



Phase 2 Site Investigation

**Bolton to Goldthorpe Cycle Link,
Bolton-upon-Dearne**

Report Reference: SM/2364/091001/P2

October 2009

Report to:

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Report Title: **Phase 2 Site Investigation: Bolton to Goldthorpe Cycle Link,
Bolton-upon-Deerne**

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Executive Summary

Site Location and Current Condition	The site is a former railway embankment located between Carr Field Lane and Highgate Lane, Bolton Upon Dearne. The National Grid Reference is SE 452 035.
Proposed Land Use	This investigation is to facilitate the development of the Bolton to Goldthorpe Cycle Link.
Site Investigation	Twelve window samples were excavated across the site on 17 th September 2009.
Ground Conditions	The embankment appears to comprise made ground of sandy very gravelly clay or very gravelly sand with gravel of sandstone, mudstone, clinker, ash, brick, quartz and coal overlying natural disturbed/ reworked ground of sandy gravelly clay or very gravelly sand.
Contamination Assessment	Potential sources of contamination noted included the central ash and clinker gravel along the central path, areas of burnt waste, dog fouling and general littering. Chemical analysis identified slightly elevated levels of arsenic. All other analytes were below relevant screening criteria. It is considered that protection of site workers can be achieved through the provision of appropriate personal protective equipment for the period of any below ground works. Guidance from the Health and Safety Executive¹ for the protection of workers and the general public should be followed. In addition, a capping layer used to form the foundations of the cycle path may minimise potential pathways to human health. The Waste Acceptance Criteria analysis determined that the material (WS9 at 1.0 m bgl) comprises levels of Fraction of Organic Carbon and Loss on Ignition within the Hazardous Waste classification. All other analytes indicated that the material can be classified as either Inert or Stable Non-Reactive Waste in accordance with the Landfill Regulations 2002.

¹ The Health and Safety Executive. 1991. Protection of Workers and the General Public During the Development of Contaminated Land. HMSO.



1 Introduction

1.1 Terms of Reference

- 1.1.1 ECUS Ltd (hereafter ECUS) was commissioned by Dearne Valley Green Heart partnership to carry out Phase 2 site investigation at the proposed Bolton to Goldthorpe Cycle Link, located between Carr Field Lane and Highgate Lane, Bolton Upon Dearne, hereafter referred to as 'the site'.
- 1.1.2 Figure A1, Appendix A shows the location of the site which centres on National Grid Reference SE 452 035.

1.2 Objectives of the Phase 2 Site Investigation

- 1.2.1 It is understood that the Phase 2 Site Investigation has been completed in order to facilitate the development of a cycle track. The site must undergo re-profiling in order for the gradients of the embankments to be suitable.
- 1.2.2 The aim of this investigation is to determine whether the material being excavated is potentially hazardous to site personnel during earthworks and the general public following construction of the cycle path.
- 1.2.3 In addition, this material must be characterised as inert, non-hazardous or hazardous waste. This is in accordance with the Landfill Regulations 2002, assisting the Partnership to comply with its duty of care obligations when disposing of the material.
- 1.2.4 This report is relevant to this end use and additional interpretation may be required should any change in the land use be proposed.

2 The Phase 2 Site Investigation

2.1 Objectives of the Phase 2 Investigation

- 2.1.1 The Phase 2 Site Investigation has been carried out in general accordance with the requirements of British Standard BS5930 (1999) – Code of Practice for Site Investigations.
- 2.1.2 The general objectives of the Phase 2 Investigation are as follows:
- To obtain actual data on the ground conditions at the site;
 - To provide data for a human health risk assessment of the site;
 - To classify the material in accordance with the Landfill Regulations 2002.

2.2 Preparatory Works

- 2.2.1 A Health and Safety document and Method Statement was produced prior to the excavation works. Discussions were held with the client and other relevant regulatory bodies to ensure that all requirements would be met during the works.
- 2.2.2 The excavation locations and sampling strategy was agreed with the client prior to the intrusive investigation.
- 2.2.3 Service plans were obtained and a calibrated cable avoidance tool (CAT scanner) together with radio signal generator was used to clear the excavation locations of buried services.

