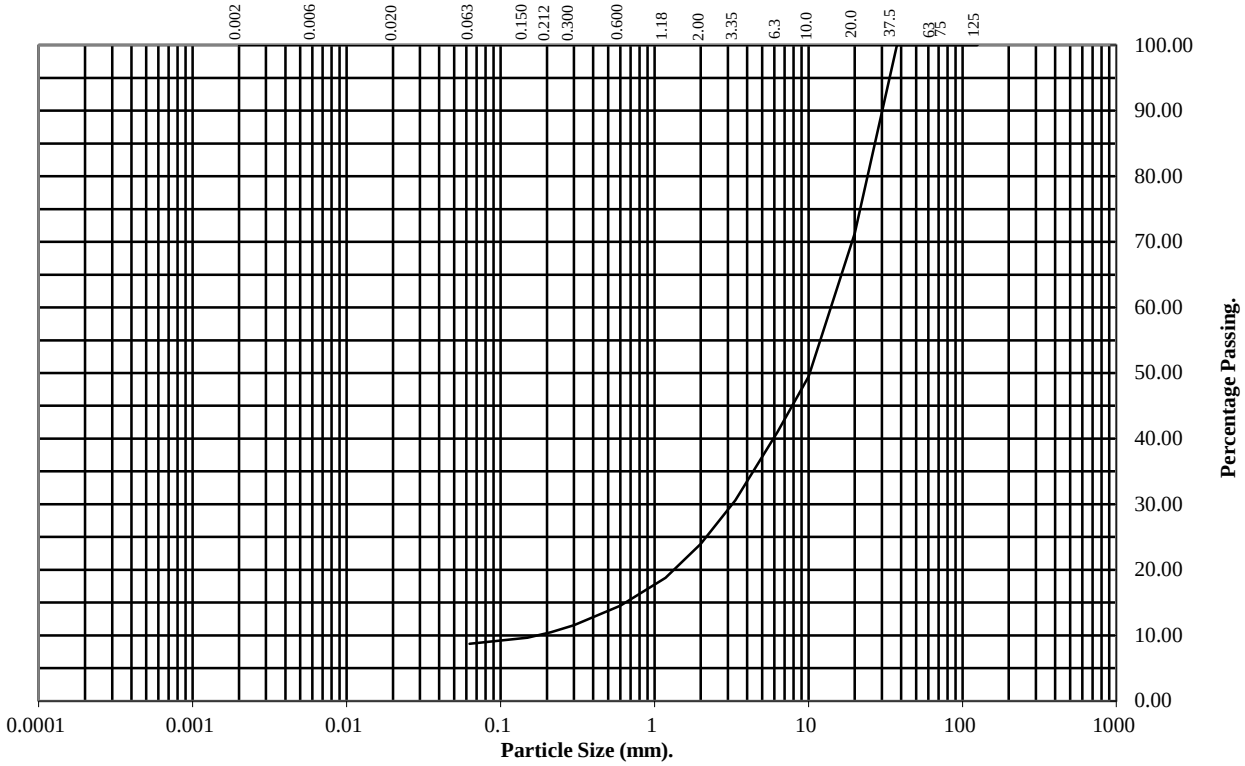
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **TP3** **Top Depth (m):** **0.30**

Sample Number: **Base Depth(m):**

Sample Type: **B**



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	100
20	71
10	49
6.3	41
3.35	31
2	24
1.18	19
0.6	15
0.3	12
0.212	10
0.15	10
0.063	9

Soil Fraction	Total Percentage
Cobbles	0
Gravel	76
Sand	15
Silt/Clay	9

Remarks:

See summary of soil descriptions.

UKAS TESTING 4043	PSL Professional Soils Laboratory	**Checked / Approved**	**Date** 05/01/16	**Contract No:** PSL15/6086
		Greenfields, Flintshire		**Client Ref:** 2638

PARTICLE SIZE DISTRIBUTION TEST

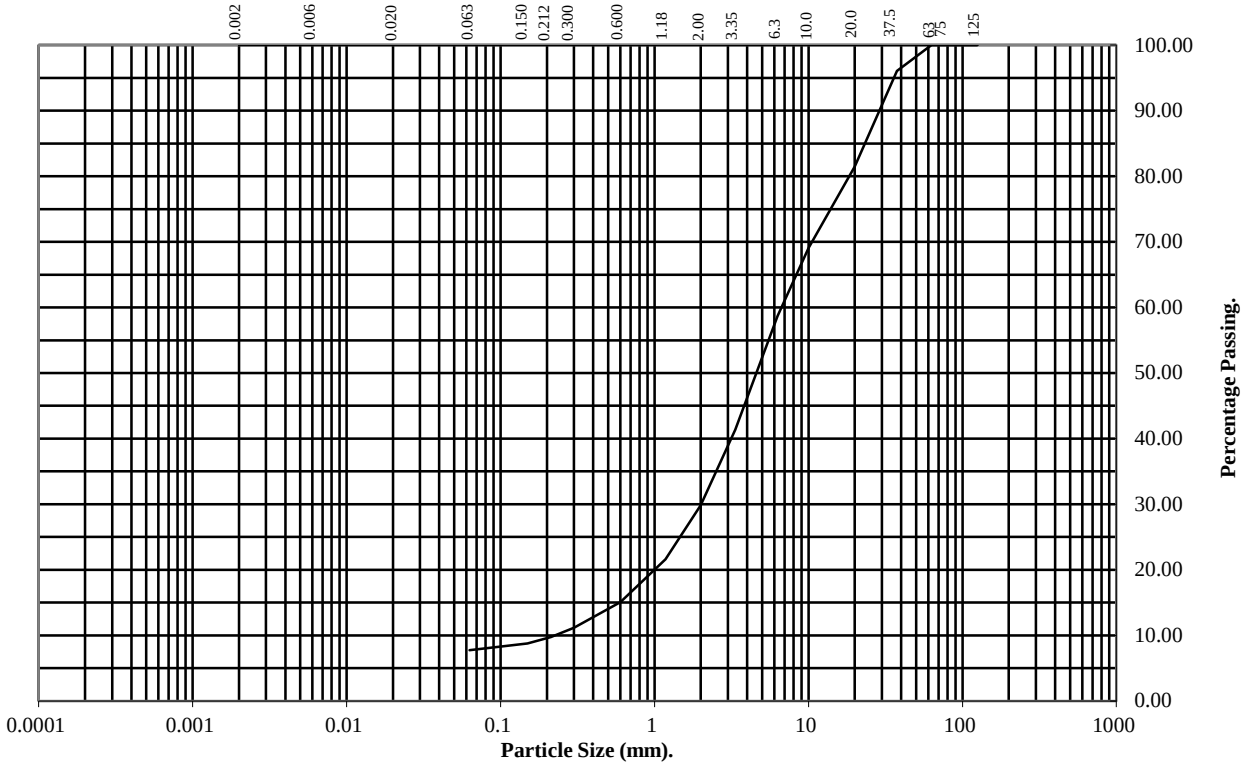
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **TP4** **Top Depth (m):** **0.80**

Sample Number: **Base Depth(m):**

Sample Type: **B**



BS Test Sieve	Percentage Passing
125	100
75	100
63	100
37.5	96
20	81
10	69
6.3	59
3.35	41
2	30
1.18	22
0.6	15
0.3	11
0.212	10
0.15	9
0.063	8

Soil Fraction	Total Percentage
Cobbles	0
Gravel	70
Sand	22
Silt/Clay	8

Remarks:

See summary of soil descriptions.

UKAS TESTING 4043	PSL Professional Soils Laboratory	**Checked / Approved**	**Date** 05/01/16	**Contract No:** PSL15/6086
		Greenfields, Flintshire		**Client Ref:** 2638

