

Phase 2 Ground Investigation – Rotary Drilling

**LAND WEST OF CLARE HILL
HUDDERSFIELD, HD1 5BU**

for

Kirklees Metropolitan District Council

Report Number 3620

April 2016

Michael D Joyce Associates LLP
Geotechnical and Geoenvironmental Consultants



Phase 2 Ground Investigation – Rotary Drilling

**LAND WEST OF CLARE HILL
HUDDERSFIELD, HD1 5BU**

for

Kirklees Metropolitan District Council

Report Number 3620

April 2016



Michael D Joyce Associates LLP

Geotechnical and Geoenvironmental Consultants

Charnock Court 6 South Parade Wakefield West Yorkshire WF1 1LR UK
T +44(0)1924 360458 **E** mdja@geoenvironmental.co.uk **W** www.geoenvironmental.co.uk

Phase 2 Ground Investigation – Rotary Drilling

Land West of Clare Hill, Huddersfield, HD1 5BU

Contents

- 1.** Introduction
- 2.** Existing Information
- 3.** Geology and Mining
- 4.** The Investigation
- 5.** Strata Profile
- 6.** Recommendations
Procedure Notes

Figures

- Figure 1 Site Plan with Exploratory Borehole Positions

Appendices

- Appendix 1 Rotary Borehole Records
Appendix 2 Site Photographs
Standard Appendices A and B

1 INTRODUCTION

- 1.1 At the request of AHR Global Limited, a Phase I Geoenvironmental and Geotechnical Assessment (Desk Study) has previously been carried out of land to the west of Clare Hill in Huddersfield by SGM Structural Design. It is proposed to redevelop the site with a new primary school, although at present there are no firm development proposals.
- 1.2 The purpose of the desk study was to review and assess published information on the site including geological, mining and hydrogeological data. It was also to review the past history of the site and its environmental setting.
- 1.3 Subsequently, a preliminary ground investigation has been carried out on behalf of Kirklees Metropolitan District Council. At this stage, this has comprised rotary drilling only. This report presents the findings of this investigation and makes recommendations in respect of the impact of coal mining below the site. It should be read in conjunction with the original desk study report.
- 1.4 The study has not included checks on services on or adjacent to the site, and no structural or asbestos surveys have been carried out.

2 EXISTING INFORMATION

- 2.1 The site comprises playing fields located approximately ½ km north of the centre of Huddersfield. The Ordnance Survey grid reference is SE 140 174. Figure 1 shows the site and its general location.
- 2.2 The following is an Executive Summary for the site as compiled by SGM Structural Design. The desk study information has not been independently verified by Michael D Joyce Associates LLP, and is assumed to be correct.

Site Characteristics

1. *The site currently comprises a playing field and allotment gardens to the north and south of the site. A pond is located within the allotment gardens.*
2. *The site has been largely left undeveloped save for 5 No. buildings erected circa 1933 and demolished circa 1956, and allotments to eastern and southern quarters. A building labelled as 'Club' was erected circa 1971 and remains.*
3. *The surrounding area is mainly residential with further allotments, Huddersfield Lawn Tennis Club and Highfields Community Centre.*
4. *The site has a negligible to very low potential for ground stability problems.*
5. *The Geological data for the site comprises Head, Pennine Lower Coal Measures and Middle Band Rock, varying across the site.*
6. *The Enviro-Check report states that the site is not in a radon affected area. Protection measures would not be necessary in the construction of new buildings.*
7. *It is anticipated that shallow strip or spread foundations could have been utilised, however, should voids be found in coal seams, deeper pile foundations or a remedial program of grout cannot be ruled out with further intrusive investigation.*
8. *If Made Ground is present, contamination/WAC testing will be required to establish the nature of the underlying soil. It is anticipated that the naturally occurring soils would not be significantly contaminated however.*

9. *No waste management sites are present within 250m of the site. The GroundSure report indicates that three areas of infilled ground are present on the site. On the basis of this, it is deemed only necessary to conduct gas monitoring if significant Made Ground is revealed during intrusive investigation works.*
10. *There is one groundwater / potable water abstraction license 254m to the North East for bottling water.*
11. *There is one river network entry 184m North West of the site, described as a River Culvert.*
12. *The site is at very low risk of flooding from Rivers.*
13. *The site is within 50m of a British Survey groundwater flooding susceptibility area.*
14. *The site is not within a source protection zone.*
15. *There have been no pollution incidents to controlled water within 250m of the site or licensed discharge.*
16. *Potential contaminative sources to the site include:-*
 - *Made Ground found from historical construction*
 - *2 No. Infilled ponds*
 - *Electricity sub-station*
 - *Railway Line*
 - *Unspecified Works / Depot*
 - *Cemetery*

These sources are all present within 250m of the site or are now (or have been previously present) on site. The primary source of potential contamination is thought to be infilled ground.

Mining

1. *The site is in an area which may be affected by Coal Mining.*
2. *The site is not within the zone likely physical influence from past or present underground workings. However, the property is in an area where the Coal Authority believes there is coal at or close to the surface. Records indicate that a seam marked 'Soft Bed (Coking) Coal' is in the vicinity of the site at an approximate depth of 20m to 40m.*
3. *The site is not within an area under consideration to grant a license to remove coal from. However, reserves of coal do exist in the local area beneath the site.*
4. *There are no known mine entries within 20m of the site boundary.*

-
5. *There is no evidence of damage arising due to geological faults or weaknesses created by coal mining.*
 6. *The site is not within the boundary of a historical or present opencast coal mine, nor is the site under consideration for future opencast coal mining.*
 7. *The last damage notice or claim for the subject site or any property within 50m was in 1991.*
 8. *There is no record of mine gas emission requiring action by the Coal Authority.*
 9. *Existing borehole records from a site immediately adjacent revealed a coal seam at a depth of approximately 18m with a thickness of 0.3m. Broken ground and voids were encountered in some of the boreholes at depths of approximately 16m to 18m with a maximum height of extraction recorded as 1.5m.*
 10. *The risk of instability from 'Soft Bed Coal' was characterised as 'Moderate'.*
 11. *NHBC and CIRIA publications both suggest that an overburden thickness of 10 times the seam thickness plus the seam thickness is sufficient to mitigate the risk of damage to surface structures from collapse of mine workings. 'Soft Bed Coal' is estimated to have a maximum thickness of 1.2m, thus 13.2m would be necessary.*

3 GEOLOGY AND MINING

3.1 Geology

3.1.1 Maps of the British Geological Survey (Sheets 77 and 246SE) show this area to be underlain by the basal zone of the Carboniferous Lower Coal Measures, which have a shallow dip to the northeast.

3.1.2 The site is shown to be underlain by the Middle Band Rock Sandstone and in turn by mudstone bedrock above the Soft Bed Coal. There are no drift deposits overlying the bedrock in this area.

3.1.3 Although geological faulting has taken place in this area, there are no faults shown crossing, or in the immediate vicinity of this site.

3.2 Mining

3.2.1 The Soft Bed Coal outcrops to the rear of the factories along the western side of St. John's Road, and follows the contours of the hillside around the northern side of this site. It is around 12" to 24" (300mm to 610mm) thick in this area and has been extensively worked at its outcrop. It is underlain by about 2' (1.22m) of fireclay which has also been worked in places for refractory purposes.

3.2.2 The Coal Authority has no records of these workings, as they took place prior to 1850. It is unlikely that a detailed survey was carried out, as it was not a requirement at that time.

3.2.3 The Soft Bed Coal is the lowest workable coal seam in the Coal Measures. No other mining will therefore have taken place beneath this site.

3.2.4 The area is now on the abandoned coalfield and is unlikely therefore to be affected by any future underground mining activity.

4 THE INVESTIGATION

- 4.1 The rotary drilling investigation was designed to ascertain whether there are any shallow coal workings underlying the site which could affect surface stability. It was also to provide preliminary information on ground conditions on the site. The investigation was undertaken in accordance with the principles of BS EN 1997-1: 2004 “Eurocode 7 - Geotechnical Design - Part 1: General Rules”, BS EN 1997-2: 2007 “Eurocode 7 - Geotechnical Design - Part 2: Ground Investigation and Testing”, BS5930: 1999 and BS10175: 2001 and under the supervision of a Chartered Engineer from Michael D Joyce Associates LLP.
- 4.2 The ground investigation was carried out between 14th and 26th April 2016 and comprised rotary open-hole drilling. The exploratory borehole positions are shown on figure 1.
- 4.3 Prior to drilling, each exploratory location was checked for underground services and an inspection pit was hand-dug to 1.2m.
- 4.4 The rotary drilling was carried out using a Beretta T250 rig and using a water flush technique. The openhole technique meant that logging was carried out by inspecting the arisings that were brought to the surface in the water flush.
- 4.5 On completion the boreholes were backfilled with arisings and bentonite. The inspection pits were infilled and the turf replaced at the surface.

5 STRATA PROFILE

- 5.1 The full exploratory borehole records are presented in Appendix 1. These give full strata descriptions based on visual examination and are in accordance with the requirements of BS EN ISO 14688-1:2002 “Geotechnical Investigation and Testing - Identification and Classification of Soil - Part 1”, BS EN ISO 14688-2:2004 “Geotechnical Investigation and Testing - Identification and Classification of Soil - Part 2”, and BS EN ISO 14689-1:2003 “Geotechnical Investigation and Testing - Identification and Classification of Rock - Part 1”.
- 5.2 The investigation encountered between 200mm and 300mm of grassed topsoil overlying orange-brown silty sandy clay containing sandstone gravel. This clay represented weathered sandstone bedrock and extended to between 1.7m and 2.1m depth.
- 5.3 The underlying sandstone was fine and medium grained rock and this extended to between 4.5m and 6.2m below existing ground level. This will be the Middle Band Rock Sandstone, as shown on the geological maps as capping the site.
- 5.4 This sandstone is in turn underlain by a grey and dark grey mudstone. An intact coal was encountered in borehole R6 between 20.9m and 21.3m depth, with a continuation of the overlying mudstone to 30m, at which point the borehole was terminated.
- 5.5 The remainder of the boreholes encountered a void and/or broken ground, which was proven to a maximum thickness of 1.3m. This suggests that only the coal has been extracted, but extensively so across the site.