2.3 Site Walkover

- 2.3.1 A walkover was carried out on 17th September 2009 in order to assess any visual signs of contamination on site. Figure A2, Appendix A shows the current layout of the site. Photographs of the site are presented in Appendix B.

2.4 Intrusive Investigation Works

- 2.4.1 An intrusive site investigation was undertaken on 17th September 2009. The excavation locations are shown on Figures A3a and A3b, Appendix A. Logs for each of the excavations are provided in Appendix C. The works carried out at the site are detailed in this section.

Window Sampling

- 2.4.2 Twelve window sample holes were advanced to depths between 1 m and 3 m below ground level (bgl) using a Competitor Dart tracked window sample rig. Depths of the excavations were chosen in order to relate to the amount of material proposed to be removed from the embankment during the re-profiling works. The location of the excavations was, on occasions, dependent on access for the window sampling rig being limited by dense vegetation and site topography.
- 2.4.3 Soil samples were recovered in 1m lengths in steel sampling tubes with a plastic liner and were logged by an ECUS environmental scientist on site. All window samples were backfilled with the arisings on completion of the hole.

On-site Assessment and Measurement

- 2.4.4 Visual and olfactory examination of retrieved samples was carried out to identify any evidence of contamination. Ground materials encountered were characterised and logged in accordance with British Standard BS5930.

Soil Sampling

- 2.4.5 Soil samples were recovered from the window samples for chemical analyses. Solid samples were selected on the basis of field observations (of discolouration or odour

of the soil) and by the depth of the samples in relation to the proposed re-profiling work.

- 2.4.6 Selected soil samples were collected by hand and immediately packed into pre-cleaned plastic pots and amber glass jars supplied by the laboratory. A new pair of disposable nitrile gloves was worn for each sample collection to prevent cross contamination between samples. The jars were packed into a cool box and transported, by courier, to the laboratory for analyses.

2.5 Chemical Analysis

- 2.5.1 The chemical analysis suite and the number and type of samples analysed were chosen to meet the objectives of the investigation, outlined in Section 2.1.
- 2.5.2 The analysis carried out comprised the chemical parameters and soil contaminants that are potentially associated with the former use as a railway embankment, as identified in the Department of the Environment Industry Profile for Railway Land.
- 2.5.3 Waste Acceptance Criteria (WAC) analysis was also carried out to provide sufficient information for a waste contractor to accept the waste for landfill should it require disposal.
- 2.5.4 The analytical methods used are presented in the laboratory reports in Appendix D.

Solid Sample Analysis

- 2.5.5 Chemical analyses were conducted by Exova, a UKAS and MCERTS accredited testing laboratory, on a total of fifteen soil samples. The analyses were selected to obtain data to inform the assessment of risks associated with the presence of contaminants at the site.
- 2.5.6 Chemical analysis carried out was as follows:
- Heavy metals: arsenic, cadmium, chromium (total and hexavalent), copper, lead mercury, nickel, selenium and zinc.
 - pH;
 - Sulphate (water soluble);
 - Speciated Polycyclic Aromatic Hydrocarbons (PAH);
 - Speciated Total Petroleum Hydrocarbons (TPH);
 - Volatile Organic Compounds (VOC);
 - Fraction of Organic Carbon (FOC);
 - Waste Acceptance Criteria (WAC).

2.5.7 The location and depth of the samples selected for analysis is presented in Table 1.

Table 1: Soil Sample Analysis

Borehole	Sample Depth (m)
WS1	0.4
WS2	0.25
WS3	0.5
WS3	0.5
WS4	0.2
WS5	0.15
WS6	0.2
WS7	0.25
WS8	1.6
WS8	0.3
WS9	0.15
WS9	1
WS10	1
WS11	0.15
WS12	0.15

3 Findings of the Phase 2 Site Investigation

3.1 Site Walkover

- 3.1.1 Site photographs are presented in Appendix B.
- 3.1.2 The walkover and anecdotal information indicates that the site currently comprises an embankment of material that was previously part of a railway line. The land rises from both the northern and southern ends of the site although the northern end is of a steeper gradient.
- 3.1.3 The land falls fairly steeply to the west and east of the embankment. The eastern side of the site appears to have a much steeper gradient and comprises dense vegetation.
- 3.1.4 At the top of the embankment the site is generally level although there are several areas comprising sunken pits, particularly towards the southern end of the site. A path comprising of clinker and ash surfacing over sandy gravelly clay runs along the centre of the site with vegetation on either side.