APPENDIX H

Summary of Chemical Test Results of Soil Samples

TerraConsult

Site: Proposed Waste Handling Depot, Greenfields Buisness Park, Flintshire

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

Job No: 2638

Analyte	Limit of Detection	TerraConsult 181564 01/12/15 TP4 0.50	TerraConsult 181565 01/12/15 TP4 0.70	TerraConsult 181566 01/12/15 TP4 1.60	TerraConsult 181567 01/12/15 TP4 1.60	TerraConsult 181568 01/12/15 TP4 1.90	TerraConsult 181569 01/12/15 TP6 0.50	TerraConsult 181570 01/12/15 TP6 1.30	TerraConsult 181571 01/12/15 TP6 1.30	TerraConsult 181572 01/12/15 TP6 1.60	TerraConsult 181573 01/12/15 TP3 0.50	TerraConsult 181574 01/12/15 TP1 0.20	TerraConsult 181575 01/12/15 TP2 0.30	TerraConsult 181576 01/12/15 TP2 0.50	TerraConsult 181577 01/12/15 TP5 0.40	TerraConsult 182802 01/12/15 WS1 0.50 - 1.00	TerraConsult 182803 01/12/15 WS3 0.50 - 1.00	TerraConsult 182804 01/12/15 WS4 0.50 - 1.00	TerraConsult 182805 02/12/15 WS2 1.50 - 2.00	TerraConsult 182806 02/12/15 WS8 0.40 - 0.80	TerraConsult 182807 02/12/15 WS9 0.50 - 1.00	Statistical Analysis: n	Standard Deviation	Minimum	Average	Maximum	SGV / GAC Statistical Results: Maximum	Commercial & Industrial Tier 1 Screening Threshold	Pass/ Fail	SGV / GAC Criteria Source: Source of Screening Criteria	Source of Toxicological Data	pC4SL Screening Criteria: Commercial	pC4SL Screening Criteria: Pass / Fail	pC4SL Criteria Source: Source of Screening Criteria	pC4SL Criteria Source: Source of Toxicological Data	LQM/CIEH S4UL Screening Criteria: Commercial	LQM/CIEH S4UL Screening Criteria: Pass / Fail	LQM/CIEH S4UL Criteria Source: Source of Screening Criteria	LQM/CIEH S4UL Criteria Source: Source of Toxicological Data
Moisture Content	<0.1 %	12.50	19.30	14.80	15.80		16.40	16.40	14.30	15.80	13.80	6.10	11.60	12.80	15.80	16.10	15.60	13.20	19.60	18.00	20.30																		
Stone Content	<0.1 %																						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Asbestos Screen	Positive / Negative	-	Not Detected	-	-	-	Detected	-	-	-	Not Detected	Not Detected	Not Detected	-	Not Detected	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Asbestos Quantification	%	-	-	-	-	-	< 0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-																	
Metals																																							
Arsenic (total)	<2 mg/kg	-	19.0	24.0	-	-	18.0	-	-	7.0	20.0	6.0	-	94.0	15.0	26.0	31.0	32.0	10.0	14.0	7.0	14	22.12	6	23	94	94.00	635	Pass	SC050021*	SC050021	640	Pass	CLEA v1.06	Defra 2014	640	Pass	CLEA v1.06	LQM/CIEH 2014
Cadmium (total)	<0.5 mg/kg	-	0.5	0.4	-	-	1.1	-	-	0.2	8.1	1.3	-	0.2	0.2	2.9	3.1	4.5	0.2	0.2	0.2	14	2.31	0	2	8	8.10	230	Pass	SC050021*	SC050021	420	Pass	CLEA v1.06	Defra 2014	190	Pass	CLEA v1.06	LQM/CIEH 2014
Chromium (total) (III for S4ULs)	<2 mg/kg	-	19	20	-	-	22	-	-	16	20	18	-	14	24	24	25	26	22	23	21	14	3.44	14	21	26	26.00	30400	Pass	CLEA v1.06	LQM 2009	-	-	-	-	8600	Pass	CLEA v1.06	LQM/CIEH 2014
Copper (total)	<4 mg/kg	-	76	111	-	-	132	-	-	11	131	27	-	476	33	287	160	194	18	176	52	14	126.27	11	135	476	476.00	71700	Pass	CLEA v1.06	LQM 2009	-	-	-	-	68000	Pass	CLEA v1.06	LQM/CIEH 2014
Lead (total)	<3 mg/kg	-	35.0	44.0	-	-	259.0	-	-	24.0	358.0	332.0	-	178.0	268.0	467.0	135.0	225.0	179.0	47.0	63.0	14	138.62	24	187	467	467.00	N/A	-	-	-	6000	Pass	CLEA v1.06	Defra 2014	-	-	-	-
Mercury (total inorganic)	<1 mg/kg	-	1	1	-	-	1	-	-	1	1	1	-	1	1	3	1	1	1	1	1	14	0.40	1	1	3	2.50	3640	Pass	SC050021*	SC050021	-	-	-	-	1100	Pass	CLEA v1.06	LQM/CIEH 2014
Nickel (total)	<3 mg/kg	-	44.0	47.0	-	-	32.0	-	-	13.0	29.0	12.0	-	12.0	21.0	35.0	75.0	72.0	19.0	64.0	9.0	14	22.78	9	35	75	75.00	840	Pass	CLEA v1.071	EFSA	-	-	-	-	980	Pass	CLEA v1.06	LQM/CIEH 2014
Selenium (total)	<3 mg/kg	-	3	3	-	-	3	-	-	3	3	3	-	42	3	6	3	3	3	3	3	14	10.42	3	6	42	42.10	13000	Pass	SC050021*	SC050021	-	-	-	-	120000	Pass	CLEA v1.06	LQM/CIEH 2014
Zinc (total)	<3 mg/kg	-	89	119	-	-	401	-	-	63	9550	349	-	735	250	798	852	1750	196	135	78	14	2476.64	63	1098	9550	9550.00	662000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	730000	Pass	CLEA v1.06	LQM/CIEH 2014
Inorganic					-	-																													-	-	-	-	-	-
pH Value	pH Units	7.7	7.9	7.6	-	-	7.4	7.6	-	7.8	7.1	7.9	7.5	7.8	7.4	7.9	7.8	7.6	7.7	6.0	3.0	17	1.19	3.0	7	7.9	7.90	-	-	-	-	-	-	-	-	-	-	-	-
Cyanide (total)	<2 mg/kg	-	2.0	2.0	-	-	2.0	-	-	2.0	2.0	2.0	-	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	14	0.00	2	2	2.0	2.00	-	-	-	-	-	-	-	-	-	-	-	-
Ammonia expressed as NH4	<0.5 mg/kg	22.1	-	-	-	-		82.1	-	-	-	-	6.3	-	-	-	-	-	-	-	-	3	39.99	6.3	37	82.1													
Magnesium water soluble	<0.1 g/l	0.0	-	-	-	-		0.0	-	-	-	-	0.0	-	-	-	-	-	-	-	-	3	0.00	0.0	0	0.0													
Nitrate (2:1)	<1.5 mg/l	6.2	-	-	-	-		1.5	-	-	-	-	1.5	-	-	-	-	-	-	-	-	3	2.71	1.5	3	6.2													
Chloride (2:1)	<0.5 mg/l	90.6	96.8	-	-	-	21.1	29.8	-	-	-	7.5	9.2	5.8	39.7	-	66.3	-	-	12.9	-	10	34.65	5.8	38	96.8													
Sulphur (total)	<0.02 %	0.3	-	-	-	-		0.1	-	-	-	-	0.3	-	-	-	-	-	-	-	-	3	0.09	0.1	0	0.3													
Sulphate (2:1)	<0.01 g/l	1.530	0.390	1.690	-	-	1.000	0.730	-	0.080	1.720	0.340	1.380	2	1.670	0.340	0.260	1.560	0.380	0.32	1.580	17	0.64	0.08	1	2	1.72	-	-	-	-	-	-	-	-	-	-	-	-
Sulphate (total)	<200 mg/kg	9120.000	1675.000	-	-	-	2962.000	2159.000	-	-	-	1829.000	6895.000	109400	5344	-	1605	-	-	3271	-	10	33465.41	1605.00	14426	109400	-	-	-	-	-	-	-	-	-	-	-	-	-
Organic																																			-	-	-	-	-	-
Soil Organic Matter	<0.1 %	-	0.80	-	-	-	4.10	-	-	-	-	5.00	-	2.1	2.2	-	1.8	-	-	2.1	-	7	1.45	0.8	3	5.00	5.00	-	-	-	-	-	-	-	-	-	-	-	-
TOC	<0.1 %	-	0.5	-	-	-	2.4	-	-	-	-	2.9	-	1.2	1.3	-	1.0	-	-	1.2	-	7	0.84	0.5	2	2.90	2.90	-	-	-	-	-	-	-	-	-	-	-	-
Phenol (Total Monohydric)	<2 mg/kg	-	2.0	2.0	-	-	2.0	-	-	2.0	2.0	2.0	-	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	14	0.00	2	2	2.0	2.00	24200	Pass	CLEA v1.06	SC050021	-	-	-	-	760	Pass	CLEA v1.06	LQM/CIEH 2014
PAH																																							
Naphthalene	<0.1 mg/kg	-	0.1	0.1	-	-	0.1	-	-	0.1	0.1	0.5	-	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	14	0.11	0.1	0	0.5	0.53	200	Pass	CLEA v1.06	LQM 2009	-	-	-	-	190	Pass	CLEA v1.06	LQM/CIEH 2014
Acenaphthylene	<0.1 mg/kg	-	0.1	0.1	-	-	0.1	-	-	0.1	0.1	0.2	-	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	14	0.03	0.1	0	0.2	0.20	84000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	83000	Pass	CLEA v1.06	LQM/CIEH 2014
Acenaphthene	<0.1 mg/kg	-	0.1	0.1	-	-	0.1	-	-	0.1	0.1	1.4	-	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	14	0.34	0.1	0	1.4	1.38	8500	Pass	CLEA v1.06	LQM 2009	-	-	-	-	84000	Pass	CLEA v1.06	LQM/CIEH 2014
Fluorene	<0.1 mg/kg	-	0.1	0.1	-	-	0.1	-	-	0.1	0.1	1.3	-	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	14	0.31	0.1	0	1.3	1.26	64000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	63000	Pass	CLEA v1.06	LQM/CIEH 2014
Phenanthrene	<0.1 mg/kg	-	0.1	0.1	-	-	0.2	-	-	0.1	0.2	18.0	-	0.1	0.1	0.5	0.1	0.1	0.1	0.1	0.1	14	4.77	0.1	1	18.0	18.00	22000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	22000	Pass	CLEA v1.06	LQM/CIEH 2014
Anthracene	<0.1 mg/kg	-	0.1	0.1	-	-	0.1	-	-	0.1	0.1	5.2	-	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	14	1.36	0.1	0	5.2	5.18	530000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	520000	Pass	CLEA v1.06	LQM/CIEH 2014
Fluoranthene	<0.1 mg/kg	-	0.1	0.1	-	-	0.3	-	-	0.1	0.4	30.5	-	0.1	0.1	1.5	0.3	0.1	0.1	0.1	0.2	14	8.09	0.1	2	30.5	30.50	23000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	23000	Pass	CLEA v1.06	LQM/CIEH 2014
Pyrene	<0.1 mg/kg	-	0.1	0.1	-	-	0.2	-	-	0.1	0.3	23.9	-	0.1	0.1	1.3	0.2	0.1	0.1	0.1	0.2	14	6.33	0.1	2	23.9	23.90	54400	Pass	CLEA v1.06	LQM 2009	-	-	-	-	54000	Pass	CLEA v1.06	LQM/CIEH 2014
Benz(a)anthracene	<0.1 mg/kg	-	0.1	0.1	-	-	0.1	-	-	0.1	0.2	12.2	-	0.1	0.1	0.9	0.2	0.1	0.1	0.1	0.1	14	3.22	0.1	1	12.2	12.20	92	Pass	CLEA v1.06	LQM 2009	-	-	-	-	170	Pass	CLEA v1.06	LQM/CIEH 2014
