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Mr R Harding
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25th July 2016

Ref: C6485A/GH/7423

Dear Robert,

Re.: Land at Oughtibridge Mill, Planning Application No. 16/01169/OUT

1.0 Introduction

You kindly forwarded us the comments on our Geoenvironmental Appraisal (our ref: C6485A Rev. A, dated March 2016) provided by the Environmental Protection Service (EPS) at Sheffield City Council (SCC). A number of these requested further consideration, investigation and/or risk assessment. Sirius responded to the comments by email on 6th June 2016, indicating that additional site investigation works, both before and after demolition, would be undertaken to address the points raised. EPS comments regarding ground gas monitoring are addressed within the ground gas risk assessment for the site, reported under separate cover.

This letter represents the report on supplementary *pre-demolition* investigation works undertaken at the site, which comprise intrusive investigation works and groundwater monitoring. We also provide any necessary updated recommendations relating to the proposed redevelopment. This letter report should be read in conjunction with the previous geoenvironmental assessment reports available for the site.

The post-demolition site investigation works should be undertaken and reported once demolition is complete and access to the relevant areas of the site is possible.

Based on the development plan available at the time of preparing this report, it is understood that the proposed development will comprise up to 320 typically low-rise residential dwellings. Residential apartment blocks with communal gardens / soft landscaping are presently proposed within the south western site area.

Preliminary proposed remediated levels have been derived, undertaken as part of an initial cut/fill balance assessment, with cognisance of minimum required flood levels. In general, final remediated levels are proposed to be raised by approximately 1.0m - 2.0m across the majority of the north western and south western site areas, and between approximately 0.5m - 1.0m within the landfill area. Only minimal volumes of cut are proposed within the landfill. Significant raising of levels are currently proposed between the north western and south western site areas, to accommodate a new proposed access road. Minor cut and fill earthworks are proposed across the mill area, to provide a development plateau, at or above minimum flood levels.

This report presents the factual information available during this appraisal, interpretation of the data obtained and any updated recommendations relevant to the defined objectives.

The objectives of these works were to:

- Undertake supplementary intrusive site investigation to assess shallow ground and groundwater conditions within previously inaccessible areas in the north west of the site and further detail concerning the former mill race.
- Provide recommendations for additional post-demolition infill investigation within the area of existing above-ground storage tanks (ASTs) and electricity sub-stations.
- Undertake supplementary groundwater monitoring and sampling within existing wells to re-assess previously identified localised hydrocarbon contamination (specifically within exploratory hole references SWS07, SWS08A and SWS21).

2.0 Supplementary Investigation Works

2.1 Fieldworks

Groundwater Sampling

Supplementary groundwater samples were retrieved (following purging) from borehole references SWS07, SWS08A and SWS21 on 10th June 2016.

Groundwater from SWS07 was purged dry during sampling, and did not immediately recharge. A limited sample was later retrieved but there was insufficient volume of groundwater to enable a full

suite of speciated TPH analysis to be completed. On the basis of the higher volatility TPH compounds being of most concern in terms of risk to site end-users through inhalation pathways, the lower carbon fractions (aliphatic and aromatic carbon bands C_5-C_{10}) and BTEX / MTBE compounds were scheduled. A subsequent groundwater monitoring visit undertaken approximately two weeks later, indicated that the borehole had remained largely dry (negligible recharge), indicative of a general lowering of the groundwater table during the summer period.

Samples of the groundwater retrieved were tested for the contaminants of concern under subcontract with Derwentside Environmental Testing Services (DETS), a UKAS and MCERTS-accredited laboratory. The results of laboratory analysis are presented in Appendix C of this letter report and are discussed in Section 2.4, below.

Supplementary Intrusive Investigation - North Western Site Area

Access into the far north western site corner was restricted during the December 2015-January 2016 site investigation because of the presence of a tensioned chain link fence for security purposes. At the request of the client, this was removed in June 2016 to allow access for the supplementary site investigation.

The supplementary intrusive investigation was undertaken on 2nd June 2016 and comprised the excavation of two machine-excavated trial pits within the previously inaccessible area (STPC06 and STPC07) to a maximum depth of 4.10m below ground level (bgl). The approximate exploratory hole positions are shown on Drawing No. C6485A/01/01 within Appendix A of this report.