- 5.6 Where a void or broken ground was encountered in the borehole, there was a total loss of water flush and as a result the boreholes could not continue once solid ground was proved.
- 5.7 It should be noted that lateral and vertical changes can occur between exploratory points and care is needed when extrapolation is used. This is particularly true of the Made Ground which, by its nature, can be very variable in its physical and chemical composition.

6 RECOMMENDATIONS

- 6.1 The rotary openhole drilling found no workings at a depth that could affect surface stability. The workings encountered are at depth and overlain by a considerable thickness of clays and mudstones. The gas monitoring at the time, and subsequently in the standpipes, has found no evidence of any mine gases. In respect of subsidence, the workings are sufficiently deep that they will not affect surface stability.
- 6.2 Where encountered the coal seam comprised 400mm of good quality coal, although it is known to be up to 600mm in the area.
- 6.3 The void and broken ground thickness reached a maximum of 1.3m suggesting that the underlying fireclay was not worked.
- 6.4 It is normal practice that the rock cover should exceed the extracted seam thickness by a ratio of 10 to 1. With a maximum seam thickness of 0.6m there is more than adequate rock cover across the whole of the site. As such no special precautions are necessary in respect of mineworkings, although lightly reinforcing any strip foundations would be prudent.

A D Joyce

BSc MSc ARSM CEng CGeol CEnv MICE FGS SiLC

April 2016

This report is subject to the provisions of the Copyright Acts and is for the sole benefit of Sheffield City Council in respect of a preliminary assessment of geotechnical and contamination conditions on the site. It does not purport to provide specialist legal advice in respect of environmental issues. The report cannot be assigned to, or relied on, by any other party without prior permission.

Procedure Notes

The desk study and ground investigation have been carried out in accordance with the principles of BS EN 1997-1: 2004 “Eurocode 7 - Geotechnical Design - Part 1: General Rules”, BS EN 1997-2: 2007 “Eurocode 7 - Geotechnical Design - Part 2: Ground Investigation and Testing”, BS5930: 1999 and BS10175: 2001, and the terms of the client’s brief. By its very nature any ground investigation only samples a small percentage of the ground. Consequently changes in ground conditions and soil properties can occur between any two exploratory points, for example local features such as soft ground, pockets of contamination and faults. This is also true of the exploration of mineworkings and such features can extend beneath parts of the site not investigated. Unrecorded bell pits and shafts can also exist between exploratory points. The ground investigation is designed to minimize such risks. Conclusions and recommendations are based on the information presented in this report, but unforeseen features may exist. Therefore, actual ground conditions should be noted during construction and further advice sought if they differ significantly from those predicted.

Further investigation can be carried out to further reduce uncertainty and risk but ultimately these risks cannot be eliminated. Similarly a desk study normally only considers readily available information and further information could be held by other sources. In commissioning further research or investigation the cost/benefit of doing so must be considered.

Where buildings are present on a site, structural and asbestos surveys have not been carried out, unless specifically stated. An unexploded ordnance survey has not been carried out. In relevant situations it would be prudent to commission such surveys.

Where information has been obtained from Third Parties, no liability can be accepted for the accuracy or completeness of this information. Where anecdotal evidence or speculations are presented, they must be treated as such and cannot be relied upon.

APPENDIX 1

Rotary Borehole Records

Site: Clare Hill [3620]

Location: Huddersfield

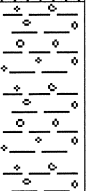
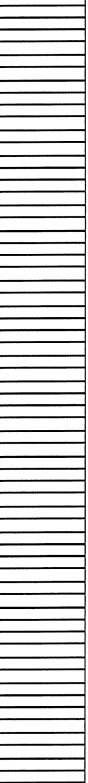
Method: Rotary Openhole Drilling

Date: 20th April 2016

Client: Kirklees MDC

Borehole No: R1

Michael D Joyce Associates LLP

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI (%)	Field Records	Reduced Level (mAOD)	Depth (m)	Description	Legend
						0	0	Ground level.	
						-0.2		[Inspection pit hand-dug to 1.2m] Grassed TOPSOIL.	
								Orange-brown silty sandy CLAY with sandstone gravel.	
						-1.7			
								Brown fine and medium grained weathered SANDSTONE.	
						-4.5			
								Grey and dark grey weathered MUDSTONE.	
							5		
							6		
							7		
							8		
							9		
							10		

Equipment: Berreta 250 rig

Flush: Water

Groundwater: Water flush

Returns: G/L not known due to water-flush

Remarks: Backfilled with bentonite

Site: Clare Hill [3620]

Location: Huddersfield

Method: Rotary Openhole Drilling

Date: 20th April 2016

Client: Kirklees MDC

Borehole No: R1

Michael D Joyce Associates LLP

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI (%)	Field Records	Reduced Level (mAOD)	Depth (m)	Description	Legend
							11	Grey and dark grey weathered MUDSTONE.	
							12		
							13		
							14		
							15		
							16		
						-17	17	VOID with some backfill and /or broken ground. Solid ground at 18.3m and no returns.	
						-18.3	18		
							19	End of Borehole	
							20		
							21		

Equipment: Berreta 250 rig

Flush: Water

Groundwater: Water flush

Returns: G/L not known due to water-flush

Remarks: Backfilled with bentonite

Site: Clare Hill [3620]

Location: Huddersfield

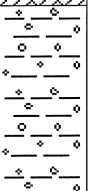
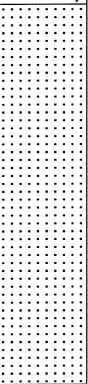
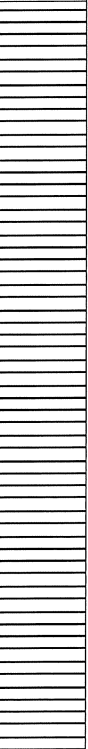
Method: Rotary Openhole Drilling

Date: 18th April 2016

Client: Kirklees MDC

Borehole No: R2

Michael D Joyce Associates LLP

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI (%)	Field Records	Reduced Level (mAOD)	Depth (m)	Description	Legend
						0	0	Ground level.	
						-0.3		[Inspection pit hand-dug to 1.2m] Grassed TOPSOIL.	
								Orange-brown silty sandy CLAY with sandstone gravel.	
						-1.8			
								Brown fine and medium grained weathered SANDSTONE.	
						-4.8	5	Grey and dark grey weathered MUDSTONE.	
							6		
							7		
							8		
							9		
							10		

Equipment: Berreta 250 rig

Flush: Water

Groundwater: Water flush

Returns: G/L not known due to water-flush

Remarks: Backfilled with bentonite

Site: Clare Hill [3620]

Location: Huddersfield

Method: Rotary Openhole Drilling

Date: 18th April 2016

Client: Kirklees MDC

Borehole No: R2

Michael D Joyce Associates LLP

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI (%)	Field Records	Reduced Level (mAOD)	Depth (m)	Description	Legend
							11	Grey and dark grey weathered MUDSTONE.	
							12		
							13		
							14		
							15		
							16		
							17		
						-17.6			
							18		
						-18.5			
							19	VOID with some backfill and /or broken ground. Solid ground at 18.5m and no returns.	
							20		
							21		
								End of Borehole	

Equipment: Berreta 250 rig

Flush: Water

Groundwater: Water flush

Returns: G/L not known due to water-flush

Remarks: Backfilled with bentonite

Site: Clare Hill [3620]

Location: Huddersfield

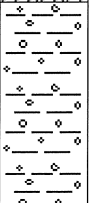
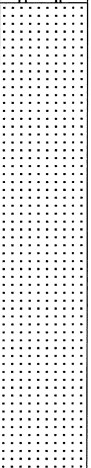
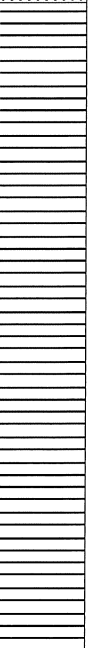
Method: Rotary Openhole Drilling

Date: 21st April 2016

Client: Kirklees MDC

Borehole No: R3

Michael D Joyce Associates LLP

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI (%)	Field Records	Reduced Level (mAOD)	Depth (m)	Description	Legend
						0	0	Ground level.	
						-0.3		[Inspection pit hand-dug to 1.2m] Grassed TOPSOIL.	
							1	Orange-brown silty sandy CLAY with sandstone gravel.	
						-1.9	2	Brown fine and medium grained weathered SANDSTONE.	
							3		
							4		
							5		
						-5.6	6	Grey and dark grey weathered MUDSTONE.	
							7		
							8		
							9		
							10		

Equipment: Berreta 250 rig

Flush: Water

Groundwater: Water flush

Returns: G/L not known due to water-flush

Remarks: Backfilled with bentonite

Site: Clare Hill [3620]

Location: Huddersfield

Method: Rotary Openhole Drilling

Date: 21st April 2016

Client: Kirklees MDC

Borehole No: R3

Michael D Joyce Associates LLP

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI (%)	Field Records	Reduced Level (mAOD)	Depth (m)	Description	Legend
							11	Grey and dark grey weathered MUDSTONE.	
							12		
							13		
							14		
							15		
							16		
							17		
							18		
						-18.5			
							19	VOID with some backfill and /or broken ground. Solid ground at 19.2m and no returns.	
						-19.2			
							20	End of Borehole	
							21		

Equipment: Berreta 250 rig

Flush: Water

Groundwater: Water flush

Returns: G/L not known due to water-flush

Remarks: Backfilled with bentonite

Site: Clare Hill [3620]

Location: Huddersfield

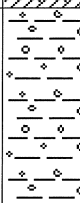
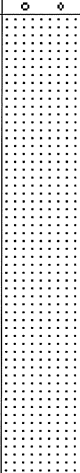
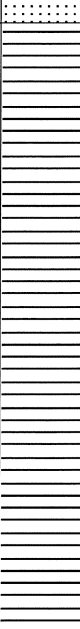
Method: Rotary Openhole Drilling

