

**HALTER INN WORKS
HOLCOMBE**

**GEOENVIRONMENTAL
INVESTIGATION REPORT
AND REMEDIATION
STRATEGY**



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1 INTRODUCTION

1.1 Background

LK Consult Ltd (LKC) has been commissioned by Finishing Techniques Ltd to carry out a geo-environmental investigation and risk assessment for Halter Inn Works, Holcombe. The investigation was undertaken in support of a planning application (Bury Council ref: 54975). The site is to be developed for residential use. Information is therefore required on the properties of any potential contaminants that may be present in, on or under the site.

The aims of this report are to establish the feasibility of developing this site, to demonstrate to the Local Planning Authority that in accordance with the National Planning Policy Framework (NPPF)¹ the site may be developed for a residential end use and that appropriate site investigation and risk assessment works are in place to allow conditional approval of any future planning application. In addition, work was conducted to confirm ground conditions for a geotechnical assessment.

A Preliminary Risk Assessment (PRA) report has previously been undertaken by LKC (Ref: CL-602-LKC 14 1496-01, dated February 2015) and summarised in Section 2. This report should be read in conjunction with the PRA report.

1.2 Site Details

A summary of site settings is presented in Table 1-1. Figures 1 and 2 indicate the site location and boundary. Figure 3 indicates the proposed development.

Location	Off Redisher Croft to the west of Bolton Road West, Holcombe, Lancashire. Centred at approximate National Grid Reference 377920E 415300N.
Area	700m ² .
Topography	Approximately 160 metres above ordnance datum (AOD). Site is approximately level.
Current Land Use	<u>Site</u> Small industrial building occupies the centre of the site with a hardstood concrete area in the south and a tarmacadam access road to the north of the building. <u>Surrounding Area</u> North: Wooded Area and Farmland. East: Redisher Croft and Public House. South: Residential Properties. West: Wooded Area.
Proposed Development	Residential dwellings including soft landscaping and car parking.

Table 1-1: Summary of site settings for Halter Inn Works, Holcombe.

¹ DCL (2012). "National Planning Policy Framework." Department of Communities and Local Government. March 2012.

2 PREVIOUS WORK

2.1 Summary of Existing Information

A PRA report (Ref: CL-602-LKC 14 1496-01, dated February 2015) has previously been undertaken by LKC.

The report comprised a review of factual information sources such as site history via historical mapping, geology, hydrogeology and an Envirocheck search. A preliminary contamination conceptual model was provided which identified several potential pollutant linkages.

A summary of the available information is provided below along with the preliminary conceptual model.

2.2 Site History

The site history is summarised in Table 2-1.

Site Features	Location	Map Dates Present	Comments
Unreferenced buildings	East	1893-1968	- No longer present by 1978 mapping.
Reservoir	Northwest corner	1893-1912	- Part of larger adjacent reservoir is present across the northwest corner of the site. - Mapping indicates reservoir is at a higher level to the majority of the site. - No longer present by 1929 mapping; reservoir converted to a series of filter beds.
Wooded area	Southwest	1893-1912	- No longer present by 1929 mapping.
Unreferenced building	Centre	1978-2014	- Building currently occupied by a Metal Finishing Works.
Surrounding Area Features	Distance/ Location	Map Dates Present	Comments
Cotton Mill	Adj to N	1893-1992	- No longer annotated as a Cotton Mill from 1937 mapping. - No longer present by 2004 mapping.
Public House	50m W	1893-2014	
Holcombe Brook	90m NW & 80m SE	1892-2014	- Section of brook assumed culverted below Holcombe Brook village centre. - Brook feeds into reservoir adjacent to northwest on 1893-1912 mapping. - Section to the northwest no longer present by 1929 mapping; assumed culverted.
Pond	200m SW	1893-1912	- No longer present by 1929 mapping.
Pond	200m S	1893-1968	- No longer present by 1978 mapping.

Table 2-1: Summary of significant historical features; surrounding area features include significant potentially contaminative features within 100m of the site or 250m of the site if a potential landfill (i.e. a possible source of landfill gas) is identified.

Site Features	Location	Map Dates Present	Comments
Filter Beds	Adj to NW	1929-1992	- Potentially associated with Redisher Bleach and Dye works, 150m NW of the site. - No longer annotated as Filter Beds by 1964 mapping. - Western portion of structure absent by 1978 mapping. - No longer present by 2004 mapping.
Garage	30m SE	1964-1992	- Building still present on 2014 mapping but not annotated as a Garage. - Noted to be a residential property during the site reconnaissance.

Table 2-1 (continued): Summary of significant historical features; surrounding area features include significant potentially contaminative features within 100m of the site or 250m of the site if a potential landfill (i.e. a possible source of landfill gas) is identified.

2.3 Environmental Setting

The environmental setting is summarised in Table 2-2.

Categories (data sources)			Details
Geology	Artificial		- None recorded on site.
	Superficial		- None recorded across north east of site. - Devensian Till recorded across the south west of site.
	Bedrock		- Holcombe Brook Grit Sandstone. - 1 fault approximately 230m south of the site striking east-west.
	BGS logs		- None relevant within 250m.
Hydro-geology	Aquifer Designation	Superficial	- Unproductive.
		Bedrock	- Secondary A.
	Groundwater Abstractions		- One within 500m: 495m N for a private water supply, licence is recorded as revoked.
Hydrology	Nearest Surface Water		- Holcombe Brook 9m east, flowing west to east.
	Water Quality Data		- 2m NE, Holcombe Brook – River Quality B.
	Flooding		- No risk from rivers or sea.
	Surface Water Abstractions		- None within 1km. Nearest is 1,147m SE, abstracted from the River Irwell for industrial process water at Greenleaf Enterprises Ltd.
	Discharge Consent		- One within 250m: 4m SE, discharge of treated sewage to Holcombe Brook.
	Pollution Incidents		- None within 250m. Nearest is 389m SE, treated sewage effluent to the River Irwell, Category 3 – Minor Incident.
Minerals / Mining	Coal Mining Development High Risk Area		- Not identified on site.
	Coal Report		- Not within the likely zone of influence from past coal workings. - No known coal mine entries present within, or within 20m of, the site boundary. - Reserves of coal exist in the area which may be worked in the future.

Table 2-2: Summary of the environmental settings for Halter Inn Works, Holcombe.

Categories (data sources)		Details
Minerals / Mining	Surface Extractions	Two recorded mineral extraction sites within 500m: - 210m NW, Redisher Farm, opencast extraction of sandstone. - 312m NW, Redisher Wood, opencast extraction of clay and shale. Both operations are now listed as ceased.
	Cheshire Brine Compensation District	- Not within site area.
Ground Stability (on-site)	Collapsible Ground	- Very low hazard.
	Compressible Ground	- No hazard.
	Landslide	- Very low hazard.
	Running Sand	- No hazard.
	Shrinking / Swelling Clay	- Very low hazard.
	Ground Dissolution	- No hazard.
Landfill sites	Known/Registered	- None within 250m; nearest is 483m E, Woodhey Dye Works, authorised waste is asbestos, construction and quarry wastes, licence is recorded as lapsed/cancelled/surrendered.
	Potential ¹	3 within 250m: - Reservoir adjacent to the NW of the site, potentially infilled by 1929 mapping. - 2no. ponds 200m, potentially infilled by 1929 and 1978 mapping.
Radon		- Probability of <1% of homes above Action Level. No further action required.
Designated Sites		- Site is part of Adopted Green Belt. - Redisher Wood Nature Reserve, 182m NW.
Contemporary Trade Directory		- 3 within 100m; nearest onsite, Halter Inn Works (Cabinet Makers), Inactive. - Nearest active is 77m S, Carter Interiors (Blinds, Awnings and Canopies).
Fuel Station Entries		- None within 100m.

Table 2-2 (continued): Summary of the environmental settings for Halter Inn Works, Holcombe.

2.4 Site Reconnaissance

A site reconnaissance was carried out on 12th January 2015. Hand dug trial holes were not undertaken due to extensive hardstanding and the current building occupying the site.

Relevant features identified on site are summarised below:

- Existing L-shaped Metal Finishing Works building present in the centre of the site.
- A concrete yard area currently used for car parking is present to the south east of the existing building. An IBC was noted to be present outside the building in this area.
- A tarmac drive is located to the north of the building. A steel container and a number of IBCs were noted to be present in this area.
- The site is topographically lower than the surrounding area to the north, south and west.
- A retaining wall is present to the rear (west) of the building and heavily vegetated ground rises up away from the site behind this wall.
- The land dips to the south east and an open section of Holcombe Brook is visible behind a wall adjacent to Redisher Croft.

- Manhole covers relating to a culverted natural watercourse were noted to be present to the north of the building onsite. From available surveys it is indicated that this watercourse discharges into Holcombe Brook to the south east of the site.
- The site is operational and is accessible off Redisher Croft. The rear of the building is not accessible to vehicles.
- No evidence of significant contamination identified.

The surrounding area comprises:

- Redisher Croft and residential properties to the north.
- Redisher Croft with a wooded area is present to the east. A Public House off Bolton Road West is beyond the wooded area.
- Residential properties off Redisher Croft to the south.
- Heavily vegetated land rises away from the site to the west

2.5 Preliminary Contamination Conceptual Model

The preliminary contamination conceptual model using contaminant-pathway-receptor linkages based on guidance in CLR11² has been summarised in Table 2-3.

The aim of the conceptual model is to provide a preliminary assessment of the likelihood of a pollutant linkage for each potential combination of contaminant, pathway and receptor. A conceptual model can be used to make an informed decision on the contamination risks associated with the site and determine what site investigation work is required.

The preliminary contamination conceptual model has identified seven generic potential pollutant linkages. Each linkage is described along with an assessment of the risk based upon guidance on probabilities and consequences outlined in CIRIA C552³.

In order to assess the potential risk for each pollutant linkage, an assessment of the magnitude of the potential consequence (severity) of the risk occurring and the magnitude of the probability (likelihood) of the risk occurring has been considered and classified. This is based on the guidance provided in CIRIA C552 and further details including a risk matrix is provided in Appendix A.

Where the risk falls into the moderate/low risk, LKC will undertake an assessment to establish what category the pollutant linkage will fall into (i.e. moderate or low risk will be chosen).

Where LKC identifies a moderate or higher risk intrusive work or precautionary remedial measures will be recommended.

Where LKC identified a low to very low risk either limited intrusive investigation work, a watching brief (during construction work) or no investigation work will be recommended. This will be dependent on the nature of the site and the proposed development.

A summary of contamination sources are as follows:

- Works Building: mineral and organic acids, oils, organic solvents, electroplating metals and inorganic compounds such as cyanides, sulphates and chlorides⁴.
- Embankments / Made Ground: heavy metals, sulphates, asbestos and PAHs⁵.

² EA (2004). "Model Procedures for the Management of Land Contamination." R&D Publication CLR 11.

³ CIRIA (2001). "Contaminated land risk assessment: A guide to good practice". C552.

⁴ Department of the Environment. Industry Profile. Metal Manufacturing, Refining and Finishing Works. 1995.

- Cotton Mill offsite: metals, other inorganic compounds (e.g. cyanides, sodium compounds, sulphide compounds, chloride compounds, mineral acids, alkalis), chlorinated organic solvents, sizing agents, other organic compounds (e.g. formaldehydes, polyvinyl chloride), water repellents (organo silicon, oxazoline), fire/flame retardants (e.g. borax, ammonium phosphate, brominated organic compounds with metals oxides), soaps and detergents.
- Garage offsite: hydrocarbons and oils from spillages / leakages.
- Landfills / potentially infilled ground: hazardous gas (principally carbon dioxide and methane).

A summary of possible pathways are as follows:

- Human Health - ingestion (of soil, dust, home produce), inhalation (of dust, fibres, vapours), dermal contact (of soils and dust).
- Controlled Waters: Migration of mobile contaminants through permeable strata and preferential pathways.
- Gas: Migration through permeable strata and preferential pathways. Build-up in confined spaces causing explosion and asphyxiation.
- Windblown dust.
- Direct contact.
- Root uptake.

A summary of possible receptors are as follows:

- Human Health: future site residents, future site users, offsite land users.
- Controlled Waters: Holcombe Brook, 9m east and underlying Secondary A Aquifer.
- Buildings and structures.
- Potable water pipes.
- Flora within future gardens/landscaping.

It should be noted that there may be risk from short term exposure from contaminated soil to site workers. The Preliminary Contamination Conceptual Model deals with long term exposure to key receptors. Acute risks can be easily mitigated by good environmental management of the site during site works. Standard health and safety precautions (as per HSE guidance⁶) should be adopted by all workers involved with site enabling and construction works. Therefore, this receptor is not considered in the contamination conceptual model.

⁵ Defra (2002). "Potential Contaminants for the Assessment of Land." R&D Publication CLR 8

⁶ HSE (1991). "Protection of workers and the general public during development of contaminated land" London HMSO.

Pollutant Linkage	Pathway	Receptor	Contaminant (source)	Probability	Consequence	Risk	Assessment
PL1	-Dermal contact. -Inhalation of soil, fibres and dust. -Ingestion of soils, dust, vegetables, soil attached to vegetables. -Windblown dust.	-Future residents. -Site users. -Offsite receptors.	-ACM (former buildings, potentially in made ground).	Likely	Severe (ACM)	High	-Likely probability from ACM due to historic buildings on site and date of demolition. -Likely probability of heavy metals and PAHs given potential for ash made ground on site due to land raising for adjacent reservoir. -Heavy metals may also be present in made ground from current use of the site as a Metal Finishing Works. -Low risk assumed for hydrocarbons as significant source not identified. -Recommendation: Intrusive investigation required.
			-Heavy metals and PAHs (ash in made ground, metal finishing works).	Likely	Medium	Moderate	
			-Hydrocarbons: oils/fuels (Metal Finishing Works onsite, Cotton Mill offsite)	Low	Medium	Moderate / Low	
PL2	-Inhalation of vapours. -Migration through permeable strata and preferential pathways.	-Future residents. -Site users.	Volatile Contaminants: -Fuels and solvents (Metal Finishing Works).	Low	Medium	Moderate / Low	-Low probability as potential volatile contamination source is only from current works on site and only small scale leakages / spillages of volatile contamination anticipated. -Low risk assumed at this stage as significant source not identified and current site predominately covered by building and hardstanding, therefore infiltration will be reduced. -Recommendation: No intrusive work required unless evidence of volatile contaminants identified in the ground.
PL3	-Inhalation of gas. -Migration through permeable strata and preferential pathways. -Explosion in confined spaces.	-Current site users. -Future residents. -Buildings. -Offsite land users.	-Methane, carbon dioxide. (potentially infilled features 250m of the site).	Likely	Severe	High	-Likely probability due to viable source of gas identified (infilled reservoir) and sensitive nature of development (residential). -Recommendation: Gas monitoring required.
PL4	-Surface Run-off. -Migration through permeable strata and preferential pathways -Perched waters migration.	-Groundwater (Secondary A Aquifer). -Surface water (Holcombe Brook).	-Mobile contaminants (hydrocarbons and solvents from Metal Finishing Works on site, Cotton Mill offsite).	Low	Medium	Moderate / Low	-Low probability as significant source of mobile contamination is not considered likely from current or historical site use. -Clay expected below part of site will inhibit migration. -Moderate risk assumed at this stage due to proximity of Holcombe Brook and potential culverted section below or adjacent to the site. -Recommendation: Intrusive investigation required.
PL5	-Sulphate attack on concrete.	-Building structure.	-Sulphate (ash identified in made ground).	Likely	Mild	Moderate / Low	-Likely probability as made ground likely to be present on site and ash considered likely which may be in contact with concrete used in future buildings. -Moderate risk assumed at this stage. -Recommendation: Intrusive investigation required
PL6	-Ingestion of tainted water supply.	-Future site users.	-Organic Contaminants (made ground).	Low	Medium	Moderate / Low	-Low probability as significant contamination not anticipated at pipeline depth (0.75-1.35m). -Risk is considered moderate at this stage due to unknown depth of made ground. -Recommendation: Intrusive investigation required if made ground present at pipeline installation depths.
PL7	-Direct Contact (plant uptake).	-Flora.	-Phytotoxic Contaminants (made ground).	Low	Minor	Very Low	-Low probability as contamination considered possible, which may be taken up by flora in soft landscaping / gardens. -Recommendation: Intrusive investigation work as part of PL1.

Table 2-3 Contamination Conceptual Model for Halter Inn Works, Holcombe.

3 GROUND INVESTIGATION

3.1 Site Investigation Design and Methodology

In order to investigate the potential pollutant linkages identified in the preliminary contamination conceptual model, an intrusive investigation was undertaken using window sample boreholes and a hand dug trial hole on the 21st January 2015.

The intrusive site investigation involved the drilling of four window sample boreholes (referenced WS101 to WS104) to depths of between 2.39mbgl and 3.25mbgl. Where dense or stiff conditions prevailed and the standard window sample refused, the split spoon sampler was then used to determine SPTs was used to penetrate as far as possible into the natural strata. An additional hand dug trial hole (TH101) was undertaken to the rear of the works building, as this area was inaccessible for the window sample rig. All sampling locations are shown on Figure 4.

Head space samples were collected for onsite testing using a Photoionisation Detector (PID) and further soil samples were collected for laboratory chemical analysis.

The number of sampling points corresponds to one location per approximately 12m square centres (approximate herringbone pattern) which is considered appropriate for a 'main investigation' in accordance with BS10175⁷. All exploratory locations are shown in Figure 4. All profile logs are provided in Appendix B and are in line with BS5930⁸ and BS14688-1⁹.

3.2 Well Installations

All the boreholes were installed with monitoring wells for gas and groundwater monitoring and groundwater sampling. Monitoring wells were installed in accordance with BS10175 and CIRIA C665¹⁰ and generally comprised approximately 1m plain pipe over a length of slotted pipe surrounded by pea gravel and sealed at the top with bentonite and concrete.

Well installation details are provided in Profile Logs in Appendix B.

3.3 Sampling Protocol

3.3.1 Soil Sample Collection

Contamination

Standard sampling protocol and preservation of samples was undertaken as described in the EA guidance on site investigation¹¹.

Soil was collected for onsite testing. A plastic zip bag was half filled with soil allowing a suitably sized headspace. The bag was sealed and stored for at least 20 minutes before being tested for total volatile organic compounds using a TVA-1000 photoionisation detector (PID). Results of the PID readings are presented on the profile logs (Appendix B). The on-site monitoring was carried out in line CIRIA C665¹² to aid in screening samples for volatile analysis.

⁷ British Standard (2011). "Investigation of Potentially Contaminated Sites – Code of Practice." BS10175:2011.

⁸ British Standard (1999). "Code of Practice for Site Investigations." BS5930:1999.

⁹ British Standards (2002) Geotechnical investigation and testing – Identification and Classification of Soil. Part 1: Identification and description. BS EN ISO 14688-1:2002.

¹⁰ CIRIA (2007). "Assessing Risks Posed by Hazardous Ground Gases to Buildings." CIRIA C665.