Selected samples of the made ground retrieved were tested for a range of potential contaminants. The results of laboratory analysis are presented in Appendix C of this letter report and are discussed in Section 2.4, below.

Supplementary Assessment - Former Mill Race

Access into part of the south western site area (where a proportion of the mill race is evident at ground level) was restricted during the original site investigation due to the presence of heavily reinforced concrete, steep stockpiles of demolition rubble that posed a health and safety risk, and the presence of a number of underground obstructions. The mill race is still largely buried under the pre-existing demolition rubble stockpiles and is located at significant depth in parts (>4m bgl) in an area where numerous live underground services exist.

WSP produced a Preliminary Appraisal report (ref. 70006973 dated October 2014), which indicated that "*Anecdotal evidence indicates the presence of an underground water pipe which runs northwest to southeast approximately parallel with the River Don in the southwest of the site. Historically, this pipe was used to flush paper, acids, oil, grease and polymers into the River Don, and therefore the current demolition works classed the remaining contents as 'Contaminated Waste'. This is scheduled to be decommisioned and backfilled with quarry stone*."

The currently exposed portion of the former mill race visually appears to comprise granular crushed stone, indicating that at least partial 'remediation' of the former culvert may have been completed, consistent with the above.

Extensive future remedial works in this area are proposed following service disconnection and when appropriate temporary retaining measures and other health and safety precautions for work adjacent to the River Don can be implemented. These remedial works will include grubbing out of

sub-structures (such as the mill race, former foundations and redundant drainage) and the remediation of the identified area of hydrocarbon contamination and any other additional significant contamination discovered.

A detailed strategy for remediation works and verification within this area will be included within the Remedial Strategy for the site.

Supplementary Intrusive Investigation - Electricity Sub-Stations and Above Ground Storage Tanks

Access into the areas of electricity sub-stations and above ground storage tanks remains impossible and these areas are recommended to be investigated following demolition and clearance. A detailed strategy for investigation within these areas will be included within the Remedial Strategy for the site.

The locations of the electricity sub-stations and above-ground storage tanks are shown on Drawing No. C6485A/01/02 within Appendix A.

2.2 Ground Conditions

A complete record of the strata encountered is given on the exploratory hole logs contained within Appendix B.

Made ground soils were encountered within the north western site area to a maximum depth of 4.0m bgl. These were recorded to comprise made ground topsoil, with fragments of brick, ash, glass, clinker and concrete to depths of 0.20m bgl. The made ground topsoil was underlain by dark grey silty gravelly sand of ash and clinker, with brick, concrete and rare glass fragments. STPC07 was terminated at a depth of 3.90m bgl, because of collapse of the overlying granular made ground soils into the trial pit.

Natural soils were proven at a depth of 4.0m bgl within STPC06, recorded to comprise soft sandy clays, considered to represent residual Millstone Grit strata.

No groundwater ingress into the trial pits was observed.

2.3 Visual / Olfactory Evidence of Contamination

No olfactory or visual evidence of hydrocarbon or similar contamination was encountered within STPC06 and STPC07.

The supplementary groundwater sample from borehole SWS21 was recorded to exhibit a slight sheen, although no associated hydrocarbon odours were detected. No visual or olfactory evidence of potential contamination was apparent within the samples obtained from SWS07 or SWS08A.

2.4 Contamination Assessment

Soil Data

The laboratory test data were reviewed for completeness and consistency. Those determinands that represent potential contaminants of concern were subjected to further evaluation. For each potential contaminant of concern, analytical data for soil samples were evaluated against the relevant Generic Assessment Criterion (GAC) for residential with home-grown produce end-use, conservatively assuming a sandy soil with a Soil Organic Matter (SOM) content of 1%. Source data for all GACs are provided in Appendix D.

Table 1 presents a summary of the analytical results obtained and their evaluation against the applicable GACs. The samples taken comprised one made ground topsoil and one granular made ground soil sample.