Date: 18th April 2016

Client: Kirklees MDC

Borehole No: R4

Michael D Joyce Associates LLP

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI (%)	Field Records	Reduced Level (mAOD)	Depth (m)	Description	Legend
						0	0	Ground level.	
						-0.35		[Inspection pit hand-dug to 1.2m] Grassed TOPSOIL.	
							1	Orange-brown silty sandy CLAY with sandstone gravel.	
						-2	2	Brown fine and medium grained weathered SANDSTONE.	
							3		
							4		
							5		
						-5.8	6	Grey and dark grey weathered MUDSTONE.	
							7		
							8		
							9		
							10		

Equipment: Berreta 250 rig

Flush: Water

Groundwater: Water flush

Returns: G/L not known due to water-flush

Remarks: Backfilled with bentonite

Site: Clare Hill [3620]

Location: Huddersfield

Method: Rotary Openhole Drilling

Date: 18th April 2016

Client: Kirklees MDC

Borehole No: R4

Michael D Joyce Associates LLP

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI (%)	Field Records	Reduced Level (mAOD)	Depth (m)	Description	Legend
							11	Grey and dark grey weathered MUDSTONE.	
							12		
							13		
							14		
							15		
							16		
							17		
							18		
						-19.1	19		
						-19.6		VOID with some backfill and /or broken ground. Solid ground at 19.6m and no returns.	
							20	End of Borehole	
							21		

Equipment: Berreta 250 rig

Flush: Water

Groundwater: Water flush

Returns: G/L not known due to water-flush

Remarks: Backfilled with bentonite

Michael D Joyce Associates LLP

Remarks: Backfilled with bentonite

Site: Clare Hill [3620]

Location: Huddersfield

Method: Rotary Openhole Drilling

Date: 25th April 2016

Client: Kirklees MDC

Borehole No: R5

Michael D Joyce Associates LLP

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI (%)	Field Records	Reduced Level (mAOD)	Depth (m)	Description	Legend
							11	Grey and dark grey weathered MUDSTONE.	
						-17.8	18	VOID with some backfill and /or broken ground. Solid ground at 18.8m and no returns.	
						-18.8	19	End of Borehole	
							20		
							21		

Equipment: Berreta 250 rig

Flush: Water

Groundwater: Water flush

Returns: G/L not known due to water-flush

Remarks: Backfilled with bentonite

Site: Clare Hill [3620]

Location: Huddersfield

Method: Rotary Openhole Drilling

Date: 15th April 2016

Client: Kirklees MDC

Borehole No: R6

Michael D Joyce Associates LLP

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI (%)	Field Records	Reduced Level (mAOD)	Depth (m)	Description	Legend
							11	Grey and dark grey weathered MUDSTONE.	
							12		
							13		
							14		
							15		
							16		
							17		
							18		
							19		
							20		
						-20.9	21	Intact black COAL.	
						-21.3			

Equipment: Berreta 250 rig

Flush: Water

Groundwater: Water flush

Returns: G/L not known due to water-flush

Remarks: Backfilled with bentonite

Site: Clare Hill [3620]
Location: Huddersfield
Method: Rotary Openhole Drilling
Date: 15th April 2016
Client: Kirklees MDC

Borehole No: R6

Michael D Joyce Associates LLP

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI (%)	Field Records	Reduced Level (mAOD)	Depth (m)	Description	Legend
								Grey and dark grey weathered MUDSTONE.	
							22		
							23		
							24		
							25		
							26		
							27		
							28		
							29		
						-30	30	End of Borehole	
							31		

Equipment: Berreta 250 rig
Flush: Water
Groundwater: Water flush
Returns: G/L not known due to water-flush
Remarks: Backfilled with bentonite

Client: Kirklees MDC

Michael D Joyce Associates LLP

Remarks: Backfilled with bentonite

Site: Clare Hill [3620]

Location: Huddersfield

Method: Rotary Openhole Drilling

Date: 26th April 2016

Client: Kirklees MDC

Borehole No: R7

Michael D Joyce Associates LLP

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI (%)	Field Records	Reduced Level (mAOD)	Depth (m)	Description	Legend
							11	Grey and dark grey weathered MUDSTONE.	
							12		
							13		
							14		
							15		
							16		
							17		
						-17.6			
							18	VOID with some backfill and /or broken ground. Solid ground at 18.4m and no returns.	
						-18.4			
							19	End of Borehole	
							20		
							21		

Equipment: Berreta 250 rig

Flush: Water

Groundwater: Water flush

Returns: G/L not known due to water-flush

Remarks: Backfilled with bentonite

Site: Clare Hill [3620]
Location: Huddersfield
Method: Rotary Openhole Drilling
Date: 22nd April 2016
Client: Kirklees MDC

Borehole No: R8

Michael D Joyce Associates LLP

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI (%)	Field Records	Reduced Level (mAOD)	Depth (m)	Description	Legend
						0	0	Ground level.	
						-0.2		[Inspection pit hand-dug to 1.2m] Grassed TOPSOIL.	
							1	Orange-brown silty sandy CLAY with sandstone gravel.	
						-1.8	2	Brown fine and medium grained weathered SANDSTONE.	
							3		
							4		
						-4.5	5	Grey and dark grey weathered MUDSTONE.	
							6		
							7		
							8		
							9		
							10		

Equipment: Berreta 250 rig
Flush: Water
Groundwater: Water flush
Returns: G/L not known due to water-flush
Remarks: Backfilled with bentonite

Site: Clare Hill [3620]

Location: Huddersfield

Method: Rotary Openhole Drilling

Date: 22nd April 2016

Client: Kirklees MDC

Borehole No: R8

Michael D Joyce Associates LLP

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI (%)	Field Records	Reduced Level (mAOD)	Depth (m)	Description	Legend
							11	Grey and dark grey weathered MUDSTONE.	
							12		
							13		
							14		
							15		
							16		
							17		
						-18.2	18		
						-19	19	VOID with some backfill and /or broken ground. Solid ground at 19m and no returns.	
							20	End of Borehole	
							21		

Equipment: Berreta 250 rig

Flush: Water

Groundwater: Water flush

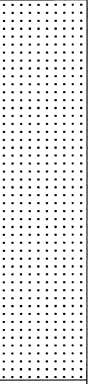
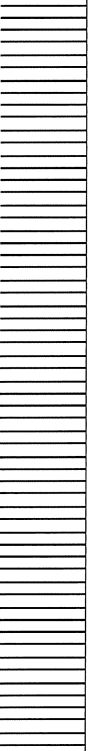
Returns: G/L not known due to water-flush

Remarks: Backfilled with bentonite

Site: Clare Hill [3620]
Location: Huddersfield
Method: Rotary Openhole Drilling
Date: 14th April 2016
Client: Kirklees MDC

Borehole No: R9

Michael D Joyce Associates LLP

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI (%)	Field Records	Reduced Level (mAOD)	Depth (m)	Description	Legend
						0	0	Ground level.	
						-0.3		[Inspection pit hand-dug to 1.2m] Grassed TOPSOIL.	
								Orange-brown silty sandy CLAY with sandstone gravel.	
						-1.8			
								Brown fine and medium grained weathered SANDSTONE.	
						-4.8	5	Grey and dark grey weathered MUDSTONE.	
							6		
							7		
							8		
							9		
							10		

Equipment: Berreta 250 rig
Flush: Water
Groundwater: Water flush
Returns: G/L not known due to water-flush
Remarks: Backfilled with bentonite

Site: Clare Hill [3620]
Location: Huddersfield
Method: Rotary Openhole Drilling
Date: 14th April 2016
Client: Kirklees MDC

Borehole No: R9
Michael D Joyce Associates LLP

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI (%)	Field Records	Reduced Level (mAOD)	Depth (m)	Description	Legend
							11	Grey and dark grey weathered MUDSTONE.	
							12		
							13		
							14		
							15		
							16		
							17		
						-17.5			
								VOID with some backfill and /or broken ground. Solid ground at 18.2m and no returns.	
						-18.2	18		
								End of Borehole	
							19		
							20		
							21		

Equipment: Berreta 250 rig
Flush: Water
Groundwater: Water flush
Returns: G/L not known due to water-flush
Remarks: Backfilled with bentonite

APPENDIX 2

Site Photographs



Photo A: View of southern part of the site.



Photo B: View of playing fields looking to the northwest.



Photo C: View of playing fields looking to the east.



Photo D: View of playing fields looking to the southeast with Clare Road beyond.



Photo E: Entrance from Clare Hill.