Chrysene	<0.1 mg/kg	-	0.1	0.1	-	-	0.1	-	-	0.1	0.2	11.6	-	0.1	0.1	0.9	0.2	0.1	0.1	0.1	0.2	14	3.06	0.1	1	11.6	11.60	138	Pass	CLEA v1.06	LQM 2009	-	-	-	-	350	Pass	CLEA v1.06	LQM/CIEH 2014
Benzo(b)fluoranthene	<0.1 mg/kg	-	0.1	0.1	-	-	0.2	-	-	0.1	0.3	12.3	-	0.1	0.1	1.2	0.2	0.1	0.1	0.1	0.2	14	3.24	0.1	1	12.3	12.30	100	Pass	CLEA v1.06	LQM 2009	-	-	-	-	44	Pass	CLEA v1.06	LQM/CIEH 2014
Benzo(k)fluoranthene	<0.1 mg/kg	-	0.1	0.1	-	-	0.1	-	-	0.1	0.1	5.6	-	0.1	0.1	0.5	0.1	0.1	0.1	0.1	0.1	14	1.46	0.1	1	5.6	5.59	140	Pass	CLEA v1.06	LQM 2009	-	-	-	-	1200	Pass	CLEA v1.06	LQM/CIEH 2014
Benzo(a)pyrene	<0.1 mg/kg	-	0.1	0.1	-	-	0.1	-	-	0.1	0.2	11.0	-	0.1	0.1	0.8	0.2	0.1	0.1	0.1	0.1	14	2.90	0.1	1	11.0	11.00	14	Pass	CLEA v1.06	LQM 2009	77	Pass	CLEA v1.06	Defra 2014	35	Pass	CLEA v1.06	LQM/CIEH 2014
Indeno(123cd)pyrene	<0.1 mg/kg	-	0.1	0.1	-	-	0.1	-	-	0.1	0.2	6.4	-	0.1	0.1	0.5	0.1	0.1	0.1	0.1	0.1	14	1.68	0.1	1	6.4	6.41	60	Pass	CLEA v1.06	LQM 2009	-	-	-	-	500	Pass	CLEA v1.06	LQM/CIEH 2014
Dibenzo(ah)anthracene	<0.1 mg/kg	-	0.1	0.1	-	-	0.1	-	-	0.1	0.1	1.0	-	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	14	0.23	0.1	0	1.0	0.95	13	Pass	CLEA v1.06	LQM 2009	-	-	-	-	3.5	Pass	CLEA v1.06	LQM/CIEH 2014
Benzo(ghi)perylene	<0.1 mg/kg	-	0.1	0.1	-	-	0.1	-	-	0.1	0.2	5.7	-	0.1	0.1	0.4	0.1	0.1	0.1	0.1	0.1	14	1.50	0.1	1	5.7	5.73	650	Pass	CLEA v1.06	LQM 2009	-	-	-	-	3900	Pass	CLEA v1.06	LQM/CIEH 2014
Coronene	<0.1 mg/kg	-	0.1	0.1	-	-	0.1	-	-	0.1	0.1	0.1	-	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	14	0.00	0.1	0	0.1	0.10	1900	Pass	CLEA v1.06	LQM 2009	-	-	-	-	-	-	-	-
Total Oily Waste PAHs	<1 mg/kg	-	1.00	1.00	-	-	1.00	-	-	1.00	1.10	60.00	-	1.00	1.00	4.80	1.00	1.00	1.00	1.00	1.00	14	15.72	1.0	5	60.0	60.00	-	-	-	-	-	-	-	-	-	-	-	-
Total Dutch 10 PAHs	<1 mg/kg	-	1.00	1.00	-	-	1.00	-	-	1.00	1.60	107.00	-	1.00	1.00	6.00	1.00	1.00	1.00	1.00	1.00	14	28.25	1.0	9	107.0	107.00	-	-	-	-	-	-	-	-	-	-	-	-
Total EPA-16 PAHs	<1.6 mg/kg	-	1.60	1.60	-	-	1.60	-	-	1.60	2.20	147.00	-	1.60	1.60	8.50	1.60	1.60	1.60	1.60	1.60	14	38.75	1.6	13	147.0	147.00	-	-	-	-	-	-	-	-	-	-	-	-
Total WAC-17 PAHs	<1.7 mg/kg	-	1.70	1.70	-	-	1.70	-	-	1.70	2.20	147.00	-	1.70	1.70	8.50	1.70	1.70	1.70	1.70	1.70	14	38.73	1.7	13	147.0	147.00	-	-	-	-	-	-	-	-	-	-	-	-
BTEX Benzene	<0.002 mg/kg	-	0.002	0.002	-	-	0.002	-	-	0.002	0.002	0.002	-	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	14	0.00	0.002	0	0.002	0.00	43.6	Pass	CLEA v1.06	SC050021	100	Pass	CLEA v1.06	Defra 2014	27	Pass	CLEA v1.06	LQM/CIEH 2014
Toluene	<0.005 mg/kg	-	0.005	0.005	-	-	0.005	-	-	0.005	0.005	0.005	-	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	14	0.00	0.005	0	0.005	0.01	86200	Pass	CLEA v1.06	SC050021	-	-	-	-	56000	Pass	CLEA v1.06	LQM/CIEH 2014
Ethyl Benzene	<0.01 mg/kg	-	0.002	0.002	-	-	0.002	-	-	0.002	0.002	0.002	-	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	14	0.00	0.002	0	0.002	0.00	25000	Pass	CLEA v1.06	SC050021	-	-	-	-	5700	Pass	CLEA v1.06	LQM/CIEH 2014
Xylene (o)	<0.01 mg/kg	-	0.002	0.002	-	-	0.002	-	-	0.002	0.002	0.002	-	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	14	0.00	0.002	0	0.002	0.00	10,700	Pass	CLEA v1.06	SC050021	-	-	-	-	6600	Pass	CLEA v1.06	LQM/CIEH 2014
Xylene (m)	<0.01 mg/kg	-	0.002	0.002	-	-	0.002	-	-	0.002	0.002	0.002	-	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	14	0.00	0.002	0	0.002	0.00	9.990	Pass	CLEA v1.06	SC050021	-	-	-	-	6200	Pass	CLEA v1.06	LQM/CIEH 2014
Xylene (p)	<0.01 mg/kg	-	0.002	0.002	-	-	0.002	-	-	0.002	0.002	0.002	-	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	14	0.00	0.002	0	0.002	0.00	9,630	Pass	CLEA v1.06	SC050021	-	-	-	-	5900	Pass	CLEA v1.06	LQM/CIEH 2014
MTBE	<0.001 mg/kg	-	0.005	0.005	-	-	0.005	-	-	0.005	0.005	0.005	-	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	14	0.00	0.005	0	0.005	-	-	-	-	-	-	-	-	-	-	-	-	-
Petroleum Hydrocarbons		-																																				
DRO (C_{10} - C_{28})	<6 mg/kg	-	6	6	-	-	6	-	-	6	79	447	-	6	6	20	6	6	6	6	6	14	117.70	6	44	447	447	-	-	-	-	-	-	-	-	-	-	-	-
Oil (C_{28} - C_{40})	<6 mg/kg	-	6	6	-	-	18	-	-	6	636	1520	-	6	6	53	16	6	6	6	6	14	424.42	6	164	1520	1520	-	-	-	-	-	-	-	-	-	-	-	-
Mineral Oil (C_{10} - C_{40})	<6 mg/kg	-	10	10	-	-	10	-	-	10	182	283	-	10	10	10	10	10	10	10	10	14	83.19	10	42	283	283	-	-	-	-	-	-	-	-	-	-	-	-
TPH (C_6 - C_{40})	<10 mg/kg	-																																	-	-	-	-	-	-
Aliphatic >C_5 - C_6	<0.01 mg/kg	-	0.01	-	-	-	0.01	-	-	-	-	0.01	-	0.01	0.01	-	0.01	-	-	0.01	-	7	0.00	0.01	0.01	0.01	0.01	3400	Pass	CLEA v1.06	LQM 2009	-	-	-	-	3200	Pass	CLEA v1.06	LQM/CIEH 2014
Aliphatic >C_6 - C_8	<0.05 mg/kg	-	0.05	-	-	-	0.05	-	-	-	-	0.05	-	0.05	0.05	-	0.05	-	-	0.05	-	7	0.00	0.05	0.05	0.05	0.05	8300	Pass	CLEA v1.06	LQM 2009	-	-	-	-	7800	Pass	CLEA v1.06	LQM/CIEH 2014
Aliphatic >C_8 - C_{10}	<2 mg/kg	-	2.0	-	-	-	2.0	-	-	-	-	2.0	-	2.0	2.0	-	2.0	-	-	2.0	-	7	0.00	2	2	2.0	2.00	2100	Pass	CLEA v1.06	LQM 2009	-	-	-	-	2000	Pass	CLEA v1.06	LQM/CIEH 2014
Aliphatic >C_{10} - C_{12}	<2 mg/kg	-	2.0	-	-	-	2.0	-	-	-	-	2.0	-	2.0	2.0	-	2.0	-	-	2.0	-	7	0.00	2	2	2.0	2.00	10000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	9700	Pass	CLEA v1.06	LQM/CIEH 2014
Aliphatic >C_{12} - C_{16}	<3 mg/kg	-	3.0	-	-	-	3.0	-	-	-	-	3.0	-	3.0	3.0	-	3.0	-	-	3.0	-	7	0.00	3	3	3.0	3.00	61000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	59000	Pass	CLEA v1.06	LQM/CIEH 2014
Aliphatic >C_{16} - C_{21}	<3 mg/kg	-	3.0	-	-	-	3.0	-	-	-	-	4.0	-	3.0	3.0	-	3.0	-	-	3.0	-	7	0.38	3	3	4.0	4.00	1600000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	160000	Pass	CLEA v1.06	LQM/CIEH 2014
Aliphatic >C_{21} - C_{35}	<10 mg/kg	-	10.0	-	-	-	10.0	-	-	-	-	208.0	-	10.0	10.0	-	10.0	-	-	10.0	-	7	74.84	10	38	208.0	208.00	1600000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	160000	Pass	CLEA v1.06	LQM/CIEH 2014
Total Aliphatic >C_5 - C_{35}	<6 mg/kg	-	21	-	-	-	21	-	-	-	-	213	-	21	21	-	21	-	-	21	-	7	72.57	21	48	213.0	213.00	-	-	-	-	-	-	-	-	-	-	-	-
Aromatic C_5 - C_7	<0.01 mg/kg	-	0.01	-	-	-	0.01	-	-	-	-	0.01	-	0.01	0.01	-	0.01	-	-	0.01	-	7	0.00	0.01	0.01	0.01	0.01	28000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	26000	Pass	CLEA v1.06	LQM/CIEH 2014
Aromatic C_7 - C_8	<0.05 mg/kg	-	0.05	-	-	-	0.05	-	-	-	-	0.05	-	0.05	0.05	-	0.05	-	-	0.05	-	7	0.00	0.05	0.05	0.05	0.05	59000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	56000	Pass	CLEA v1.06	LQM/CIEH 2014
Aromatic >C_8 - C_{10}	<2 mg/kg	-	2.0	-	-	-	2.0	-	-	-	-	2.0	-	2.0	2.0	-	2.0	-	-	2.0	-	7	0.00	2	2	2.0	2.00	3700	Pass	CLEA v1.06	LQM 2009	-	-	-	-	3500	Pass	CLEA v1.06	LQM/CIEH 2014
Aromatic >C_{10} - C_{12}	<2 mg/kg	-	2.0	-	-	-	2.0	-	-	-	-	2.0	-	2.0	2.0	-	2.0	-	-	2.0	-	7	0.00	2	2	2.0	2.00	17000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	16000	Pass	CLEA v1.06	LQM/CIEH 2014
Aromatic >C_{12} - C_{16}	<3 mg/kg	-	2.0	-	-	-	2.0	-	-	-	-	18.0	-	2.0	2.0	-	2.0	-	-	2.0	-	7	6.05	2	4	18.0	18.00	36000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	36000	Pass	CLEA v1.06	LQM/CIEH 2014
Aromatic >C_{16} - C_{21}	<3 mg/kg	-	3.0	-	-	-	3	-	-	-	-	166	-	3.0	3.0	-	3.0	-	-	3.0	-	7	61.61	3	26	166.0	166.00	28000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	28000	Pass	CLEA v1.06	LQM/CIEH 2014
Aromatic >C_{21} - C_{35}	<10 mg/kg	-	10.0	-	-	-	10.0	-	-	-	-	771	-	10.0	10.0	-	10.0	-	-	10.0	-	7	287.63	10	119	771.0	771.00	28000	Pass	CLEA v1.06	LQM 2009	-	-	-	-	28000	Pass	CLEA v1.06	LQM/CIEH 2014
Total Aromatic >C_5 - C_{35}	<6 mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-						-	-	-	-	-	-	-	-	-	-	-	-
Chlorinated Hydrocarbons		-																																				
Suite of 99 VOC and SVOCs all below detetcion limits		-	-	Not Detected	-	-	-	Not Detected	-	-	-	Not Detected	Not Detected	Not Detected	-	Not Detected	-	-	Not Detected	-	Not Detected																		