Table 1 Summary of Total Soil Concentrations - Made Ground, North Western Site Area

Determinand	No. of Samples Tested	Range of Results (mg/kg unless specified)	GAC (1% SOM)	No. of Samples >GAC	Samples Exceeding GAC
Inorganic Arsenic	2	2.6 - 5.4	37	0	
Cadmium	2	<0.1	11	0	
Chromium (III)	2	6.1 - 64	910	0	
Lead	2	6.5 - 44	200	0	
Inorganic Mercury	2	<0.05 - 0.06	40	0	
Selenium	2	<0.5	250	0	
Copper	2	14 - 19	200	0	
Nickel	2	6.8 - 12	180	0	
Zinc	2	6.4 - 29	450	0	
pH	2	9.4 - 9.7	<5 or >9	2	STPC06 at 0.1m and 0.6m
Total Sulphate	2	1000 - 1300	2400	0	
Water Sol. Sulphate	2	0.043 - 0.12g/l	0.5 g/l	0	
Acenaphthene	2	<0.1 - 0.2	200	0	
Anthracene	2	<0.1 - 1.1	2200	0	
Acenaphthylene	2	<0.1 - 0.9	170	0	
Benzo(a)anthracene	2	<0.1 - 5.2	*b(a)p**	0	
Benzo(b)fluoranthene	2	<0.1 - 4.8	*b(a)p**	0	
Benzo(k)fluoranthene	2	<0.1 - 3.0	*b(a)p**	0	
Benzo(g,h,i)perylene	2	<0.1 - 4.2	*b(a)p**	0	
Benzo(a)pyrene	2	<0.1 - 6.1	2.1	1	STPC06 at 0.1m
Chrysene	2	<0.1 - 5.1	*b(a)p**	0	

Determinand	No. of Samples Tested	Range of Results (mg/kg unless specified)	GAC (1% SOM)	No. of Samples >GAC	Samples Exceeding GAC
Dibenzo(a,h)anthracene	2	<0.1 - 0.9	*b(a)p**	0	
Fluoranthene	2	<0.1 - 9.7	280	0	
Fluorene	2	<0.1 - 0.3	170	0	
Indeno(1,2,3-cd)pyrene	2	<0.1 - 4.7	*b(a)p**	0	
Naphthalene	2	<0.1 - 0.3	1.0	0	
Pyrene	2	<0.1 - 9.3	620	0	
Phenanthrene	2	<0.1 - 3.7	95	0	
Aliphatic EC 5-6	2	<0.01	24	0	
Aliphatic EC >6-8	2	<0.01	53	0	
Aliphatic EC >8-10	2	0.02 - 4.2	13	0	
Aliphatic EC >10-12	2	<1.5	62	0	
Aliphatic EC >12-16	2	<1.2	510	0	
Aliphatic EC >16-35	2	<4.9	41000	0	
Aromatic EC 5-7	2	<0.01	53	0	
Aromatic EC >7-8	2	<0.01	100	0	
Aromatic EC >8-10	2	<0.01 - 0.1	20	0	
Aromatic EC >10-12	2	<0.9	63	0	
Aromatic EC >12-16	2	<0.5 - 1.8	140	0	
Aromatic EC >16-21	2	<0.6 - 39	260	0	
Aromatic EC >21-35	2	<1.4 - 110	1100	0	
Benzene	2	<0.01	0.063	0	
Toluene	2	<0.01	100	0	
Ethylbenzene	2	<0.01	26	0	
Xylenes (total)	2	<0.01	28	0	
MTBE	2	<0.01	31	0	
Phenol	2	1.6 - 2.3	110	0	
TOC	2	1.2 - 3.4	3 w/w%	1	STPC06 at 0.1m
Calorific Value	2	<1 - 2.7MJ/kg	2 MJ/kg	1	STPC06 at 0.1m
Asbestos	2	NAD	Fibres present	0	

GACs based on a residential with home-grown produce end-use, assuming sandy soil.
* Assessed using benzo(a)pyrene as a surrogate marker, except where stated in text.
NAD – No Asbestos Detected.

Metals and Metalloids

No metals recorded concentrations above the relevant GAC.

Other Inorganic Analytes

Total organic carbon (TOC) was recorded at a concentration marginally exceeding the relevant GAC within one sample of made ground topsoil. TOC does not pose a potential risk to human health and is specified at the 'Inert' waste threshold for information purposes only.