Standard Appendices

A and B

NOTES ON SITE INVESTIGATION PROCEDURE

1. **GENERAL.** The ground investigation has been carried out in accordance with the requirements of Eurocode 7, in particular BS EN 1997-2: 2007 Eurocode 7 – Geotechnical Design, Part 1 and BS EN 1997:2004 Eurocode 7 – Geotechnical Design, Part 2. It is also in accordance with British Standards BS EN ISO 14688-1 and 2 “Geotechnical Investigation and testing – Identification and Classification of Soil” Parts 1 and 2 and BS EN ISO 14689-1 “Geotechnical Investigation and Testing – Identification and Classification of Rock”. BS 5930 the Code of Practice for Site Investigation is partly superseded. This appendix briefly describes the nature of the work carried out. It also gives a brief description of the more important tests, which are made for engineering purposes on rocks and soils (see also BS 1377). By its very nature, any ground investigation only samples a small percentage of the ground. Consequently, changes in ground conditions and soil properties can occur between any two exploratory points, for example local features such as soft ground, pockets of contamination and faults. This is also true of the exploration of mineworkings and such features can extend beneath parts of the site not investigated. Unrecorded bell pits and shafts can also exist between exploratory points. The ground investigation is designed to minimise such risks but they cannot be eliminated.
2. **GROUND INVESTIGATION.**
 - 2.1 **BOREHOLE AND TRIAL PIT RECORDS.** These illustrate the ground conditions only at the location of the particular borehole or trial pit. Correlation between boreholes is for guidance only and its accuracy cannot be guaranteed.
 - 2.2 **SHELL AND AUGER BORING.** This technique uses a tripod winch and an essentially percussive action using a variety of tools. Disturbed and undisturbed samples can be taken. This is the most suitable method for soft ground investigation, enabling the maximum amount of information to be obtained. However, minor changes in lithology may be overlooked unless continuous undisturbed sampling is used.
 - 2.3 **GROUNDWATER.** Groundwater levels vary seasonally and the details given on the borehole logs relate only to the dates and the conditions described in the borehole records. The rate of boring may not have allowed an equilibrium water level to be established and the use of casing may seal off certain seepages.
 - 2.4 **SAMPLING.** Disturbed samples of soils are taken for identification and classification purposes. In cohesive soils 'undisturbed' samples 100mm in diameter are taken by open drive sampler for laboratory testing of strength, permeability and consolidation characteristics.
 - 2.5 **STANDARD PENETRATION TESTS.** S.P.T tests are used in granular and cohesive materials and in soft or weathered rocks. Difficulties in obtaining true 'N' values mean they must only be used as a guide and not as an absolute value in foundation design.
 - 2.6 **ROTARY DRILLING.** Two main types of rotary drilling are carried out in rock. Rock coring using diamond or tungsten carbide tipped core bits provides samples and information on rock types, fissuring and weathering. Openhole drilling only produces small particles for identification purposes and the information gained is therefore limited. The latter is, however, useful as a quick method for detecting major strata changes and for the location of coal seams and old workings. Water, air, foam or drilling muds may be used as the flushing medium in either case.
 - 2.7 **PERMEABILITY TESTS.** These can be carried out in boreholes or trial pits and gives a good indication of in-situ permeability.
 - 2.8 **TRIAL PITTING.** This enables soil conditions to be closely examined at any specific point and samples taken. It also gives useful information on the stability of excavations and ingress of water.
 - 2.9 **WINDOW SAMPLING.** Window sampling consists of driving a series of 1m-long tubes into the ground using a dropping weight. On completion of each 1m run, the tube is withdrawn. The next tube is then inserted and the process repeated to provide a continuous profile of the ground. On each run the tube diameter is reduced in order to assist in its recovery.
 - 2.10 **GAS MONITORING.** This is routinely carried out in trial pits or probe holes to check for elevated levels of methane and carbon dioxide or oxygen deficiency, particularly since risks can exist from natural gases, landfill sites and rising groundwater levels in mine workings below ground. Longer term monitoring is carried out with gas monitoring standpipes.
3. **SOIL DESCRIPTION.** Samples from borings or trial pits are described as specified in the standard procedure outlined in the British Standards. The description includes colour, consistency, structure, weathering, lithological type, inclusions and origin. All descriptions are based on visual and manual identification.

Fire Soils (Cohesive Soils)

The following field terms are used:

Soil Type	Description
Very soft	Exudes between fingers
Soft	Moulded by light finger pressure
Firm	Cannot be moulded by the fingers but can be rolled in hand to 3mm threads.
Stiff	Crumbles and breaks when rolled to 3mm threads but can be remoulded to a lump.
Very stiff	No longer moulded but crumbles under pressure. Can be indented with thumbs.

The following terms are used in accordance with the results of laboratory and field tests.

Description	Undrained Shear Strength c_u (kPa)
Extremely Low	<10
Very Low	10 - 20
Low	20 - 40
Medium	40 - 75
High	75 - 150
Very High	150 - 300
Extremely High	>300

Fine soils can also be classified according to their sensitivity, which is the ratio between undisturbed and remoulded undrained shear strength.

Sensitivity	Ratio
Low	8
Medium	8 - 30
High	>30
Quick	>50

Granular Soils (Non-Cohesive)

The following descriptions are used for granular soils.

Description	Normalised Blow Count (N_1) 60
Very Loose	0 - 3
Loose	3 - 8
Medium	8 - 25
Dense	25 - 42
Very Dense	42 - 58

4. **NATURAL OR IN-SITU MOISTURE CONTENT.** The natural or in-situ moisture content of a soil is defined as the weight of water contained in the pore space, expressed as a percentage of the dry weight of solid matter present in the soil. Soil properties are greatly affected by the moisture content and the test can help to give an indication of likely engineering behaviour.

5. **LIQUID AND PLASTIC LIMITS.** Two simple classification tests are known as the liquid and plastic limits. If a cohesive soil is remoulded with increasing amounts of water, a point will be reached at which it ceases to behave as a plastic material and becomes essentially a viscous fluid. The moisture content corresponding to this change is arbitrarily determined by the liquid limit test. 'Fat' clays, which have high contents of colloidal particles, have high liquid limits; 'lean' clays, having low colloidal particle contents have correspondingly low liquid limits. An increase in the organic content of a clay is reflected by an increase in the liquid and plastic limits.

If a cohesive soil is allowed to dry progressively, a point is reached at which it ceases to behave as a plastic material, which can be moulded in the fingers, and it becomes friable. The moisture content of the soil at this point is known as the 'plastic limit' of the soil.

The range of water content over which a cohesive soil behaves plastically, i.e. the range lying between the liquid and plastic limits, is defined as the plasticity index.

A cohesive soil with a natural water content towards its liquid limit will, in general, be an extremely soft material whereas a cohesive soil with a natural water content below its plastic limit will tend to be a stiff material.

6. **PARTICLE-SIZE DISTRIBUTION.** A knowledge of particle-size distribution is used to classify soils and to indicate likely engineering behaviour. British Standards define soils in relation to their particle-size as shown below:-

Boulders	>200mm	Coarse Sand	2.0	to	0.63mm
Cobbles	200 to 63mm	Medium Sand	0.63	to	0.2mm
		Fine Sand	0.2	to	0.063mm
Coarse Gravel	63 to 20mm	Coarse Silt	0.063	to	0.02mm
Medium Gravel	20 to 6.3mm	Medium Silt	0.02	to	0.0063mm
Fine Gravel	6.3 to 2mm	Fine Silt	0.0063	to	0.002mm
		Clay	<0.002mm		

7. **BULK DENSITY.** The bulk density of a material is the weight of that material per unit volume and includes the effects of voids whether filled with air or water. The 'dry density' of a soil is defined as the weight of solids contained in a unit volume of the soil.

8. **PERMEABILITY.** The permeability of a material is defined as the rate at which water flows through it per unit area of soil under unit hydraulic gradient.
9. **CONSOLIDATION CHARACTERISTICS.** When subjected to pressure, a soil tends to consolidate as the air or water in the pore space is forced out and the grains assume a denser state of packing. The decrease in volume per unit of pressure is defined as the 'compressibility' of the soil, and a measure of the rate at which consolidation proceeds is given by the 'coefficient of consolidation' of the soil. These two characteristics M_v and C_v are determined in the consolidation test and the results are used to determine settlement of structures or earthworks.
10. **STRENGTH CHARACTERISTICS.** The strength of geological materials is generally expressed as the maximum resistance that they offer to deformation or fracture by applied shear or compressive stress. The strength characteristics of geological materials depend to an important degree on their previous history and on the conditions under which they will be stressed in practice. Consequently, it is necessary to simulate in the laboratory tests the conditions under which the material will be stressed in the field.

In general, the only test carried out on hard rocks is the determination of their compressive strength but consideration must be given to fissuring, jointing and bedding planes.

The tests at present in use for soils and soft rocks fall into two main categories. Firstly, those in which the material is stressed under conditions of no moisture content change, and secondly those in which full opportunity is permitted for moisture content changes under the applied stresses. Tests in the first category are known as undrained (immediate or quick) tests, while those in the second category are known as drained (slow or equilibrium) tests. The tests are normally carried out in the triaxial compression apparatus but granular materials may be tested in the shear box apparatus.

The undrained triaxial test gives the apparent cohesion C_u and the angle of shearing resistance ϕ_u . In dry sands, $C_u = 0$ and ϕ_u is equal to the angle of internal friction whereas with saturated non-fissured clays ϕ_u tends to 0 and the apparent cohesion C_u is equal to one-half the unconfined compression strength q_u . On site the vane test gives an approximate measure of shear strength.

For some stability problems use is made of a variant of the undrained triaxial test in which the specimen is allowed to consolidate fully under the hydrostatic pressure and is then tested to failure under conditions of no moisture content change. This is known as the consolidated undrained triaxial test. Pore water pressures may be measured during this test or a fully drained test may be carried out. In either case the effective shear strength parameters C' and ϕ' can be obtained which can be used to calculate shear strength at any given pore water pressure.

11. **COMPACTION.** The density at which any soil can be placed in an earth dam, embankment or road depends on its moisture content and on the amount of work which is used in compaction. The influence of these two factors can be studied in compaction tests, which can determine the maximum dry density (MDD) achievable at a certain optimum moisture content (OMC).
12. **CALIFORNIA BEARING RATIO TEST.** In flexible pavement design a knowledge of the bearing capacity of the subgrade is necessary to enable the thickness of pavement for any particular combination of traffic and site conditions to be determined. The quality of the subgrade can be assessed by means of the California Bearing Ratio Test or approximately by the MEXE cone penetrometer.
13. **ROCK DESCRIPTION.** This is based on;
 - i. Colour (minor then principal colour).
 - ii. Grain Size.

Description	Predominate Grain Size (mm)
Very Coarse - grained	>63
Coarse - grained	63 - 2
Medium - grained	2 - 0.063
Fine - grained	0.063 - 0.002
Very Fine - grained	<0.002

- iii. Matrix.
- iv. Weathering.

Term	Description
Fresh	No visible sign of weathering/alteration of the rock material.
Discoloured	The colour of the original fresh rock material is changed and is evidence of weathering/alteration. The degree of change from the original colour should be indicated. If the colour change is confined to particular mineral constituents, this should be mentioned.
Disintegrated	The rock material is broken up by physical weathering, so that bonding between grains is lost and the rock is weathered/alterd towards the condition of a soil in which the original material fabric is still intact. The rock material is friable but the grains are not decomposed.
Decomposed	The rock material is weathered by the chemical alteration of the mineral grains to the condition of a sol in which the original material fabric is still intact; some or all of the grains are decomposed.