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 range of data rather than to provide any detailed statistical appraisal.
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 exposure assumptions
7. pC4SL for benzene assumes 6% SOM

APPENDIX I

Summary of Chemical Test Results of Water & Leachate Samples

Job No: 2638

Site: Proposed Waste Handling Depot, Greenfields Buisness Park, Flintshire

Summary of Groundwater Data - Tier I Screening

Sample Location	Units	Drinking Water Standard	EQS Freshwater	Other	TerraConsult Site Investigation Data		
					01/12/15	16/12/15	16/12/15
					TP4	WS4	WS9
					Trial pit grab sample	Groundwater Sample	Groundwater Sample
Water Quality - Laboratory							
pH	pH units	-	-	-	7.2	7	7.3
Electricial Conductivity	uS/cm	-	-	-	5910	1360	2270
Alkalinity (as $CaCO_3$)	mg/l	-	-	-	-	370	290
Hardness (as $CaCO_3$)	mg/l	-	-	-	-	1520	1340
Metals - Minor Cations							
Arsenic	µg/l	10	50	-	5	5	5
Boron	µg/l	1000	2000	500	327	354	66
Cadmium	µg/l	5	5	5	7.0	25.1	2.5
Chromium (Total)	µg/l	50	200*	-	5	5	5
Copper	µg/l	2000	10*	-	14	23	5
Lead	µg/l	25	125*	-	5	5	5
Mercury	µg/l	1	1	-	0.05	0.05	0.05
Nickel	µg/l	20	150*	200	46	81	11
Selenium	µg/l	10	-	10	5	5	24
Zinc	µg/l	3000	1000*	500	3290	890	99
Anions							
Chloride	mg/l	250	250	250	-	1710	34
Sulphate (as SO4)	mg/l	250	400	250	1150	1220	1380
Ammonium (as NH4)	µg/l	50			1030	107	50
Free Ammonium (as NH3)	µg/l	0.150			0.006032	0.000627	0.000293
Total Cyanide	µg/l	50	5	70	5	17	5
Organics							
Phenol	µg/l	50	300	30	10	10	10
PAH							
Naphthalene	µg/l	10[2]	2.4	10	0.03	1.74	1.35
Acenaphthylene	µg/l	-	-	-	0.01	0.01	0.01
Acenaphthene	µg/l	-	-	-	0.01	0.06	0.03
Fluorene	µg/l	-	-	-	0.01	0.08	0.04
Phenanthrene	µg/l	-	-	-	0.03	0.17	0.08
Anthracene	µg/l	-	0.40	-	0.01	0.02	0.02
Fluoranthene	µg/l	-	0.10	-	0.01	0.05	0.03
Pyrene	µg/l	-	-	-	0.01	0.04	0.03
Benzo[a]anthracene	µg/l	-	-	-	0.01	0.01	0.01
Chrysene	µg/l	-	-	-	0.01	0.01	0.01
Benzo[b]fluoranthene	µg/l	-	0.03	-	0.01	0.01	0.01
Benzo[k]fluoranthene	µg/l	-	0.03	-	0.01	0.01	0.01
Benzo[a]pyrene	µg/l	0.01	0.1	-	0.01	0.01	0.01
indeno[1,2,3-cd]pyrene	µg/l	-	0.002	-	0.01	0.01	0.01
dibenzo[a,h]anthracene	µg/l	-	-	-	0.01	0.01	0.01
Benzo[ghi]perylene	µg/l	-	0.002	-	0.01	0.01	0.01
Total EPA-16 PAHs	µg/l	-	-	-	0.09	2.16	1.58
PAH Total 4 DWS#	µg/l	0.1	-	0.1			
TPH							
Mineral Oil (C10 - C40)	µg/l	10	-	-	34	-	-
Aliphatic >C5 - C6	µg/l	10	-	-	-	10	10
Aliphatic >C6 - C8	µg/l	10	-	-	-	10	10
Aliphatic >C8 - C10	µg/l	10	-	-	-	10	10
Aliphatic >C10 - C12	µg/l	10	-	-	-	10	10
Aliphatic >C12 - C16	µg/l	10	-	-	-	10	10
Aliphatic >C16 - C21	µg/l	10	-	-	-	10	10
Aliphatic >C21 - C34	µg/l	10	-	-	-	10	10
Aliphatic C35 - C40	µg/l	10	-	-	-	-	-
Aromatic >C5 - C7	µg/l	10	-	-	-	10	10
Aromatic >C7 - C8	µg/l	10	-	-	-	10	10
Aromatic >C8 - C10	µg/l	10	-	-	-	10	10
Aromatic >C10 - C12	µg/l	10	-	-	-	10	10
Aromatic >C12 - C16	µg/l	10	-	-	-	10	10
Aromatic >C16 - C21	µg/l	10	-	-	-	10	10
Aromatic >C21 - C35	µg/l	10	-	-	-	10	10
Aromatic C35 - C40	µg/l	10	-	-	-	-	-
Aliphatic (C5 - C34)	µg/l	10	-	-	-	70	70
Aromatic (C5 - C35)	µg/l	10	-	-	-	70	70
Total TPH (C5 - C35)	µg/l	10	-	-	-	140	140
BTEX							
Benzene	µg/l	1	30	10	1	1	1
Toluene	µg/l	-	50	700	5	5	5
Ethylbenzene	µg/l	-	200	300	5	5	5
p & m-xylene	µg/l	-	30	500	10	10	10
o-xylene	µg/l	-	30	500	5	5	5
VOC's (suite of 53)	µg/l	-	-	-	-	All below detection limits	All below detection limits