An elevated calorific value of 2.7MJ/kg was recoded the sample of the made ground topsoil obtained from STPC06 at 0.10m bgl. This is considered attributable to the ash component recorded within the sample. Elevated calorific value may indicate a potential risk of combustion but in this case the exceedance is marginal and localised, therefore further consideration is not required.

Marginally elevated pH values (>pH9) were recorded within both made ground soil samples, which are not considered to pose a potentially unacceptable risk to end users during normal site occupancy.

No other inorganics recorded concentrations above the relevant GAC.

Asbestos

No asbestos fibres were detected within the soil samples tested.

Organics

Benzo(a)pyrene within the sample of made ground topsoil was recorded at a concentration of 6.1mg/kg, exceeding both the relevant Stage 1 and Stage 2 GACs (2.1mg/kg and 4.9mg/kg, respectively). The presence of this contaminant is likely due to the ash content of the sample and we conclude that ashy made ground topsoils in this specific area may pose a **moderate** risk to site end-users in the post-development case and are also considered unsuitable for re-use as clean cover soils in the development. Remedial measures for these soils are detailed in Section 3.0.

No other organics recorded concentrations above the relevant GAC.

Groundwater Data

The results of the supplementary groundwater analysis have been evaluated against GACs based on both Drinking Water Standards (DWS) and inland waters Environmental Quality Standards (EQS).

Table presents a summary of the analytical results obtained for the sample collected on 10th June 2016 and their evaluation against the applicable GACs. A detailed assessment of groundwater samples previously retrieved (January 2016) was reported in the Sirius Geoenvironmental

Appraisal report, dated March 2016 (ref. C6485A), although these will be discussed below where they inform interpretation of the additional results.

Table 2 Summary of Groundwater Analysis

Determinand	No. of Samples Tested	No. Samples Above Limit of Detection	Range of Results (µg/l unless specified)	GAC value (µg/l unless specified)		No. of Samples >GAC and Sample ID
TPH				**EQS (Note 1)**	**DWS (Note 2)**	
TPH (speciated analysis) *per fraction*	3	2	<10 – 1200	10	10	1 (SWS21)
BTEX and MTBE compounds						
Benzene	3	0	<1	10	1	0
Toluene	3	0	<1	74	700	0
Ethylbenzene	3	0	<1	20	300	0
Xylenes (sum)	3	0	<1	NA	500	0
Methyl tert-Butyl Ether (MTBE)	3	0	<1	2600	200	0

NA – Not Applicable
1 - Inland Waters EQS values. 2 - DWS values

TPH was not recorded above the laboratory limit of detection (LoD) within the groundwater sample retrieved from SWS08A and only a single fraction was recorded at a trace concentration within SWS07, although it is noted that there was insufficient sample volume from the latter borehole to test the full speciated TPH suite.

Both of these boreholes had previously subjected to sampling and analysis. The sum TPH concentration within the sample collected from SWS08 was 1,400µg/l, whereas both subsequent rounds of sampling recorded a sum TPH concentration below the LoD. Two rounds of sampling have been undertaken for SWS07 - the initial result recorded a sum TPH concentration of 300µg/l with a much lower concentration (4.8µg/l, albeit on a sample analysed for potentially volatile components only) on the second visit.

Given the absence of any discernible sources within the soils in the vicinity of SWS07 and SWS08A and the short-term presence of elevated concentrations within groundwater, it is considered that the initial elevated TPH concentrations were artefacts caused by disturbance during drilling and the risk posed by TPH contamination in these locations is **low** and does not require further consideration.

A sum TPH concentration of 1,200µg/l was recorded within SWS21 (located within the western extent of the landfill area), comprising aliphatic and aromatic fractions principally within the range C_{12}-C_{35}. Samples from this same borehole exhibited a TPH composition during previous sampling events with sum TPH concentrations of 7,900µg/l and 370µg/l respectively. These results are consistent with observed sheens on the groundwater surface and visual and olfactory evidence of hydrocarbon contamination within the granular made ground soils in this borehole at a depth of 4.50m bgl (which will likely remain at a similar depth following proposed cut and fill earthworks). However, the components detected are of low volatility and situated at significant depth and the properties in this area will require ground gas protection measures for the mitigation of risk posed by carbon dioxide and methane. We consequently consider the level of risk posed by this contamination to site end-users in the post-development case to be **low**.