- v. Carbonate Content.
- vi. Stability of Rock Material.

Stable indicates no changes when sample left in water for 24 hours. Fairly stable indicates fissuring and crumbling of surfaces. Unstable indicates complete disintegration of the sample.
- vii. Unconfined Compressive Strength.

Term	Field Identification	Unconfined Compressive Strength (MPa)
Extremely Weak ^a	Indented by thumbnail.	Less than 1
Very Weak	Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife.	1 to 5
Weak	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer.	5 to 25
Medium Strong	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer.	25 to 50
Strong	Specimen required more than one blow of geological hammer to fracture it.	50 to 100
Very Strong	Specimen requires many blows of geological hammer to fracture it.	100 to 250
Extremely Strong	Specimen can only be chipped with geological hammer.	Greater than 250
^a Some extremely weak rocks will behave as soils and should be described as soils.		

viii. Structure.

Sedimentary	Metamorphic	Igneous
Bedded	Cleaved	Massive
Interbedded	Foliated	Flowbanded
Laminated	Schistose	Folded
Folded	Banded	Lineated
Massive	Lineated	
Graded	Gneissose	
	Folded	

ix. Discontinuities.

x. Discontinuity Spacing, persistence and roughness, infilling and seepage.

xi. Weathering of the Rock Mass.

Term	Description	Grades
Fresh	No visible sign of rock material weathering; perhaps slight discolouration on major discontinuity surfaces.	0
Slightly weathered	Discolouration indicates weathering of rock material and discontinuity surfaces.	1
Moderately weathered	Less than half of the rock material is decomposed or disintegrated. Fresh or discoloured rock is present either as a continuous framework or as core stones.	2
Highly weathered	More than half of the rock material is decomposed or disintegrated. Fresh or discoloured rock is present either as a continuous framework or as core stones.	3
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.	4
Residual soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soils has not been significantly transported.	5

xii. Rock Mass Permeability

14. **CHEMICAL TESTS.** A knowledge of total soluble sulphate content and pH of soils and groundwater is important in determining the protection required for concrete or steel in contact with the ground. Other specialist tests may be carried out on sites suspected of being contaminated by toxic materials (see standard appendix B).

15. **REFERENCES**

CIRIA: Asbestos in Soil and Made Ground: a guidance to understanding and managing risks, 2014
The Coal Authority: Guidance on Managing the Risk of Hazardous Gases when Drilling or Piling Near Coal, 2013
Site Investigation Practice by Michael D Joyce; E & F N Spon 1982.

BRITISH STANDARDS

BS EN 1997-1: 2004 "Eurocode 7 – Geotechnical Design – Part 1: General Rules"
BS EN 1997-2: 2007 "Eurocode 7 – Geotechnical Design – Part 2: Ground Investigation and Testing"
BS ISO 14688-1:2002 "Geotechnical Investigation and Testing – Identification and Classification of Soil – Part 1"
BS ISO 14688-2:2004 "Geotechnical Investigation and Testing – Identification and Classification of Soil – Part 2"
BS ISO 14689-1:2003 "Geotechnical Investigation and Testing – Identification and Classification of Rock – Part 1"
BS 5930 Codes of Practice for Site Investigation 1999 (partly superseded)
BS 1377 Methods of Test for Soils for Civil Engineering Purposes 1990 (Parts 1 to 8)

1. **GENERAL.** The desk study and/or intrusive ground investigation is typically carried out in accordance with the requirements of BS5930 and BS10175. In relation to contamination the desk study is referred to as the preliminary investigation in BS10175 and the intrusive ground investigation is referred to as the Exploratory Investigation. This appendix briefly describes the nature of the work carried out and explains the standards against which contamination data has been assessed. The nature of any contamination investigation is such that only a small percentage of the ground, and therefore potential contamination, is sampled. Consequently variations in both ground conditions and contaminant levels can occur between any two sampling positions. The contamination investigation is designed to minimise such risks, but they cannot be eliminated.
2. **REVIEW OF CONTAMINATION ISSUES.** Part 2A of the Environmental Protection Act 1990 created a new regime for the identification and remediation of contaminated land. It introduced a definition of contaminated land described in Section 78A(2) of the Act of:

"any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that

- (a) significant harm is being caused or there is a significant possibility of such harm being caused; or
- (b) significant pollution of controlled waters is being caused or there is a significant possibility of such pollution being caused:

Both Part 2A and the planning regime embrace the "suitable for use" approach. In the context of Part IIA, action is necessary only where there are unacceptable risks to health or to the environment, taking into account the current use of the land and its environmental setting.

For humans, significant harm is defined as "death, disease, serious injury". Specifically, disease is taken to mean an unhealthy condition of the body or part of it. "Significant possibility of significant harm" is described as health effects arising from the intake of a contaminant or other direct bodily contact with the contaminant where the intake or exposure is unacceptable. The assessment should also take into account the total intake from all sources, the relative contribution of the pollutant linkage in question, and the duration of intake or exposure. The various statutory definitions are given overleaf.

The presence of unnatural substances does not automatically constitute a risk unless there is a link or pathway between the contamination (the hazard) and the receptor (the target) be it humans, the environment or property. Therefore the assessment needs to determine whether a hazard is present and whether the necessary pathway exists the so-called "pollution linkage" or "conceptual site model".

The effect of any hazard on a site depends primarily on the site use and groundwater conditions since these determine who and what may be at risk and the routes by which they may be exposed to the hazard. Site uses can include allotments, domestic gardens on residential developments, amenity and recreational areas, public open space and industrial and commercial buildings. On any site, the potential contaminants have to be identified together with the potential receptors. The pathway for that contaminant to reach its target has then to be considered.

3. **PRELIMINARY INVESTIGATION.** The preliminary Phase I Geoenvironmental Assessment (desk study) report normally considers the following key sections:

Introduction	
The Site	Contaminated Land
Site History	Radon
Geology and Mining	Geoenvironmental Risk Assessment
Hydrogeology	Geotechnical Assessment
Landmark Envirocheck	Ground Investigation (Recommendations)

The report will summarise the findings and also relate our opinions to the potential for a site to be geoenvironmentally impaired, at levels likely to warrant mitigation or further consideration appropriate to the current or future use.

Findings are based on information obtained and described during the desk study and site inspection without intrusive ground investigation. It is possible that further information exists. The absence of indicators of impairment does not mean that such impairment does not exist. Additional investigation including intrusive methods can reduce the risks but cannot eliminate them and may not be cost effective. We can advise on the additional research opportunities, their cost and their possible impact on mitigating risk. Recommendations are normally given based on the redevelopment proposals for the site.

Type of Receptor	Description of harm that is to be regarded as significant harm	Conditions For There Being A Significant Possibility Of Significant Harm
1. Human beings	Death, disease, serious injury, genetic mutation, birth defects or the impairment of reproductive functions. For these purposes, disease is to be taken to mean an unhealthy condition of the body or a part of it and can include, for example, cancer, liver dysfunction or extensive skin ailments. Mental dysfunction is included only insofar as it is attributable to the effects of a pollutant on the body of the person concerned.	If the amount of the pollutant in the pollutant linkage represents an unacceptable intake or direct bodily contact, assessed on the basis of relevant information on the toxicological properties of that pollutant. Such an assessment should take into account: - the likely total intake of, or exposure to, the substance or substances which form the pollutant, from all sources including that from the pollutant linkage in question; - the relative contribution of the pollutant linkage in question to the likely aggregate intake of, or exposure to, the relevant substance or substances; and - the duration of intake or exposure resulting from the pollutant linkage in question. The question of whether an intake or exposure is unacceptable is independent of the number of people who might experience or be affected by that intake or exposure. Toxicological properties should be taken to include carcinogenic, mutagenic, teratogenic, pathogenic, endocrine-disrupting and other similar properties.
2. All other human health effects (particularly by way of explosion or fire)		If the probability, or frequency, of significant harm of that description is unacceptable. The pollutant linkage might cause "significant harm which" - would be irreversible or incapable of being treated; - would affect a substantial number of people; - would result from a single incident such as a fire or an explosion; or - would be likely to result from a short-term (less than 24-hour) exposure to the pollutant.
3. Any ecological system, or living organism forming part of such a system, within a location which is protected.	For any protected location: - harm which results in an irreversible adverse change, or in some other substantial adverse change, in the functioning of the ecological system within any substantial part of that location; or - harm which affects any species of special interest within that location and which endangers the long-term maintenance of the population of that species at that location.	If either: - significant harm of that description is more likely than not to result from the pollutant linkage; or - there is a reasonable possibility of significant harm of that description being caused, and if that harm were to occur, it would result in such a degree of damage to features of special interest at the location in question that they would be beyond any practicable possibility of restoration.
4. Property in the form of: - crops, including timber; - produce grown domestically, or on allotments, for consumption; - livestock; - other owned or domesticated animals; - wild animals which are the subject of shooting or fishing rights.	For crops, a substantial diminution in yield or other substantial loss in the value resulting from death, disease or other physical damage. For domestic pets, death, serious disease or serious physical damage. For other property in this category, a substantial loss in its value resulting from death, disease or other serious physical damage.	If significant harm of that description is more likely than not to result from the pollutant linkage in question.
5. Property in the form of buildings.	Structural failure, substantial damage or substantial interference with any right of occupation.	If significant harm of that description is more likely than not to result from the pollutant linkage in question during the expected economic life of the building.
6. Controlled waters.		

4. **INTRUSIVE INVESTIGATION.** BS10175 describes this as an exploratory investigation. Intrusive ground investigation is described in Standard Appendix A. During the investigation representative or indicative samples are obtained for testing by an accredited laboratory. The aim is to determine (with a degree of confidence appropriate to the objectives), the presence, concentration and distribution of contaminants in respect of those points investigated. The extent of any necessary intrusive investigation will depend on the size of the site and any hazards, either known or suspected.

5. **ASSESSMENT OF CONTAMINATION.** The assessment of contaminated land under the terms of Part II A of the Environmental Protection Act 1990 is based upon pollution linkage (source - pathway - receptor model).

