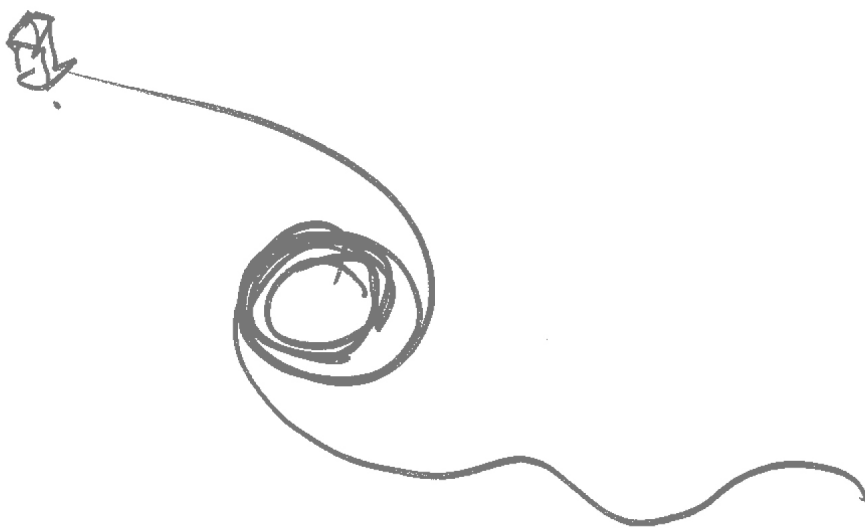




South Tyneside Council



**South Shields New Central Library  
and Digital Media Centre**  
Phase 2 Ground Investigation Report

June 2014

# South Shields New Central Library & Digital Media Centre Phase 2 Ground Investigation

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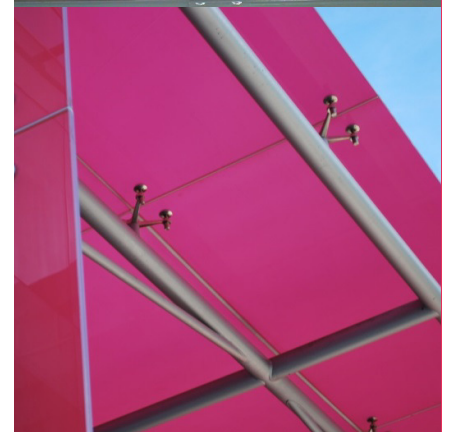
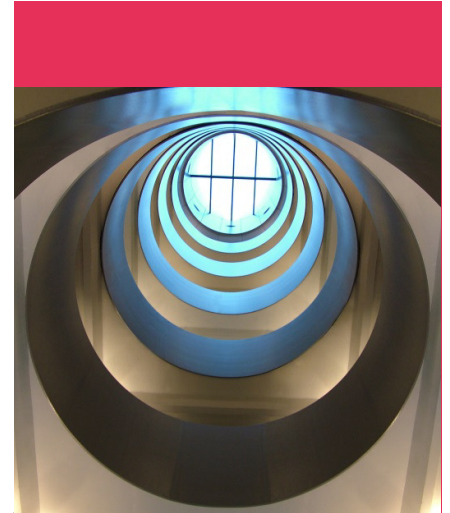
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## Executive Summary

### Appointment

In January 2014 Curtins were instructed by Muse Developments to undertake a Phase 2 Ground Investigation of two parcels of land separated by Ferry Street, South Shields the eastern portion of which had most recently been occupied by Woodhave House.

### Development Proposals

Development proposals comprise the construction of South Shields New Central Library & Digital Media Centre as well as associated car parking and a pedestrian link. The Existing market place will also be remodelled including the erection of a market stall canopy structure.

### Fieldworks

The site investigation fieldworks were undertaken over two stages; the first January 2014 comprised the advancement of; three cable percussion boreholes within the New Central Library & Digital Media Centre building footprint and the second stage in March 2014 comprised the advancement of six machine excavated trial pits as well as machine excavated trial trenches to expose existing foundations.

### Ground Model

The revealed ground model is consistent with the development sites' former uses with demolition arisings present across both site areas.

### Laboratory Testing

Representative samples of the shallow site soils (made-ground) and underlying natural deposits were obtained and submitted to a suitably accredited laboratory for environmental chemistry analysis. The environmental chemistry results have been compared with the Tier 1 criteria for soils with respect to human health for the intended 'Commercial' end use and no exceedances were recorded.

### Quantitative Risk Assessment – Human Health

The risk presented by the made-ground and natural soils to human health is considered to be low and consequently, no remedial action is recommended.

### Quantitative Risk Assessment – Controlled Waters

The risk to the underlying Secondary A aquifer and the nearest surface water feature is considered to be Low considering: the low levels of potential soil contamination encountered within the site made-ground and natural soils and given the lack of nearby potable abstractions and the fact the site is not located within a Source Protection Zone.

### Quantitative Risk Assessment – Ground Gases

The risk from ground gases is considered to be very low and consequently no gas protection measures recommended within the New Central Library & Digital Media Centre.