¹¹ EA (2000). "Technical Aspects Of Site Investigation. Volumes 1 & 2 Text Supplements Research and Development Technical Report." P5-065/Tr.

¹² CIRIA (2007). "Assessing Risks Posed by Hazardous Ground Gases to Buildings." CIRIA C665

Soil samples of approximately 500g were recovered in amber jars, amber vials for volatile analysis and plastic tubs. All the samples were labelled and stored in cool boxes prior to being collected by courier at the end of the day for delivery to the Chemtest laboratory in Newmarket. If collection was not possible the same day then samples were stored in the sample storage fridge at the LK Group offices below 4°C. Samples were tracked using appropriate Chain of Custody forms provided by Chemtest.

It should be noted that hexavalent chromium soil is analysed using the USEPA recommended method of alkaline leach. This method limits chromium (VI) reduction to chromium (III)¹³.

Many of the tests are UKAS or MCERTS accredited and further details are given in the Certificate of Analysis presented in Appendix C and summarised in Table 3-1. The soil risk assessment is presented in Section 6.

Geotechnical

Bulk samples were collected for laboratory geotechnical testing by Murray Rix of Stockport. Many of the tests are UKAS accredited and further details are given in the Certificate of Analysis presented in Appendix D and summarised in Table 3-1. The geotechnical appraisal is presented in Section 5.

Summary of Soil Testing

Representative soil samples taken during the site investigation and were selected for chemical and geotechnical testing. Table 3-1 summarises the testing undertaken.

Suites and Contaminants	No. Samples	Justification
Suite 5: Metals / metalloids, water soluble sulphate, pH, speciated PAHs, SOM and asbestos.	5	No evidence of contamination identified with the possible exception of some ash, clinker and coal therefore basic suite considered most appropriate. No evidence of volatile contamination based on olfactory assessment and PID readings. Made ground samples selected.
pH and Sulphate	1	Additional samples of natural ground taken across the site to assess the pH and sulphate for geotechnical purposes.
Atterberg Limits (plasticity testing)	3	A selection of clay samples across the site were tested for Atterberg Limits to assess their shrinkability potential.

Table 3-1. Summary of soil sampling suite undertaken for Halter Inn Works, Holcombe.

Notes: Metal/metalloids = arsenic, cadmium, chromium, (total and hexavalent), copper, lead, mercury, nickel, selenium, vanadium, zinc and boron; PAH=polycyclic aromatic hydrocarbons; SOM=Soil Organic Matter.

3.3.2 Water Sample Collection

To establish the condition of groundwater LKC collected two groundwater samples (WS102 and WS104).

The groundwater samples were collected a minimum of 1 week after drilling had finished. Sample collection was undertaken using a low flow sampling pump using thin walled tubing to encourage laminar flow and minimise the potential loss of volatiles during sampling. The sample was collected in glass and plastic bottles and a glass vial. The borehole was purged of all standing water and the sample collected from the recharged water.

¹³ Palmer, CD and Roberts, WP (1994). "Natural Attenuation of Hexavalent Chromium in Groundwater and Soils." EPA Issue EPA/540/5-94/505.

Table 3-2 shows the groundwater testing undertaken.

Suites and Contaminants	No. Samples	Justification
Suite 1: Metals / metalloids, cyanide suite, water soluble sulphate, pH, TPHCWG, BTEX, MTBE, speciated PAHs, phenol, SOM and asbestos.	2	Suite 1 undertaken in WS102 and WS104 to confirm if potential contamination from made ground has impacted groundwater.

Table 3-2. Summary of groundwater sampling suites undertaken for Halter Inn Works, Holcombe.

Notes: Metal/metalloids = arsenic, cadmium, chromium, (total and hexavalent), copper, lead, mercury, nickel, selenium, vanadium, zinc and boron; TPHCWG=carbon banded and aromatic/aliphatic split petroleum hydrocarbons; PAH=polycyclic aromatic hydrocarbons, BTEX=benzene, toluene, ethylbenzene and xylenes; MTBE=Methyl tert-butyl ether.

Many of the tests are UKAS or MCERTS accredited and further details are given in the Certificate of Analysis presented in Appendix E. The controlled water risk assessment is presented in Section 6.3.

3.3.3 In-situ Onsite Geotechnical Testing

In-situ geotechnical tests were performed in the boreholes to further characterise the sub-soil conditions. In total, eight Standard Penetration Tests were performed on the underlying sub-soils.

Shear Vane tests were performed in the natural clay identified in the trial pits to further characterise the sub-soil conditions.

A summary of these results is provided in Section 5 and results are presented in the profile logs (Appendix B).

3.3.4 Gas Monitoring

All of the boreholes have been monitored for hazardous / ground gas on six occasions from 27th January to 2nd April 2015.

Monitoring is being undertaken using a Geotechnical Instruments GA2000 plus in accordance with the monitoring protocol outlined in CIRIA C665 (flow rate measured first). The monitoring was undertaken over a range of weather conditions (including low and falling barometric pressure and heavy rain) to demonstrate worst case conditions.

The gas monitoring results are reproduced in full in Appendix F.

4 GROUND CONDITIONS

4.1 Summary of Ground Conditions

The ground conditions beneath the site comprised made ground underlain by natural silty clay. A band of natural clayey gravel was noted in WS101. Underlying mudstone and shale was identified in three of the exploratory hole locations. A summary of typical ground conditions are detailed below in Table 4-1.

Depth (mbgl)	WS101	WS102	WS103	WS104	TH101
0-1	0.0-1.40m Made Ground with brick, ash and clinker.	0.0-0.60m Made Ground with brick and ash.	0.0-1.65m Made Ground	0.0-0.45m Made Ground with brick, ash and clinker.	0.0-1.05m Made Ground with brick.
1-2		0.60-1.40m Firm to stiff brown sandy gravelly CLAY with rare coal fragments.		0.45-1.35m Soft brown silty gravelly CLAY.	
2-3	1.40-2.20m Soft greyish brown slightly gravelly silty CLAY with frequent wood.	1.40-2.90m Soft to firm brown silty gravelly CLAY.	1.65-2.10m Soft brown silty gravelly CLAY.	1.35-1.43m Black SHALE	
	2.20-2.98m Black silty clayey GRAVEL		2.10-2.39m Grey MUDSTONE		
3-4		2.90-3.25m Black weathered MUDSTONE			

Table 4-1: Summary of ground conditions for Halter Inn Works, Holcombe.

No visual or olfactory evidence of significant contamination was noted during the site investigation. No PID readings greater than 1ppm were recorded in made ground samples taken.

4.2 Groundwater

Groundwater monitoring has been undertaken on six occasions. An oil-water interface probe (approximately 1cm detection limit) was used to detect the presence of free phase hydrocarbons within each borehole. Results are summarised in Table 4-2.

BH/TP REF	WATER STRIKE DEPTHS (MBGL)	DEPTH TO TOP OF GROUNDWATER (MBGL)				NO. VISITS	GROUNDWATER SAMPLED Y OR N?	FREE PRODUCT DETECTED	HYDROCARBON ODOURS IN GROUNDWATER (NO. VISITS)
		Max	Min	Base	Response				
WS101	2.3	1.54	1.35	2.82	1.0-2.98	6	N	No	0
WS102	N/A	2.17	1.94	2.88	1.0-3.0	6	Y	No	0
WS103	N/A	1.94	1.50	2.00	1.0-2.0	6	N	No	0
WS104	N/A	0.92	0.0	1.32	0.45-1.43	6	Y	No	0

Table 4-2: Summary of water strike depths within boreholes for Halter Inn Works, Holcombe.

High groundwater levels were recorded in WS104 on a number of occasions and groundwater was observed to be at ground level on three occasions.

5 GEOTECHNICAL APPRAISAL

5.1 Geotechnical Testing

5.1.1 Standard Penetration Tests

Eight in-situ standard penetration tests (SPTs) were undertaken. The results are summarised in Table 5-1 below and provided within the profile logs in Appendix B.

Depth (mbgl)	WS101	WS102	WS103	WS104
1.0-1.45	1 (MG)	47 (C)	6 (MG)	50 (C/G)
2.0-2.45	16 (C/G)	5 (C)	50 (C/MS)	-
2.80-2.98	50 (G)	-	-	-
3.0-3.25	-	50 (MS)	-	-
GW Level	2.3	N/A	N/A	N/A

Table 5-1: Summary of SPT (N) values recorded for Halter Inn Works, Holcombe.

Notes:

MG = Made Ground, M/S = mudstone, G=Gravel, C=Clay.

5.1.2 Shear Vanes

Hand shear vane readings within the clay strata at 0.5-2.40mbgl recorded undrained shear strengths of between 10kN/m² and 155 kN/m².

Borehole Ref. and depth (mbgl)	Shear Vane Readings (kg/cm ²)	Adjusted Undrained Shear Strength kN/m ²
WS101 / 1.50	0.10	10
WS101 / 1.80	0.12	12
WS102 / 0.70	1.48	145
WS102 / 0.80	1.58	155
WS102 / 1.80	0.56	55
WS102 / 2.40	0.63	62
WS103 / 1.80	0.21	21
WS103 / 1.90	0.29	28
WS104 / 0.50	0.32	31
WS104 / 0.95	0.47	46

Table 5-2: Summary of average shear vane values recorded for Halter Inn Works, Holcombe.

5.1.3 Sulphate and pH

Water soluble sulphate and pH tests were carried out on soil and groundwater samples. Full results are presented in Appendix C (soils) and Appendix E (groundwater) and summarised below in Table 5-2.

Strata	pH		Sulphate	
	Soil	Groundwater	Soil (g/l)	Groundwater (mg/l)
Made Ground	7.9-11.0	8.0-8.4	0.034-0.20	55-150
Natural	7.6		0.26	

Table 5-3: Summary of pH and sulphate results for Halter Inn Works, Holcombe.

5.2 Atterberg Limits and Moisture Content

Three representative samples of natural clay were subjected to Atterberg Limits and Moisture Content testing and the results are summarised in Table 5-4.

The modified plasticity index (I_p) as stipulated in NHBC Chapter 4.2-D5 is given by the formula:

$$I_p = \text{plasticity index (Ip)} \times \% \text{ less than } 425\mu\text{m sieve} / 100\%$$

Sample Ref. and depth	Moisture Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Class	Passing 425 micron (%)	Modified Plasticity Index (%)
WS101 1.6-1.8m	67	41	20	21	CL	95	19.95
WS102 1.8-2.0m	39	38	18	20	CL	96	19.20
WS103 0.7-0.9m	74	45	22	23	CL	94	21.62

Table 5-4: Summary of moisture content and plasticity index testing for Halter Inn Works, Holcombe.

The modified plasticity index is between 19.20% and 21.62%. This characterises the clay as having a low to medium volume change potential.

5.3 Anticipated Allowable Bearing Pressures

No foundation loads for the proposed new building on the site have been provided. The proposed site layout is shown in Figure 2. The proposed buildings occupy the centre of the site; as such the data from WS101 is considered most relevant.

The geological sequence encountered within the boreholes and trial pits is generally consistent across the site and comprises made ground underlain by soft to stiff clay. The bedrock geology was confirmed to be mudstone.

5.3.1 Made Ground/Topsoil

Due to the low density and compressible nature of the made ground these strata are not considered suitable for supporting structural loads. In addition, it is considered unlikely that this material will provide sufficient support for a ground bearing slab.

5.3.2 Natural Clay

Clay strata encountered from 0.6mbgl to up to 2.9mbgl have 'N' values from between 5 to 47 characterising these strata as soft to very stiff. Shear vane readings correlate well. Clay at 1mbgl and below may provide a suitable founding strata with a maximum unconfined shear strength of 155kPa and a minimum allowable bearing pressure of approximately 40kN/m². However, due recourse should be given to potential plasticity effects and the influence of trees.

5.4 Foundation Solution Options

Given the variable strata encountered in the upper 3m, traditional shallow foundations may not be suitable unless significant engineering works are undertaken to strengthen the ground.

Piling may be a more viable foundation option. The depth of piles required will depend on the loading of the building. It is anticipated that the underlying mudstone should prove suitable founding stratum. However, piles can potentially act as a pathway and precautions should be taken to ensure minimal migration of contaminants.

Further advice from a suitably qualified structural engineer should be sought.

5.5 Concrete Specification

Based upon the results of the soil sample analysis and groundwater results, sulphate resistant concrete is not required at the site. The concentrations of soluble sulphate in the made ground when contrasted to BRE Digest 2005¹⁴ categorise the concrete requirement as DS-1 AC-1.

¹⁴ BRE (2005). "Concrete in Aggressive Ground." Special Digest 1.

6 GENERIC RISK ASSESSMENT

6.1 Introduction

Current good practice requires that the findings from a site investigation should be evaluated on a site specific basis, using a risk based approach. Risk assessment involves identification and evaluation of the hazards presented by the concentrations of contaminants measured followed by an evaluation of the risks which are associated with these hazards (CLR11¹⁵). Information gathered from the risk assessment has been collated in the revised contamination conceptual model in Section 6.6.

6.2 Soil Risk Assessment

With regards to the soil risk assessment LKC will use the following hierarchy:

- Soil Guideline Values (SGVs) or Category 4 Screening Levels (C4SLs).
- LQM Suitable 4 Use Levels (S4ULs).
- ATKINS Soil Screening Levels (SSVs) and CL:AIRE Generic Assessment Criteria (GACs).

New C4SLs have recently been published^{16,17}. The recent change to the contaminated land guidance has changed the evaluation of risk from 'minimal' (SGVs) to 'low' (referred to as Lowest Level of Toxicological Concern (LLTCs)). The policy companion document and supporting letter by Defra, dated 3rd September, states that C4SLs '*could be used under the planning regime, as well as within Part 2A*'. Based on these comments LKC considers the justifications and assumptions used to generate 'low' risk are suitable for the planning regime.

Where no C4SLs have been generated LKC will use the LQM S4ULs¹⁸. Similar assumptions and land uses to C4SLs have been used. However, toxicological information has been based on 'minimal risk' as per previous guidelines and assumptions^{19,20,21,22}.

If contaminants are not present as SGVs, C4SLs and S4ULs then LKC will use ATRISK SSVs or CL:AIRE GACs²³. These follow the 'minimal' risk principal and more stringent exposure parameters and will be conservative.

LKC consider the main risk drivers for PAHs are benzo(a)pyrene (B(a)P) and naphthalene. This is due to B(a)P possibly being a carcinogen and most toxic of the PAHs^{24,25} and naphthalene the most volatile and soluble²⁶. The new C4SLs indicate B(a)P as a surrogate

¹⁵ EA (2004). "Model Procedures for the Management of Land Contamination." R&D Publication CLR 11.

¹⁶ Defra (2014). "SP1010: Development of Category 4 Screening Levels and Assessment of Land Affected by Contamination – Policy Companion Document."

¹⁷ CL:AIRE (2013). "SP1010: Development of Category 4 Screening Levels and Assessment of Land Affected by Contamination – Final project Report."

¹⁸ LQM (2014). "The LQM/CIEH 44SLs for human health Risk Assessment."

¹⁹ EA (2008). "Updated Technical Background to the CLEA Model." Science Report – SC050021/SR3.

²⁰ EA (2008). "Human Health Toxicological Assessment of Contaminants in Soils." Science Report – SC050021/SR2.

²¹ EA (2008). "A Review of Body Weight and Height Data used within the Contaminated Land Exposure Assessment Model (CLEA)." Project SC050021/Technical Review 1.

²² EA (2009). "Compilation of Data for Priority Organic Pollutants for Derivation of Soil Guideline Values." Science report SC050021/SR7.

²³ CL:AIRE (2009). "The Soil Generic Assessment Criteria for Human Health Risk Assessment."

²⁴ EA (2002). "Contaminants in Soils: Collation of Toxicological Data and Intake Values for Humans. Benzo[a]pyrene." R&D Publication TOX2.

²⁵ USEPA (1984). "Health Effects Assessment of Polycyclic Aromatic Hydrocarbons (PAHs). EPA 540/1-86-013."

²⁶ EA (2003). "Review of the Fate and Transport of Selected Contaminants in the Soil Environment." Draft technical report P5-079/TR1.

marker for carcinogenic PAHs, since the risk from other non-carcinogenic PAHs are considered negligible²⁷. Naphthalene will be treated separately using the LQM S4ULs.

All criteria have been generated using the CLEA V1.06 model²⁸ based on 1%, 2.5% and 6% Soil Organic matter (SOM). Criteria will be compared to the nearest appropriate SOM.

A summary of the Generic Assessment Criteria are provided in Appendix G. ATRISK values were not required for this assessment.

Contaminant		Units	No. of samples	Result Ranges	No. Exceeded	Criteria	Source of Criteria
Metals	Arsenic	mg/kg	5	2 to 72	WS103 (1.0-1.2m) = 72mg/kg	37	C4SL
	Lead	mg/kg	5	19 to 540	WS101 (0.1-0.3m) = 380mg/kg	200	C4SL
					WS104 (0.2-0.4m) = 540mg/kg		
General	pH	pH	5	Range 7.9 to 11			
	SOM	%	5	Range 0.88 to 17			

Table 6-1: Summary of elevated analytical results for Halter Inn Works, Holcombe.

Notes:

Only results that exceeded SGVs and SSVs have been shown and results from **all depths** are noted. Assumed pH7 and appropriate nearest SOM (1%, 2.5%, 6%) where this parameter is required.

Elevated lead concentrations were recorded above the generic assessment criteria in two samples of made ground on site. Elevated arsenic was also recorded in one sampling location.

6.2.1 Direct Contact Risk – Pollutant Linkage 1

The identified elevated contaminants in soil pose a risk to future site users.

Direct contact (ingestion, dermal and inhalation of dust) are the primary pathways to the receptor for these contaminants. The likely sources for these contaminants are from a combination of ash and clinker within the made ground on site. Given the locations of the elevated contaminants across the site LKC considers there is a potential site wide risk from direct contact associated with metals in garden areas.

Based upon the above LKC considers the risk from pollutant linkage 1 to be moderate and remediation is required to mitigate this risk.

6.2.2 Inhalation Risk – Pollutant Linkage 2

No elevated concentrations of volatile contaminants have been identified in the chemical analysis of the soil samples collected from site to date. No significant elevated PID readings were recorded (<1.0ppm) from the vapour assessment carried out on soil samples during the site investigation and no visual or olfactory evidence of significant contamination was identified.

Based upon the above LKC consider that volatile hydrocarbons do not pose a significant human health risk to the future residents and the risk from pollutant linkage 2 is considered low.

²⁷ CL:AIRE (2013). "SP1010: Development of Category 4 Screening Levels and Assessment of Land Affected by Contamination – Final project Report."

²⁸ EA (2008). "CLEA Software (Version 1.05) Handbook." Science Report – SC050021/SR4.

6.3 Controlled Water Assessment

LKC considers the primary receptor to be Holcombe Brook which has an open section within 10m of the eastern site boundary.