The Contaminated Land Report (CLR) series of documents have been produced by the Department for Environment, Food and Rural Affairs (DEFRA) and the Environment Agency, to provide regulators with "relevant, appropriate, authoritative and scientifically based information and advice on the assessment of risk from contamination in soils".

The Environment Agency has issued a number of Soil Guideline Values (SGVs), which whilst non-binding, may be used as guidance in the assessment of land and in setting remediation targets. They should only be applied to human health assessments.

The SGVs have been derived using the Contaminated Land Exposure Assessment Model (CLEA) and are based on assumptions relating to soil conditions, pollutant type and behaviour, land use patterns and the availability of receptors. SGVs are also subject to statistical assessment. The CLR documentation requires that the results of laboratory testing are subject to statistical analysis to remove uncertainty over a so-called 'averaging area'.

To date only selective SGVs have been issued for the following land-uses

- Residential with and without plant uptake
- Allotments
- Commercial/Industrial

Soil Guideline Values (mg/kg)			
Analyte	Residential	Allotments	Commercial
Arsenic	32 (37)	43	640
Cadmium	10 (17)	1.8	230
Chromium (total)	130		5000
Mercury	170	80	3600
Nickel	130	230	1800
Selenium	350	120	13000
Lead (2)	450 (82)		750
Toluene	610	120	4400
Ethylbenzene	350	90	2800
Phenol	420	280	3200
Benzene	0.33 (0.42)	0.07	95
o-xylene	250	160	2600
m-xylene	240	180	3500
p-xylene	230	160	3200
Copper (1)	2330	524	71,700
Zinc (1)	3750	618	665,000
Benzo(a)pyrene (1)	1.0 (2.4)	2.1	14
Naphthalene (1)	8.7	23	1100
Flourene (1)	780	160	71,000

(1) Generic Assessment Criteria (mg/kg) derived by LQM / CIEH

(2) Geometric mean value across site

(3) The figures in brackets are the latest C4SLs (see later in text)

DEFRA previously issued “Outcome of the Way Forward Exercise on Soil Guideline Values”. This document was intended to provide guidance to determine if there is a Significant Possibility of Significant Harm (SPOSH) i.e. whether land meets the legal trigger of being contaminated land.

In the context of Part 2A, a risk assessor using an SGV would conclude the following (DEFRA, 2008).

- At a representative average soil concentration at or below an SGV, it is very unlikely that there will be a *significant possibility of significant harm (SPOSH)*.
- At a representative average soil concentration above an SGV, there *might* be a *significant possibility of significant harm* with the significance linked to the margin of exceedance, the duration and frequency of exposure, and other site-specific factors that the enforcing authority may wish to take into account. Further investigation and/or detailed evaluation will usually be required.

It should be stressed that where there is any uncertainty as to whether or not there is a SPOSH, it was the policy of this practice to adopt a conservative approach, particularly in the adoption of clean cover systems.

In April 2012, Defra both published new Statutory Guidance which forms a major part of their contaminated land regimes under Part 2A of the Environment Protection Act 1990. The regime provides a means of dealing with contaminated land which poses a significant risk to human health or the environment where there is no alternative solution. It also works alongside planning rules and building regulations to help ensure that affected land is made suitable for use when it is redeveloped.

Since the regime was introduced in 2000 there has been considerable uncertainty over how to decide when land is, and is not contaminated land on grounds of the legal test of *significant possibility of significant harm to human health or the environment*.

To help address this, one of the main changes set out in the new Statutory Guidance, is the introduction of a new four category test to help decide when land is, and is not, contaminated land on grounds of *significant possibility of significant harm to human health*. Under the new four category test:

- Category 1 describes land that is clearly contaminated land, for example because similar land is known to have caused significant harm in the past.
- Categories 2 and 3 cover less straightforward land where more detailed consideration is needed before the regulator can decide either: (a) that there is a strong case for regulatory action, in which case the land would be in Category 2 and be classified as contaminated land under Part 2A; or (b) that such a case does not exist, in which case the land would be in Category 3 and not be classified as contaminated land under Part 2A.
- Category 4 describes land that is clearly not contaminated land, as discussed below.

One of the main purposes of including the Categories in the Statutory Guidance is to provide a legal framework against which new technical tools can be developed by the land contamination sector to describe the Categories in more detail with regard to specific substances and/or situations.

The new Category 4 test is particularly important in terms of reducing uncertainty over when land is definitely not caught by the regime.

The new Statutory Guidance makes clear what land should be placed into Category 4, for example:

- (a) Land where no relevant contaminant linkage has been established.
- (b) Land where there are only normal levels of contaminants in soil (as explained in Section 3 of the guidance), unless there is a particular reason to consider otherwise. In other words land with normal background concentrations in the soil.
- (c) Land that has been excluded from the need for further inspection and assessment under Part 2A because contaminant levels do not exceed relevant generic assessment criteria in accordance with Section 3 of the guidance, or relevant technical tools or advice that may be developed in accordance with paragraph 3.30 of the guidance, e.g. Category 4 Screening Levels.
- (d) Land where estimated levels of exposure to contaminants in soil are likely to form only a small proportion of what a receptor might be exposed to anyway through other sources of environmental exposure (e.g. in relation to average estimated national levels of exposure to substances commonly found in the environment, to which receptors are likely to be exposed to in the normal course of their lives).

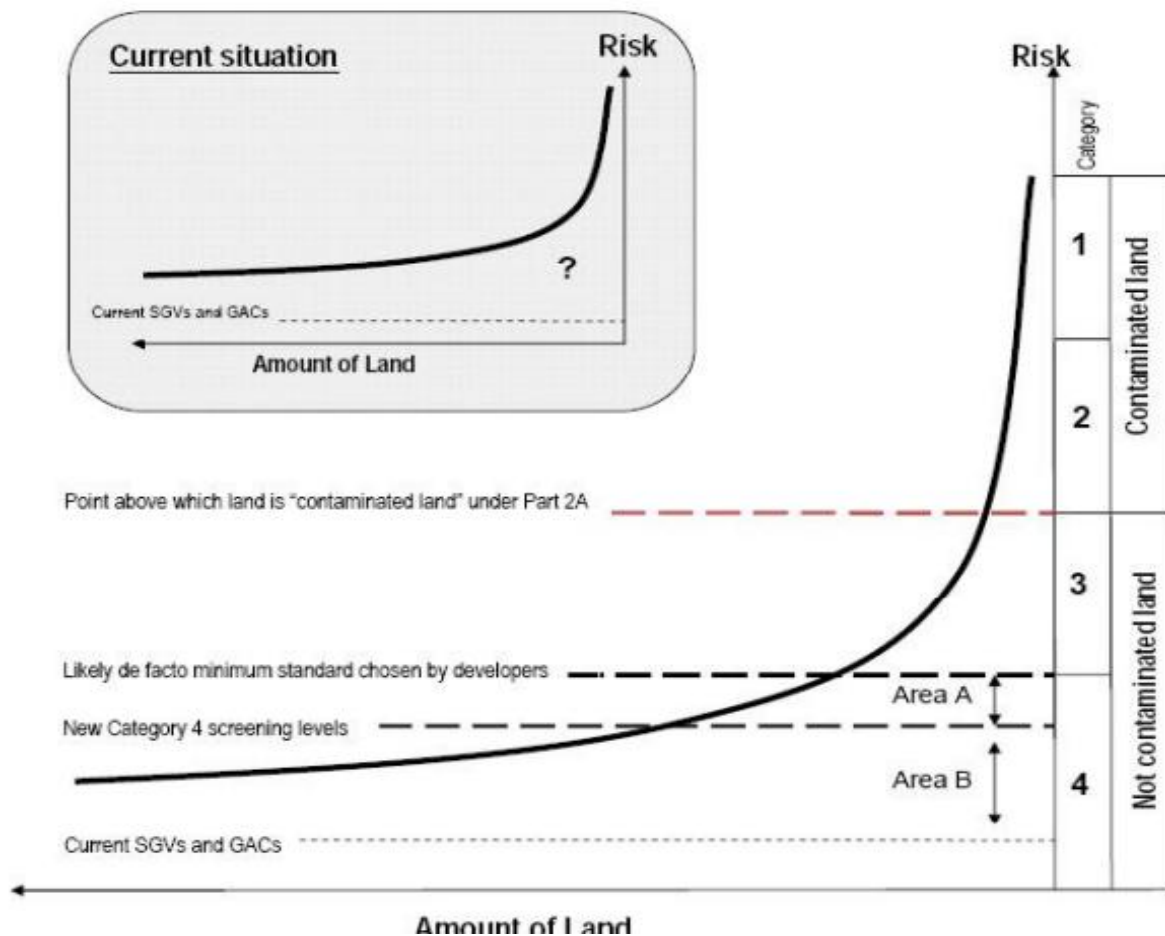
The guidance clarifies how generic assessment criteria (including the currently available SGVs/GACs) should and should not be used. It states that:

- 3.27 *It is common practice in contaminated land risk assessment to use “generic assessment criteria” (GACs) as screening tools in generic quantitative human health risk assessment to help assessors decide when land can be excluded from the need for further inspection and assessment, or when further work may be warranted.*
- 3.28 *Local authorities may use GACs and other technical tools to inform certain decisions under the Part 2A regime, provided: (i) they understand how they were derived and how they can be used appropriately; (ii) they have been produced in an objective, scientifically robust and expert manner by reputable organizations; and (iii) they are only used in a manner that is in accordance with Part 2A and this Guidance.*
- 3.29 *GACs relating to human health risk assessment represent cautious estimates of levels of contaminants in soil at which there is considered to be no risk to health or, at most, a minimal risk to health. With regard to such GACs:*
- (a) They may be used to indicate when land is very unlikely to pose a significant possibility of significant harm to human health. This is on the basis that they are designed to estimate levels of contamination at which risks are likely to be negligible or minimal and far from posing a significant possibility of significant harm to human health.
 - (b) They should not be used as direct indicators of whether a significant possibility of significant harm to human health may exist. Also, the local authority should not view the degree by which GACs are exceeded (in itself) as being particularly relevant to this consideration, given that the degree of risk posed by land would normally depend on many factors other than simply the amount of contaminants in soil.
 - (c) They should not be seen as screening levels which describe the boundary between Categories 3 and 4 in terms of Section 4 (i.e. the two Categories in which land would not be contaminated land on grounds of risks to human health). In the very large majority of cases, these SGVs/GACs describe levels of contamination from which risks should be considered to be comfortably within Category 4.
 - (d) They should not be viewed as indicators of levels of contamination above which detailed risk assessment would automatically be required under Part 2A.
 - (e) They should not be used as generic remediation targets under the Part 2A regime. Nor should they be used in this way under the planning system, for example in relation to ensuring that land affected by contamination does not meet the Part 2A definition of contaminated land after it has been developed.