### Geotechnical Considerations

Geotechnical advice is presented herein with recommendations made for a piled foundation solution. As part of the enabling works a reduced level excavation is recommended to remove the numerous below ground obstructions encountered during the ground investigation.

### Unexploded Ordnance

The likelihood of encountering unexploded ordnance on both development sites is considered to be low either as a result of the proposed works (shallow excavations) or through an assessment based on available evidence. It is recommended that all operatives undertaking intrusive works are informed to the potential (low) presence of unexploded ordnance. The report does not recommend any special measures are adopted. Furthermore, in any event should unexploded ordnance be encountered on site the procedure is: "*stop work immediately, prevent access to the area and inform the police*".

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## Appendices

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**Appendix A2 - Exploratory Hole Location Plan**

**Appendix A3 - Exploratory Hole Logs**

**Appendix A4 - Laboratory Testing Results**

**Appendix A5 - Tier 1 Thresholds**

## 1.0 Introduction

### 1.1 Project background

In January 2014 Curtins were instructed by Muse Developments to undertake a Phase 2 Ground Investigation of two parcels of land separated by Ferry Street, South Shields one of which had most recently been occupied by Woodhave House.

Development proposals comprise the construction of South Shields New Central Library & Digital Media Centre as well as associated car parking and a pedestrian link. The Existing market place will also be remodelled and a new market stall canopy structure erected.

The site location and development plans for the development can be referred to within Appendix A1.

### 1.2 Scope of Works

The Phase 2 Ground Investigation was undertaken in order to provide an assessment of the ground conditions on the subject site with respect to any potential contamination in the underlying soils and or groundwater.

Specifically the Phase 2 report is intended to determine,

- a) If there is a risk of the proposed end user being adversely impacted upon by potential contamination in shallow site soils that may be present on the site due to its known current, recent and historical use.
- b) If there is a risk of groundwater and/or surface water being adversely impacted upon by potential contamination that may be present on the site due to its known current, recent and historical use.
- c) If there is a risk to the end user from soil gases including methane, carbon dioxide, oxygen and hydrogen sulphide.
- d) Recommendations for the design of foundations and building ground floor slabs.
- e) Recommendations for the specification of sub-structure concrete and water supply pipes.



## 2.0 Phase 1 Desk Study Summary

This section of the report presents a summary of Curtins Phase 1 Desk Study reporting (ref. EB1285/NF/R1 dated February 2014)

### 2.1 Current Setting

The development site is divided into two areas, west and east of Ferry Street approximately 750m west of South Shields town city centre.

A site location plan is presented in Appendix A1.

### 2.2 Site History

With reference to the earliest historical maps (mid 1800s) the eastern part of the site was occupied by two blocks of terraced housing, whilst the western part of the site was occupied with a large glass works which extended south west of the site. The glass works appears to become disused in the late 1800s and is potentially used as part of the colliery staithes (landing stage), situated adjacent to the river thereafter.

The former glass works building on the west of the site is demolished in the 1950's and replaced with extensive railway sidings and small outbuildings which extend onto the site. The terraced housing on site is noted as 'ruins' in the late 1960's and soon afterwards, demolished and replaced with large civic buildings labelled as 'Woodhave house, Government buildings' which remains on site until 2013 mapping. From site reconnaissance it is known that these buildings have now been demolished. The railway sidings and associated buildings on and adjacent to the western side of the site remain present until the early 1990s, when this part of the site becomes vacant, remaining this way until the present day.

### 2.3 Geology

A study of the Envirocheck records and British Geological Survey (BGS) 1:50000 mapping records (Bedrock and Superficial Editions) for Tynemouth indicates the following geological succession underlying the site's as follows;

- Made-Ground deposits (indicated on the western portion of the site only).
- Glaciolacustrine deposits, including clay and silt of *Devensian* age.
- Pennine Middle Coal measures formation including sandstone, siltstone and mudstone of *Bolsovian (Westphalian C)/Duckmanthian (Westphalian B)* age.

## 2.4 Hydrogeology

The 1:10,000 Groundwater Vulnerability Map indicates that the site, corresponding with the underlying solid geology, overlies a Secondary A Aquifer. These are;

*Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.*

The site superficial deposits are considered to be unproductive.

The site soils are of 'high leaching potential' (U); soil information for restored mineral working and urban areas is based on fewer observations than elsewhere. Therefore a worst case vulnerability classification (H) is assumed until proven otherwise.

The site is not situated within a Source Protection Zone (SPZ).

The nearest surface water feature is recorded 44m west of site (The River Tyne). No water quality data is provided for this section of The River Tyne however it is known to be a salmonoid river further upstream whose quality is improving.

There are no recorded groundwater or surface water abstractions recorded within 1000m of the site.

No discharge consents, local authority pollution prevention and control permits or pollution incidents to controlled waters are recorded on the site.

The site is not situated in an area that is at risk from extreme flooding or flooding from rivers or sea without defences.