Since no potable groundwater abstractions have been identified within 1km of the site LKC considers groundwater results should be compared to River Basin District Standards and Threshold Values (DSTV)²⁹ and Environment Agency Values for freshwater Environmental Quality Standards³⁰ (EQS) for coarse fish or UK Drinking Water Standards (UKDWS)^{31,32} if these were not available.

Furthermore, the risk from List 2 compound (EC Dangerous Substance Directive 76/464/EEC) in a freshwater ecosystem is governed by the hardness of the water. Where applicable, the hardness was taken into account for these contaminants.

No elevated contaminants above the relevant assessment criteria were recorded in groundwater samples taken from boreholes on site and no visual or olfactory evidence of significant contamination was identified during the site investigation.

Based on the above LKC considers the risk from pollutant linkage 4 to be low and no remediation is required.

6.4 Gas Risk Assessment

Six gas monitoring visits have been undertaken on the study site over three months. Gas monitoring was only undertaken on WS104 on three occasions as high groundwater levels prevented monitoring on the other three visits. A summary of the findings are provided within Table 6-2 below and all gas monitoring results are presented in Appendix F.

Following guidance set out in CIRIA C665³³ and BS8485:2007³⁴ peak methane and steady carbon dioxide concentrations have been used in the gas risk assessment. In addition, and as per guidance, flow rates were measured first.

Boreholes	Range of Monitoring Results					Max GSV (l/hr)	CS/TL
	Peak CH ₄ (%v/v)	Steady CO ₂ (%v/v)	Peak Flow (l/h)	Groundwater (mbgl)	Pressure (mb)		
WS101	<0.1	0.2 to 0.6	<0.1	1.35 to 1.54	981 to 1015 (2 visits < 1000mb)	6E-04	CS1/Green
WS102	<0.1	0.1 to 3.5	<0.1	1.94 to 2.17		3.5E-03	CS1/Green
WS103	<0.1	0.1 to 1.1	<0.1	1.50 to 1.94		1.1E-03	CS1/Green
WS104	0.1	0.1 to 1.0	<0.1	0.0 to 0.92		1E-03	CS1/Green

Table 6-2: Summary of ground gas monitoring for Halter Inn Works, Holcombe.

Notes:

If concentrations / flow are zero then equipment detection limits are assumed.

CS – Characteristic Situation; TL= Traffic Light

²⁹ Defra (2010) "The River Basin Districts Typology, Standards and Groundwater Threshold Values". Water Framework Directive (England and Wales) Directions 2010.

³⁰ EA (2002). "Environment Agency technical advice to third parties on Pollution of Controlled Waters for Part IIA of the Environment Protection Act 1990."

³¹ EA (2002). "Environment Agency technical advice to third parties on Pollution of Controlled Waters for Part IIA of the Environment Protection Act 1990."

³² HMSO (2009) "Water England: The Private Water Supplies Regulations". Statutory Instruments No.3101.

³³ CIRIA (2007). "Assessing Risks Posed by Hazardous Ground Gases to Buildings." CIRIA C665.

³⁴ BSI (2007). "Code of Practice for the Characterisation and Remediation from Ground Gas in Affected Developments." BS8485:2007.

In accordance with current guidance CIRIA C665 a Gas Screening Value (GSV) may be calculated. The data generated GSVs for carbon dioxide and methane of 3.5E-03 l/hr and 1E-04 l/hr respectively placing the gas risk within a Characteristic Situation (CS) 1 or NHBC Green status. This indicates that no specific remediation measures will be required with regards to gas protection.

Based on the above the risk from pollutant linkage 3 is considered low and no specific remediation is required.

6.5 Additional Risk Assessment

6.5.1 Concrete

Based upon the results of the soil sample analysis and groundwater results, sulphate resistant concrete is not required at the site. The concentrations of soluble sulphate in the made ground when contrasted to BRE Digest 2005³⁵ categorise the concrete requirement as DS-1 AC-1.

Based on the above the risk from pollutant linkage 5 is considered low and sulphate resistant concrete will not be required on site.

6.5.2 Potable Water Supply

United Utilities (UU) guidelines have been recently replaced with new guidance³⁶, where sampling is required for contaminants that include speciated petroleum hydrocarbons, chlorinated compounds, BTEX compounds, phenols, cresols, ethers, nitrobenzene, ketones, aldehydes and amines. However, the guidelines do state a robust risk assessment can be undertaken on why specific pipework is not required. If pipework is to be founded in made ground it is likely that barrier pipe would be required given elevated naphthalene concentrations recorded in WS102. This is subject to completing a UU risk assessment form and consultation with UU.

Based on the above LKC considers the risk from pollutant linkage 6 is moderate pending the completion of a UU risk assessment document.

6.5.3 Phytotoxicity

No analysed soil concentrations are considered phytotoxic as outlined in BS3882³⁷.

Based on the above the risk from pollutant linkage 7 is considered low and no specific remediation to protect flora is required, although consideration to the soil matrix should be assessed to establish if made ground is a suitable growing medium for flora.

6.6 Revised Conceptual Model

A revised conceptual model may be undertaken for the site using all available data and this is presented in Table 6-3.

This conceptual model is based upon contaminant-pathway-receptor pollutant linkages, on the premise that if there is no pollutant linkage then there will be no risk to the receptor³⁸.

³⁵ BRE (2005). "Concrete in Aggressive Ground." Special Digest 1.

³⁶ UU(2011). "United Utilities Water Supplementary Guidance for the Selection of Water Pipes in Land Potentially Affected by Contamination."

³⁷ BS (2007). "Specifications for Topsoil and Requirements for use." BS3882:2007.

³⁸ EA (2004). "Model Procedures for the Management of Land Contamination." R&D Publication CLR 11.

Each linkage is described along with an assessment of the risk based upon guidance on probabilities and consequences outlined in CIRIA C552³⁹.

In order to assess the potential risk for each pollutant linkage, an assessment of the magnitude of the potential consequence (severity) of the risk occurring and the magnitude of the probability (likelihood) of the risk occurring has been considered and classified. This is based on the guidance provided in CIRIA C552 and further details including a risk matrix is provided in Appendix A.

Where there is a moderate/low risk is identified, an assessment will be undertaken to establish what category the pollutant linkage will fall into.

Where LKC identifies a moderate or higher risk remediation or further investigation work is recommended. Where a low or very low risk is identified no specific remediation is required.

Further details of the recommended remediation strategy are given in Section 8.

³⁹ CIRIA (2001). "Contaminated land risk assessment: A guide to good practice". C552.

Pollutant Linkage	Pathway	Receptor	Contaminant (source)	Probability	Consequence	Risk	Assessment
PL1	-Dermal contact. -Inhalation of soil, fibres and dust. -Ingestion of soils, dust, vegetables, soil attached to vegetables. -Windblown dust.	-Future residents. -Site users. -Offsite receptors.	-ACM (former buildings, potentially in made ground).	Unlikely	Severe (ACM)	Moderate / Low	-Unlikely probability from ACM as none encountered during site investigation and none recorded in soil samples analysed. -Likely probability of heavy metals as elevated arsenic and lead recorded in soils samples. -Heavy metal contamination may pose a risk to future site users in garden areas. -Unlikely probability of PAHs as no elevated concentrations recorded in soil samples. -Unlikely probability of hydrocarbons as significant source not identified. - Recommendation: Clean capping layer in gardens.
			-Heavy metals (ash in made ground, metal finishing works).	Likely	Medium	Moderate	
			-PAHs (ash in made ground)	Unlikely	Medium	Low	
			-Hydrocarbons: oils/fuels (metal finishing works onsite, cotton mill offsite)				
PL2	-Inhalation of vapours. -Migration through permeable strata and preferential pathways.	-Future residents. -Site users.	Volatile Contaminants: -Fuels and solvents (metal finishing works).	Unlikely	Medium	Low	-Unlikely probability as no significant source of potential volatile contamination source identified and no evidence of volatile contamination noted during the site investigation. - Recommendation: Watching brief following development works.
PL3	-Inhalation of gas. -Migration through permeable strata and preferential pathways. -Explosion in confined spaces.	-Current site users. -Future residents. -Buildings. -Offsite land users.	-Methane, carbon dioxide. (potentially infilled features 250m of the site).	Unlikely	Severe	Moderate / Low	-Unlikely probability based on the gas monitoring data and results of the gas risk assessment. -Risk is considered low as no positive flow rates were recorded during the gas monitoring programme. - Recommendation: No specific remediation measures required.
PL4	-Surface Run-off. -Migration through permeable strata and preferential pathways -Perched waters migration.	-Groundwater (Secondary A Aquifer). -Surface water (Holcombe Brook).	-Mobile contaminants: hydrocarbons and solvents (metal finishing works on site, cotton mill offsite).	Unlikely	Medium	Low	-Unlikely probability as no elevated concentrations of contaminants identified in groundwater samples collected from boreholes on site. - Recommendation: No further action required. Site is considered to be adequately characterised with respect to controlled waters.
PL5	-Sulphate attack on concrete.	-Building structure.	-Sulphate (ash identified in made ground).	Low	Mild	Low	-Low probability as no elevated sulphate recorded in made ground analysed as part of site investigation. - Recommendation: No further action recommended
PL6	-Ingestion of tainted water supply.	-Future site users.	-Organic Contaminants (made ground).	Low	Medium	Moderate / Low	-Low probability as only localised organic contamination identified which may pose a risk to potable water supply pipes if they are placed in made ground. -Moderate risk assumed at this stage dependent upon completion of a UU Risk Assessment. - Recommendation: Completion of a UU Risk Assessment Document and consultation with UU.
PL7	-Direct Contact (plant uptake).	-Flora.	-Phytotoxic Contaminants (made ground).	Low	Minor	Very Low	-Low probability as no elevated concentrations of phytotoxic contaminants identified. - Recommendation: Clean capping layer recommended as part of PL1 will provide a suitable growing media.

Table 6-3 Revised Contamination Conceptual Model for Halter Inn Works, Holcombe.

7 SUMMARY CONCLUSIONS

7.1 Summary Conclusions

The site is to be developed for a residential end use and the proposed layout includes residential dwellings, gardens and car parking.

A ground investigation has been carried out to confirm the ground conditions below the site. This investigation included four window sample boreholes and one hand auger hole.

Ground Conditions

The ground conditions beneath the site comprised made ground underlain by natural silty clay. A band of gravel was noted in WS101. These natural strata are underlain by mudstone.

No visual or olfactory evidence of significant contamination was noted during the site investigation. PID readings were all <1ppm in the made ground samples taken.

Groundwater was recorded at between 0.10mbgl and 2.17mbgl during the six groundwater monitoring visits completed.

Geotechnical Assessment

Given the variable strata encountered in the upper 3m, traditional shallow foundations may not be suitable unless significant engineering works are undertaken to strengthen the ground.

Piling may be a more viable foundation option. The depth of piles required will depend on the loading of the building. It is anticipated that the underlying mudstone should prove suitable founding stratum.

Consideration should be given to relic foundation structures and potential shallow groundwater.

The concrete requirement has been classified as DS-1 AC-1.

The modified plasticity index is between 19.20% and 21.62%. This characterises the clay as having a low to medium volume change potential.

Further advice from a suitably qualified structural engineer should be sought.

Contamination Assessment

Elevated lead and arsenic concentrations were recorded above the residential with veg uptake generic assessment criteria in made ground.

There was considered to be a risk to site users from direct contact with made ground in proposed garden areas and remediation is recommended to mitigate the risk.

No elevated concentrations of contaminants were recorded in groundwater samples taken from boreholes on site. Therefore, no remediation is recommended with respect to controlled waters.

Six gas monitoring visits have been undertaken and maximum concentrations of 0.2%v/v carbon dioxide and <0.1%v/v methane have been recorded with no positive flow detected. A worst gas screening value of 3.5E-03 l/hr was calculated, characterising the site as Characteristic Situation 1/Green. Therefore, no specific remediation is required with respect to gas risk.

Given the localised organic contamination identified in the made ground, it is considered likely that barrier piping will be required to protect potable water pipes in some areas of the site. This is subject to discussions with UU and completing a UU Potable Waters Risk Assessment Form.

No elevated phytotoxic contaminants were identified therefore there is not considered to be a risk to proposed flora.

LKC conclude that there are three remaining pollutant linkages that still exist, which will need to be remediated (detailed below).

A revised contamination conceptual model has been produced by LKC which is summarised in Table 7-1 below (more detailed model provided in Section 6). Where a moderate / low risk was identified, the assumed risk at this stage has been shown.

Pollutant Linkage		Risk	Further Action Required
1	Non-volatile contaminants (metals, petroleum hydrocarbons, PAHs, SVOCs, ACM) posing a risk to site users via dermal contact, ingestion and inhalation (of soil, dust, fibres and vegetables).	Low (ACM, hydrocarbons, PAHs), Moderate (metals)	-Elevated lead and arsenic considered a site wide risk. - Recommendations: Capping layer required in garden areas.
2	Volatile contaminants posing a risk to site users via the inhalation of vapours.	Low	-No volatile contamination identified during the site investigation. - Recommendations: Watching brief during development works.
3	Gas posing a risk to buildings and site users via the migration of gas into building causing explosion and asphyxiation.	Low	-Gas monitoring results from six visits indicate that the site is with CS1/Green scenario. - Recommendations: No specific remediation measures required.
4	Mobile contamination posing a risk to controlled waters via the migration through permeable strata.	Low	-No groundwater identified above generic assessment criteria. - Recommendations: No remediation required.
5	Sulphate posing a risk to building via direct contact (sulphate attack).	Low	-No elevated sulphate identified in made ground samples analysed from site investigation. - Recommendations: No further action required.
6	Organic contaminants posing a risk to water pipes.	Moderate	-Localised organic contamination identified at potable pipe depth of 0.75-1.35mbgl. - Recommendations: UU risk assessment to be completed. It is likely that barrier pipe will be required.
7	Phytotoxic metals posing a risk to flora via root uptake.	Very Low	-No phytotoxic metals above generic criteria. - Likely Remediation: No specific remediation. However, remediation associated with PL1 will further reduce risk to flora.

Table 7-1: Summary Risk Table for Halter Inn Works, Holcombe.

7.2 Recommendations

Remediation work is recommended to mitigate the risks from the identified pollutant linkages and the work required is detailed in the Remediation Strategy presented in Section 8. LKC should stress that no remediation, enabling works or designing works should take place until Regulatory approval has been obtained.

8 REMEDIATION STRATEGY

8.1 Remediation Objectives

The proposed remediation works are required in order to break the pollutant linkages identified during the investigation and risk assessment of the site and in order to ensure the site is "suitable for use".

8.2 Watching Brief

The current investigation works have been completed with the existing Metal Finishing Works building present on site. However, additional assessment of ground conditions below the footprint of the existing building is recommended following demolition. LKC consider it unnecessary at this stage to undertake further intrusive investigation. However, a minimum of a watching brief should be maintained during site clearance and development works for any unusual ground conditions and visual and / or olfactory evidence of hydrocarbon contamination. The watching brief should be carried out by a suitably qualified person.

Confirmation that the ground conditions below the existing building are similar to those identified in the intrusive investigation should be made and this should include a visual/olfactory assessment and PID/headspace testing

If ground conditions differ significantly and/or visual and olfactory evidence of contaminants are identified, then near surface sampling will likely be required to characterise the material and recommendations for appropriate remediation undertaken, if required. Samples should be collected in sufficient quantity and analysed for a suitable suite of determinands to demonstrably characterise the site.

8.3 Clean Capping Layer in all Garden and Soft Landscaping Areas

Due to the elevated levels of arsenic and lead in the made ground across site, it is recommended that all garden and soft landscaping areas on the site are installed with a clean capping layer.

LKC advise that the capping layer in garden and landscaped areas should comprise as a minimum:

- All private garden areas: at least 600mm thick clean capping layer including sufficient topsoil for a growing medium.
- Any areas of open soft landscaped: 300mm thick clean capping layer including sufficient topsoil for a growing medium.

Depending on proposed site levels the capping layer may be placed directly on existing soils or may be accommodated by the excavation of an appropriate depth of soil and removal off-site.

It should be noted that if any material from the site is required to be removed off site to accommodate the installation of the capping layer, then copies of the analytical results from the site investigation report will need to be provided to the landfill facility.

Furthermore, copies of all waste transfer notes for the removal of the material should be retained and copies provided to LKC for inclusion within the site Validation / Completion Report.

Soils for use within the capping layer will need to be validated to ensure they are suitable for use. This includes potential site-won soil and imported soils. This is discussed in more detail in Section 8.5.

The above remedial recommendations will break pollutant linkage 1.

8.4 Service Pipes

A potential risk to potable water supplies has been identified and it is likely that United Utilities (UU) will require a potable water risk assessment form to be completed prior to the installation of water pipes.

LKC would advise that barrier piping is likely to be required, subject to consultation and approval by UU.

Copies of all correspondence with United Utilities should be retained and copies provided to LKC for inclusion within the site Validation / Completion Report.

The above remedial recommendations will break pollutant linkage 6.

8.5 Validation

Validation works of the site is a vital component in verifying that the remediation has achieved its objectives. This may be undertaken both during, on completion of and post remediation works.

8.5.1 Validation of any Unexpected Contamination Removal

Should unexpected contamination be encountered then the investigation works undertaken to assess the nature of the contamination should be documented fully in the Validation / Site Completion report. Any subsequent remediation that may be required should be fully validated. This could include samples of the sides and base of any 'hotspot' removal excavations.

8.5.2 Validation of Imported / Site Won Materials

LKC would also recommend that any incoming soil material for use on the site is chemically validated prior to importation.

Imported material will require testing to ensure it is 'suitable for use' in gardens.

The sampling suite and regime should follow Local Authority guidance. A typical sampling regime would be 1 per 50m³ for topsoil and 1 per 150m³ for subsoil (or a minimum of 3 samples per source). Typical composite samples (from an unknown or Brownfield site) would be tested for a comprehensive suite comprising the following:

- Arsenic, cadmium, chromium (total and hexavalent), copper, lead, mercury, nickel, selenium, vanadium, zinc, water soluble sulphate, pH, USEPA PAH 16, organic matter, boron, banded petroleum hydrocarbons (TPHCWG), BTEX, MTBE, cyanide suite, asbestos identification and phenols.

Any soil generated from a Greenfield site should be tested for a basic suite of analysis comprising:

- Arsenic, cadmium, chromium (total and hexavalent), copper, lead, mercury, nickel, selenium, vanadium, zinc, water soluble sulphate, pH, USEPA PAH 16, organic matter and asbestos identification.

Any soil with visual or olfactory evidence of hydrocarbons should be rejected.

If subsoil is virgin quarried material then no sampling will be required.

Provenance from all sources of imported material should be provided for the Completion Report.

8.5.3 Validation of Depth of Capping Layer

Validation of depth and composition of the capping layer in all the garden and soft landscaped areas must be undertaken. The depth and composition of the capping layer should be validated at one point in the front and rear in each private garden and at two points in any areas of soft landscaping. Depth validation involves:

- Digging of pit / auger hole in each location.
- Measurement of the capping layer.
- Photographs of the pit / hole showing cover depth and measurement staff.