Note:

Fail: Above UK EQS

Fail: Above UK DWS

Pass: Detection limit higher than screening criteria

Result below Detection Limit

Pass: Detection limit higher than screening criteria

* EQS for substances based on >100-150 mg/l CaCO3 Hardness band and Cyprinid designation for receiving water

** Calculated from ammoniacal nitrogen and pH results using an assumed water temperature of 10 degrees.

Total of 4 Drinking Water Standard PAHs: Benzo[b]fluoranthene, Benzo[k]fluoranthene, Indeno[1,2,3-cd]pyrene, Benzo[ghi]perylene

APPENDIX J

Current Guidance for Ground Gas Risk Assessment

Current Guidance for Ground Gas Risk Assessment

Origin of Ground and Landfill Gases

When carrying out a ground gas risk assessment for permanent ground gases (e.g. methane and carbon dioxide), the origin or source of the gases is important as potential risks will vary depending on the source. This Appendix relates to the risk of the two main ground gases of concern: methane and carbon dioxide, and does not apply to other ground gases (e.g. radon or vapours from hydrocarbon spills). Methane and carbon dioxide are major constituents of landfill gas but can also occur from a variety of anthropogenic and natural sources, as summarised in Table G1 below:

Table G1. Potential Sources of Ground Gases

Gas	Source	Comments
Landfill Gas	Anaerobic decomposition of degradable waste within landfill sites. Typically 60% methane and 40% carbon dioxide during methanogenic phase.	Composition varies over time, particularly in early stages. Contains a range of minor constituents (particularly carbon monoxide and hydrogen sulphide).
Landfill Associated Gases	- Anaerobic degradation of leachate external to the site; - Degassing of dissolved gases in groundwater; - Evolution of gases following interaction between leachate and groundwater	Can result in secondary (external) production of methane or carbon dioxide.
Made Ground	Anaerobic degradation of organic components	Very variable depending on source
Sewer Gas, Cess Pits	Anaerobic degradation of organic components of sewage producing methane and carbon dioxide.	Often characterised by hydrogen sulphide odour.
Mains Gas	Leakage from underground pipework or storage tanks. Mainly methane but often contains higher alkanes.	An odouriser is added to permit detection of leaks. Typically 90% CH_4, but 1 to 27% C_2-C_4 alkanes, May also contain other trace gases e.g. CO, helium and CO_2 (from degradation of CH_4 in the ground).
Other Anthropogenic Sources	- Degradation of leaked or spilled hydrocarbons or other industrial chemicals; - Anaerobic degradation of organic contaminants in groundwaters (e.g. silage liquor); - Reactions between monitoring well construction components and environment; - Burial grounds/cemeteries.	Hydrocarbon spillages often have an 'oily' odour. Fuel spillages common – Petrol or Diesel and can contain a wide range of VOC's. Can degrade to produce methane / carbon dioxide.
Alluvium / Marsh / Peat Gas	Anaerobic microbial degradation of organic material (usually waterlogged vegetation / peat). Often associated with the presence of alluvial deposits or dredgings.	
Geogenic Gas	Natural seepages of carbon dioxide and hydrocarbon gases derived from geologic sources such as coal seams and deep oil / gas source formations. Can be present in solution in groundwaters.	Methane most common but can contain carbon dioxide and higher alkanes.
Mine Gases	Various types. Most common is "fire damp" with high methane, produced by the desorption of gas trapped in coal. "Black damp" (Stythe gas) with high carbon dioxide and denser than air. "White damp" is high in carbon monoxide.	Methane most common. Can contain higher alkanes, carbon dioxide and carbon monoxide. Often low in oxygen.
Natural Shallow Ground Gas	Various types - high carbon dioxide formed by subsurface aerobic activity leading to depleted oxygen and elevated carbon dioxide; - chemical degradation of rocks (e.g. carbonates) producing carbon dioxide; - carbon dioxide production in root zone of soils by plants.	Gases can be emitted from ground under falling barometric pressure conditions.

This Appendix concentrates on the assessment of risk from methane and carbon dioxide. This Appendix does not provide guidance for the assessment of risk when other gases are present due to 'Other Sources' from the above table (particularly organic compounds such as BTEX and VOC's or for the risk from radon or hydrogen sulphide).

To determine the origin of the gas a range of factors must be considered together, including;

1. Proximity of likely sources;
2. Ground conditions (geology, hydrogeology, anthropogenic pathways etc);
3. Properties of gases present including:
   - Chemical composition;
   - Physical properties;
   - Ratios of components e.g. methane : carbon dioxide.
4. Timeframe of activities such as infilling periods, capping works, installation of gas control systems etc.

Identification of the originating source may be problematic given that there may be more than one source present and trace gas analysis may be required. Identification of the sources of the gases encountered during monitoring is usually carried out through a process of eliminating the most unlikely potential sources (given the site setting) and selecting those which are the more likely candidates.

Hazards Associated with Presence of Ground Gases

Methane gas is combustible and potentially explosive. When the concentration of methane in air is between the limits of 5.0%v/v and 15.0%v/v an explosive mixture is formed. The Lower Explosive Limit (LEL) of methane is 5.0%v/v, which is equivalent to 100% LEL. The 15.0%v/v limit is known as the Upper Explosive Limit (UEL), but concentrations above this level cannot be assumed to represent safe concentrations. Further, the LEL and UEL will vary (up and down) depending upon the proportion of other gases (including oxygen). However, the fact that methane is a colourless, odourless gas means that there is no simple indicator of the presence of the gas until such a time as explosive limits are reached and an incident occurs. Methane is lighter than air and has a low toxicity. However, at high concentrations it can result in asphyxiation due to oxygen displacement.

Carbon dioxide is a colourless, odourless gas, which, although non-flammable, is both toxic and an asphyxiant. As carbon dioxide is denser than air, it will collect in low points and depressions. The UK Health & Safety Executive (HSE) has published information relating to concentrations of carbon dioxide that humans may be exposed to, which uses concentrations contained in the Control of Substances Hazardous to Health Regulations 2002 (as amended). These are the Long Term Occupational Exposure Limit (LTOEL, 8 hour period) and the Short Term Occupational Exposure Limit (STOEL, 15 minute period), which are 0.5% and 1.5% carbon dioxide, respectively.

Parameters Influencing the Rate of Ground Gas Production

Figure G2 is taken from EA guidance document LFTGN 03 illustrates typical ground gas generation curves from biodegradable materials:

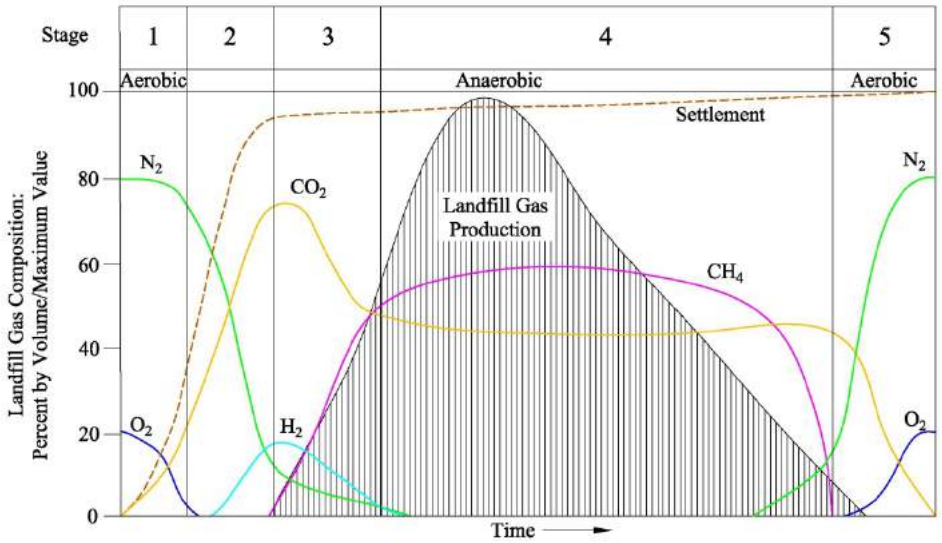


Figure G2. Idealised Representation of Landfill Gas Generation.