The way in which the new four category system is intended to operate and the place of the C4SLs within that system, was explained in detail in the Impact Assessment which accompanied the Statutory Guidance. Please note that although the detail of the Impact Assessment is included here to provide clarity on the job expected of C4SLs, the Statutory Guidance, itself, sets out the regime that needs to be delivered under Part 2A.

Paragraph 47 of the Impact Assessment describes the diagram in detail. Of particular relevance to this project is the description of the overall diagram (sub-paragraph a), description of category 4 (sub-paragraphs c (part iv) and h) and the description of how the monetised benefits of the new system will be realised (sub-paragraph h). These sub-paragraphs are reproduced below.

Diagram showing the new Category 1-4 system (compared to current situation)



The diagram above seeks to illustrate, in a simplified manner, broadly what the changes to the statutory guidance on significant possibility of significant harm to human health are intended to achieve. To explain:

- (a) The curved line and axes illustrate the spectrum of risk presented by land contamination. The idea is to show that a very large amount of land is low risk, and only a small amount of land would pose sufficient risk to be contaminated land in the legal sense. The axes and lines in the diagrams are not to scale, and they have been compressed for the purposes of illustration (in reality the risks on Category 1 land would probably be orders of magnitude above Category 4 risks, and vastly more land would be in Category 4 compared to the other Categories).
- (b) The smaller diagram summarizes the current situation. In the area below the SGV/GACs there is near certainty that land is not contaminated land, however, above the line there is increasing uncertainty. As explained above, currently remediation usually occurs to just below the SGV/GAC level because they are perceived as offering the only cast-iron guarantee of when land is definitely not contaminated land. Sometimes consultants are employed to justify remediating to levels above the SGV/GACs, however the further they go away from the SGV/GACs the more legal risk they and their clients are exposed to.
- (c) The new statutory guidance will end the current situation, and it would not be legally possible e.g. for individual regulators to ignore the changes being made. For example, as explained above, the new statutory guidance will specifically say:
 - (i) that Part 2A cannot be used to force remediation to below a point where it ceases to be contaminated land in the legal sense i.e. the Category 2/3 border in terms of the diagram), although responsible parties can choose to go further;
 - (ii) that SGV/GACs cannot be used as one size fits all remediation thresholds under either Part 2A of the planning system;
 - (iii) that normal background levels of contamination are not caught by Part 2A; and
 - (iv) that SGV/GACs are well into Category 4, sometimes by only a few times and sometimes by orders of magnitude. These changes and others also provide the legal backing for the development e.g. of Category 4 screening levels, as discussed below.

- (d) The new Category 1-4 system divides the spectrum of risk posed by contaminated land into four different categories, and the statutory guidance will explain how to decide when land falls into each Category. This is more sophisticated than the current statutory guidance, which in effect has only two categories (contaminated land or not) and does not explain how to decide which category land falls into. The new Category 1-4 system reflects what assessors find when they investigate real sites i.e. some are clearly contaminated land (Category 1); some clearly are not (Category 4) and some are less-straightforward and need some level of detailed assessment before a decision can be taken as to whether or not they are contaminated land (Categories 2 and 3).
- (e) In the case of Category 2 and 3 sites, the regulator will have flexibility to take decisions within the parameters set by the new Guidance. There would be less flexibility for Category 2 and 3 sites that clearly pose either a high or low risk. However, the regulator will have considerable flexibility for sites closer to the Category 2/3 border to judge which side of the border a site would fall (e.g. taking account of their understanding of the risks, uncertainties and the interests of the local community). These are often complex decisions which need to be taken case-by-case given the many factors involved.
- (f) In the case of Categories 1 and 4 the regulator will have far less flexibility. For example, if a regulator claimed that a site matching the Category 1 description was not contaminated land, or that a site matching the Category 4 description was contaminated land, they would be acting directly against the statutory guidance which the Act requires that they follow, and decisions could be challenged (e.g. in a law court) with a high chance that the challenge would be successful. Among other things, the intention of doing this is to create far more legal certainty around when land is definitely not contaminated land in the legal sense. With the specific wording of the new statutory guidance, and the supporting tools such as the new Category 4 screening levels, it would be very difficult for a regulator e.g. to threaten landowners with the Part 2A regime, and if they tried to determine land as contaminated land they would be operating in direct opposition to the statutory guidance.
- (g) In the many consultation meetings held in developing the Category 1-4 system, all the developers, landowners and consultants we spoke to were strongly of the view that they would want to ensure their land is safely within Category 4 (even though in theory they could remediate to a level within Category 3 and still satisfy Part 2A and planning rules). They would do this for various reasons, including the fact that the flexibility granted to regulators in Categories 2 and 3 means that the further into Category 3 a site gets, the greater the risk that the regulator might decide it is in Category 2. Also they would want to be in Category 4 for reasons of marketability, future proofing etc. So developers and others would have a strong incentive to seek the regulatory certainty of being safely within Category 4. Thus, as far as development taking place under the planning system is concerned, Category 3 would, in effect, normally be a buffer which provides added reassurance that development falling within Category 4 will not be caught by the Part 2A regime.
- (h) The new statutory guidance will bring about a situation where the current SGV/GACs are replaced with more pragmatic (but still strongly precautionary) Category 4 screening levels (C4SLs) which will provide a higher simple test for deciding that land is suitable for use and definitely not contaminated land. Above the C4SLs, in Area A on the diagram, there will be much stronger legal backing for experts to use their judgement to make sensible and precautionary decisions on when land should be considered to be towards the top end of Category 4, without fear that land may be caught as contaminated land. This recognizes that the generic C4SLs will not be able to describe the Category 3/4 border itself because they are generic and would therefore have to err on the side of caution whilst a detailed site specific assessment would be able to push further by looking at specific circumstances relating to a specific site.
- (i) The very large majority of the monetized benefits of the changes to the regime discussed in this Impact Assessment manifest themselves in Category 4, and in particular in Areas A and B on the diagram. The main effects of moving to the new system would include Low risk land falling within Area B (pre-development) on the diagram would no longer have to be remediated because it would fall below the new C4SLs. Similarly land which is in Area A pre-development would no longer need to be remediated if justified by a detailed site-specific assessment. For these sites the cost of remediation would be removed altogether. The cost of remediating land which is initially in Categories 3, 2 or 1 would fall because it would be remediated to the new C4SL levels (or somewhere within Area A if there has been a detailed assessment) rather than the SGV/GAC level. This will have the overall effect of reducing the cost of remediation, with the effect varying according to specific site circumstances, the type of remediation etc. Generally the cost of remediation would fall for many affected brownfield land sites. This would have the general effect of making such land more economically viable for development. It would also mean that some land that is not currently economically viable to develop becomes reduce pressure to develop Greenfield land in some cases. The C4SLs will also speed up regulatory decisions on the reuse of brownfield land by providing a simple remediation standard.

The C4SLs are intended as “*relevant technical tools*” (in relation to Paragraph 4.2.1(c)) provides to help local authorities and others when deciding to stop further assessment of a site, on the grounds that it falls within Category 4 (Human Health).

The Impact Assessment (IA), which accompanied the revised SG (Defra, 2012b) provides further information on the nature and potential role of the C4SLs. Paragraph 47(h) of the IA states that:

“The new statutory guidance will bring about a situation where the current SGVs/GACs are replaced with more pragmatic (but still strongly precautionary) Category 4 screening levels (C4SLs) which will provide a higher simple test for deciding that land is suitable for use and definitely not contaminated land”.

A key distinction between the Soil Guideline Values (SGVs) and the C4SLs is the level of risk that they describe. As described by the Environment Agency (2009a):

“SGVs are guidelines on the level of long-term human exposure to individual chemicals in soils that, unless stated otherwise, are tolerable or pose a minimal risk to human health”.

C4SLs, therefore, should not be viewed as “SPOSH levels” and they should not be used as a legal trigger for the determination of land under Part 2A.

In 2014 CL:AIRE (Contaminated Land: Application in Real Environments) published “*Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination*”. In it a series of C4SLs were proposed as follows;

Analyte	Residential (with home grown produce) (mg/kg)	Residential (without home grown produce) (mg/kg)	Allotments (mg/kg)	Commercial (mg/kg)	PoS Residential (mg/kg)
Arsenic	37	40	49	640	79
Benzene	0.42	1.40	0.09	90	72
Benzo(a)Pyrene	2.40	2.50	2.70	36	4.90
Cadmium	17	87	3.1	220	120
Chromium (vi)	6.1	6.1	120	33	7.7
Lead	82	130	30	1100	270

6. GEOENVIRONMENTAL RISK ASSESSMENT

- 6.1 **Potential Hazard Sources.** Ground contamination can occur through several causes, particularly from historical use of the site and is often linked to the processes of waste disposal, underground storage, open storage, process pipework, leaks, spillages, tanks, site filling and various other reasons. The contamination can either arise from site sources or be the result of migration from other sources off site.
- 6.2 **Potential Migratory Pathways.** The primary pathways are considered to be laterally or vertically downward through underlying strata or upward to the ground surface. Such pathways also provide the potential for contaminants to migrate towards local watercourses and groundwater.
- 6.3 **Potential Targets At Risk.** Potential environmental liabilities related to current legislation associated with contaminated land with regard to existing ownership and redevelopment are summarised.