Copies of the photographs and a description of the cover system will be provided as part of the site Validation / Completion Report.

8.5.4 Protective Water Pipes

All copies of correspondence with the relevant Utilities provider along with the specification of services pipes installed will be provided to the Local Authority as part of the Remediation Validation Report.

For the final validation report LKC will also require confirmation of the installation of protective water pipes and / or sterile trenches including certificates of installation and photographs.

8.6 Additional Considerations

8.6.1 Unexpected Contamination

The relevant contractors should be briefed that during development works at the site should any unusual ground conditions and / or visual or olfactory evidence of contamination be encountered at the site, LKC and the Local Authority should be informed and further assessment of the material may be required.

8.6.2 Health and Safety Considerations

In working with, removing or treating any contaminating material it is important that any potential risks associated with the actual site works are mitigated by good environmental management of the site during the remedial phases. Standard health and safety precautions (as per HSE guidance⁴⁰) should be adopted by all workers involved with site enabling and construction works.

⁴⁰ HSE (1991). "Protection of workers and the general public during development of contaminated land" London HMSO.

8.6.3 Piling in Contaminated Land

If piling is deemed to be the most appropriate foundation option then this may provide a preferential pathway for contaminants to the Secondary A Aquifer. Once the method of piling has been determined, good practice for the drilling of piles on contaminated sites should be adhered to, such as guidance provided by the Environment Agency⁴¹.

8.7 Regulatory Approval

Once planning approval is successful it is strongly recommended that the proposals detailed within this report are approved in writing by the Local Authority prior to works starting on site.

The Site Completion Report will assist the Local Authority in the discharge of any future relevant planning conditions and will also be of use to solicitors acting on behalf of any prospective conveyancer who may have concerns over the former use of the site.

⁴¹Environment Agency (2001) Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention.

FIGURES

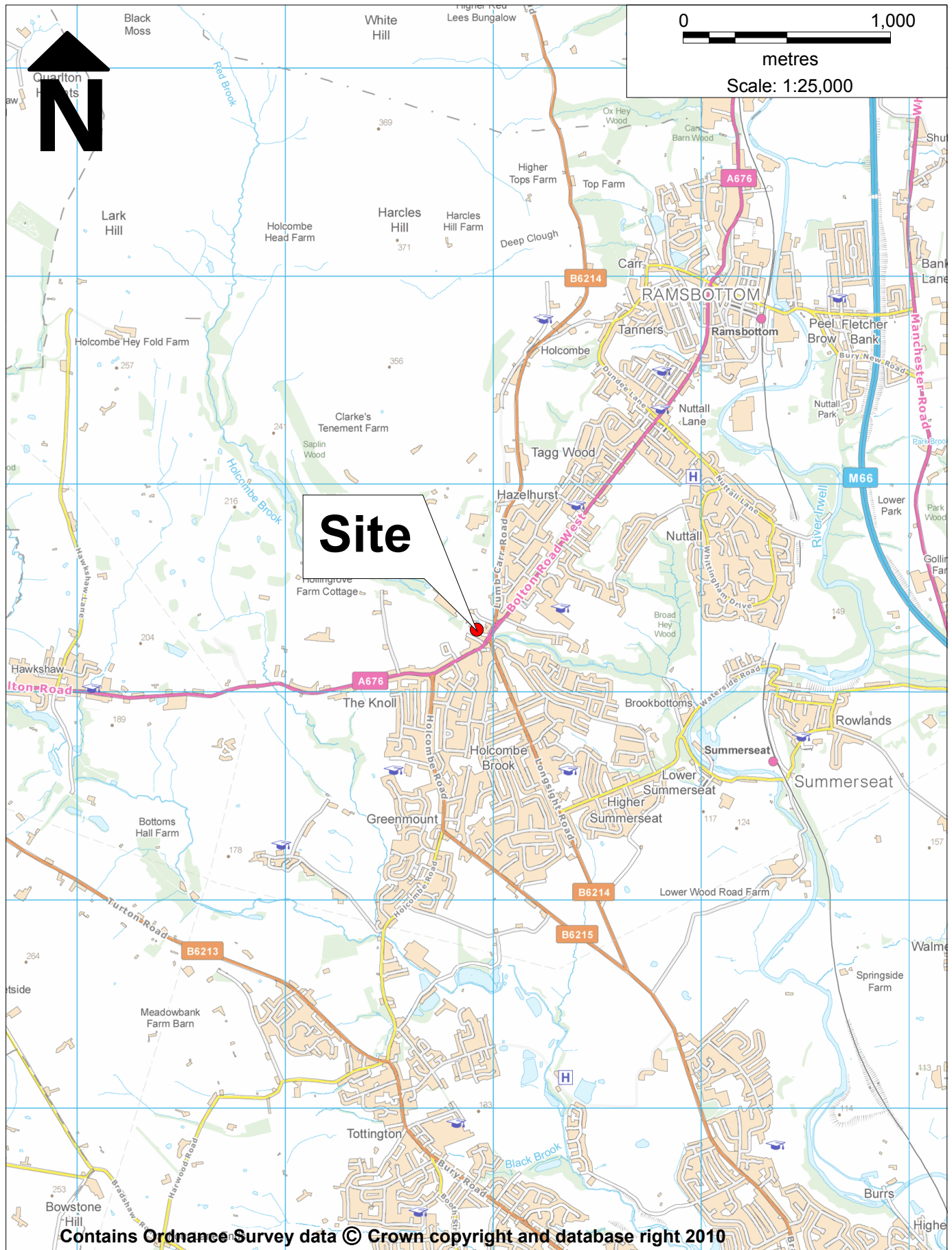


Figure 1: Site Location Plan, Halter Inn Works, Holcombe

Drawn: January 2015 Scale: 1:25,000 @ A4 (see scale bar)

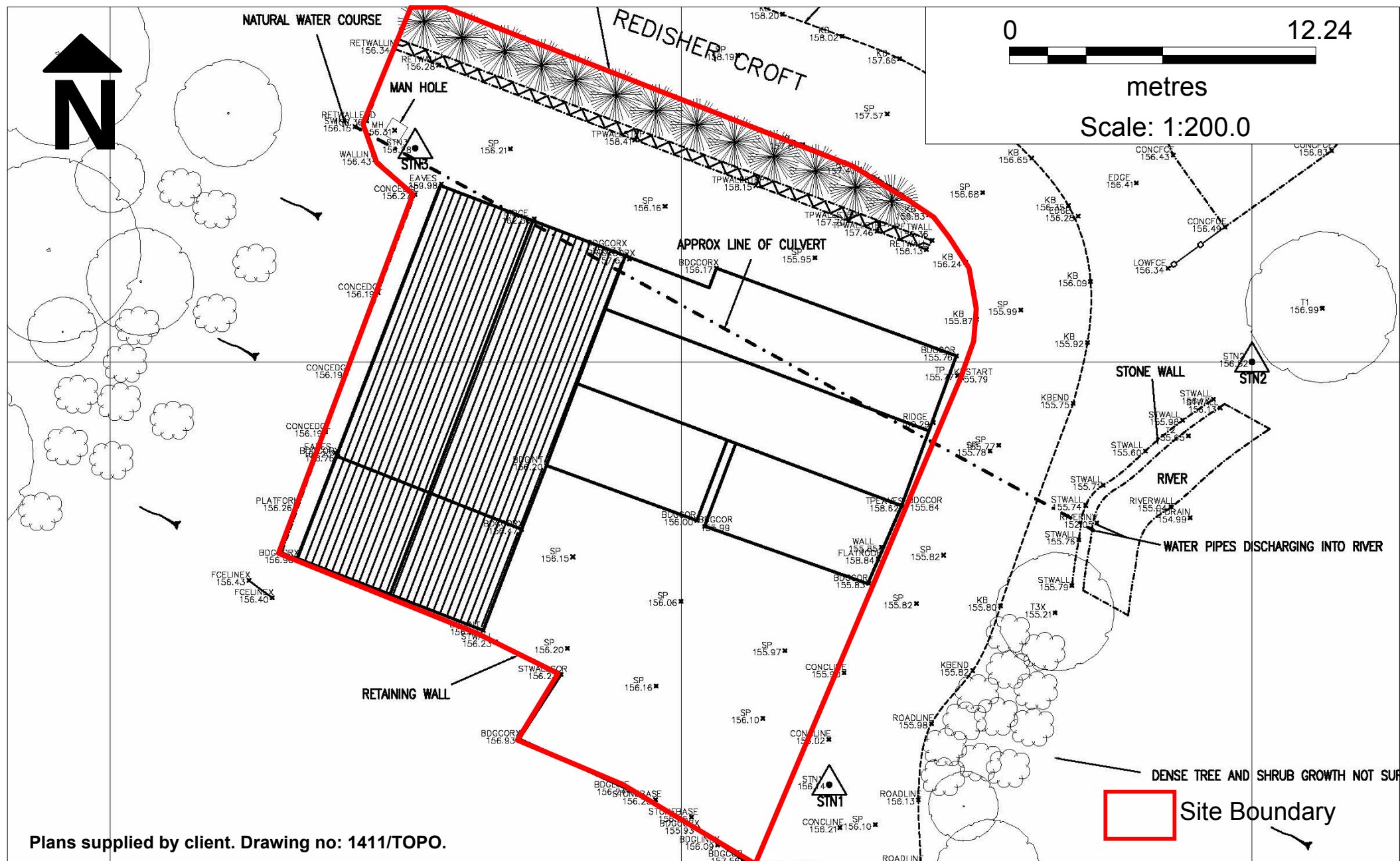


Figure 2: Site Boundary Plan, Halter Inn Works, Holcombe

Drawn: January 2015 Scale: See Scale Bar (approx 1:200 @ A4)

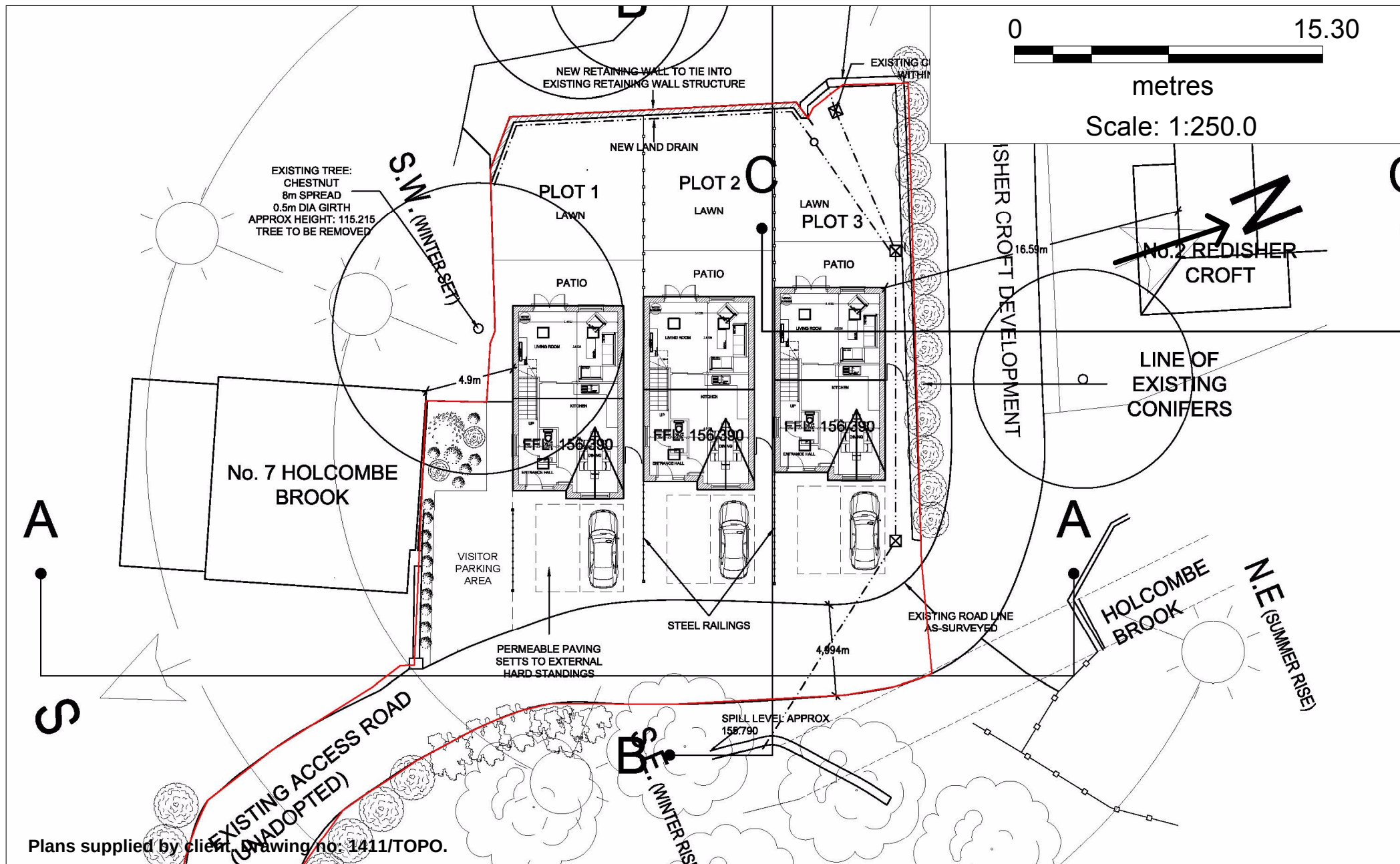


Figure 3: Proposed Development Plan, Halter Inn Works, Holcombe

Drawn: January 2015 Scale: See Scale Bar (approx 1:250 @ A4)

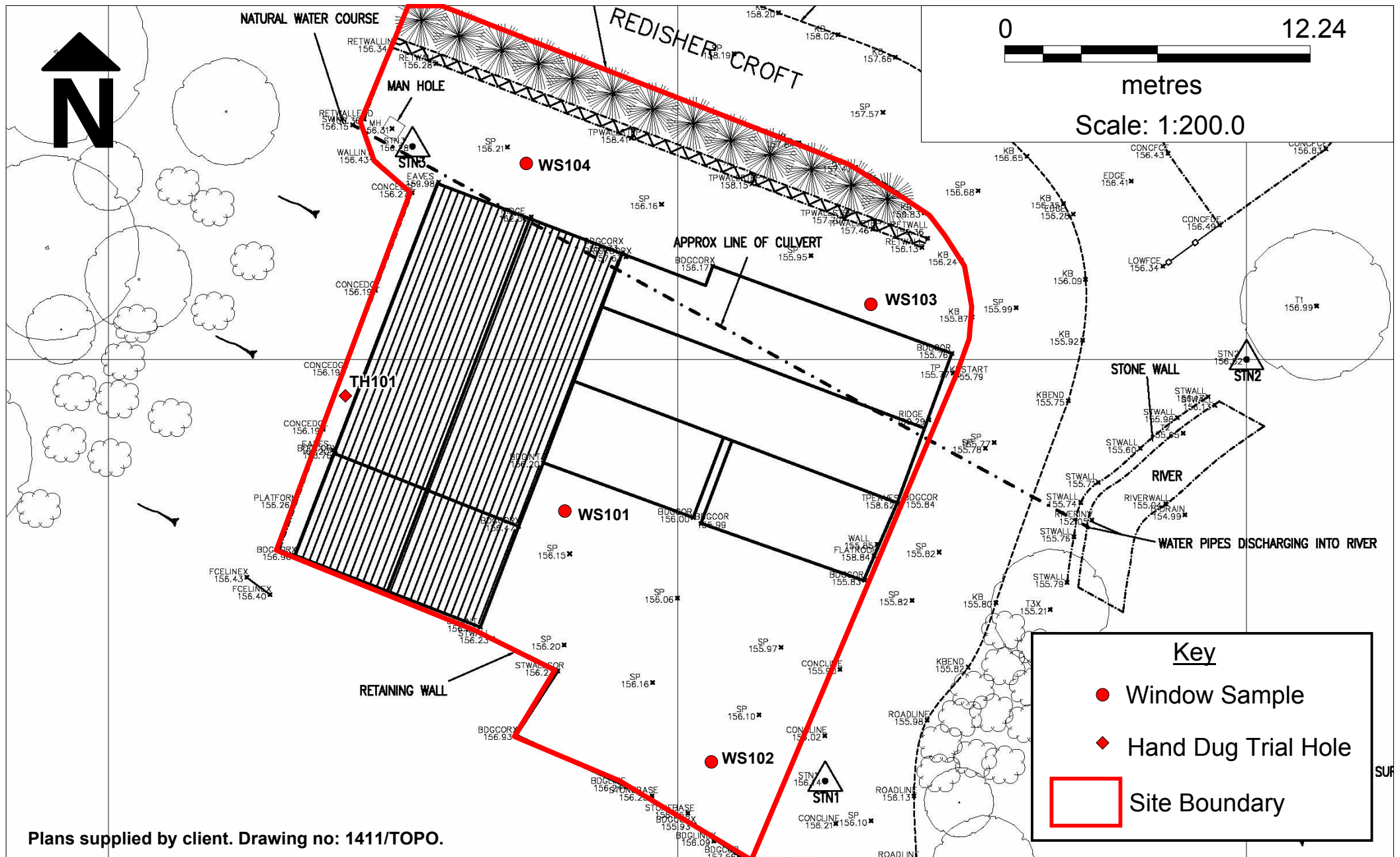


Figure 4: Sampling Location Plan, Halter Inn Works, Holcombe

Drawn: January 2015 Scale: See Scale Bar (approx 1:200 @ A4)

APPENDIX A

RISK MATRIX

Risk Evaluation

The method for risk evaluation is a qualitative method of interpreting the output from the risk estimation stage of the assessment, based on CIRIA 552¹³. It involves the classification of the:

- Magnitude of the potential consequence (severity) of the risk occurring (Table F-1).
- Magnitude of the probability (likelihood) of the risk occurring (Table F-2).

Consequence (Severity)		
Classification	Definition	Example
Severe	- Short term (acute) risk to human health likely to result in 'significant harm' as defined by the Environment Protection Act 1990, Part IIA. - Short term risk of pollution (note: water Resources Act contains no scope for considering significance of pollution) of sensitive water resource. - Catastrophic damage to buildings/properties. - A short term risk to a particular ecosystem, or organism forming part of such ecosystem (note: the definition of ecological systems within the Draft Circular on Contaminated Land, DETR, 2000).	- High Concentrations of cyanide on the surface of an informal recreation area. - Major spillage of contaminants from site into controlled waters. - Explosion, causing building collapse (can also equate to short term human health risk if buildings are occupied).
Medium	- Chronic damage to Human Health ('significant harm' as defined in DETR, 2000). - Pollution of sensitive water resources (note Water Resources Act contains no scope for considering significance of pollution). - A significant change in a particular ecosystem, or organism forming part of such ecosystem.	- Concentrations of a contaminant from site exceed generic, or site specific assessment criteria. - Leaching of contaminants from a site to a major or minor aquifer (Principal and Secondary). - Death of a species within a designated nature reserve.
Mild	- Pollution of non-sensitive water resources. - Significant damage to crops, buildings, structures and services ('significant harm' as defined in DETR, 2000). - Damage to sensitive buildings/structures/services or the environment.	- Pollution of non-classified groundwater. - Damage to building rendering it unsafe to occupy (e.g. foundation damage resulting in instability).
Minor	- Harm, although not necessarily significant harm, which may result in a financial loss, or expenditure to resolve. - Non-permanent health effects to human health (easily prevented by means such as personal protective clothing etc). - Easily repairable damage to buildings, structures and services.	- The presence of contaminants at such concentrations that protective equipment is required during site works. - The loss of plants in a landscaping scheme. - Discoloration of concrete.