The production of methane and carbon dioxide at a landfill site may be expected to be considerable and ongoing. Concentrations of methane will eventually decrease, followed by concentrations of carbon dioxide, but the duration and rate of gas production can vary markedly between sites. Five distinct phases of gas production occur during the process which are, in order of event (as marked on Figure G2), as follows:

1. An aerobic phase involving oxygen depletion and temperature increase through aerobic respiration;
2. The establishment of anaerobic conditions and the evolution of carbon dioxide and hydrogen through acidogenic activity;
3. Commencement of methanogenic activity; the establishment of populations of methanogenic bacteria;
4. A phase of stable methanogenic activity, which may go on for many tens of years;
5. A phase of decreasing methanogenic activity, representing depletion of the organic material and a return to aerobic conditions.

The time scale for the return to the normal ground gas concentrations will be highly variable, depending upon the types and quantities of materials present. In addition, the optimum parameters influencing the rate of decomposition and ground gas production within the ground at a site are as follows:

- High water content with adequate rainfall and water infiltration to provide moisture content between approximately 20 to 26%;
- Conditions that either are or are very close to anaerobic;
- High proportion of biodegradable materials;
- A pH between 6.5 and 8.5, ideally verging slightly on the acidic between pH 6 to 7;
- Temperature between 25°C and 55°C;
- The ratio of the biochemical and chemical oxygen demands (BOD:COD);
- High permeability;
- Small particle size, as finer subsurface materials possess a greater surface area to provide a growing ‘face’ for the micro-organisms but high fines levels reduces permeability and reduces decomposition rate.

For this reason, it is vital that sources of methane and carbon dioxide are identified prior to the commencement of any work on a construction site, and that the ground gas regime is characterised at the worst temporal conditions a site may experience. From this, a risk assessment is carried out to identify the risk at the site from ground gases so that suitable protection measures can be designed and incorporated into a development to prevent a dangerous build-up of gas occurring.

Factors Influencing the Migration and Behaviour of Ground Gases

There are many factors that influence the migration of ground gases which can affect the risk from a gassing source:

- driving force – pressure differential along a pathway, diffusion and dissolved in solution;
- meteorological conditions – short term and seasonal conditions including atmospheric pressure changes (e.g. rapidly falling pressure causes gas to expand increasing emission rates), rainfall, frozen ground and thawing, temperature;
- geological and groundwater conditions – these can have the over-riding influence on the direction/pathways and quantity of migrating gas;
- anthropogenic influences – man-made pathways include mine shafts, service runs/drains, foundation piles, underground voids/pits/basements, foundation/building design/construction

Guidance Documents

Currently in the UK, there are no statutory threshold limits for hazardous gases in the ground as site specific variables mean that standard threshold values cannot be applied. The published guidance relating to development of sites where methane and carbon dioxide are present has been produced in response to building projects on or close to landfill sites, as both gases are principal constituents of landfill gas. Much of the historic guidance that has been produced on gas risk assessment focused on landfill sites and as a result there has previously been a lack of clarity when relating the process to gas conditions on non-landfill sites.

Statutory guidance regarding methane in the ground has previously taken a limiting concentration of 1.0 % by volume methane (equal to 20% of the lower explosive limit of methane in air) above which necessary actions will be appropriate. For carbon dioxide the limiting recommended trigger was 1.5 % by volume (the Long Term Exposure Limit for carbon dioxide). Above these concentrations the Building Regulations Approved Document C (1992) stated that consideration should be given to whether actions may be appropriate, whilst more specific solutions would be likely to be necessary at concentrations greater than 5% by volume of carbon dioxide (Building Regulations Approved Document C, 1992). However, the latest fully revised version of Approved Document C (DoE, 2004) no longer endorses this approach and instead requires the use of a risk-based approach in interpreting the findings of a gas monitoring survey. Further, the latest EA documentation on landfill gas (LFTGN 03, 2004) continues to sanction the use of a risk-based approach through a structured approach to the assessment of ground gases and links with the risk assessment process outlined within CLR 11 for soil contaminants.

With the above in mind, recent guidance has been produced in 2006 and 2007 with the aim of providing up to date advice in relation to residential and commercial development. The guidance does not address issues associated with gas derived from landfills, for this refer to *"Guidance on the Management of Landfill Gas"* (Environment Agency 2004) for an overview.

Recent guidance relevant to gas assessments for residential and commercial development includes;

- **Wilson *et al.* (CIRIA C665, December 2007) *"Assessing Risks Posed by Hazardous Ground Gases for Buildings."***

  This document provides up to date advice on all aspects of ground gas risk assessment such as investigation, monitoring programmes, data collection and interpretation. The guidance presents separate methodologies for the characterisation of:

  - **All development types except low rise housing with gardens and for Low Rise Buildings without a 150mm void** (Situation A) (Table 8.5 CIRIA C665)

  and;

  - **Low rise housing with gardens with a 150mm ventilated sub-floor void** (Situation B) (Table 8.7 CIRIA C665)
    (See below for further explanation of the methods of characterisation)

- **Boyle and Witherington (NHBC / RSK Group, Report 10627-R01(04) January 2007) *"Guidance on the Evaluation of Development Proposals on Sites where Methane and Carbon Dioxide are Present."***
  This document presents the "Traffic Lights System" detailed below and is relevant only for low rise properties (e.g. bungalows and town houses) that have a ventilated sub-floor void (i.e. Situation B as described in CIRIA C665).

- **Wilson and Card (CIEH, expected 2011) *"Ground Gas Handbook for Designers and Regulators"***
  This document is expected to provide practical guidance on ground gas assessments and the design and evaluation of protection measures.

- **British Standard (BS 8485, June 2015) *"Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings"***
  This document provides an overview of gas characterisation and assessment. The Standard is intended to be used by designers of gas protection measures and regulators involved in the assessment of design solutions. The Standard provides a framework in line with CLR11 allowing designers to judge the adequacy of ground gas and related site investigation data. The document provides an approach to determine appropriate ground gas parameters that can be used to identify a range of possible construction solutions mitigating against the presence of ground gas on a development site.

Each of these documents continues to highlight the importance of, and give further guidance towards, carrying out a tiered risk-based decision-making process in accord with government policy on dealing with contamination from historic or natural sources and highlight the importance of the Conceptual Model in site characterisation. These documents also stress the importance that the assessor should be confident that the ground gas monitoring results are representative of the likely worse case ground gas regime on a site and that the data collected from the site is sufficient. With this in mind, CIRIA C665 sets out ideal monitoring periods as below.

Idealised Frequency and Period of Monitoring (after Table 5.5a and 5.5b, CIRIA C665)						
		Generation Potential of Source				
		Very Low	Low	Moderate	High	Very High
Sensitivity of Development	Low (Commercial)	4/1	6/2	6/3	12/6	12/12
	Moderate (Flats)	6/2	6/3	9/6	12/12	24/24
	High (Residential with Gardens)	6/3	9/6	12/6	24/12	24/24

Notes

1. First number is the number of readings and the second is the minimum period in months (e.g. 6/2 – six sets of readings over two months).

2. At least two sets of readings must be at low (preferably under 1,000 mb) and falling pressure.

3. High sensitivity end use on high or very high hazard site will not normally be acceptable unless the source is treated to reduce gassing potential.

Before the latest guidance, good practice for site characterisation had been based upon the method proposed by Wilson and Card (1999). CIRIA C665 (2007) effectively supersedes Wilson and Card (1999) and includes a modified version of the Wilson and Card method (Tables 8.5, 8.6 and Box 8.1). Gas concentrations and flow rates for either methane and/or carbon dioxide measured at a site to 'Characteristic Situations.' Appropriate protection measures are selected from Table 8.6 (if using modified Wilson & Card method) and from Box 8.4 from CIRIA C665 (if using the NHBC traffic lights method). Throughout the risk assessment process, strong regard must be given to the nature of the gassing source, the flow rates and the estimated surface emissions. Note that certain protection measures are stated in CIRIA Report 149 that are now considered wholly inappropriate to certain developments and consequently should not be used without modification. Throughout the process, it is important to remember that these tables are not intended to be used as a definitive design tool and have been prepared to show the typical scope of measures for gas control.

Both the NHBC (2007) and CIRIA (2007) guidance documents and BS 8485 (2015) propose that both ground gas concentrations and flow rates are used to calculate the limiting gas well gas volume flow rates for methane and carbon dioxide, based on the ground gas conditions monitored for during the worse-case temporal conditions. This limiting gas well volume flow rate is termed the Gas Screening Value (GSV, note that this was termed borehole gas volume flow), and is calculated as follows:

$$\textbf{GSV}\ (\text{l/hr}) = \frac{[\text{gas well gas concentration (\%v/v)}]\ \textbf{x}\ [\text{gas well flow rate (l/hr)}]}{100}$$

These GSVs are then compared to generic 'Traffic Lights' contained within the NHBC guidance, which present typical maximum gas concentrations and limiting GSV's, for 'Situation B Development' (Low rise housing with gardens).