## 2.5 Landfills

There are no Environment Agency (EA) or British Geological Society (BGS) recorded landfill sites, historic or currently operational, on or within 250m of the site.

## 2.6 Mining and Radon

The Coal Authority Mining Report confirms that the site is in an area which may be affected by mining activity confirmed within the historical mapping and Envirocheck Report with a large local historic colliery identified 287m south east of site (St Hildas Colliery), operation is known to have ceased.

The Envirocheck Report indicates two other BGS recorded mineral sites exist within 500m of the site including Swinburnes Brick field 333m south-east of site and Oystons Brick Fields 362m east of site, operations at both these mineral sites are known to have ceased.

The Coal Authority Mining Report confirms the site is in the likely zone of influence from workings of 2 seams of coal at 140m to 180m depth last worked in 1916. Any ground movement from these coal workings should have stopped by now.

There are no known mine entries within 20m of the boundary of the site. The site is not in the likely zone of influence of any present underground coal workings. The site is not in an area for which the Coal Authority has determined or is determining whether to grant a licence to, nor is the site in an area that is likely to be affected by any planned future workings. However coal reserves do exist in the area which could be worked at some time during the future.

The site is not within the boundary or within 200m of the boundary of an opencast site which coal has or is being removed by opencast methods. The site is not within 800m of an opencast site of which the Coal Authority have granted a license for coal removal by opencast methods or within 800m of a site which the Coal Authority is determining whether to grant a license.

The Coal Authority has not received a damage notice or claim for the subject site or any property within 50 metres, since 31<sup>st</sup> October 1994. There is no current Stop Notice delaying the start of repairs or remedial works to the site. The report also confirms the Authority is not aware of any request having been made to carry out preventive works before coal is worked under section 33 of the Coal Mining Subsidence Act 1991.

Both the Radon Atlas for England and Wales and the Envirocheck report presented within the Phase 1 Desk Study confirm that the site is in an area where less than 1% of homes are affected by radon. No radon protective measures are therefore considered necessary in the construction of new dwellings or extensions.

## **2.7 Unexploded Ordnance**

South Shields was subject to multiple Luftwaffe bombing raids during the Second World War and received a high number of high explosive bombs. Indicative risk mapping therefore places the site in a high risk area.

The Tyneside area was a target due to its industrial activity and owing to South Shields location on the coast the Luftwaffe may have dropped any remaining ordnance on return from other target locations along the Tyne. Online testimonials including a letter from the 3<sup>rd</sup> October 1941 suggest some large bombing raids were experienced in South Shields where a young teacher describes bombing raids in which resulted in approximately 30 deaths and 250 houses destroyed. The presence of a ruin on site in the post-war period is suggestive of direct bomb strikes on the site.

Unexploded Ordnance Risk Assessment reports undertaken by BAE Systems in February 2008 and April 2014 (Report Ref: A0805-00-R1-3 and A1128-00-R1-1 respectively) relate to both the car park (2008 report) and the New Central Library & Digital Media Centre (2014 report).

The 2008 report (car park) concludes by determining this portion of the development site as a 'high' risk area. The report does however state that the majority of shallow ground is likely to have been disturbed on site since WWII (considering previous cycles of development), and therefore supervision of shallow excavations by an explosives safety engineer is unlikely to significantly reduce the risk and is not recommended, neither are ordnance awareness briefings for personnel involved in shallow excavations. Considering the end use of this portion of the development site; road and car park construction including shallow excavations for services this risk is evaluated as low.

The 2014 report (New Central Library & Digital Media Centre) concludes by determining an overall low likelihood of encountering unexploded ordnance on the site. The report recommends that all operatives undertaking intrusive works are informed to the potential (low) presence of unexploded ordnance. The report does not recommend any special measures are adopted.

In any event both reports clarify the procedure should unexploded ordnance be encountered on site: **stop work immediately, prevent access to the area and inform the police.**

## 2.8 Existing Reports

The existing Unexploded Ordnance Risk Assessment reports undertaken by BAE Systems in February 2008 and April 2014 (Report Ref: A0805-00-R1-3 and A1128-00-R1-1 respectively) were reviewed within Section 2.7 above.

No other existing reports have been made available for review.

## 2.9 Other Significant Factors Potentially Affecting Re-development

No other significant features are noted that could potentially affect re-development.

### 3.0 Phase 2 Investigation Proposals

The Desk Study, as summarised in Section 2.0, revealed an overall '**Low to Moderate**' level of potential risk to the end user.

Consequently the Desk Study concluded that there could be a risk of the site end user and controlled waters being adversely impacted upon by material potentially present on the site.

A strategy for the initial Phase 2 Ground Investigation was derived accordingly and comprised the following operations,

- Advancement, logging and sampling of representative soils in three cable percussion boreholes with installations in all boreholes to allow water sampling and gas monitoring to be undertaken.
- Advancement, logging and sampling of representative soils in six machine excavated trial pits.
- Advancement of machine excavated trial trenches to investigate existing pile positions.
- Environmental chemistry analysis for a suite of determinands reflecting the known use of the site on a number of samples representative of the made-ground and natural materials encountered.
- Geotechnical analysis (both in-situ and laboratory) representative of the ground conditions encountered.
- Gas and groundwater monitoring within upgraded boreholes.