Table F-1. Classification of Consequence

¹³ CIRIA C552 (2001) Contaminated Land Risk Assessment - A guide to good practice.

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

Table F-2. Classification of Probability.

These classifications are then compared to indicate the risk presented by each pollutant linkage (Table F-3). It is important that this classification is only applied where there is a possibility (which can range from high likelihood to unlikely) of a pollutant linkage existing.

		Consequence			
		Severe	Medium	Mild	Minor
Probability	High Likelihood	Very High Risk	High Risk	Moderate Risk	Moderate / Low Risk
	Likely	High Risk	Moderate Risk	Moderate / Low Risk	Low Risk
	Low Likelihood	Moderate Risk	Moderate / Low Risk	Low Risk	Very Low Risk
	Unlikely	Moderate / Low Risk	Low Risk	Very Low Risk	Very Low Risk

Table F-3. Comparison of Consequence against Probability

Once the risk has been determined the corresponding action can be assessed (Table F-4).

Risk	Action Required
Very High Risk	- 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 already undertaken) and remediation are likely to be required.
High Risk	- 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 longer term.
Moderate Risk	- It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it 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	- It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.
Very Low Risk	- There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.

Table F-4. Description of the Classification and Likely Action Required.

Where the risk falls into the moderate/low risk, LKC will undertake an assessment to establish what category the pollutant linkage will fall into (i.e. moderate or low risk will be chosen).

Where LKC identifies a moderate or higher risk intrusive work or precautionary remedial measures will be recommended.

Where LKC identified a low to very low risk either limited intrusive investigation work, a watching brief (during construction work) or no investigation work will be recommended. This will be dependent on the nature of the site and the proposed development.

APPENDIX B

PROFILE LOGS

**LK CONSULT LTD**Bury Business Centre, Kay Street, Bury, BL9 6BU
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Halter Inn Works, Holcombe

Number
WS101**Excavation Method**

Drive-in Window Sampler

Dimensions**Ground Level (mOD)****Client**

Finishing Techniques Ltd.

Job
Number
LKC 14 1496**Location** (Observed measurements)
WS101**Dates**
21/01/2015**Engineer**
LKC**Sheet**
1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.10-0.30 0.30-0.50	C1 PID1 0.79ppm				0.08 (0.72)	MADE GROUND: Concrete. MADE GROUND: Brown / grey sandy cobbly gravel with frequent brick fragments, clinker and occasional ash. Sand is fine to medium. Gravel is fine to coarse, subangular to angular.	 		
0.80-1.00	C2				0.80 (0.30)	MADE GROUND: Light brown gravelly sand with frequent brick fragments and occasional ash. Sand is fine to coarse. Gravel is fine to coarse, subangular to subangular.			
1.00-1.45 1.10-1.30	SPT N=1 C3		2,1/0,0,0,1		1.10 (0.30)	MADE GROUND: Dark brown / grey silty gravelly clay with occasional ash, rare brick fragments and clinker. Sand is fine to medium. Gravel is fine to medium, subrounded to subangular.			
1.40-1.60 1.50 1.60-1.80 1.80	C4 SV 10kPa B1 SV 12kPa				1.40 (0.80)	MADE GROUND: Dark brown / grey silty gravelly clay with occasional ash, rare brick fragments and clinker. Sand is fine to medium. Gravel is fine to medium, subrounded to subangular.			
2.00-2.45 2.20-2.40	SPT N=16 B2		1,2/3,3,5,5 Water strike(1) at 2.30m.		2.20 (0.78)	Soft consistency, low strength, dark brown / grey slightly gravelly silty CLAY with frequent wood. Gravel is fine to medium, subrounded to subangular. Gravel comprises shale and sandstone. Organic odour noted.		Σ1	
2.80-2.98	SPT 25/30		5,5/25		2.98	Black silty clayey GRAVEL. Gravel is fine to medium, subangular to angular. Gravel comprises shale. Complete at 2.98m			
Remarks Groundwater strike at 2.3mbgl.							Scale (approx) 1:50	Logged By TB	Figure No. LKC 14 1496.WS101

**LK CONSULT LTD**Bury Business Centre, Kay Street, Bury, BL9 6BU
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Halter Inn Works, Holcombe

Number
WS102**Excavation Method**

Drive-in Window Sampler

Dimensions**Ground Level (mOD)****Client**

Finishing Techniques Ltd.

Job
Number

LKC 14 1496

Location (Observed measurements)

WS102

Dates

21/01/2015

Engineer

LKC

Sheet

1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.15-0.30 0.30-0.50	C1 PID1 0.67ppm				0.11 (0.49)	MADE GROUND: Concrete.			
0.70 0.70-0.90 0.80 1.00-1.45	SV 145kPa C2 SV 155kPa SPT N=47		4,5/11,12,13,11		0.60 (0.80)	MADE GROUND: Brown slightly clayey sandy gravel with occasional ash and fine brick fragments. Sand is fine to coarse. Gravel is fine to medium, subangular to angular.			
1.80 1.80-2.00 2.00-2.45 2.40	SV 55kPa B1 SPT N=5 SV 62kPa		1,2/1,1,2,1		1.40 (1.50)	Firm to stiff consistency, high strength, brown sandy gravelly CLAY with rare coal fragments. Sand is fine to medium. Gravel is fine to medium, subrounded to subangular. Gravel comprises sandstone and siltstone.			
3.00-3.25	SPT 49/100		10,13/24,25		2.90 (0.35) 3.25	Soft to firm consistency, medium strength, brown silty gravelly CLAY. Gravel is fine to medium, subrounded to subangular. Gravel comprises sandstone and shale.			
						Black weathered MUDSTONE.			
						Complete at 3.25m			

Remarks

No groundwater strike.

Scale
(approx)

1:50

Logged
By

TB

Figure No.

LKC 14 1496.WS102

**LK CONSULT LTD**Bury Business Centre, Kay Street, Bury, BL9 6BU
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Halter Inn Works, Holcombe

Number
WS103**Excavation Method**

Drive-in Window Sampler

Dimensions**Ground Level (mOD)****Client**

Finishing Techniques Ltd.

Job
Number
LKC 14 1496**Location** (Observed measurements)
WS103**Dates**
21/01/2015**Engineer**
LKC**Sheet**
1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
1.00-1.45 1.00-1.20	SPT N=6 C1		1,1/3,2,0,1		0.05 (0.35) 0.40 (0.50) 0.90	MADE GROUND: Tarmacadam. MADE GROUND: Brown sandy gravel. Sand is fine to medium. Gravel is fine to coarse, subrounded to subangular. MADE GROUND: Light brown gravel. Gravel is fine to medium, subrounded to rounded.	  		  
1.70-1.90 1.80 1.90 2.00-2.39	C2 SV 21kPa SV 28kPa SPT 50/240		3,3/3,10,27,10		(0.75) 1.65 (0.45) 2.10 (0.29) 2.39	MADE GROUND: Dark brown sandy clayey gravel with frequent ash, occasional brick fragments and rare clinker. Gravel is fine to medium, subangular to angular. Soft consistency, low strength, brown silty gravelly CLAY. Gravel is fine to medium, subangular to angular. Gravel comprises shale. Grey MUDSTONE. Complete at 2.39m	  		  

Remarks

No groundwater strike.

Scale
(approx)

1:50

Logged
By

TB

Figure No.

LKC 14 1496.WS103

**LK CONSULT LTD**Bury Business Centre, Kay Street, Bury, BL9 6BU
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Halter Inn Works, Holcombe

Number
WS104**Excavation Method**

Drive-in Window Sampler

Dimensions**Location**

WS104

Ground Level (mOD)**Dates**

01/01/2015

Client

Finishing Techniques Ltd.

Job
Number

LKC 14 1496

Engineer

LKC

Sheet

1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.20-0.40 0.50 0.50-0.70	C1 SV 31kPa C2				0.05 (0.15) 0.20 (0.25) 0.45	MADE GROUND: Tarmacadam. MADE GROUND: Light brown sandy gravel. Sand is fine to medium. Gravel is fine to medium, subangular to angular.	 		 
0.70-0.90 0.95 1.00-1.43	B1 SV 46kPa SPT 54/280		2,2/2,2,15,35		(0.90) 1.35 1.43	MADE GROUND: Grey / orange sandy gravel with frequent brick fragments, clinker and ash. Gravel is fine to medium, subrounded to subangular. Soft consistency, low to medium strength, silty gravelly CLAY. Gravel is fine to medium, subrounded to subangular. Gravel is sandstone and shale. Black SHALE. Complete at 1.43m	  		  

Remarks

No groundwater strike.

Scale
(approx)

1:50

Logged
By

TB

Figure No.

LKC 14 1496.WS104

 LK CONSULT LTD Bury Business Centre, Kay Street, Bury, BL9 6BU Tel: 0161 763 7200 web: www.thelkgroup.com					Site Halter Inn Works, Holcombe			Trial Pit Number TH101	
Excavation Method Trial Pit		Dimensions		Ground Level (mOD)		Client Finishing Techniques Ltd.		Job Number LKC 14 1496	
		Location (Observed measurements)		Dates 01/01/2015		Engineer LKC		Sheet 1/1	
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description		Legend	Water
0.20-0.30	C1				(0.15) 0.13 (0.80) 0.95 1.05	MADE GROUND: Brown slightly clayey sandy gravel. Sand is fine to medium. Gravel is fine to medium, subangular to angular. MADE GROUND: Orange / brown clayey gravelly cobbles with abundant brick fragments. Gravel is fine to coarse, subangular to angular. Soft consistency, brown gravelly CLAY. Gravel is fine to coarse, subangular to angular. Complete at 1.05m		  	
Plan .					Remarks No groundwater strike.				
					Scale (approx) 1:50		Logged By TB		Figure No. LKC 14 1496.TH101

APPENDIX C

CERTIFICATE OF ANALYSIS - SOIL



2183



Final Report

Report Number: 15-01298 Issue-1

Initial Date of Issue: 26-Jan-15

Client: Leyden Kirby

Client Address: Unit 25 Bury Business Centre
Kay Street
Bury
Lancashire
BL9 6BU

Contact(s): Chris Hughes

Project: LKC 14 1496 Halter Inn Works, Holcombe

Quotation No.: **Date Received:** 22-Jan-15

Order No.: 731172 **Date Instructed:** 22-Jan-15

No. of Samples: 11 **Results Due:** 26-Jan-15

Turnaround:
(Weekdays) 3

Date Approved: 26-Jan-15

Approved By:

Details: Darrell Hall, Laboratory Director

Results Summary - Soil

Project: LKC 14 1496 Halter Inn Works, Holcombe

Client: Leyden Kirby	Chemtest Job No.:				15-01298	15-01298	15-01298	15-01298	15-01298
Quotation No.:	Chemtest Sample ID.:				92220	92224	92226	92228	92230
Order No.: 731172	Client Sample Ref.:								
	Client Sample ID.:				WS101	WS102	WS103	WS104	TH101
	Sample Type:				SOIL	SOIL	SOIL	SOIL	SOIL
	Top Depth (m):				0.10	0.15	1.00	0.20	0.20
	Bottom Depth(m):				0.30	0.30	1.20	0.40	0.30
	Date Sampled:				21-Jan-15	21-Jan-15	21-Jan-15	21-Jan-15	21-Jan-15
Determinand	Accred.	SOP	Units	LOD					
ACM Type	U	2192			-	-	-	-	-
Asbestos Identification	U	2192	%	0.001	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected
Moisture	N	2030	%	0.02	17	13	22	11	16
Soil Colour	N				Brown	Brown	Brown	Brown	Brown
Other Material	N				Stones	Stones	Stones	Stones	Stones
Soil Texture	N				Sand	Sand	Sand	Sand	Clay
pH	M	2010			11.0	10.7	7.9	8.2	8.0
Sulphate (2:1 Water Soluble) as SO ₄	M	2120	g/l	0.01	0.19	0.20	0.034	0.78	0.041
Arsenic	M	2450	mg/kg	1	18	17	72	11	2.0
Cadmium	M	2450	mg/kg	0.1	0.30	0.62	0.32	0.30	0.21
Chromium	M	2450	mg/kg	1	18	60	40	73	24
Copper	M	2450	mg/kg	0.5	28	78	150	34	19
Mercury	M	2450	mg/kg	0.1	< 0.10	< 0.10	0.22	0.21	< 0.10
Nickel	M	2450	mg/kg	0.5	22	28	53	48	21
Lead	M	2450	mg/kg	0.5	380	170	140	540	19
Selenium	M	2450	mg/kg	0.2	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
Vanadium	U	2450	mg/kg	5	30	30	120	32	20
Zinc	M	2450	mg/kg	0.5	130	140	120	200	58
Chromium (Hexavalent)	N	2490	mg/kg	0.5	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Organic Matter	M	2625	%	0.4	6.6	13	17	2.1	0.88
Naphthalene	M	2700	mg/kg	0.1	< 0.10	0.82	< 0.10	< 0.10	< 0.10
Acenaphthylene	M	2700	mg/kg	0.1	< 0.10	0.20	< 0.10	< 0.10	< 0.10
Acenaphthene	M	2700	mg/kg	0.1	< 0.10	1.0	< 0.10	< 0.10	< 0.10
Fluorene	M	2700	mg/kg	0.1	< 0.10	0.99	< 0.10	< 0.10	< 0.10
Phenanthrene	M	2700	mg/kg	0.1	< 0.10	6.0	0.65	2.1	< 0.10
Anthracene	M	2700	mg/kg	0.1	< 0.10	1.7	0.30	0.47	< 0.10
Fluoranthene	M	2700	mg/kg	0.1	0.25	7.5	0.40	2.4	< 0.10
Pyrene	M	2700	mg/kg	0.1	0.22	7.3	0.43	2.3	< 0.10
Benzo[a]anthracene	M	2700	mg/kg	0.1	< 0.10	3.6	< 0.10	0.89	< 0.10
Chrysene	M	2700	mg/kg	0.1	< 0.10	4.7	< 0.10	1.1	< 0.10
Benzo[b]fluoranthene	M	2700	mg/kg	0.1	< 0.10	5.2	< 0.10	0.81	< 0.10
Benzo[k]fluoranthene	M	2700	mg/kg	0.1	< 0.10	1.9	< 0.10	0.12	< 0.10

Results Summary - Soil

Project: LKC 14 1496 Halter Inn Works, Holcombe

Client: Leyden Kirby	Chemtest Job No.:					15-01298	15-01298	15-01298	15-01298	15-01298
Quotation No.:	Chemtest Sample ID.:					92220	92224	92226	92228	92230
Order No.: 731172	Client Sample Ref.:									
	Client Sample ID.:					WS101	WS102	WS103	WS104	TH101
	Sample Type:					SOIL	SOIL	SOIL	SOIL	SOIL
	Top Depth (m):					0.10	0.15	1.00	0.20	0.20
	Bottom Depth(m):					0.30	0.30	1.20	0.40	0.30
	Date Sampled:					21-Jan-15	21-Jan-15	21-Jan-15	21-Jan-15	21-Jan-15
Determinand	Accred.	SOP	Units	LOD						
Benzo[a]pyrene	M	2700	mg/kg	0.1	< 0.10	4.3	< 0.10	0.65	< 0.10	
Indeno(1,2,3-c,d)Pyrene	M	2700	mg/kg	0.1	< 0.10	3.0	< 0.10	0.47	< 0.10	
Dibenz(a,h)Anthracene	M	2700	mg/kg	0.1	< 0.10	0.81	< 0.10	< 0.10	< 0.10	
Benzo[g,h,i]perylene	M	2700	mg/kg	0.1	< 0.10	2.7	< 0.10	1.1	< 0.10	
Total Of 16 PAH's	M	2700	mg/kg	2	< 2.0	52	< 2.0	12	< 2.0	

Report Information

Key

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

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

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

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

All Asbestos testing is performed at our Coventry laboratory

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

Sample Deviation Codes

- A - Date of sampling not supplied
- B - Sample age exceeds stability time (sampling to extraction)
- C - Sample not received in appropriate containers
- D - Broken Container

Sample Retention and Disposal

All soil samples will be retained for a period of 60 days from the date of receipt

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

Charges may apply to extended sample storage

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

customerservices@chemtest.co.uk

APPENDIX D

CERTIFICATE OF ANALYSIS – GEOTECHNICAL

MURRAY RIX
CONSULTANCY, SITE INVESTIGATION
CONSTRUCTION MATERIALS TESTING
TEST REPORT



Client

LK Consult Ltd

Kay Street
Bury
BL9 6BU

Contract Halter Inn Works, Holcombe

Job Number MRN 2347/99

Date of Issue 03 February 2015

Page 1 of 5

Approved Signatory

S J Hutchings, A W Hutchings, A Richardson

Notes

- 1 All remaining samples and remnants from this contract will be disposed 28 days from the date of this report unless you notify us to the contrary.
- 2 Result certificates, in this report, not bearing a UKAS mark, are not included in our UKAS accreditation schedule.
- 3 Opinions and interpretations expressed herein are outside the scope of our UKAS accreditation
- 4 Certified that the samples have been examined and tested in accordance with the terms of the contract/order and unless otherwise stated conform to the standards/specifications quoted. This does not, however, guarantee the balance of the materials from which the tested samples have been taken to be of equal quality.