Table 8.7 NHBC Traffic light system for 150 mm void				
Traffic Light	**Methane [1]**		**Carbon Dioxide [2]**	
	Typical max concentration [3] (% by volume)	**Gas Screening Value [2,4] (litres/hour)**	**Typical max concentration [3] (% by volume)**	**Gas Screening Value [2,4] (litres/hour)**
Green	**1**	**0.13**	**5**	**0.78**
Amber 1	**5**	**0.63**	**10**	**1.6**
Amber 2	**20**	**1.60**	**30**	**3.10**
Red				

Notes:
1. The worst-case ground gas regime identified on the site, either methane or carbon dioxide, at the worst-case temporal conditions that the site may be expected to encounter will be the decider as to what Traffic Light is allocated;
2. Borehole Gas Volume Flow Rate, in litres per hour as defined in Wilson and Card (1999), is the borehole flow rate multiplied by the concentration in the air stream of the particular gas being considered;
3. The Typical Maximum Concentrations can be exceeded in certain circumstances should the Conceptual Site Model indicate it is safe to do so;
4. The Gas Screening Value thresholds should not generally be exceeded without the completion of a detailed ground gas risk assessment taking into account site-specific conditions.

Box 8.4 of CIRIA C665 Gas protection measures for low-rise housing development based upon allocated NHBC Traffic light (Boyle and Witherington, 2007)	
Traffic Light Classification	**Protection Measures Required**
Green	Negligible gas regime identified and gas protection measures are not considered necessary.
Amber 1	Low to intermediate gas regime identified, which requires low-level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to limit the ingress of gas into buildings. Gas protection measures should be as prescribed in BRE Report 414. Ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours.
Amber 2	Intermediate to high gas regime identified, which requires high-level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to prevent the ingress of gas into buildings. Gas protection measures should be as prescribed in BRE Report 414. Membranes should always be fitted by a specialist Contractor. As with Amber 1, ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours. Certification that these passive protection measures have been installed correctly should be provided.
Red	High gas regime identified. It is considered that standard residential housing would not normally be acceptable without a further Gas Risk Assessment and/or possible remedial mitigation measures to reduce and/or remove the source of gas.

For a 'Situation A Development' (All development except low rise housing with gardens), the GSV value is used to derive the appropriate Characteristic Situation from Table 8.5 of CIRIA C665 (below):

Table 8.5 from CIRIA C665 Modified Wilson and Card Classification

Characteristic Situation (CIRIA R149)	Comparable Partners in Technology gas Regime (see Box 8.2)	Risk Classification	Gas Screening Value (CH_4 or CO_2) (l/hr)[1]	Additional Factors	Typical Source of Generation
1	A	Very low risk	<0.07	Typically methane ≤ 1% and/or carbon dioxide ≤ 5%. Otherwise consider increase to Situation 2	Natural soils with low organic content "Typical" made ground
2	B	Low risk	<0.7	Borehole air flow rate not to exceed 70l/hr. Otherwise consider increase to characteristic Situation 3	Natural soil, high peat/organic content. "Typical" made ground
3	C	Moderate risk	<3.5		Old landfill, inert waste, mine working flooded
4	D	Moderate to high risk	<15	Quantitative risk assessment required to evaluate scope of protective measures.	Mine working susceptible to flooding, completed landfill (WMP 26B criteria)
5	E	High risk	<70		Mine working unflooded inactive with shallow workings near surface
6	F	Very high risk	>70		Recent landfill site

It was intended in CIRIA C665 that the characteristic situation allocated to the development from the table above would then be used in Table 8.6 of CIRIA C665 in order to determine the level of gas protection the development requires. However, BS8485:2015 superseded this document and a different set of mitigation standards were put forward.

The recommended minimum gas protection score (points) be selected based on the building type (Table 3 which defines four building types) and the ground gas Characteristic Situation as detailed in Table 4 of BS8485:2015 (see below).

The first step in the decision making process is to obtain the level of gas protection necessary in the range 0 to 7.5 from Table 4. Then a combination of structural barriers (Table 5) ventilation protection measures (Table 6) and/or gas resistant membranes (Table 8)should be chosen to meet that requirement. The level of gas protection necessary should take into account the characteristic gas situation and a number of other factors. The whole decision making process should be made transparent, where all parties can see the approach being taken, can understand the various steps and decisions made and be confident that a risk-assessed solution has been designed and installed commensurate with the construction and site constraints.

Where the gas Characteristic Situation is 4 or more (and for NHBC Red situations according to CIRIA C665), the site requires a comprehensive risk assessment to confirm the scope of protection measures. These are higher risk sites and reliance on Table 4 alone is not sufficient.

BS8485:2015 Table 3 Building Types				
	Type A	**Type B**	**Type C**	**Type D**
Ownership	Private	Private or commercial/ public, possible multiple	Commercial / public	Commercial / industrial
Control (change of use, structural alterations, ventilation	None	Some but not all	Full	Full
Room sizes	Small	Small / medium	Small to large	Large industrial / retail park style

BS8485:2015 Table 4 Gas Protection Score by CS and Type of Building				
CS	**Required Gas Protection**			
	High risk	**Medium risk**		**Low risk**
	Type A	**Type B**	**Type C**	**Type D**
1	0	0	0	0
2	3.5	3.5	2.5	1.5
3	4.5	4	3	2.5
4	6 (A)	5.5(A)	4.5	3.5
5	(B)	6.5(A)	5.5	4.5
6	(B)		7.5	6.5

a) Residential building should not be built on CS4 or higher sites unless the type of construction or site circumstances allow additional levels of protection to be incorporated, e.g. high-performance ventilation or pathway intervention measures, and an associated sustainable system of management of maintenance of the gas control system, e.g. in institutional and/or fully serviced contractual situations.

b) The gas hazard is too high for this empirical method to be used to define the gas protection measures

NOTE 3 The NHBC has published guidance for use on residential developments, which utilise an alternative classification ("traffic light") system. This guidance typically applies to Type A buildings utilising beam and block floor constructions with clear void ventilation. The design choice variables are limited to decisions relating to the membrane specification and verification recommendations (see Table 7). Designers utilising this system would therefore need to refer to NHBC to assess compliance for specific recommendations [see 8485:2015 for further on this note]

NOTE4 The method of selecting the combination of these types of protection is given in section 7.2 of BS8485:2015. Once type of measures has been decided, the detailed design and specification of the measures should be undertaken (section 7.3)

Section 7.2 defines the order of selecting protective measures. The first choice is provided by structural barriers as defined in Table 5.

BS8485:2015 Table 5 Gas protection scores for structural barriers		
PROTECTION ELEMENT/SYSTEM	**SCORE**	**COMMENTS**
Floor and substructure design		
Floor slabs		*General – score conditional that breaches of slab are sealed*
Block and beam floor slab	0	
Cast in situ ground-bearing floor slab (with only nominal mesh reinforcement)	0.5	
Cast in situ monolithic reinforced ground-bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations(with only nominal mesh reinforcement)	1 or 1.5	*To achieve 1.5, raft or suspended slab to be well reinforced to prevent cracking and minimal penetrations*
Basement floor and walls to BS 8102:2009, Grade 2 waterproofing	2	
Basement floor and walls to BS 8102:2009, Grade 3 waterproofing	2.5	*Conditional that waterproofing is not based on geosynthetic clay liner*

Ventilation methods are detailed in Table 6, and points can only be gained from using one of the five types

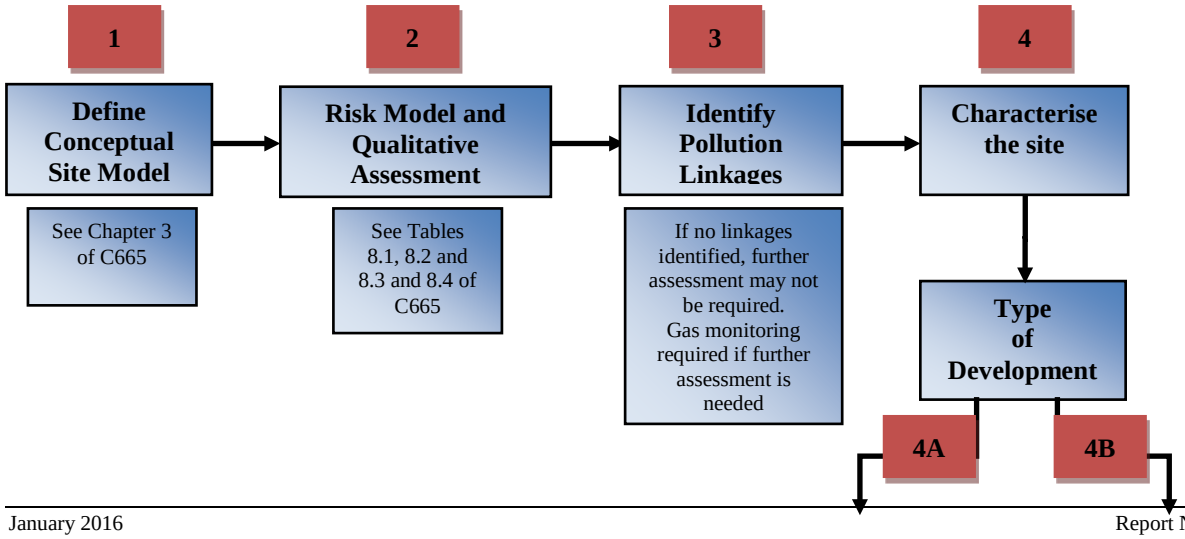
BS8485:2015 Table 6 Gas Protection Scores for Ventilation Protection Measures		
PROTECTION ELEMENT/SYSTEM	**SCORE**	**COMMENTS**
a) Pressure relief pathway (usually formed by low fines gravel or with a thin geocomposite blanket with strips terminating in a gravel trench external to the building	0.5	*Whenever possible, a pressure pathway relief pathway (as a minimum) should be installed in all gas protection measures systems.* *If a layer has a low permeability and/or is not terminating in a venting trench (or similar), then the score is zero.*
b) Passive sub floor dispersal layer Very good performance Good performance Media used to provide the dispersal layer are: • Clear void • Polystyrene void forming blanket • Geocomposite void former blanket • No-fines gravel layer with gas drains • No-fines gravel layer	 2.5 1.5	*Performance criteria shown in Fig B.6 and B.7 of BS 8484:2015.[See Annex B]*
c) Active dispersal layer, usually comprising fans with active abstraction (suction) from a subfloor dilution layer, with roof level vents. The dilution layer may comprise a clear void or be formed of geocomposite or polystyrene void formers	1.5 to 2.5	*This system relies on continued serviceability of the pumps, therefore alarm and response systems should be in place. [See Annex B].*
d) Active positive pressurisation by the creation of a blanket of external fresh air beneath the building floor slab by pumps supplying air to points across the central footprint of the building into a permeable layer, usually formed of a thin geocomposite blanket	1.5 to 2.5	*This system relies on continued operation of the pumps, therefore alarm and response systems should be in place. [See Annex B].*
e) Ventilated car park (floor slab of occupied part of the building under consideration is underlain by a basement or under croft)	4	*Assumes car park is vented , designed to Building Regulations 2000, Approved Document F.*