The probability of a hazard, linked with its consequences, can be used to assess risk in accordance with the tables below for use in decision making.

Consequence of Pollution Linkage

Severe	Damage to human health. Substantial pollution of controlled waters. Significant change in ecosystem population. Irreparable damage to property.
Moderate	Non-permanent damage to human health. Minor pollution of controlled waters. Change in ecosystem. Damage to property.
Mild	Short term health effects. Slight pollution of controlled waters. Slight effect on ecosystem. Minor repairable damage to property.
Near Zero	No noticeable effect on human health. No significant pollution to controlled waters. No measurable effect on ecosystem densities. Non-structural cosmetic damage to property.

Decision Making

Probability of a hazard and an associated linkage	Consequences of a pollution linkage (hazard-pathway-target)			
	Severe	Moderate	Mild	Near Zero
High	High	High	Medium/low	Negligible
Medium	High	Medium	Low	Negligible
Low	High/medium	Medium/low	Low	Negligible
Unlikely	High/medium/low	Medium/low	Low	Negligible

Final overall risk is based on an assessment of probability of a hazard and its consequences. Risk categories are shown shaded in the table above and defined below.

Risk	Description
High	Site probably or certainly unsuitable for present use or environmental setting. Contamination probably or certainly present and likely to have an unacceptable impact on key targets. Urgent action needed.
Medium/ Moderate	Site may not be suitable for present use or environmental setting. Contamination may be present, and likely to have unacceptable impact on key targets. Action may be needed on the medium term.
Low	Site considered suitable for present use and environmental setting. Contamination may be present but unlikely to have unacceptable impacts on key targets. Action unlikely to be needed in present use.
Negligible	Site considered suitable for present use and environmental setting. Contamination may be present but unlikely to have unacceptable impacts on key targets. No action needed while site remains in present use.

The review of the information from the exploratory investigation may be such that a decision is made that there is no need for further investigation. Alternatively, it may be necessary to carry out a further main investigation.

7. SITE WASTE MANAGEMENT PLANS (SWMPs)

In England, the SWMP Regulations 2008 came into force on 6th April 2008. They apply to 'construction projects', and to the whole life of a construction project, from design all the way through to completion. As well as including actual construction works, they include renovation projects, site preparation works, the installation of services, and all kinds of demolition. If you carry out a construction project where the value of the materials plus labour exceeds £300,000, it becomes a criminal offence (for both the project manager and the main contractor) not to produce a SWMP.

The Plans must include basic elements like who prepared it, who's in charge of the project, who's the main contractor, what's the location, and what's the estimated value. But it must also include details of the decisions taken at the outset on (1) the design of the project, (2) the methods employed and (3) the materials employed in order to MINIMISE the quantity of waste produced on site. It will therefore be crucial to have evidence of that thought process. The SWMP must describe each type of waste that will be produced, and estimate the volume. Then, you must identify the particular waste management 'action' that will apply to the waste. Is it to be dumped, sent for recycling, or perhaps recovered through use for land treatment under an exemption?

8. WASTE MANAGEMENT LICENSING

The Environment Agency has set out guidance as to the classification of waste arising from construction sites in its document "The Definition of Waste" dated April 2006. This document outlines how waste is to be handled

The following activities are not regarded as a waste management activity requiring licensing.

- 1) Construction activities carried out for the purpose of producing a suitably engineered soil e.g. lime stabilisation, vibro-replacement and piling.
- 2) Uncontaminated materials produced on site (including excavated soils and materials from demolition) which can be reused without further treatment. Examples include site regrading and footing excavations.

These must be done in accordance with the Planning Permission. Demolition material must be used in accordance with the quality protocols for the production of aggregates from inert waste, subject to appropriate testing and the lack of any harmful constituents. Uses include pipe bedding, backfill and sub-base.
- 3) Contaminated soils can be moved on-site providing they do not require treatment or containment. There should be no risk to the environment i.e. non-leachable and in accordance with Planning Permission. Relevant activities can include site regrading and use of materials below clean cover systems, capping, buildings and hardstanding.

Where contaminated materials have to be placed in an engineered cell to prevent pollution, then this would be classed as landfilling and require PPC permits. Any material taken off site is considered to be waste. However, this is under review. If material is waste, then there is a duty of care including ensuring material is transported by a registered carrier. The destination of material leaving the site should be regularly checked and Waste Transfer Notes kept.

Clean Covers Systems

According to the Environment Agency's Remediation Position Statements of May 2006, the placement of a cover system using "clean" material is not treatment of waste. Consequently, no licensing/permitting position statements are applicable to this type of remediation. If the cover system uses 'waste materials' in its construction, waste management licensing exemption paragraph 9A may be applicable to its installation. If the installation of the proposed cover system does not meet the criteria for registration of this exemption, the activity may be regulated through a waste management site licence.

9. WASTE ACCEPTANCE CRITERIA (WAC)

The main objective of the Landfill Directive is to prevent or reduce as far as possible the negative effects of landfilling waste on the environment and on human health. It is intended to reduce the disposal of waste materials to landfills and to encourage more sustainable approaches to dealing with wastes. It bans the landfill of liquids and certain solid wastes, introduces requirements for the treatment of wastes prior to landfill and provides for the classification of landfills as sites for inert, hazardous or non-hazardous waste and prohibits co-disposal.

It sets out procedures for waste acceptance at landfills and the types of waste for each class of landfill as specified by Waste Acceptance Criteria (WAC). The WAC are predominantly lists of "limit values" for certain parameters obtained from standard leaching tests of wastes going to landfills. WAC are set out in the Landfill Directive itself. Full details can be found in the Environment Agency document "Guidance for waste destined for disposal in landfills" Version 2 June 2006.

10. GAS MONITORING

In March 2007, the NHBC issued a report entitled "Guidance on Evaluation of Development Proposals on Sites Where Methane and Carbon Dioxide are Present".

The document recommends that a Conceptual Site Model is produced at the desk study stage. This can be used to produce a Preliminary Risk Assessment (PRA), with a view to assessing whether a ground gas investigation is necessary. The NHBC guidance suggests that the production of a PRA is a preliminary tool only and "cannot remove

the need entirely for ground gas monitoring data ..". This suggests that gas monitoring is needed in all circumstances. This would normally comprise the use of gas monitoring wells over a suitable time period in order to establish maximum gas concentrations and flow rates.

Our view however, and it may not be the view of the NHBC or the Local Authority, is that if there is no evidence of any gas producing source and if spike testing or on-site testing shows no evidence of landfill gases, then we regard the risk of hazardous gas production to be minimal such that further on-going monitoring would not be required. This is in line with the concept of there being no significant risk of significant harm i.e. no contamination. If there is any element of doubt, basic gas protection measures can be installed at minimal cost and each site dealt with individually.

11. MAIN REFERENCES

British Standards Institution	BS3882: British Standard Specification for Topsoil BS5930: British Standard Code of Practice for Site Investigations, 1999 BS8485: British Standard Code of Practice for the characterization and remediation from ground gas in affected developments, 2007 BS10175: British Standard Code of Practice for the Investigation of Potentially Contaminated Sites, 2001
BRE	Radon: Guidance on protective measures for new dwellings, BR211 Protective measures for housing on gas-contaminated land, BR414, 2001 Cover systems for land regeneration, 2004 Concrete in aggressive ground. Special Digest SD1, 3 rd Edition, 2005
Cairney T	Reclaiming Contaminated Land, 1987 Contaminated Land, Problems and Solutions, 1993
CIEH	The LQM / CIEH Generic Assessment Criteria for Human Health Risk Assessment (2 nd Edition)
CIRIA	Assessing risks posed by hazardous ground gases to buildings, CIRIA C665 Asbestos in Soil and Made Ground: a guide to understanding and managing risks, CIRIAC733, 2014
CL:AIRE	Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination, SP1010, 2013

DOE	CLR reports 1-4 Waste Management Paper No. 26A "Landfill completion: A technical memorandum..." Waste Management Paper No. 27 "Landfill Gas: A technical memorandum..."
DEFRA	Contaminated Land Report CLR 11, 2002 (7-10 withdrawn) R & D Publications TOX 1 – 12, 14, 16 – 25 R & D Publications SGV 1, 3, 4, 5, 7, 8, 9, 10, 15 and 16 (withdrawn) Improvements to Contaminated Land Guidance - "Outcome of the "Way Forward", 2008 Exercise on Soil Guideline Values. July 2008 Guidance on the Legal Definition of Contaminated Land. July 2008 Simplification of the Contaminated Land Regime Impact Assessment No: Defra 1133
DETR	Circular 02/2000. Contaminated Land, 2000 Guidelines for Environmental Risk Assessment and Management, 2000
Environment Agency	Guidance for the Safe Development of Housing on Land Affected by Contamination, 2000 Guidance for waste destined for disposal in landfills, Version 2, June 2006 Protective measures for housing on gas-contaminated land Remediation Position Statements, May 2006 Guidance and monitoring of landfill leachate, groundwater and surface water Human health toxicological assessment of contaminants in soil (Science Report SC050021/SR2) 2008 Updated technical background in the CLEA model (Science Report SC0520021/SR3) Using Soil Guideline Values, 2009
HMSO	Part 2A of the Environmental Protection Act Part 2A Statutory Guidance – April 2012 Contaminated Land (England) Regulations 2006 The contaminated Land (England) (Amendment) Regulations 2012 The Water Act 2003 (Commencement No. 11) Order 2012 Welsh Government Statutory Guidance on Contaminated Land
Institution of Civil Engineers	Contaminated Land: Investigation, Assessment and Remediation, 2 nd Edition
Joyce M D	Site Investigation Practice, 1982
NHBC	Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present, 2007
OPDM	Planning Policy Statement 23: Planning and Pollution Control Annex 2: Development on Land Affected by Contamination

This list is not intended to be exhaustive.



Michael D Joyce Associates LLP

Geotechnical and Geoenvironmental Consultants

Charnock Court 6 South Parade Wakefield West Yorkshire WF1 1LR

Tel: 01924 360458

Web: www.geoenvironmental.co.uk Email: mdja@geoenvironmental.co.uk