33C, Vauxhall Industrial Estate, Greg Street, Reddish, Stockport SK5 7BR Tel: 0161 475 0870 Fax: 0161 475 0871

Email: steve@mtt-uk.com Website: www.murrayrix.com

Also at: London: 020 8523 1999

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MURRAY RIX

33C Vauxhall Ind. Estate, Greg Street
Reddish, Stockport SK5 7BR
TEL 0161 475 0870 FAX 0161 475 0871



TEST CERTIFICATE

LIQUID AND PLASTIC LIMIT

BS 1377: PART 2: 1990 Clause 4.4 ONE POINT METHOD & Clause 5.3

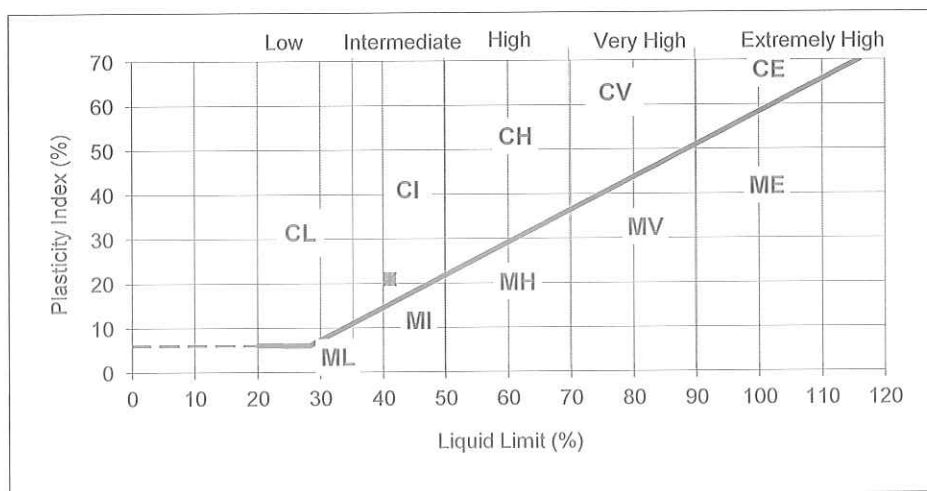
MOISTURE CONTENT METHOD BS 1377: PART 2: 1990 Clause 3.2

CLIENT	LK Group Ltd
SITE	Halter Inn Works, Holcombe
JOB NUMBER	MRN 2347/99

SAMPLE LABEL	WS101-1.6-1.8m	DATE SAMPLED	N/A
SAMPLE No.	60513	DATE RECEIVED	22-Jan-15
DATE TESTED	23-Jan-15	SAMPLED BY	Client

MATERIAL	Brown silty Clay with trace gravel
ADVISED SOURCE	Site Won

Moisture Content (Natural) (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 425 micron (%)
67	41	20	21	95



REMARKS

Sample was tested in natural condition

SIGNED

NAME

Page 2 of 5

A Richardson

(Deputy Laboratory Manager)

DATE

03-Feb-15

MURRAY RIX

UNIT 33C, VAUXHALL IND. ESTATE, GREG STREET
REDDISH, STOCKPORT, SK5 7BR
TEL 0161 475 0870 FAX 0161 475 0871

TEST CERTIFICATE

pH and Sulphate as SO₄
BS 1377: PART 3: 1990

CLIENT	LK Group Ltd
SITE	Halter Inn Works, Holcombe
JOB NUMBER	MRN 2347/99

SAMPLE LABEL	WS101-1.6-1.8m	DATE SAMPLED	Not Advised
LAB SAMPLE No	60513	DATE RECEIVED	22 January 2015
DATE TESTED	23 January 2014	SAMPLED BY	Client

ADVISED SOURCE	Site Won
PRE TREATMENT	Air Dried

PH Value	7.6	g/l
Sulphate as SO ₄ (2:1 Water Extract)	0.26	

REMARKS

SIGNED



NAME A. Richardson
Deputy Laboratory Manager

DATE 03 February 2015

MURRAY RIX

33C Vauxhall Ind. Estate, Greg Street
Reddish, Stockport SK5 7BR
TEL 0161 475 0870 FAX 0161 475 0871



TEST CERTIFICATE

LIQUID AND PLASTIC LIMIT

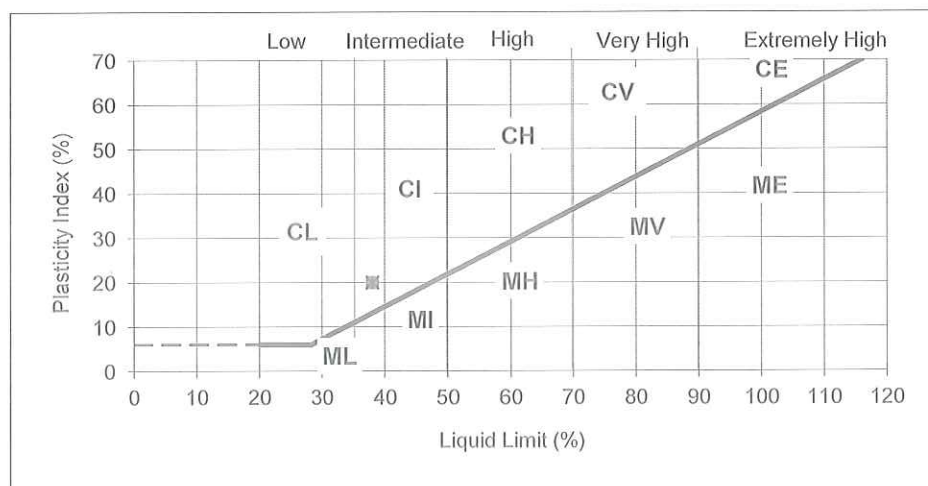
BS 1377: PART 2: 1990 Clause 4.4 ONE POINT METHOD & Clause 5.3
MOISTURE CONTENT METHOD BS 1377: PART 2: 1990 Clause 3.2

CLIENT	LK Group Ltd
SITE	Halter Inn Works, Holcombe
JOB NUMBER	MRN 2347/99

SAMPLE LABEL	WS102-1.8-2.0m	DATE SAMPLED	N/A
SAMPLE No.	60514	DATE RECEIVED	22-Jan-15
DATE TESTED	23-Jan-15	SAMPLED BY	Client

MATERIAL	Light brown silty Clay with trace gravel
ADVISED SOURCE	Site Won

Moisture Content (Natural) (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 425 micron (%)
39	38	18	20	96



REMARKS

Sample was tested in natural condition

SIGNED

NAME

A Richardson

DATE

03-Feb-15

Page 4 of 5

(Deputy Laboratory Manager)

MURRAY RIX

33C Vauxhall Ind. Estate, Greg Street
Reddish, Stockport SK5 7BR
TEL 0161 475 0870 FAX 0161 475 0871



TEST CERTIFICATE

LIQUID AND PLASTIC LIMIT

BS 1377: PART 2: 1990 Clause 4.4 ONE POINT METHOD & Clause 5.3

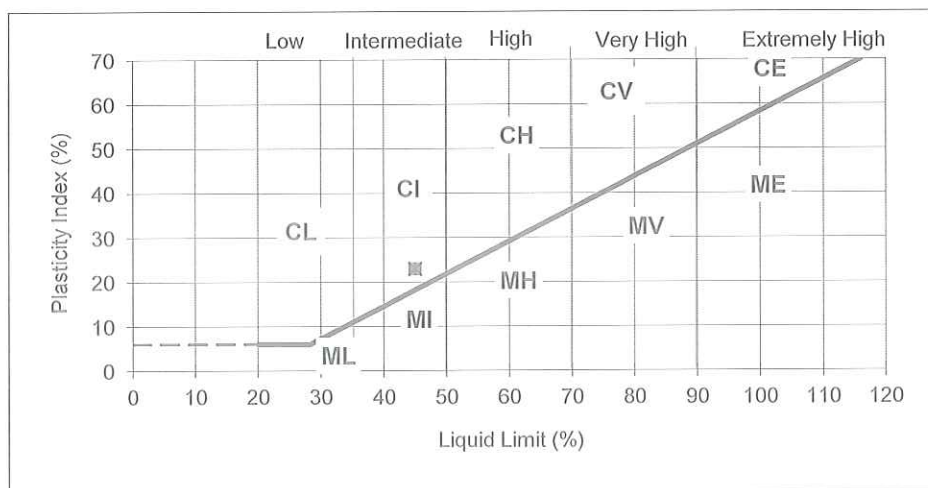
MOISTURE CONTENT METHOD BS 1377: PART 2: 1990 Clause 3.2

CLIENT	LK Group Ltd
SITE	Halter Inn Works, Holcombe
JOB NUMBER	MRN 2347/99

SAMPLE LABEL	WS104-0.7-0.9m	DATE SAMPLED	N/A
SAMPLE No.	60515	DATE RECEIVED	22-Jan-15
DATE TESTED	23-Jan-15	SAMPLED BY	Client

MATERIAL	Brown silty Clay with trace gravel
ADVISED SOURCE	Site Won

Moisture Content (Natural) (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 425 micron (%)
74	45	22	23	94



REMARKS

Sample was tested in natural condition

SIGNED

NAME

Page 5 of 5

A Richardson

(Deputy Laboratory Manager)

DATE

03-Feb-15

APPENDIX E

CERTIFICATE OF ANALYSIS – WATER



Final Report

Report Number: 15-01789 Issue-1

Initial Date of Issue: 30-Jan-15

Client: Leyden Kirby

Client Address: Unit 25 Bury Business Centre
Kay Street
Bury
Lancashire
BL9 6BU

Contact(s): Chris Hughes

Project: LKC 14 1496 Halter Inn Works, Holcombe

Quotation No.: **Date Received:** 28-Jan-15

Order No.: 731187 **Date Instructed:** 28-Jan-15

No. of Samples: 2 **Results Due:** 30-Jan-15

Turnaround:
(Weekdays) 3

Date Approved: 30-Jan-15

Approved By:

Details: Darrell Hall, Laboratory Director

Project: LKC 14 1496 Halter Inn Works, Holcombe

Client: Leyden Kirby	Chemtest Job No.:				15-01789	15-01789
Quotation No.:	Chemtest Sample ID.:				94895	94896
Order No.: 731187	Client Sample Ref.:					
	Client Sample ID.:				WS102	WS104
	Sample Type:				WATER	WATER
	Top Depth (m):					
	Bottom Depth(m):					
	Date Sampled:				27-Jan-15	27-Jan-15
Determinand	Accred.	SOP	Units	LOD		
pH	U	1010			8.0	8.4
Sulphate	U	1220	mg/l	1	55	150
Cyanide (Total)	U	1300	mg/l	0.05	< 0.050	< 0.050
Cyanide (Free)	U	1300	mg/l	0.05	< 0.050	< 0.050
Hardness	U	1415	mg/l	15	290	140
Arsenic (Dissolved)	U	1450	µg/l	1	2.6	2.1
Boron (Dissolved)	U	1450	µg/l	20	110	< 20
Cadmium (Dissolved)	U	1450	µg/l	0.08	< 0.080	< 0.080
Chromium (Dissolved)	U	1450	µg/l	1	2.1	2.1
Copper (Dissolved)	U	1450	µg/l	1	< 1.0	4.1
Mercury (Dissolved)	U	1450	µg/l	0.5	< 0.50	< 0.50
Nickel (Dissolved)	U	1450	µg/l	1	1.6	2.2
Lead (Dissolved)	U	1450	µg/l	1	< 1.0	< 1.0
Selenium (Dissolved)	U	1450	µg/l	1	3.1	6.0
Vanadium (Dissolved)	U	1450	µg/l	1	< 1.0	2.2
Zinc (Dissolved)	U	1450	µg/l	1	6.6	4.1
Chromium (Hexavalent)	U	1490	µg/l	20	< 20	< 20
Total Organic Carbon	N	1610	mg/l	1	4.3	< 2.5
Fuel Type	N	1670			na	na
Aliphatic TPH >C5-C6	N	1675	µg/l	0.1	< 0.10	< 0.10
Aliphatic TPH >C6-C8	N	1675	µg/l	0.1	< 0.10	< 0.10
Aliphatic TPH >C8-C10	N	1675	µg/l	0.1	< 0.10	< 0.10
Aliphatic TPH >C10-C12	N	1675	µg/l	0.1	< 0.10	< 0.10
Aliphatic TPH >C12-C16	N	1675	µg/l	0.1	< 0.10	< 0.10
Aliphatic TPH >C16-C21	N	1675	µg/l	0.1	< 0.10	< 0.10
Aliphatic TPH >C21-C35	N	1675	µg/l	0.1	< 0.10	< 0.10
Aliphatic TPH >C35-C44	N	1675	µg/l	0.1	< 0.10	< 0.10
Total Aliphatic Hydrocarbons	N	1675	µg/l	5	< 5.0	< 5.0
Aromatic TPH >C5-C7	N	1675	µg/l	0.1	< 0.10	< 0.10
Aromatic TPH >C7-C8	N	1675	µg/l	0.1	< 0.10	< 0.10
Aromatic TPH >C8-C10	N	1675	µg/l	0.1	< 0.10	< 0.10
Aromatic TPH >C10-C12	N	1675	µg/l	0.1	< 0.10	< 0.10
Aromatic TPH >C12-C16	N	1675	µg/l	0.1	< 0.10	< 0.10

Project: LKC 14 1496 Halter Inn Works, Holcombe

Client: Leyden Kirby	Chemtest Job No.:				15-01789	15-01789
Quotation No.:	Chemtest Sample ID.:				94895	94896
Order No.: 731187	Client Sample Ref.:					
	Client Sample ID.:				WS102	WS104
	Sample Type:				WATER	WATER
	Top Depth (m):					
	Bottom Depth(m):					
	Date Sampled:				27-Jan-15	27-Jan-15
Determinand	Accred.	SOP	Units	LOD		
Aromatic TPH >C16-C21	N	1675	µg/l	0.1	< 0.10	< 0.10
Aromatic TPH >C21-C35	N	1675	µg/l	0.1	< 0.10	< 0.10
Aromatic TPH >C35-C44	N	1675	µg/l	0.1	< 0.10	< 0.10
Total Aromatic Hydrocarbons	N	1675	µg/l	5	< 5.0	< 5.0
Total Petroleum Hydrocarbons	U	1675	µg/l	10	< 10	< 10
Naphthalene	N	1700	µg/l	0.01	< 0.010	< 0.010
Acenaphthylene	N	1700	µg/l	0.01	< 0.010	< 0.010
Acenaphthene	N	1700	µg/l	0.01	< 0.010	< 0.010
Fluorene	N	1700	µg/l	0.01	< 0.010	< 0.010
Phenanthrene	N	1700	µg/l	0.01	< 0.010	< 0.010
Anthracene	N	1700	µg/l	0.01	< 0.010	< 0.010
Fluoranthene	N	1700	µg/l	0.01	< 0.010	< 0.010
Pyrene	N	1700	µg/l	0.01	< 0.010	< 0.010
Benzo[a]anthracene	N	1700	µg/l	0.01	< 0.010	< 0.010
Chrysene	N	1700	µg/l	0.01	< 0.010	< 0.010
Benzo[b]fluoranthene	N	1700	µg/l	0.01	< 0.010	< 0.010
Benzo[k]fluoranthene	N	1700	µg/l	0.01	< 0.010	< 0.010
Benzo[a]pyrene	N	1700	µg/l	0.01	< 0.010	< 0.010
Indeno(1,2,3-c,d)Pyrene	N	1700	µg/l	0.01	< 0.010	< 0.010
Dibenz(a,h)Anthracene	N	1700	µg/l	0.01	< 0.010	< 0.010
Benzo[g,h,i]perylene	N	1700	µg/l	0.01	< 0.010	< 0.010
Total Of 16 PAH's	N	1700	µg/l	0.2	< 0.20	< 0.20
Benzene	U	1760	µg/l	1	< 1.0	< 1.0
Toluene	U	1760	µg/l	1	< 1.0	< 1.0
Ethylbenzene	U	1760	µg/l	1	< 1.0	< 1.0
m & p-Xylene	U	1760	µg/l	1	< 1.0	< 1.0
o-Xylene	U	1760	µg/l	1	< 1.0	< 1.0
Methyl Tert-Butyl Ether	N	1760	µg/l	1	< 1.0	< 1.0
Total Phenols	U	1920	mg/l	0.03	< 0.030	< 0.030

Report Information

Key

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

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

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

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

All Asbestos testing is performed at our Coventry laboratory

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

Sample Deviation Codes

- A - Date of sampling not supplied
- B - Sample age exceeds stability time (sampling to extraction)
- C - Sample not received in appropriate containers
- D - Broken Container

Sample Retention and Disposal

All soil samples will be retained for a period of 60 days from the date of receipt

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

Charges may apply to extended sample storage

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

customerservices@chemtest.co.uk

APPENDIX F

GAS MONITORING RESULTS

LK CONSULT LTD

GAS MONITORING RECORD

SITE	Halter Inn Works, Holcombe
REF	LKC 14 1496
DATE	27-Jan-2015
STAFF	TB
VISIT	1 of 6

EQUIPMENT*1		
Instrument / Model Type	Serial Number	Comments
Geotechnical Instruments GA2000+	GA10350	Serviced, calibrated & gas checked.
Solinst Interface Meter	122008632	Operating Normally

ATMOSPHERIC / GROUND CONDITIONS	
Atmospheric Pressure Trend on Site	Steady
Atmospheric Pressure (Prev 24hrs)	Falling from 1026mb.
Weather Conditions	Cloudy, windy
Ground Conditions	Wet

Borehole ID	Date/Time	CH4 (% v/v)	CO2 (% v/v)	O2 (% v/v)	Peak CH4 (% v/v)	% of Lower Explosive Limit*2	CO Pod (ppm)	H2S Pod (ppm)	Balance (%)	Barometric Pressure (mb)	Relative Pressure (mb)	Internal Flow *3 (ltr/hr)	Standing Water Level (mbgl)	Installation Base Dip (mbgl)	Notes
WS101	27/01/2015 12:37	0.0	0.2	20.8	0.0	0.0	0	0.0	79.0	1005	-0.5	0.0	1.34	3.81	
WS102	27/01/2015 12:25	0.0	0.1	20.8	0.0	0.0	0	0.0	79.1	1005	-0.5	0.0	1.99	2.86	
WS103	27/01/2015 12:42	0.0	0.1	21.0	0.0	0.0	0	0.0	78.9	1005	-0.5	0.0	1.74	2.00	
WS104	27/01/2015 12:47	0.0	0.1	21.1	0.0	0.0	0	0.0	78.8	1005	-0.5	0.0	0.69	1.32	

ABBREVIATIONS

*1	Refer to Note 1
ND	Not detected
NR	Not recorded
UR	Unable to record
OS	Off recordable scale
N/A	Not applicable
% v/v	Percentage volume by total volume

ppm	Parts per million
mb	Millibars
ltr/hr	Litres per hour
mbgl	Metres below ground level
LEL	Lower explosive limit in air
OEL	Occupational exposure limit

NOTES

- Equipment is serviced and checked as recommended by the manufacturer. Refer to calibration records and service certificates.
- CH4 is explosive between the range of 5 - 15% v/v. 100% lower explosive limit is equal to 5% v/v CH4.
- Flow readings are based on a 1 minute average value where flow is detected (equipment range of +/- 12
- After CIRIA C665. GSV = gas concentration (%) x flow rate. Peak CH4 and Steady CO2 values used.
- Monitoring is carried out in line with procedures set by LKC Ltd with reference to CIRIA C665. Refer to p



LK CONSULT LTD

GAS MONITORING RECORD

SITE	Halter Inn Works, Holcombe
REF	LKC 14 1496
DATE	9-Feb-2015
STAFF	TB
VISIT	2 of 6

EQUIPMENT*1		
Instrument / Model Type	Serial Number	Comments
Geotechnical Instruments GA2000+	GA10350	Serviced, calibrated & gas checked.
Solinst Interface Meter	122008632	Operating Normally

ATMOSPHERIC / GROUND CONDITIONS	
Atmospheric Pressure Trend on Site	Steady
Atmospheric Pressure (Prev 24hrs)	Falling from 1037mb.
Weather Conditions	Cloudy, windy
Ground Conditions	Wet