3.0 Conclusions and Recommendations

This supplementary site investigation has been performed for land at Oughtibridge Mill and should be read in conjunction with the previous geoenvironmental appraisal reports available for the site. It has been assumed in the production of this report that the site is to be redeveloped for a typically low-rise residential with gardens end use, with proposed apartment blocks (with associated areas of communal gardens / soft landscaping) in the south west of the site. In addition, it has been assumed that ground levels will change in general accordance with those detailed in Section 1 of this report.

To enable the proposed redevelopment of the site, it has been recommended by Sirius that, where made ground is present, a minimum 600mm cover layer of suitable soils be placed in all areas proposed for private gardens and a minimum 450mm within proposed new areas of soft landscaping. The clean cover system should be underlain at its base by a geotextile marker or a further dense granular 'no dig' layer of at least 150mm in thickness. Deep rooted plants would need to be 'potted'. Where the site is underlain directly by natural ground, then a nominal 150mm depth of clean topsoil should be provided in gardens and new areas of soft landscaping to provide a suitable medium for plant growth.

Subsoil and topsoil for use in clean cover may need to be imported. However, any site-won natural topsoil encountered during enabling works may be suitable for re-use and should be stockpiled and tested to assess its suitability.

Given the historical site uses and the potential for associated contamination, vigilance should be maintained during site clearance, remediation, enabling and construction works for currently unknown hotspots of contamination. If any unexpected areas of noxious, odorous, brightly coloured, fibrous, liquid or other suspect contamination are encountered, then these are to be reported and advice sought from a suitably qualified consultant.

A Remediation Strategy report must be produced and agreed with the regulatory authorities prior to commencement of remediation and ground preparatory works.

3.1 Near-Surface Made Ground Topsoil within the North Western Portion of the Site

The ashy made ground topsoil in the vicinity of investigation locations STPC06 and STPC07 contains elevated concentrations of benzo(a)pyrene (and other genotoxic PAHs). The level of risk posed by this material will be mitigated by the proposed capping soil layer and no further action will be required to protect human health These soils will be considered unsuitable for re-use as clean cover soils in the development.

3.2 Groundwater Contamination in the Vicinity of Boreholes SWS07, SWS08A and SWS21

Based upon the results of this and previous investigations, it is considered that no specific remedial works are required to protect site end users or controlled waters as a result of the minor and localised hydrocarbon contamination detected within these boreholes.

3.3 Former Mill Race

The currently exposed portion of the former mill race visually appears to comprise granular crushed stone, indicating that at least partial 'remediation' of the former culvert may have been completed, consistent with information provided within WSP's Preliminary Appraisal report dated October 2014.

Extensive future remedial works in this area are proposed following service disconnection, existing rubble stockpiles removed, and when appropriate temporary retaining measures and other health and safety precautions for work adjacent to the River Don can be implemented. These remedial works will include grubbing out of sub-structures (such as the mill race, former foundations and redundant drainage) and the remediation of the identified area of hydrocarbon contamination and any other additional significant contamination discovered.

3.4 Existing Electricity Sub-Station and Above-Ground Storage Tanks

The electricity sub-stations and above-ground storage tank areas will require investigation once demolition and clearance allows access. A detailed strategy for investigation within these areas will be included within the Remedial Strategy for the site.

We recommend that this letter be forwarded to the appropriate regulators for their comments/approval.

Should you have any questions regarding this letter report, please do not hesitate to call.