3.2 Potential Contaminant Sources Noted During the Site Walkover

- 3.2.1 The following potential sources of contamination were noted during the site walkover:
 - The clinker and ash surfacing located along the path.
 - Some areas where burning of waste had occurred were noted along the top of the embankment.
 - Dog fouling was noted in several places along the embankment.
- 3.2.2 *In addition general waste was located across the site, particularly at the northern and southern ends. Significant polystyrene waste was noted along the eastern boundary of the site, adjacent to the industrial estate.*

3.3 Ground Conditions

- 3.3.1 The ground encountered within the window samples is assumed to originate from 'cut and fill' processes in order to create the railway embankment. This is due to the fact that generally shallow depths of made ground were encountered across the site comprising of either very sandy very gravelly clay or very gravelly sand with gravel of sandstone, mudstone, clinker, ash, brick, quartz and coal overlying bands of disturbed sandy gravelly clay or very gravelly sand.
- 3.3.2 Weathered sandstone bedrock was encountered within window sample WS1 at 2.5 m bgl.

3.4 Visual and Olfactory Observations of Contamination

- 3.4.1 Ash and clinker gravel was encountered in the window sample holes in samples retrieved from the surface and to depths of 1.4 m bgl.
- 3.4.2 A slight organic odour was noted within WS1 at depths between 1.85 to 2.0 m bgl.
- 3.4.3 No other visual or olfactory observations of significant soil contamination were noted during the intrusive investigation.

3.5 Analytical Results

3.5.1 Laboratory analysis and data sheets for solid samples and groundwater samples are presented in Appendix D. Table 2 provides a summary of the chemical analysis results for the soil samples. Table 3 provides a summary of WAC Analytical results for the soil samples.

Table 2: Summary of Analytical Results – Soil Samples.

Analyte	No. of Samples	Minimum Conc.*	Maximum Conc.*
Arsenic	13	<5	166
Cadmium	13	<0.5	1.1
Chromium (total)	13	10	29
Copper	13	20	119
Lead	13	15	50
Mercury	13	<0.5	1.7
Nickel	13	12	41
Selenium	13	<5	<5
Zinc	13	31	160
Chromium (VI)	13	<10	<10
pH	13	3.8	7.2
Sulphate (water soluble) (g/l)	13	<0.1	3.1
Fraction of Organic Carbon	4	0.004	0.107
Polycyclic Aromatic Hydrocarbons (PAH)			
Naphthalene	13	<0.1	1.7
Acenaphthylene	13	<0.1	<0.1
Acenaphthene	13	<0.1	0.3
Fluorene	13	<0.1	0.2
Phenanthrene	13	<0.1	2.9
Anthracene	13	<0.1	0.8
Fluoranthene	13	<0.1	3.1
Pyrene	13	<0.1	2.7
Benz(a)anthracene	13	<0.1	2
Chrysene	13	<0.1	1.9
Benzo(b)fluoranthene	13	<0.1	1.3
Benzo(k)fluoranthene	13	<0.1	0.9
Benzo(a)pyrene	13	<0.1	1.2
Indeno(1,2,3-cd)pyrene	13	<0.1	0.6
Dibenz(a,h)anthracene	13	<0.1	0.2
Benzo(ghi)perylene	13	<0.1	0.6
Total Petroleum Hydrocarbons (TPH)			
EC>5-6 Aliphatic (µg/kg)	13	17	157
EC>6-8 Aliphatic (µg/kg)	13	11	36
EC>8-10 Aliphatic (µg/kg)	13	<1000	<1000
EC>10-12 Aliphatic (µg/kg)	13	<1000	<1000
EC>12-16 Aliphatic (µg/kg)	13	<1000	<1000
EC>16-35 Aliphatic (µg/kg)	13	1120	1540
EC>35-44 Aliphatic (µg/kg)	13	<1000	<1000
Total Aliphatics (µg/kg)	13	1210	1590
EC>5-7 Aromatic (µg/kg)	13	<10	<10
EC>7-8 Aromatic (µg/kg)	13	<10	<10
EC>8-10 Aromatic (µg/kg)	13	<1000	<1000
EC>10-12 Aromatic (µg/kg)	13	<1000	<1000
EC>12-16 Aromatic (µg/kg)	13	<1000	<1000

*All concentrations are in mg/kg unless otherwise stated.