Membrane methods are detailed in Table 7.

BS8485:2015 Table 7 Gas protection score for gas resistant membrane		
PROTECTION ELEMENT/SYSTEM	**SCORE**	**COMMENTS**
Gas resistant membrane meeting all of the following criteria: • Sufficiently impervious to gases with a methane gas transmission rate <40.0 ml/day/m^2/atm (average) for sheet and joints (tested in accordance with BS ISO 15105-1 manometric method) • Sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions; • Sufficiently strong to withstand in-service stresses (eg settlement if placed below a floor slab); • Sufficiently strong to withstand the installation process and following trades until covered (eg penetration from steel fibres in fibre reinforced concrete, dropping tools etc); • capable, after installation, of providing a complete barrier to the entry of the relevant gas; and • verified in accordance with CIRIA C735	2	*The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation, and the integrity of joints.* *If a membrane is installed that does not meet the criteria, then the score is zero.*

For a site which is impacted by migratory gases from an off-source, the development may be protected by imposing pathway intervention methods, which if successfully validated, could also remove the need for further analysis. It is essential that the gas regime in these circumstances has been fully characterised and that the only source impacting the site is located off site and that the pathway is clearly defined and its interception equally proven before construction commences. Pathway intervention methods may include vertical membrane installations, venting trenches, rows of stone columns, activated trenches and various proprietary systems. These systems are particularly relevant to domestic housing where there is limited scope for foundation type solutions.

Following the choice of protection measures, detailed design should be entered into [section 8 of BS 8485:2015].
s:

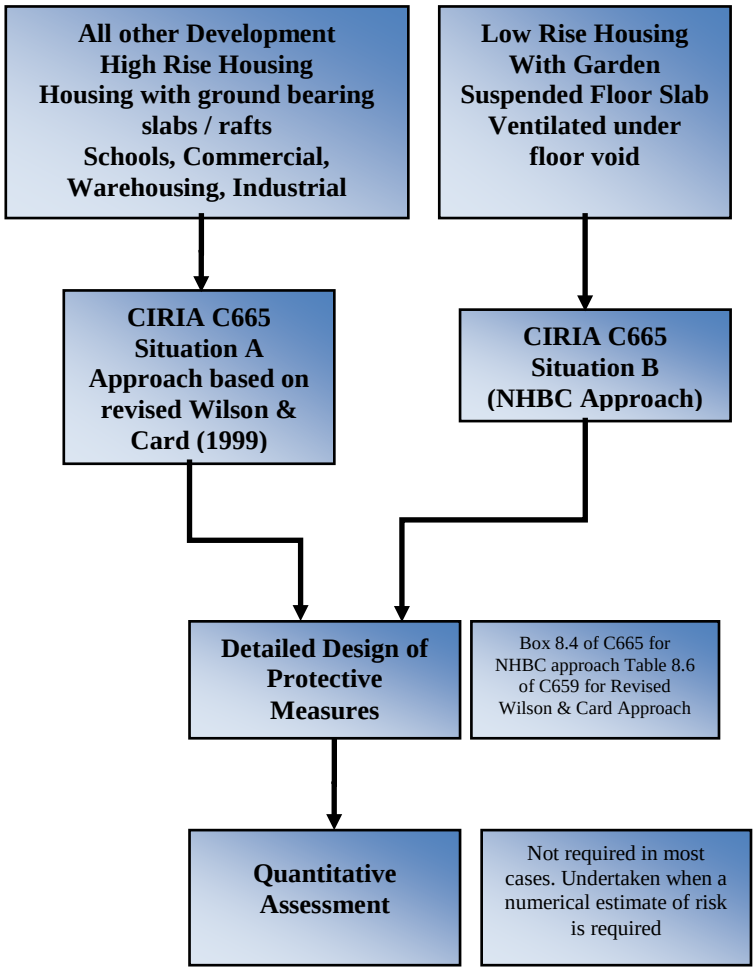


Flowchart showing the general Risk Assessment process, as defined in CIRIA C665 *"Assessing Risks posed by Hazardous Ground Gases to Buildings"*

Each stage is numbered and corresponds to the relevant Risk Assessment stage in the document.

Reference should be made to Section 8 of the document which goes into further detail on the Risk Assessment processes defined here.

Reference should also be made to NHBC / RSK Group Report No. 10627-R01(04) *"Guidance on Evaluation of Development Proposals on Sites where Methane and Carbon Dioxide are present"*



APPENDIX K

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 2015/16 tax year is £2.60/Tonne for inactive waste (inert and some types of non-hazardous waste) and £82.60/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.

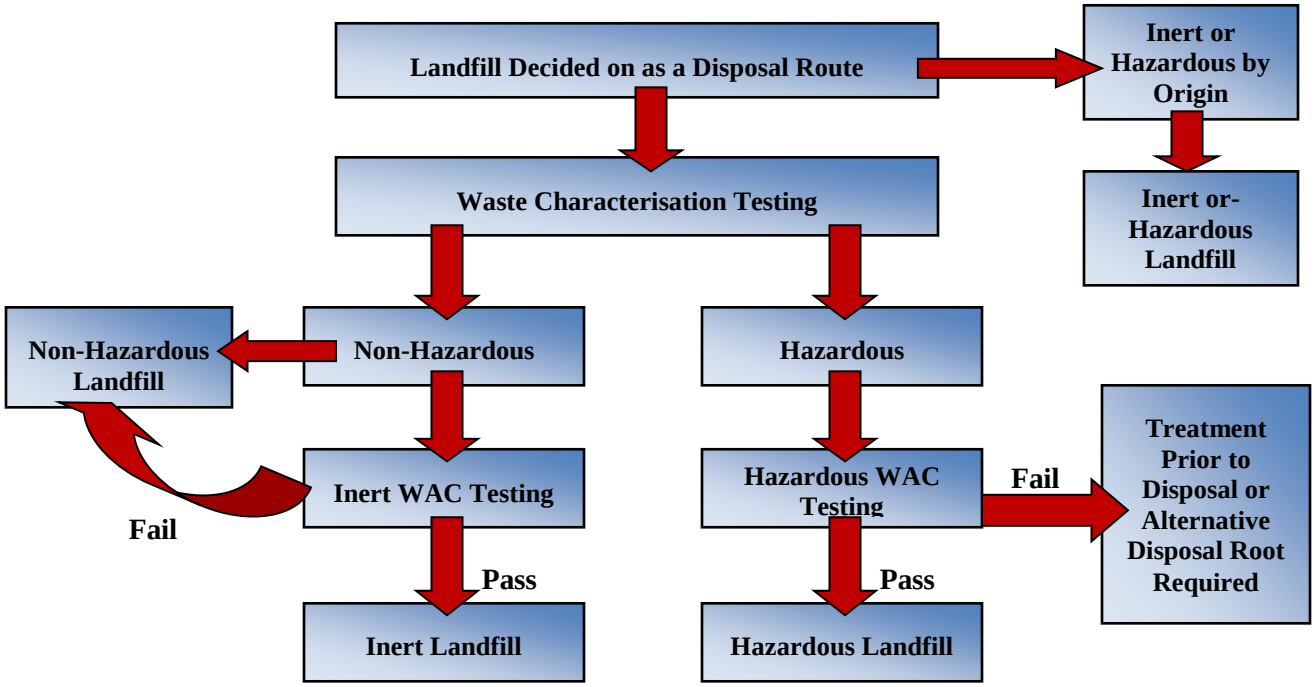
For waste classified as not being hazardous, then there are two options available. Currently, waste correctly characterised as not being hazardous may be disposed of without WAC testing to a non-hazardous landfill. Alternatively WAC testing for Inert Waste can be carried out (this is similar to the list 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 they can be pre-treated on site or taken to a soil treatment centre for pre-treatment (such as at the facility run by Biffa at Risley near Warrington). Here the soil's hazardous properties may be reduced (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 £82.60/T and applies to all wastes unless they qualify for the reduced rate of landfill tax of £2.60/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.







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