## 4.0 Fieldwork

### 4.1 General

The site investigation fieldworks were undertaken over two stages; the first January 2014 comprised the advancement of; three cable percussion boreholes within the building footprint and the second stage in March 2014 comprised the advancement of six machine excavated trial pits as well as machine excavated trial trenches to expose existing foundations.

Appropriate chemical and geotechnical samples were obtained representative of the ground conditions revealed.

Curtins drawing ref. EB1285/L001 records the locations of the exploratory holes a copy of which is contained within Appendix A2.

### 4.2 Cable Percussion Borehole Investigation

Three cable percussion boreholes were advanced on the subject site under the supervision of a suitably experienced engineer. The boreholes were logged in general accordance with BS5930: 1999.

The cable percussion boreholes were terminated within the superficial deposits after chiselling for a minimum of 2 hours.

On advancement water strikes were recorded within all boreholes at the depths detailed in Table 4.2a.

**Table 4.2a** Cable Percussion Boreholes: Water Strikes

Borehole Reference	Strike (m bgl)	Resting Level after 20mins (m bgl)	Productive Strata
BH1	3.20	3.00	Very clayey, silty, SAND
BH2	15.20	14.00	Possible sand lens
BH3	5.10 14.10	4.50 13.80	Sandy, slightly gravelly CLAY Possible sand lens



A single well standpipe installation was incorporated within each of the three cable percussion boreholes as detailed in Table 4.2 below.

**Table 4.2b** Cable Percussion Boreholes: Response Zones

Borehole Reference	Response Zone(s) (m bgl)	Strata Description(s) (Principal strata in capitals)
BH1	2.00 to 4.00	Slightly sandy, slightly gravelly CLAY over very clayey, silty sand over Slightly sandy, slightly gravelly CLAY
BH2	1.00 to 4.00	MADE-GROUND over slightly sandy, slightly gravelly clay.
BH3	12.00 to 15.00	Slightly sandy, slightly gravelly CLAY

The response zones were targeted at; a) water bearing strata, b) strata likely to have the highest permeability and c) strata with the greatest gassing potential.

The response zone targeted the natural soils. Given the composition (no visual or olfactory evidence of contamination) of the made-ground deposits the effect of creating preferential pathways was considered to carry an overall low risk to the underlying aquifer.

Copies of all borehole logs can be referred to in Appendix A3 of this report.

### 4.3 Machine Excavated Trial Pit Investigation

Six machine excavated trial pits were excavated across the full development site; four across the car park site (TPC1 to TPC4) and two across the New Central Library & Digital Media Centre site (TP14 and TP16). The trial pits were advanced across the subject site under the supervision of a suitably experienced engineer and were logged in general accordance with BS5930: 1999.

All excavations remained open on completion and on advancement groundwater ingress was not encountered within any machine excavated trial pit.

Copies of all trial pit logs can be referred to in Appendix A3 of this report.

### 4.4 Machine Excavated Trial Trenching Investigation

A total of 20 No. machine excavated trial pits/trenches were excavated across the New Central Library & Digital Media Centre development site. The trial pits/trenches were advanced across the subject site under the supervision of a suitably experienced engineer and, in accordance with the agreed scope of works, the locations and dimensions of any piles revealed or below ground features recorded.

## 5.0 Laboratory Testing

### 5.1 Environmental Chemistry Testing

A programme of environmental chemistry testing was scheduled reflecting the findings of the summary desk study and on-site observations.

The sampling positions (boreholes) were generally located in a non-targeted, systematic array to give adequate and representative coverage of the site accounting for the historical site use, end use of the site and the immediate environmental setting.

#### 5.1.1 Soil Analysis

The nature and type of soil contamination potentially present on the site was considered to include, amongst others; organic matter, ash and fill, hydrocarbons (e.g. fuel oils), heavy metals and asbestos the extent of which is captured by the broad environmental testing suite listed in Table 5.1.1 below.