Yours sincerely

G Halliday

Gemma Halliday
Principal Engineer
For and on behalf of Sirius Geotechnical & Environmental Ltd

Enc.:

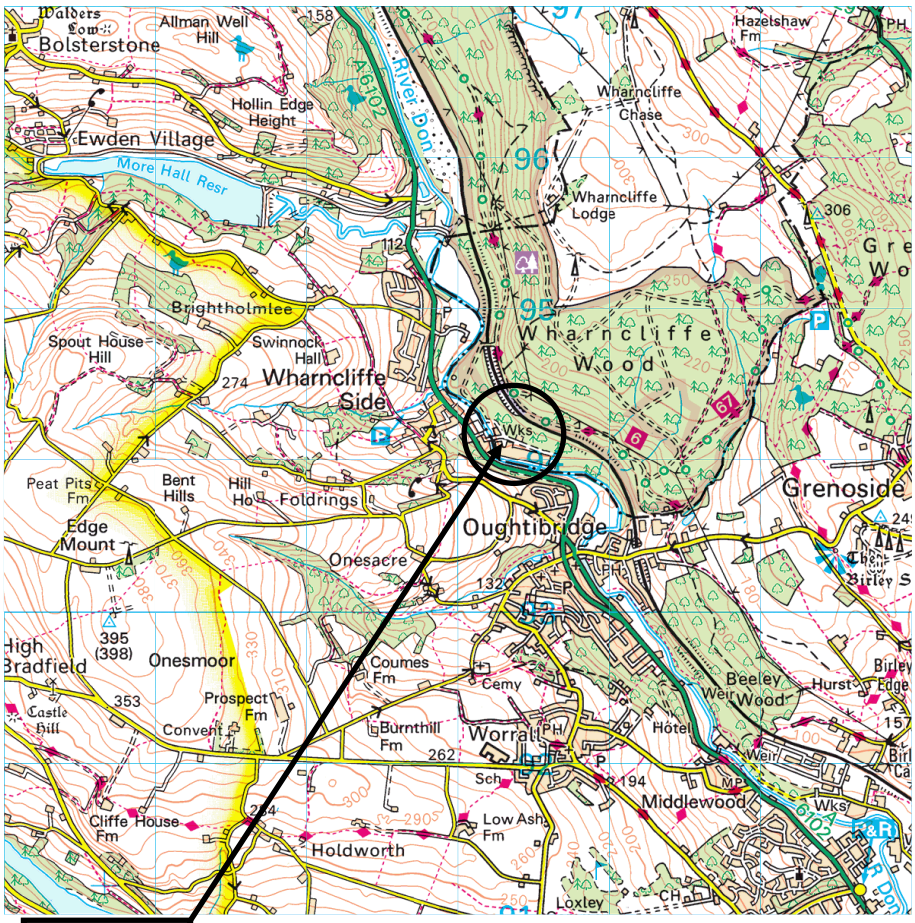
Appendix A	Drawings
Appendix B	Exploratory Hole Logs
Appendix C	Chemical Laboratory Test Results
Appendix D	Sirius Generic Assessment Criteria

APPENDIX A

DRAWINGS

Site Location Plan

Contract Number	C6485A/01
Contract	Oughtibridge Mill
Client	CEG



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Scale	1:50,000		
Drawn by	SH	Approved	JF
Drawing Number	C6485A/01/01		

NOTES

Existing Site Features

- Above Ground Storage Tank (AST)
- Electrical Sub-Station
- Weigh Bridge
- Flow Direction
- Oil Interceptors
- Assumed Route of Culverted Drain c. 4.00 mbgl (as Annotated From Arcadis Drawing 3178910005-CAD Dated 06/01/15)

Historical Site Features

- Former Boiler House
- Approximate Location of Former Diethandamine Bund / Tank c.3x3m
- Former Effluent Tanks
- Former Reservoirs
- Unknown Features
- Former Mill Race
- Former Railway Line / Sidings
- Former Chimneys
- Former Oil Store
- Former Mill Building / Engine / Machinery House Dated Between 1894-2015

Site Zones

- Site Boundary
- North West Area - Former Effluent Tanks / Reservoirs
- Woodland Areas
- Former Landfill Area (Approximate Location)
- South West Area - Former Buildings Machinery / Engine House
- Mill Area

REVISION

0	>>
A	>>
B	>>
C	>>

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CLIENT

CEG

SITE

Oughtibridge Mill

DRAWING TITLE

Site Features & Zoning Plan

DRAWING NO.	REVISION NO.
C6485A/01/02	0
DRAWN BY: DT	APPROVED BY: GH
DATE: July 2016	SCALE: 1:1000
	PAPER SIZE: A0