Table 2: Continued.

Analyte	No. Samples	Minimum Conc.*	Maximum Conc.*
Total Petroleum Hydrocarbons (TPH)			
EC>16-21 Aromatic (µg/kg)	13	<1000	<1000
EC>21-35 Aromatic (µg/kg)	13	2120	9890
EC>35-44 Aromatic (µg/kg)	13	<1000	<1000
Total Aromatics (µg/kg)	13	2120	9890
Methyl t-butyl ether (µg/kg)	13	<10	<10
Benzene (VPH) (µg/kg)	13	<10	<10
Toluene (VPH) (µg/kg)	13	<10	<10
Ethylbenzene (VPH) (µg/kg)	13	<10	<10
m&p-Xylene (VPH) (µg/kg)	13	<10	<10
Total VPH (µg/kg)	13	17	195
Total EPH (µg/kg)	13	1210	9900
o-Xylene (VPH) (µg/kg)	13	<10	<10
Volatile Organic Compounds (µg/kg)			
All below laboratory detection Limits			

*All concentrations are in mg/kg unless otherwise stated.

Table 3: Summary of WAC Analytical Results

Analyte	Units	WS3 0.5m bgl	WS9 1.0m bgl
Fraction of Organic Carbon (FOC)	%	HW	SNR
Loss On Ignition	%	HW	< HW
BTEX (SUM)	µg/kg	Below Lab Detection Limits	Below Lab Detection Limits
PCB (Congeners)	µg/kg		
PAH (total)	mg/kg	Inert	Inert
Mineral Oil	mg/kg	Inert	Inert
pH	-	SNR	SNR
All Other Leachate Analysis	mg/kg	Inert	Inert

SNR - Stable Non-Reactive Waste

<HW - Concentration is less than Hazardous Waste Landfill Limit

HW - Hazardous Waste

4 Risk Assessment

4.1 Introduction

- 4.1.1 As discussed in Section 2.1, soil analysis has been carried out to assess whether the material proposed to be excavated is potentially hazardous to site personnel during earthworks and the general public following construction of the cycle path.
- 4.1.2 The actual risks to these receptors are considered in turn in the following sections.

4.2 Risks to Site End Users

- 4.2.1 DEFRA and the Environment Agency are responsible for publishing guidance for the assessment of risks to human health associated with chronic (long term) exposure to contaminated soils. In August 2008, the majority of the existing guidance (the CLR 7-10 Series) was withdrawn. In the CLR7-10 Series, for a number of contaminants, and a number of standard land uses, DEFRA and the Environment Agency had published soil guideline values (SGVs), for use in the assessment of risks associated with long term exposure to contaminants in soil.
- 4.2.2 The SGVs and the associated technical algorithms and supporting documentation were all withdrawn in August 2008. They have now been replaced by new guidance^{2,3,4} supported by a new software model (the CLEA model version 1.05) which was published in September 2009. Practitioners were advised to calculate new site specific guideline values or Site Specific Action Criteria (SSAC) for assessing risks to human health and to cease to use the SGVs.
- 4.2.3 The calculation of soil screening values is reliant on toxicological data relating to the impact of contaminants on human health. DEFRA and the Environment Agency are also responsible for providing relevant toxicity data and have published some toxicology reports for a selection of common contaminants relevant to the assessment of land contamination. Further information on how the chemical toxicology reports have been used to derive SGVs can be found in the SGV technical notes.
- 4.2.4 Atkins have derived ATRISK Soil Screening Values (SSVs) based on the January 2009 guidance (SC050021/SR3 (the CLEA Report) and SC050021/SR2 (the TOX report) for several land scenarios including parks, playing fields and open spaces. At the time of writing this report Atkins have not yet produced SSVs based on the September 2009 guidance.
- 4.2.5 The land use scenario for Open Spaces derived by Atkins has been found to correspond satisfactorily with the site land use. Full details of the basic settings and parameters used by Atkins can be found on the website, www.atrisksoil.co.uk.