**Table 5.1.1** Environmental Chemistry Analysis Suite: Soils

Suite Ref	Analysis	LOD	Suite Ref	Analysis	LOD
S1A	Asbestos Screen		S1B	pH	
	pH			Soil Organic Matter	
	Soil Organic Matter			Arsenic	5 mg/kg
	Arsenic	5 mg/kg		Boron (water soluble)	1 mg/kg
	Boron (water soluble)	1 mg/kg		Cadmium	0.5 mg/kg
	Cadmium	0.5 mg/kg		Chromium	5 mg/kg
	Chromium	5 mg/kg		Chromium VI	5 mg/kg
	Chromium VI	5 mg/kg		Copper	5 mg/kg
	Copper	5 mg/kg		Lead	0.1 mg/kg
	Lead	5 mg/kg		Mercury	5 mg/kg
	Mercury	0.1 mg/kg		Nickel	5 mg/kg
	Nickel	5 mg/kg		Selenium	5 mg/kg
	Selenium	5 mg/kg		Zinc	10 mg/kg
	Zinc	5 mg/kg		Cyanide (total)	200 mg/kg
	Cyanide (total)	10 mg/kg		Sulphate (total)	2 mg/kg
Sulphate (total)	200 mg/kg	Sulphide	20 mg/kg		
Sulphide	2 mg/kg	Sulphur (elemental)	1 mg/kg		
Sulphur (elemental)	20 mg/kg	Phenols (screen)	0.1 mg/kg		
Phenols (screen)	1 mg/kg	PAH's (USEPA16)	0.01 mg/kg to 0.01 mg/kg		
PAH's (USEPA16)	0.1 mg/kg	TPH (Total)			
TPH (CWG Banding - Aro/AlI Split)	0.01 mg/kg to 0.1 mg/kg				

Soil samples were taken from the shallow made-ground deposits in each of the three cable percussion borehole locations as well as the machine excavated trial pits (TPC1 to TPC4) and tested for Suite S1a. Soil samples were also taken from the deeper natural soils (BH1 and BH3) or made-ground soils (BH2) and tested for Suite S1b.

Copies of the environmental chemistry testing certificates can be referred to in Appendix A4 of this report.

**5.1.2 Groundwater Analysis**

Minimal groundwater ingress was encountered on advancement of boreholes and therefore groundwater sampling was not undertaken during the fieldwork.

Groundwater sampling and analysis was not scheduled on return monitoring following receipt and appraisal of the soil analysis results detailed herein.

**5.2 Geotechnical Testing**

A programme of geotechnical testing was scheduled in order to develop the ground model for the site.

Geotechnical samples representative of the main soil types encountered on site were tested for the suites detailed in Table 5.2 below.

**Table 5.2 Geotechnical Analysis Suite**

Suite Reference	Geotechnical Analysis
G1a	Natural moisture content (BS 1377-2: 1990 Clause 3.2)
G1b	Atterberg limits (BS 1377-2: 1990 Clauses 4.3 and 5)
G1c	Particle size distribution (BS 1377-2: 1990 Clause 9.2)
G1d	Water soluble sulphate & pH (BS 1377-3: 1990 Clauses 3, 5.2, 5.5, 7.2 & 9)
G1e	Multistage undrained triaxial (BS 1377-7: 1990 Clause 9) with cell pressure of overburden x 0.5, 1 and 2

## 6.0 Ground Conditions

The revealed site geology was consistent with the anticipated geology and historical use of the site with the generalised geological succession is summarised in Table 6.0 below.

**Table 6.0** Summary of Generalised Geological Succession

Strata	Depth Range (m bgl)	Description
MADE GROUND	0.00 to 3.70	<p><i>Across the New Central Library &amp; Digital Media Centre site:</i></p> <p>Predominantly granular (gravels) with cohesive (clay) inclusions or full lenses, typically at shallower depths.</p> <p>Silty, sandy, cobbly occasionally bouldery (brick fill or demolition arisings)</p> <p>Local and occasional obstructions, e.g. relic brick walls or concrete slabs.</p> <p><i>Across the car park site:</i></p> <p>As above but without obstructions and including a band (0.40m to 0.70m thick) of suspected ballast (brown to dark brown, ashy, silty, sandy gravel of flint, quartzite, sandstone and brick)</p>
CLAY	1.10 to 18.50	<p><i>Across the New Central Library &amp; Digital Media Centre site:</i></p> <p>Firm to very stiff becoming stiff or hard respectively, sandy, gravelly, cobbly occasionally bouldery. Infrequent sand lenses.</p> <p>Soft to firm (BH3 only; 5.00m to 5.50m).</p> <p>Silt band (BH1 only; 7.10m to 8.50m)</p>
SAND	3.00 to 4.00	<p><i>Across the car park site:</i></p> <p>Silty, gravelly, sand with occasional shell fragments (TPC1) and hydrocarbon odour (TPC2). Possible made-ground.</p>

## 6.1 Made-Ground

Made-ground deposits were encountered in all exploratory hole locations to a maximum depth of 3.70m bgl. The made-ground deposits are broadly consistent with demolition arisings, predominantly granular silty, sandy, gravelly, cobbly brick fill and with local and occasional obstructions, e.g. relic brick walls and concrete slabs. Where present, gravel comprises; angular brick, concrete and sandstone.

As part of the machine excavated trial trench investigation as well as relic brick wall and concrete slabs, relic pile caps and relic piles were revealed across the development site associated with the former Woodhave House building.

The co-ordinates of all revealed piles and buried obstructions encountered as part of the trial trenching investigation are presented in Appendix A2.

Within the car park site a limited (0.40m to 0.70m) band of suspected ballast was encountered at the base of the made-ground deposits.

With the exception of grey mottling and a hydrocarbon odour within the made-ground soils of TPC2, within the car park site, no olfactory or visual evidence of free product contamination was noted within the made-ground deposits.