Borehole ID	Date/Time	CH4 (% v/v)	CO2 (% v/v)	O2 (% v/v)	Peak CH4 (% v/v)	% of Lower Explosive Limit*2	CO Pod (ppm)	H2S Pod (ppm)	Balance (%)	Barometric Pressure (mb)	Relative Pressure (mb)	Internal Flow *3 (ltr/hr)	Standing Water Level (mbgl)	Installation Base Dip (mbgl)	Notes
WS101	09/02/2015 15:19	0.0	0.5	20.9	0.0	0.0	0	0.0	78.6	1015	-0.3	0.0	1.54	3.81	
WS102	09/02/2015 15:14	0.0	2.8	18.0	0.0	0.0	0	0.0	79.2	1015	-0.4	0.0	2.17	2.86	
WS103	09/02/2015 15:25	0.0	1.1	20.3	0.0	0.0	0	0.0	78.6	1015	-0.4	0.0	1.94	2.00	
WS104	09/02/2015 15:30	0.0	1.0	19.6	0.0	0.0	5	0.0	79.4	1015	-0.5	0.0	0.89	1.32	

ABBREVIATIONS

*1	Refer to Note 1
ND	Not detected
NR	Not recorded
UR	Unable to record
OS	Off recordable scale
N/A	Not applicable
% v/v	Percentage volume by total volume

ppm	Parts per million
mb	Millibars
ltr/hr	Litres per hour
mbgl	Metres below ground level
LEL	Lower explosive limit in air
OEL	Occupational exposure limit

NOTES

- Equipment is serviced and checked as recommended by the manufacturer. Refer to calibration records and service certificates.
- CH4 is explosive between the range of 5 - 15% v/v. 100% lower explosive limit is equal to 5% v/v CH4.
- Flow readings are based on a 1 minute average value where flow is detected (equipment range of +/- 12
- After CIRIA C665. GSV = gas concentration (%) x flow rate. Peak CH4 and Steady CO2 values used.
- Monitoring is carried out in line with procedures set by LKC Ltd with reference to CIRIA C665. Refer to p



LK CONSULT LTD

GAS MONITORING RECORD

SITE	Halter Inn Works, Holcombe
REF	LKC 14 1496
DATE	23-Feb-2015
STAFF	TB
VISIT	3 of 6

EQUIPMENT*1		
Instrument / Model Type	Serial Number	Comments
Geotechnical Instruments GA2000+	GA10350	Serviced, calibrated & gas checked.
Solinst Interface Meter	122008632	Operating Normally

ATMOSPHERIC / GROUND CONDITIONS	
Atmospheric Pressure Trend on Site	Steady
Atmospheric Pressure (Prev 24hrs)	Falling from 986mb.
Weather Conditions	Cloudy
Ground Conditions	Wet

Borehole ID	Date/Time	CH4 (% v/v)	CO2 (% v/v)	O2 (% v/v)	Peak CH4 (% v/v)	% of Lower Explosive Limit*2	CO Pod (ppm)	H2S Pod (ppm)	Balance (%)	Barometric Pressure (mb)	Relative Pressure (mb)	Internal Flow *3 (ltr/hr)	Standing Water Level (mbgl)	Installation Base Dip (mbgl)	Notes
WS101	24/02/2015 10:08	0.0	0.6	20.7	0.0	0.0	0	0.0	78.7	981	-0.5	0.0	1.40	2.80	
WS102	24/02/2015 10:03	0.0	3.5	17.0	0.0	0.0	0	0.0	79.5	981	-0.4	0.0	1.94	2.86	
WS103	24/02/2015 10:13	0.0	0.8	20.2	0.0	0.0	0	0.0	79.0	981	-1.2	0.0	1.50	2.01	
WS104	Not monitored due to high groundwater levels.														

Unable to monitor WS104.

ABBREVIATIONS

*1	Refer to Note 1.
ND	Not detected
NR	Not recorded
UR	Unable to record
OS	Off recordable scale
N/A	Not applicable
% v/v	Percentage volume by total volume

ppm	Parts per million
mb	Millibars
ltr/hr	Litres per hour
mbgl	Metres below ground level
LEL	Lower explosive limit in air
OEL	Occupational exposure limit

NOTES

1. Equipment is serviced and checked as recommended by the manufacturer. Refer to calibration records and service certificates.
2. CH4 is explosive between the range of 5 - 15% v/v. 100% lower explosive limit is equal to 5% v/v CH4.
3. Flow readings are based on a 1 minute average value where flow is detected (equipment range of +/- 12
4. After CIRIA C665. GSV = gas concentration (%) x flow rate. Peak CH4 and Steady CO2 values used.
5. Monitoring is carried out in line with procedures set by LKC Ltd with reference to CIRIA C665. Refer to p



LK CONSULT LTD

GAS MONITORING RECORD

SITE	Halter Inn Works, Holcombe
REF	LKC 14 1496
DATE	11-Mar-2015
STAFF	TB
VISIT	4 of 6

EQUIPMENT*1		
Instrument / Model Type	Serial Number	Comments
Geotechnical Instruments GA2000+	GA10350	Serviced, calibrated & gas checked.
Solinst Interface Meter	122008632	Operating Normally

ATMOSPHERIC / GROUND CONDITIONS	
Atmospheric Pressure Trend on Site	Steady
Atmospheric Pressure (Prev 24hrs)	Falling from 1028mb.
Weather Conditions	Cloudy, raning
Ground Conditions	Wet

Borehole ID	Date/Time	CH4 (% v/v)	CO2 (% v/v)	O2 (% v/v)	Peak CH4 (% v/v)	% of Lower Explosive Limit*2	CO Pod (ppm)	H2S Pod (ppm)	Balance (%)	Barometric Pressure (mb)	Relative Pressure (mb)	Internal Flow *3 (ltr/hr)	Standing Water Level (mbgl)	Installation Base Dip (mbgl)	Notes
WS101	11/03/2015 13:21	0.0	0.4	20.7	0.0	0.0	0	0.0	78.9	1003	-0.6	0.0	1.35	2.79	
WS102	11/03/2015 13:16	0.0	2.9	17.4	0.0	0.0	0	0.0	79.7	1003	-0.6	0.0	2.07	2.88	
WS103	11/03/2015 13:26	0.0	0.2	21.0	0.0	0.0	0	0.0	78.8	1003	-0.6	0.0	1.75	1.99	
WS104	Not monitored due to high groundwater levels.														

Unable to monitor WS104.

ABBREVIATIONS

*1	Refer to Note 1.
ND	Not detected
NR	Not recorded
UR	Unable to record
OS	Off recordable scale
N/A	Not applicable
% v/v	Percentage volume by total volume

ppm	Parts per million
mb	Millibars
ltr/hr	Litres per hour
mbgl	Metres below ground level
LEL	Lower explosive limit in air
OEL	Occupational exposure limit

NOTES

- Equipment is serviced and checked as recommended by the manufacturer. Refer to calibration records. and service certificates.
- CH4 is explosive between the range of 5 - 15% v/v. 100% lower explosive limit is equal to 5% v/v CH4.
- Flow readings are based on a 1 minute average value where flow is detected (equipment range of +/- 12
- After CIRIA C665. GSV = gas concentration (%) x flow rate. Peak CH4 and Steady CO2 values used.
- Monitoring is carried out in line with procedures set by LKC Ltd with reference to CIRIA C665. Refer to p



LK CONSULT LTD

GAS MONITORING RECORD

SITE	Halter Inn Works, Holcombe
REF	LKC 14 1496
DATE	23-Mar-2015
STAFF	TB
VISIT	5 of 6

EQUIPMENT*1		
Instrument / Model Type	Serial Number	Comments
Geotechnical Instruments GA2000+	GA10350	Serviced, calibrated & gas checked.
Solinst Interface Meter	122008632	Operating Normally

ATMOSPHERIC / GROUND CONDITIONS	
Atmospheric Pressure Trend on Site	Steady
Atmospheric Pressure (Prev 24hrs)	Falling from 1009mb.
Weather Conditions	Sunny, Clear
Ground Conditions	Wet

Borehole ID	Date/Time	CH4 (% v/v)	CO2 (% v/v)	O2 (% v/v)	Peak CH4 (% v/v)	% of Lower Explosive Limit*2	CO Pod (ppm)	H2S Pod (ppm)	Balance (%)	Barometric Pressure (mb)	Relative Pressure (mb)	Internal Flow *3 (ltr/hr)	Standing Water Level (mbgl)	Installation Base Dip (mbgl)	Notes
WS101	23/03/2015 15:00	0.0	0.3	19.9	0.0	0.0	0	0.0	79.1	994	-0.5	0.0	1.41	2.79	
WS102	23/03/2015 14:55	0.0	2.5	17.8	0.0	0.0	0	0.0	79.7	994	-0.5	0.0	2.14	2.88	
WS103	23/03/2015 15:04	0.0	1.1	19.9	0.0	0.0	0	0.0	79.2	994	-0.6	0.0	1.75	1.99	
WS104	23/03/2015 15:09	0.0	0.7	20.3	0.1	0.0	0	0.0	78.9	994	-0.4	0.0	0.92	1.31	

Unable to monitor WS104.

ABBREVIATIONS

*1	Refer to Note 1.
ND	Not detected
NR	Not recorded
UR	Unable to record
OS	Off recordable scale
N/A	Not applicable
% v/v	Percentage volume by total volume

ppm	Parts per million
mb	Millibars
ltr/hr	Litres per hour
mbgl	Metres below ground level
LEL	Lower explosive limit in air
OEL	Occupational exposure limit

NOTES

- Equipment is serviced and checked as recommended by the manufacturer. Refer to calibration records and service certificates.
- CH4 is explosive between the range of 5 - 15% v/v. 100% lower explosive limit is equal to 5% v/v CH4.
- Flow readings are based on a 1 minute average value where flow is detected (equipment range of +/- 12
- After CIRIA C665. GSV = gas concentration (%) x flow rate. Peak CH4 and Steady CO2 values used.
- Monitoring is carried out in line with procedures set by LKC Ltd with reference to CIRIA C665. Refer to p



LK CONSULT LTD

GAS MONITORING RECORD

SITE	Halter Inn Works, Holcombe
REF	LKC 14 1496
DATE	2-Apr-2015
STAFF	CH
VISIT	6 of 6

EQUIPMENT*1		
Instrument / Model Type	Serial Number	Comments
Geotechnical Instruments GA2000+	GA10350	Serviced, calibrated & gas checked.
Solinst Interface Meter	122008632	Operating Normally

ATMOSPHERIC / GROUND CONDITIONS	
Atmospheric Pressure Trend on Site	Steady
Atmospheric Pressure (Prev 24hrs)	Rising from 1000mb.
Weather Conditions	Sunny, Clear
Ground Conditions	Wet

Borehole ID	Date/Time	CH4 (% v/v)	CO2 (% v/v)	O2 (% v/v)	Peak CH4 (% v/v)	% of Lower Explosive Limit*2	CO Pod (ppm)	H2S Pod (ppm)	Balance (%)	Barometric Pressure (mb)	Relative Pressure (mb)	Internal Flow *3 (ltr/hr)	Standing Water Level (mbgl)	Installation Base Dip (mbgl)	Notes
WS101	02/04/2015 11:55	0.0	0.5	20.2	0.0	0.0	0	0.0	79.3	1002	-0.5	0.0	1.37	2.79	
WS102	02/04/2015 11:47	0.0	3.5	17.1	0.0	0.0	0	0.0	79.6	1002	-0.5	0.0	2.02	2.88	
WS103	02/04/2015 12:09	0.0	0.8	19.3	0.0	0.0	0	0.0	79.9	1002	-0.5	0.0	1.67	1.99	
WS104	Not monitored due to high groundwater levels.														

Unable to monitor WS104.

ABBREVIATIONS

*1	Refer to Note 1.
ND	Not detected
NR	Not recorded
UR	Unable to record
OS	Off recordable scale
N/A	Not applicable
% v/v	Percentage volume by total volume

ppm	Parts per million
mb	Millibars
ltr/hr	Litres per hour
mbgl	Metres below ground level
LEL	Lower explosive limit in air
OEL	Occupational exposure limit

NOTES

- Equipment is serviced and checked as recommended by the manufacturer. Refer to calibration records and service certificates.
- CH4 is explosive between the range of 5 - 15% v/v. 100% lower explosive limit is equal to 5% v/v CH4.
- Flow readings are based on a 1 minute average value where flow is detected (equipment range of +/- 12
- After CIRIA C665. GSV = gas concentration (%) x flow rate. Peak CH4 and Steady CO2 values used.
- Monitoring is carried out in line with procedures set by LKC Ltd with reference to CIRIA C665. Refer to p



APPENDIX G

GENERIC ASSESSMENT CRITERIA VALUES

Category 4 Screening Levels (C4SL)

Substance	Residential (with home- grown produce)	Residential (without home- grown produce)	Allotments	Commercial	Public Open Space 1	Public Open Space 2
Arsenic	37 mg/kg	40 mg/kg	49 mg/kg	640 mg/kg	79 mg/kg	168 mg/kg
Benzene	0.87 mg/kg	3.3 mg/kg	0.18 mg/kg	98 mg/kg	140 mg/kg	230 mg/kg
Benzo(a)pyrene	5 mg/kg	5.3 mg/kg	5.7 mg/kg	76 mg/kg	10 mg/kg	21 mg/kg
Cadmium	26 mg/kg	149 mg/kg	4.9 mg/kg	410 mg/kg	220 mg/kg	880 mg/kg
Chromium VI	21 mg/kg	21 mg/kg	170 mg/kg	49 mg/kg	23 mg/kg	250 mg/kg
Lead	200 mg/kg	310 mg/kg	80 mg/kg	2330 mg/kg	630 mg/kg	1300 mg/kg

Summary Table for the Generic Assessment Criteria for Human Health Risk Assessment Land Quality Management (LQM) S4ULs.

All GAC are based on sandy loam soils with a pH 7.

		LQM Generic Assessment Criteria (mg/kg) Dry weight soil						
Contaminant		SOM	Res +	Res -	Allot.	Comm.	POS _{resi}	POS _{park}
Metals	Inorganic Arsenic	6%	37	40	43	640	79	170
	Beryllium	6%	1.7	1.7	35	12	2.2	63
	Boron	6%	290	11,000	45	240,000	21,000	46,000
	Cadmium	6%	11	85	1.9	190	120	532
	Chromium (III)	6%	910	910	18,000	8,600	1,500	33,000
	Chromium (VI)	6%	6.0	6.0	1.8	33	7.7	220
	Copper	6%	2,400	7,100	520	68,000	12,000	44,000
	Elemental Mercury	6%	1.2	1.2	21	58 (25.8) ^{vap}	16	30 (25.8) ^{vap}
	Inorganic Mercury	6%	40	56	19	1,100	120	240
	Methylmercury	6%	11	15	6.0	320	40	68
	Nickel	6%	180	180	230	980	230	3,400
	Selenium	6%	250	430	88	12,000	1,100	1,800
	Vanadium	6%	410	1,200	91	9,000	2,000	5,000
	Zinc	6%	3,700	40,000	620	730,000	81,000	170,000
BTEX Compounds	Benzene	1%	0.087	0.38	0.017	27	72	90
		2.5%	0.17	0.70	0.034	47	72	100
		6%	0.37	1.4	0.075	90	73	110
	Toluene	1%	130	880 (869) ^{vap}	22	56,000 (869) ^{vap}	56,000	87,000 (869) ^{vap}
		2.5%	290	1,900	51	110,000 (1,920) ^{vap}	56,000	95,000 (1,920) ^{vap}
		6%	660	3,900	120	180,000 (4,360) ^{vap}	56,000	100,000 (4,360) ^{vap}
	Ethylbenzene	1%	47	83	16	5,700 (518) ^{vap}	24,000	17,000 (518) ^{vap}
		2.5%	110	190	39	13,000 (1,220) ^{vap}	24,000	22,000 (1,220) ^{vap}
		6%	260	440	91	27,000 (2,840) ^{vap}	25,000	27,000 (2,840) ^{vap}
	o-xylene	1%	60	88	28	6,600 (478) ^{sol}	41,000	17,000 (478) ^{sol}
		2.5%	140	210	67	15,000 (1,120) ^{sol}	42,000	24,000 (1,120) ^{sol}
		6%	330	480	160	33,000 (2,620) ^{sol}	43,000	33,000 (2,620) ^{sol}
	m-xylene	1%	59	82	31	6,200 (625) ^{vap}	41,000	17,000 (625) ^{vap}
		2.5%	140	190	74	14,000 (1,470) ^{vap}	42,000	24,000 (1,470) ^{vap}
		6%	320	450	170	31,000 (3,460) ^{vap}	43,000	32,000 (3,460) ^{vap}
	p-xylene	1%	56	79	29	5,900 (576) ^{sol}	41,000	17,000 (576) ^{sol}
		2.5%	130	180	69	14,000 (1,350) ^{sol}	42,000	23,000 (1,350) ^{sol}
		6%	310	430	160	30,000 (3,170) ^{sol}	43,000	31,000 (3,170) ^{sol}

NOTES

^{sol/vap} = solubility / vapour limit (potentially use if free product identified, although highly conservative).

f = oral, dermal and inhalation exposures compared to oral HCV.

All GAC are based on sandy loam soils with a pH 7.