² Environment Agency, 2009. Science Report SC050021/SR2: *Human health toxicological assessment of contaminants in soil*.

³ Environment Agency, 2009. Science Report SC050021/SR3: *Updated technical background to the CLEA model*.

⁴ Environment Agency, 2009. Science Report SC050021/SR4: *CLEA Software (Version 1.05) Handbook*.

4.3 Assessment of Risks to Site Users

- 4.3.1 An initial assessment of the risks to site end users has been carried out using relevant SSV and is presented in Table 4.
- 4.3.2 In the first instance, maximum concentrations of contaminants which have the potential to affect human health have been compared to the relevant SSVs.
- 4.3.3 There is a satisfactorily representative dataset for the site, and therefore, where the maximum concentration of a contaminant is less than the SSV, it can be stated with a satisfactory degree of confidence that potential contaminant linkages between that contaminant within site soil and human health represent a low risk, and that further assessment is not necessary.
- 4.3.4 Where the maximum concentration of a contaminant within soil is greater than the SSV (highlighted in bold text in the table) further assessment is required, as discussed below.

Table 4: Comparison of Soil Analysis with appropriate SSVs

Analyte	Maximum Conc.*	SSV*	Comments
Arsenic	166	132	Maximum concentration less than SSV. No further assessment required.
Cadmium	1.1	237	
Chromium (VI)	<10	582	
Copper	119	40,600	
Lead	50	929	
Mercury	1.7	25.8	
Nickel	41	1,190	
Selenium	<5	2,320	
Zinc	160	183,000	
Polycyclic Aromatic Hydrocarbons (PAH)			
Naphthalene	1.7	432	Maximum concentration less than SSV. No further assessment required.
Acenaphthylene	<0.1	-	
Acenaphthene	0.3	937	
Fluorene	0.2	746	
Phenanthrene	2.9	-	
Anthracene	0.8	20.9	
Fluoranthene	3.1	113	
Pyrene	2.7	13.2	
Benz(a)anthracene	2	10.3	
Chrysene	1.9	2.64	
Benzo(b)fluoranthene	1.3	7.29	
Benzo(k)fluoranthene	0.9	4.12	
Benzo(a)pyrene	1.2	5.46	
Indeno(1,2,3-cd)pyrene	0.6	86.9 [†]	
Dibenz(a,h)anthracene	0.2	11.6 [†]	
Benzo(ghi)perylene	0.6	1,500 [†]	
Total Petroleum Hydrocarbons (TPH)			
EC>5-6 Aliphatic	0.157	1,100	Maximum concentration less than SSV. No further assessment required.
EC>6-8 Aliphatic	0.036	769	
EC>8-10 Aliphatic	<1.0	476	
EC>10-12 Aliphatic	<1.0	297	
EC>12-16 Aliphatic	<1.0	126	
EC>16-35 Aliphatic	1.54	359,000,000	

* No SSV generated

[†] As determined using the combined assessment criterion given by CLEA due to the stability of the large carbon chains.

Table 4: Comparison of Soil Analysis with appropriate SSVs

Analyte	Maximum Conc.*	SSV*	Comments
Total Petroleum Hydrocarbons (TPH)			
EC>5-7 Aromatic	<0.01	75.9	Maximum concentration less than SSV. No further assessment required.
EC>7-8 Aromatic	<0.01	4,360	
EC>8-10 Aromatic	<1.0	3,600	
EC>10-12 Aromatic	<1.0	2,190	
EC>12-16 Aromatic	<1.0	925	
EC>16-21 Aromatic	<1.0	5,380	
EC>21-35 Aromatic	9.89	5,380	Maximum concentration less than SSV. No further assessment required.
Methyl t-butyl ether (µg/kg)	<10	-	
Benzene (VPH) (µg/kg)	<10	75,900	
Toluene (VPH) (µg/kg)	<10	4,360,000	
Ethylbenzene (VPH) (µg/kg)	<10	2,840,000	
m&p-Xylene (VPH) (µg/kg)	<10	3,170,00**	
o-Xylene (VPH) (µg/kg)	<10	2,620,000	
Volatile Organic Compounds (µg/kg)			
All below laboratory detection Limits			