## 6.2 Natural Deposits

**Superficial** deposits were encountered beneath the made-ground deposits, in the majority of exploratory hole locations excluding TPC3 and TPC4 within the car park site.

The superficial deposits were predominantly cohesive in nature, generally consistent across the development site and comprised; initially firm to very stiff, becoming stiff to hard brown to dark grey sandy gravelly clay with infrequent sand lenses

**Bedrock** deposits were not encountered within any exploratory hole locations

No visual evidence of contamination, e.g. staining, was noted within the natural soils.

Olfactory evidence of contamination (hydrocarbon odour) was noted within the sand deposits of TPC2.

## 6.3 Groundwater

On advancement of the cable percussion boreholes groundwater strikes were recorded as detailed in Table 4.2a within Section 4.2. On return monitoring visits groundwater levels were recorded between 2.89m (BH1) and 8.13 (BH3).

No groundwater ingress was recorded on advancement of the machine excavated trial pits.

## 7.0 Geochemical Ground and Groundwater Assessment

### 7.1 Overall Assessment

The Summary Phase 1 Desk Top Study presented in Section 2.0 revealed an overall, 'Moderate to Low' level of potential risk to the end user.

A strategy for a Phase 2 Ground Investigation was consequently developed with reference to this information, the initial conceptual site model and the development use as 'Commercial'.

The ground investigation was undertaken in order to provide an assessment of the ground conditions on the subject site with respect to potential contamination in the underlying soils and the risk from soil gases.

This section of the report includes the assessment of the potential contamination, solid, liquid and gas, identified on the subject site which may present a risk to the end users, associated utilities and the wider environment.

Curtins use a tiered approach in assessing the risk from potential contamination, such assessment being based on the known history of the site as determined by the desk study in conjunction with observations made during the ground investigation. This assessment is based solely on the results of the chemical and other testing data obtained as part of Curtins Consulting's investigation.

Under the Contaminated Land (England) Regulations 2000 a Local Authority has from time to time to survey the land within its boundaries to identify "Contaminated Land". This is land "in such condition, by reason of substances in, on, or under the land, that: significant harm is being caused, or pollution of controlled waters is being or likely to be caused".

In guidance published by the Environment Agency, the risk to end users or controlled waters is determined through an assessment of pollutant linkages between a source of contamination and a sensitive receptor such as house occupants, plants grown in gardens or groundwater abstracted for drinking. This is termed a source-pathway-receptor relationship.

With respect to this investigation the source is taken as being a point or area of contamination within the ground. The pathway is a mechanism by which the contamination could reach the receptor.

For instance this could be through eating contaminated soil or plants contaminated through taking up contamination in the soil through their roots, inhaling contaminated dust or drinking contaminated water. Other pathways include directly causing degradation of buried building materials such as plastic or concrete. Further indirect pathways include groundwater transporting contamination to a groundwater abstraction point or to a river or stream and thus causing it to become polluted.

In order to assess whether a potential pollutant linkage is significant with respect to human health, the Environment Agency and the Department of the Environment, Food and Rural Affairs (DEFRA),



published in 2002 guidance referred to as the Contaminated Land Exposure Assessment Model (CLEA). The software originally developed with this model was withdrawn in October 2006 and subsequently reissued in January 2009 (CLEA v1.04).

A model for assessing the potential for pollution of controlled waters and for deriving a safe concentration in ground and groundwater is the Environment Agency's publication "Remedial Targets Methodology - Hydrogeological Risk Assessment for Land Contamination".

These models have a common approach, which is one of a tiered assessment. At each stage of the assessment further detail can be applied to the model to provide a detailed interpretation on a site by site basis. This is to determine whether the criteria are being met to prevent contamination of controlled waters and to protect human health and the environment.

This assessment is the first tier in the process. It is a comparison between various sets of generic criteria and the result of testing from the investigation. Where available these criteria are drawn from the CLEA guidance itself in the form of Soil Guideline Values (SGV's).

These values have been derived from lengthy research applying knowledge of the toxicity and carcinogenicity of substances and the mechanism by which each acts in the environment.

To date there are SGV's published for only eleven determinands and consequently Curtins Consulting utilise Generic Assessment Criteria (GAC's) to supplement these for the Tier 1 assessment as shown in Appendix A6 of this report.

Currently, within the UK, there are no Tier 1 assessment values published by regulatory bodies for a wide range of organic compounds, petroleum hydrocarbons, volatile and semi-volatile compounds. Therefore other guidance may be referred to, for example the TPH Criteria Working Group series of documents, the LQM/CIEH and EIC/AGS/CL:AIRE published thresholds.

In relation to the standards for controlled waters, there are currently no generic groundwater standards or surface water standards that are necessarily applicable to all sites.

However, dependant on the receptor identified as being at risk, the Surface Water (Abstraction for Drinking Water) and or the Environment Agency's national Environmental Quality Standards (EQS's) are considered appropriate (and are considered acceptable to the Regulators) and are used in this Tier 1 assessment.