All GAC are based on sandy loam soils with a pH 7.			LQM Generic Assessment Criteria (mg/kg) Dry weight soil					
Contaminant		SOM	Res +	Res -	Allot.	Comm.	POS _{resi}	POS _{park}
Polycyclic Aromatic Hydrocarbons (PAHs)	Acenaphthene	1%	210	3,000 (57.1) ^{sol}	34	84,000 (57.0) ^{sol}	15,000	29,000
		2.5%	510	4,700 (141) ^{sol}	85	97,000 (141) ^{sol}	15,000	30,000
		6%	1,100	6,000 (336) ^{sol}	200	100,000	15,000	30,000
	Acenaphthylene	1%	170	2,900 (86.1) ^{sol}	28	83,000 (86.1) ^{sol}	15,000	29,000
		2.5%	420	4,600 (212) ^{sol}	69	97,000 (212) ^{sol}	15,000	30,000
		6%	920	6,000 (506) ^{sol}	160	100,000	15,000	30,000
	Anthracene	1%	2,400	31,000 (1.17) ^{vap}	380	520,000	74,000	150,000
		2.5%	5,400	35,000	950	540,000	74,000	150,000
		6%	11,000	37,000	2,200	540,000	74,000	150,000
	Benz(a)anthracene	1%	7.2	11	2.9	170	29	49
		2.5%	11	14	6.5	170	29	56
		6%	13	15	13	180	29	62
	Benzo(a)pyrene (only)	1%	2.2	3.2	0.97	35	5.7	11
		2.5%	2.7	3.2	2.0	35	5.7	12
		6%	3.0	3.2	3.5	36	5.7	13
	Benzo(b)fluoranthene	1%	2.6	3.9	0.99	44	7.1	13
		2.5%	3.3	4.0	2.1	44	7.2	15
		6%	3.7	4.0	3.9	45	7.2	16
	Benzo(ghi)perylene	1%	320	360	290	3,900	640	1,400
		2.5%	340	360	470	4,000	640	1,500
		6%	350	360	640	4,000	640	1,600
	Benzo(k)fluoranthene	1%	77	110	37	1,200	190	370
		2.5%	93	110	75	1,200	190	410
		6%	100	110	130	1,200	190	440
	Chrysene	1%	15	30	4.1	350	57	93
		2.5%	22	31	9.4	350	57	110
		6%	27	32	19	350	57	120
	Dibenzo(ah)anthracene	1%	0.24	0.31	0.14	3.5	0.57	1.1
		2.5%	0.28	0.32	0.27	3.6	0.58	1.3
		6%	0.3	0.32	0.43	3.6	0.58	1.4
	Fluoranthene	1%	280	1,500	52	23,000	3,100	6,300
		2.5%	560	1,600	130	23,000	3,100	6,300
		6%	890	1,600	290	23,000	3,100	6,400
	Fluorene	1%	170	2,800 (36.0) ^{sol}	27	63,000 (30.9) ^{sol}	9,900	20,000
		2.5%	400	3,800 (76.5) ^{sol}	67	68,000	9,900	20,000
		6%	860	4,500 (183) ^{sol}	160	71,000	9,900	20,000
	Indeno(123-cd)pyrene	1%	27	45	9.5	500	82	150
		2.5%	36	46	21	510	82	170
		6%	41	46	39	510	82	180
	Naphthalene	1%	2.3 ^f	2.3 ^f	4.1 ^f	190 ^f (76.4) ^{sol}	4,900 ^f	1,200 ^f (76.4) ^{sol}
		2.5%	5.6 ^f	5.6 ^f	10 ^f	460 ^f (183) ^{sol}	4,900 ^f	1,900 ^f (183) ^{sol}
		6%	13 ^f	13 ^f	24 ^f	1,100 ^f (432) ^{sol}	4,900 ^f	3,000
	Phenanthrene	1%	95	1,300 (36.0) ^{sol}	15	22,000	3,100	6,200
		2.5%	220	1,500	38	22,000	3,100	6,200
		6%	440	1,500	90	22,000	3,100	6,300
	Pyrene	1%	620	3,700	110	54,000	7,400	15,000
		2.5%	1,200	3,800	270	54,000	7,400	15,000
		6%	2,000	3,800	620	54,000	7,400	15,000
Coal Tar (B(a)P as surrogate marker)	1%	0.79	1.2	0.32	15	2.2	4.4	
	2.5%	0.98	1.2	0.67	15	2.2	4.7	
	6%	1.1	1.2	1.2	15	2.2	4.8	

NOTES

^{sol} / ^{vap} = solubility / vapour limit (potentially use if free product identified, although highly conservative).

^f = naphthalene is based on comparison of inhalation exposure with TDI_{Inhal} for localised effect.

All GAC are based on sandy loam soils with a pH 7.

LQM Generic Assessment Criteria (mg/kg) Dry weight soil

Contaminant	SOM	Res +	Res -	Allot.	Comm.	POS _{resi}	POS _{park}
Aliphatic							
EC 5-6	1%	42	42	730	3,200 (304) ^{sol}	570,000(304) ^{sol}	95,000 (304) ^{sol}
EC>6-8	1%	100	100	2,300	7,800 (144) ^{sol}	600,000	150,000 (144) ^{sol}
EC>8-10	1%	27	27	320	2,000 (78) ^{sol}	13,000	14,000 (78) ^{vap}
EC>10-12	1%	130 (48) ^{vap}	130 (48) ^{vap}	2,200	9,700 (48) ^{sol}	13,000	21,000 (48) ^{vap}
EC>12-16	1%	1,100 (24) ^{sol}	1,100 (24) ^{sol}	11,000	59,000 (24) ^{sol}	13,000	25,000 (24) ^{sol}
EC>16-35	1%	65,000 (8.48) ^{f, sol}	65,000 (8.48) ^{f, sol}	260,000 ^f	160,000 ^f	250,000 ^f	450,000 ^f
EC>35-44	1%	65,000 (8.48) ^{f, sol}	65,000 (8.48) ^{f, sol}	260,000 ^f	160,000 ^f	250,000 ^f	450,000 ^f
Aliphatic							
EC 5-6	2.5%	78	78	1,700	5,900 (558) ^{sol}	590,000	130,000 (558) ^{sol}
EC>6-8	2.5%	230	230	5,600	17,000 (322) ^{sol}	610,000	220,000 (322) ^{sol}
EC>8-10	2.5%	65	65	770	4,800 (190) ^{vap}	13,000	18,000 (190) ^{vap}
EC>10-12	2.5%	330 (118) ^{vap}	330 (118) ^{vap}	4,400	23,000 (118) ^{vap}	13,000	23,000 (118) ^{vap}
EC>12-16	2.5%	2,400 (59) ^{sol}	2,400 (59) ^{sol}	13,000	82,000 (59) ^{sol}	13,000	25,000 (59) ^{sol}
EC>16-35	2.5%	92,000 (21) ^{f, sol}	92,000 (21) ^{f, sol}	270,000 ^f	1,700,000 ^f	250,000 ^f	480,000 ^f
EC>35-44	2.5%	92,000 (21) ^{f, sol}	92,000 (21) ^{f, sol}	270,000 ^f	1,700,000 ^f	250,000 ^f	480,000 ^f
Aliphatic							
EC 5-6	6%	160	160	3,900	12,000 (1,150) ^{sol}	600,000	180,000 (1,150) ^{sol}
EC>6-8	6%	530	530	13,000	40,000 (736) ^{sol}	620,000	320,000 (736) ^{sol}
EC>8-10	6%	150	150	1,700	11,000 (451) ^{vap}	13,000	21,000 (451) ^{vap}
EC>10-12	6%	760 (283) ^{vap}	760 (283) ^{vap}	7,300	47,000 (283) ^{vap}	13,000	24,000 (283) ^{vap}
EC>12-16	6%	4,300 (142) ^{sol}	4,400 (142) ^{sol}	13,000	90,000 (142) ^{sol}	13,000	26,000 (142) ^{sol}
EC>16-35	6%	110,000 ^f	110,000 ^f	270,000 ^f	1,800,000 ^f	250,000 ^f	490,000 ^f
EC>35-44	6%	110,000 ^f	110,000 ^f	270,000 ^f	1,800,000 ^f	250,000 ^f	490,000 ^f
Aromatic							
EC5-7(benzene as non-threshold)	1%	70	370	13	26,000 (1,220) ^{sol}	56,000	76,000 (1,220) ^{sol}
EC>7-8(toluene)	1%	130	860	22	56,000 (869) ^{vap}	56,000	87,000 (869) ^{vap}
EC>8-10	1%	34	47	8.6	3,500 (613) ^{vap}	5,000	7,200 (613) ^{vap}
EC>10-12	1%	74	250	13	16,000 (364) ^{sol}	5,000	9,200 (364) ^{sol}
EC>12-16	1%	140	1,800	23	36,000 (169) ^{sol}	5,100	10,000
EC>16-21	1%	260 ^f	1,900 ^f	46 ^f	28,000 ^f	3,800 ^f	7,600 ^f
EC>21-35	1%	1,100 ^f	1,900 ^f	370 ^f	28,000 ^f	3,800 ^f	7,800 ^f
EC>35-44	1%	1,100 ^f	1,900 ^f	370 ^f	28,000 ^f	3,800 ^f	7,800 ^f
Aromatic							
EC5-7(benzene as non-threshold)	2.5%	140	690	27	46,000 (2,260) ^{sol}	56,000	84,000 (2,260) ^{sol}
EC>7-8(toluene)	2.5%	290	1,800	51	110,000 (1,920) ^{sol}	56,000	95,000 (1,920) ^{sol}
EC>8-10	2.5%	83	110	21	8,100 (1,500) ^{vap}	5,000	8,500 (1,500) ^{vap}
EC>10-12	2.5%	180	590	31	28,000 (899) ^{sol}	5,000	9,700 (899) ^{sol}
EC>12-16	2.5%	330	2,300 (419) ^{sol}	57	37,000	5,100	10,000
EC>16-21	2.5%	540 ^f	1,900 ^f	110 ^f	28,000 ^f	3,800 ^f	7,700 ^f
EC>21-35	2.5%	1,500 ^f	1,900 ^f	820 ^f	28,000 ^f	3,800 ^f	7,800 ^f
EC>35-44	2.5%	1,500 ^f	1,900 ^f	820 ^f	28,000 ^f	3,800 ^f	7,800 ^f
Aromatic							
EC5-7(benzene as non-threshold)	6%	300	1,400	57	86,000 (4,710) ^{sol}	56,000	92,000 (4,710) ^{sol}
EC>7-8(toluene)	6%	660	3,900	120	180,000 (4,360) ^{vap}	56,000	100,000 (4,360) ^{vap}
EC>8-10	6%	190	270	51	17,000 (3,580) ^{vap}	5,000	9,300 (3,580) ^{vap}
EC>10-12	6%	380	1,200	4	34,000 (2,150) ^{sol}	5,000	10,000
EC>12-16	6%	660	2,500	130	38,000	5,100	10,000
EC>16-21	6%	930 ^f	1,900 ^f	260 ^f	28,000 ^f	3,800 ^f	7,800 ^f
EC>21-35	6%	1,700 ^f	1,900 ^f	1,600 ^f	28,000 ^f	3,800 ^f	7,900 ^f
EC>35-44	6%	1,700 ^f	1,900 ^f	1,600 ^f	28,000 ^f	3,800 ^f	7,900 ^f
Aliphatic	1%	1,600 ^f	1,900 ^f	1,200 ^f	28,000 ^f	3,800 ^f	7,800 ^f
+Aromatic	2.5%	1,800 ^f	1,900 ^f	2,100 ^f	28,000 ^f	3,800 ^f	7,800 ^f
>EC44	6%	1,900 ^f	1,900 ^f	3,000 ^f	28,000 ^f	3,800 ^f	7,900 ^f

NOTES

^{sol}/^{vap} = solubility / vapour limit (potentially use if free product identified, although highly conservative).

^f = oral, dermal and inhalation exposures compared to oral HCV.

All GAC are based on sandy loam soils with a pH 7.

		LQM Generic Assessment Criteria (mg/kg) Dry weight soil						
Contaminant		SOM	Res +	Res -	Allot.	Comm.	POS _{resi}	POS _{park}
Chloalkanes and Alkenes & Explosives	1,2 Dichloroethane (DCA)	1%	7.1E-03	9.2E-03	4.6E-03	0.67	29	21
		2.5%	1.1E-02	1.3E-02	8.3E-03	0.97	29	24
		6%	1.9E-02	2.3E-02	1.6E-02	1.7	29	28
	1,1,1 Trichloroethane (TCA)	1%	8.8	9.0	48	660	140,000	57,000 (1,425) ^{vap}
		2.5%	18	18	110	1,300	140,000	76,000 (2,915) ^{vap}
		6%	39	40	240	3,000	140,000	100,000 (6,392) ^{vap}
	1,1,2,2-Tetrachloroethanes (PCA)	1%	1.6	3.9	0.41	270	1,400	1,800
		2.5%	3.4	8.0	0.89	550	1,400	2,100
		6%	7.5	17	2.0	1,100	1,400	2,300
	1,1,1,2-Tetrachloroethanes (PCA)	1%	1.2	1.5	0.79	110	1,400	1,500
		2.5%	2.8	3.5	1.9	250	1,400	1,800
		6%	6.4	8.2	4.4	560	1,400	2,100
	Tetrachloroethene (PCE)	1%	0.18	0.18	0.65	19	1,400	810 (424) ^{sol}
		2.5%	0.39	0.40	1.5	42	1,400	1,100 (951) ^{sol}
		6%	0.90	0.92	3.6	95	1,400	1,500
	Tetrachloromethane (carbon tetrachloride)	1%	2.6E-02	2.6E-02	0.45	2.9	890	190
		2.5%	5.6E-02	5.6E-02	1.0	6.3	920	270
		6%	0.13	0.13	2.4	14	950	400
	Trichloroethene (TCE)	1%	1.6E-02	1.7E-02	4.1E-02	1.2	120	70
		2.5%	3.4E-02	3.6E-02	9.1E-02	2.6	120	91
		6%	7.5E-02	8.0E-02	0.21	5.7	120	120
	Trichloromethane (chloroform)	1%	0.91	1.2	0.42	99	2,500	2,600
		2.5%	1.7	2.1	0.83	170	2,500	2,800
		6%	3.4	4.2	1.7	350	2,500	3,100
	Chloroethene (vinyl chloride)	1%	6.4E-04	7.7E-04	5.5E-04	5.9E-02	3.5	4.8
		2.5%	8.7E-04	1.0E-03	1.0E-03	7.7E-02	3.5	5.0
		6%	1.4E-03	1.5E-03	1.8E-03	0.12	3.5	5.4
	2,4,6-Trinitrotoluene (TNT)	1%	1.6	65	0.24	1,000	130	260
		2.5%	3.7	66	0.58	1,000	130	270
		6%	8.1	66	1.4	1,000	130	270
	RDX	1%	120	13,000	17	210,000	26,000	49,000 (18.7) ^{sol}
		2.5%	250	13,000	38	210,000	26,000	51,000
		6%	540	13,000	85	210,000	27,000	53,000
	HMX	1%	5.7	6,700	0.86	110,000	13,000	23,000 (0.35) ^{vap}
		2.5%	13	6,700	1.9	110,000	13,000	23,000 (0.39) ^{vap}
		6%	26	6,700	3.9	110,000	13,000	24,000 (0.48) ^{vap}
Pesticides	Aldrin	1%	5.7	7.3	3.2	170	18	30
		2.5%	6.6	7.4	6.1	170	18	31
		6%	7.1	7.5	9.8	170	18	31
	Dieldrin	1%	0.97	7.0	0.17	170	18	30
		2.5%	2.0	7.3	0.41	170	18	30
		6%	3.5	7.4	0.96	170	18	31
	Atrazine	1%	3.3	610	0.5	9,300	1,200	2,300
		2.5%	7.8	620	1.2	9,400	1,200	2,400
		6%	17.4	620	2.7	9,400	1,200	2,400
	Dichlorvos	1%	3.2E-02	6.4	4.9E-03	140	16	26
		2.5%	6.6E-02	6.5	1.0E-02	140	16	26
		6%	0.14	6.6	2.2E-02	140	16	27
	Endosulfans (2 isomers)	1%	7.4	160 (3.0E-03) ^{vap}	1.2	5,600 (3.0E-03) ^{vap}	1,200	2,300
		2.5%	18	280 (7.0E-03) ^{vap}	2.9	7,400 (7.0E-03) ^{vap}	1,200	2,400
		6%	41	410 (1.6E-02) ^{vap}	6.8	8,400 (1.6E-02) ^{vap}	1,200	2,500
	Hexachlorocyclohexane (3 isomers), inc Lindane	1%	8.5E-02	3.7	1.3E-02	65	8.1	15
		2.5%	0.2	3.8	3.2E-02	65	8.1	15
		6%	0.46	3.8	7.7E-02	65	8.1	16

NOTES

^{sol} / ^{vap} = solubility / vapour limit (potentially use if free product identified, although highly conservative).

All GAC are based on
sandy loam soils with a pH
7.

All GAC are based on sandy loam soils with a pH 7.			LQM Generic Assessment Criteria (mg/kg) Dry weight soil					
Contaminant		SOM	Res +	Res -	Allot.	Comm.	POS _{resi}	POS _{park}
Chlorobenzenes	Chlorobenzene	1%	0.46	0.46	5.9	56	11,000	1,300 (675) ^{sol}
		2.5%	1.0	1.0	14	130	13,000	2,000 (1,520) ^{sol}
		6%	2.4	2.4	32	290	14,000	2,900
	Dichlorobenzenes (3 isomers)	1%	23	24	94	2,000 (571) ^{sol}	90,000	24,000 (571) ^{sol}
		2.5%	55	57	230	4,800 (1,370) ^{sol}	95,000	36,000 (1,370) ^{sol}
		6%	130	130	540	11,000 (3,240) ^{sol}	98,000	51,000 (3,270) ^{sol}
	Trichlorobenzenes (3 isomers)	1%	2.6	2.6	55	220	15,000	1,700 (318) ^{vap}
		2.5%	6.4	6.4	140	530	17,000	2,600 (786) ^{vap}
		6%	15	15	320	1,300	19,000	4,000 (1,880) ^{vap}
	Tetrachlorobenzenes (3 isomers)	1%	0.66	0.75	0.38	49 (39.4) ^{vap}	78	110 (39) ^{vap}
		2.5%	1.6	1.9	0.90	120 (98.1) ^{vap}	79	120
		6%	3.7	4.3	2.2	240 (235) ^{vap}	79	130
	Pentachlorobenzene	1%	5.8	19	1.2	640 (43.0) ^{sol}	100	190
		2.5%	12	30	3.1	770 (107) ^{sol}	100	190
		6%	22	38	7.0	830	100	190
	Hexachlorobenzene	1%	1.8 (0.20) ^{vap}	4.1 (0.20) ^{vap}	0.47	110 (0.20) ^{vap}	16	30
		2.5%	3.3 (0.50) ^{vap}	5.7 (0.50) ^{vap}	1.1	120	16	30
		6%	4.9	6.7 (1.2) ^{vap}	2.5	120	16	30
Chlorophenol	Chlorophenols (4 congeners)	1%	0.87 ^g	94	0.13 ^g	3,500	620	1,100
		2.5%	2.0	150	0.30	4,000	620	1,100
		6%	4.5	210	0.70	4,300	620	1,100
	Pentachlorophenol	1%	0.22	27 (16.4) ^{vap}	3.0E-02	400	60	110
		2.5%	0.52	29	8.0E-02	400	60	120
		6%	1.2	31	0.19	400	60	120
Others	Carbon Disulphide	1%	0.14	0.14	4.8	11	11,000	1,300
		2.5%	0.29	0.29	10	22	11,000	1,900
		6%	0.62	0.62	23	47	11,000	2,700
	Hexachlorobutadiene	1%	0.29	0.32	0.25	31	25	48
		2.5%	0.7	0.78	0.61	66	25	50
		6%	1.6	1.8	1.4	120	25	51
	Phenol	1%	280	750	66	760 ^{dir} (31,000)	760 ^{dir} (11,000)	760 ^{dir} (8,600)
		2.5%	550	1,300	140	1,500 ^{dir} (35,000)	1,500 ^{dir} (11,000)	1,500 ^{dir} (9,700)
		6%	1,100	2,300	280	3,200 ^{dir} (37,000)	3,200 ^{dir} (11,000)	3,200 ^{dir} (11,000)

NOTES

^{sol / vap} = solubility / vapour limit (potentially use if free product identified, although highly conservative).

^{dir} = S4uls based on threshold protective of direct skin contact with phenol (brackets long term exposure for illustration purposes).

^g = derived based on 2,3,4,6-tetrachlorophenol.

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