- No SSV generated

**Most conservative Xylenes SSV

- 4.3.5 The table shows that only the maximum concentration of arsenic is greater than the SSV.
- 4.3.6 Statistical analysis is therefore required and has been carried out in accordance with the recent guidance published by the Chartered Institute of Environmental Health and CL:AIRE⁵.
- 4.3.7 Where there is 95% confidence or greater that the true mean concentration of the contaminant within site soils is less than the calculated SSV, it can be said that that contaminant does not pose an unacceptable chronic risk to human health.
- 4.3.8 Where the upper confidence limit (UCL; equivalent to the US₉₅ within CLR7) is greater than the calculated SSV, there may be an unacceptable health risk from the contaminant involved, and further risk assessment or remediation may be required prior to the redevelopment.
- 4.3.9 The full statistical analysis is presented in Appendix E.
- 4.3.10 The statistical analysis showed that the calculated UCL is 85.6 mg/kg, which is lower than the SSV. It should be noted that only one sample analysed for arsenic has a concentration of greater than the SSV. This was within WS4 at 0.2 m bgl.

⁵ CIEH and CL:AIRE, 2008. Guidance on Comparing Soil Contamination Data with a Critical Concentration.

5 Conclusions and Recommendations

5.1 Conclusions

5.1.1 The investigation has determined the following:

- The site comprises an old railway embankment that appears to be formed by the depositing of natural reworked/ disturbed clay strata. A layer of sandy gravel comprising of ash and clinker forms a central path that runs along the whole of the site.
- Potential sources of contamination noted included the central ash and clinker path, areas of burnt waste, dog fouling and general littering.
- With the exception of an organic odour noted within window sample WS1 at 1.85 to 2.0 m bgl, no other significant visual or olfactory observations of contamination were noted during the intrusive investigation.
- Generally, the chemical analysis of the soil determined that the concentrations were below the relevant screening value. However, the concentration of arsenic was found to be slightly higher than the SSV. This elevated concentration was only identified in one sample collected from WS4 at 0.2 m bgl.
- It is considered that the works proposed to facilitate the development of the cycle track may minimise any potential pathway that may be present through the slightly elevated arsenic concentrations. It is therefore considered that the material located on site would not pose a significant risk to human health.
- The Waste Acceptance Criteria analysis determined that the material collected from WS3 at 0.5 m bgl may be deemed as hazardous waste only on the amount of Fraction of Organic Carbon and the Loss on Ignition. The sample collected was described as being brown and black very sandy very gravelly clay containing clinker, ash and coal and is therefore considered to be potential colliery spoil. It is considered that the elevated FOC and LOI levels may be associated with the colliery spoil located at this location.
- All other analytes indicated that the material can be classified is either Inert or Stable Non-Reactive Waste in accordance with the Landfill Regulations 2002.

5.2 Recommendations

- 5.2.1 The investigation identified some heterogeneity of material at shallow depths across the site particularly with reference to the WAC analysis. In order to mitigate against potential high waste disposal costs associated with the re-profiling of the site, it is recommended that during the stripping and stockpiling works the waste should be segregated dependant on visual inspection and further WAC analysis be conducted on the material. This would prevent the total excavated material from being considered and costed for as hazardous waste.
- 5.2.2 In order to minimise any potential pathway that may be present at the site due to the slightly elevated arsenic concentrations we recommend that a capping layer is placed along the surface of the embankment. This may form the foundation of the cycle path.
- 5.2.3 Site workers may be at risk of short term exposure to elevated arsenic levels within the ground. It is considered that protection of site workers can be achieved through the provision of appropriate personal protective equipment for the period of any



below ground works. Guidance from the Health and Safety Executive⁶ for the protection of workers and the general public should be followed.

⁶ The Health and Safety Executive. 1991. Protection of Workers and the General Public During the Development of Contaminated Land. HMSO.