In addition, and in particular where the groundwater or surface water could not be found or sampled in sufficient quantity, a soil leaching test (BS EN 12457:2002) can be undertaken to provide a preliminary assessment of the potential for contaminants in the soil to pollute ground or surface water. The results are compared, again dependant on the receptor identified as being at risk, against the EA EQS's and or UK Drinking Water Standards.

Once contaminants of concern have been identified by the Tier 1 assessment, qualitative and or quantitative risk assessments maybe undertaken to determine whether a viable source-pathway-receptor linkage is present.

The main end use (New Central Library & Digital Media Centre) of the site is directly accounted for by published UK guidance; the end uses currently being defined as a) residential with home-grown produce b) allotments and c) commercial.

## **7.2 Site Soils**

As discussed previously, three cable percussion boreholes and six machine excavated trail pits were advanced across the development site. Soil samples were taken from the shallow made-ground deposits in each of the three cable percussion borehole locations as well as the machine excavated trial pits (TPC1 to TPC4, TP12 and TP14) and tested for Suite S1a. Soil samples were also taken from the deeper natural soils (BH1 and BH3) or made-ground soils (BH2) and tested for Suite S1b.

As discussed within the previous section, the environmental chemistry results have been compared with the Tier 1 criteria for soils with respect to human health for the intended 'Commercial' end use. The results of the environmental testing can be referred to in Appendix A4. Copies of the Tier 1 thresholds are contained within Appendix A5.

In the absence of direct readings soil organic matter (SOM) has been conservatively estimated as 1.0%.

With respect to the end use of the site Tier 1 thresholds have not been exceeded within either; the shallow made ground site soils, the deeper made-ground soils or the underlying natural soils (BH1 and BH3). Consequently, the risk presented by the made-ground soils to human health is considered to be low.

It is recommended that construction workers are to be provided with appropriate PPE and sanitary facilities with reference to the contaminants of concern observed in the site soils.

### **7.2.1 Waste Classification**

An preliminary assessment for the waste classification of the site soils encountered on site has been conducted both through an appraisal of the environmental chemistry results and using the Waste Soils Characterisation Assessment Tool, Cat-Waste<sup>Soil</sup>, developed by McArdle and Atkins. The first stage of assessment comprises a comparison of the soil analysis results against Tier 1 thresholds for 'Residential without Homegrown Produce' to determine the likelihood of soils being inert or greater. Subsequently and where necessary, the Cat-Waste<sup>Soil</sup> tool gives a rapid assessment of contaminated soils and their classification as either hazardous or non-hazardous waste.

The preliminary classification of the main materials is presented in Table 7.2.1 below.

**Table 7.2.1 Waste Classification of Materials**

Stratum	Preliminary Classification	
	Stage 1: Based on appraisal of soil analysis results	Stage 2: Based on Cat-Waste <sup>Soil</sup> assessment
Made-ground	Inert (3) <sup>1</sup>	N/A
Natural Drift	Inert (2) <sup>1</sup>	N/A

Note 1: Brackets denote dataset size.

Further WAC environmental analysis of the shallow soils encountered during the redevelopment of the site will need to be carried out to confirm the above classifications if the material is to be taken off site.

It should be noted that the preliminary waste classification is undertaken to offer indicative advice with respect to disposal requirements. Landfill operators are not obliged to accept waste and, if they were to do so, may have specific requirements beyond those outlined above prior to acceptance.

### 7.3 Controlled Waters

On advancement of the cable percussion boreholes groundwater strikes were recorded as detailed in Table 4.2a within Section 4.2.

On return monitoring visits groundwater levels were recorded between 2.89m (BH1) and 8.13 (BH3).

No groundwater ingress was recorded on advancement of the machine excavated trial pits.

Groundwater sampling was not scheduled given the low levels of potential contamination determined within the site soils (made-ground and natural) and the lack of evidence of contamination within the waters. It is therefore considered that the risk to the underlying Secondary A aquifer and the nearest surface water feature (the River Tyne, 44m west of site) is Low for these reasons and given the lack of nearby potable abstractions and the fact the site is not located within a Source Protection Zone.

## 7.4 Soil Gases

### 7.4.1 Asphyxiant, Noxious or Explosive Gases

Standpipe installations were incorporated in all three cable percussion borehole locations as detailed in Table 4.2 in Section 4.

An initial programme of six gas monitoring visits over three months was proposed. To date, all six gas monitoring visits has been completed on the following dates: 17 February 2014, 06 March 2014, 14 March 2014, 02 April 2014, 07 April 2014 and 16 April 2014.

A summary of the soil gas monitoring results to date is presented in Tables 7.4.1 below and copies of the log sheets presented in Appendix A5.

**Table 7.4.1** Summary of Soil Gas Monitoring Results

Borehole Reference	CO <sub>2</sub> Range (% vol/vol)	Max GSV (l/hr)	CH <sub>4</sub> Range (% vol/vol)	Max GSV (l/hr)
BH1	0.0 to 0.2	0.0002	< 0.1	<0.0001
BH2	< 0.1	<0.0001	< 0.1	<0.0001
BH3	0.0 to 0.2	0.0002	< 0.1	<0.0001

A maximum concentration of carbon dioxide of 0.2% vol/vol was determined whilst a maximum concentration of methane less than 0.1% vol/vol. was determined.

No hydrogen sulphide or carbon monoxide was detected.

A maximum absolute soil gas flow rate of less than 0.1l/hr was determined.

Barometric pressure was recorded between 1002mb and 1020mb across the monitoring visits with four falling pressure events.

**Considering potential on-site gas generating sources:** The gas generation potential of the made-ground soils is considered to be low based on the stratum description but accounting for its nature (demolition fill) that may contain limited amounts of timber.

**Considering potential off-site gas generating sources:** The Desk Study revealed no Environment Agency (EA) or British Geological Society (BGS) recorded landfill sites, historic or currently operational, within 250m of the site. Alluvial deposits and made-ground soils surrounding the site are therefore identified as the main, off-site potential sources the gas generation potential of which, in the absence of specific data, is considered to be moderate to low.

**Considering the ground model (potential pathways):** Demolition fill is recorded across the entire development site underlain by cohesive soils. Consequently, the pathways along which gases may potentially migrate are considered to be short and direct (direct gassing of made-ground soils into sub-floor space).

**Considering the end use of the site (potential receptors):** The commercial end use is of a low sensitivity with potentially long exposure durations albeit within predominantly large internal air spaces.

Considering both a 'worst credible scenario' (maximum 'absolute' flow rate, maximum gas concentration within a single borehole location) and 'worst possible scenario' (maximum 'absolute' flow rate, maximum gas concentration across all borehole locations) the Gas Screening Values (GSV) for the site are evaluated as 0.0002 (carbon dioxide) and <0.0001 (methane).

Considering the gas monitoring results to date gas protection measures are not considered necessary within the development.

#### **7.4.2 Radon**

Both the Radon Atlas for England and Wales and the Envirocheck report (presented as part of the Phase 1 Desk Study) confirm that the site is in an area where less than 1% of homes are affected by radon. No radon protective measures are therefore considered necessary in the construction of new dwellings or extensions.

## 8.0 Geotechnical Assessment

### 8.1 Structural Design Details

Development proposals comprise the construction of South Shields New Central Library & Digital Media Centre as well as associated car parking and a pedestrian link. The Existing market place will also be remodelled and a new market stall canopy structure erected. For the Central Library & Digital Media Centre unfactored loads of 4000kN and 2500kN have been estimated for the perimeter and internal columns respectively.

A copy of the development plan for the site can be referred to within Appendix A1.

### 8.2 Ground Conditions

Made-ground deposits consistent with recent demolition arisings were encountered across the development site to comparable depths (max. 3.70m bgl). Across the car park site similar made-ground deposits were encountered albeit underlain by older, suspected ballast consistent with the site's history; glass works and the fringes of railway sidings.

The calorific value of the made-ground soils was tested in one location (BH1) where burnt shale, coal and clinker were encountered and confirmed to be <1.0MJ/kg.

No evidence of the made-ground soils having been re-engineered (specific compaction regime) was noted and occasional, local obstructions were noted consistent with both historical uses of the site (relic, brick basement walls) and more recent use of the site (relic pile caps and concrete slabs).

Underlying the made-ground soils drift deposits (predominantly cohesive) were encountered to a maximum depth of 18.50. Plasticity testing on the natural clay deposits indicates that they are of low plasticity and predominantly fine grained with >90% of the sample mass passing 450µm in the majority of samples.

No bedrock deposits were encountered.

Results of the in-situ standard penetration testing (SPT) broadly confirmed the field observation with 'N' values generally increasing down the soil profile as illustrated on the SPT Results Presentation sheet presented in Appendix A2 and within Table 8.2.

The predominantly cohesive nature of the shallow site soils lends itself of an estimation of undrained shear strength ( $c_u$ ) and compressibility ( $m_v$ ) from SPT under Stroud's (1974) and Stroud and Butler's (1975) empirical relationships. The empirical workings are informed by an understanding of the soils plasticity, site history and local geology. Plasticity testing results confirm a low volume change potential.



Consequently, based on average, uncorrected N values the undrained shear strengths ( $c_u$ ) and coefficients of volume compressibility ( $m_v$ ) can be estimated as detailed in Table 8.2.

**Table 8.2** Estimated Geotechnical Parameters (based on Stroud, 1974 and Stroud & Butler, 1975)

Depth (m)	Mean 'N' values $\pm$ standard error	$c_u$	$m_v$
1.00	19 $\pm$ 9	Granular made-ground	Granular made-ground
3.00	42 $\pm$ 4	252 kN/m <sup>2</sup>	25200 m <sup>2</sup> /MN
5.00	41 $\pm$ 5	246 kN/m <sup>2</sup>	24600 m <sup>2</sup> /MN
7.00	45 $\pm$ 5	270 kN/m <sup>2</sup>	27000 m <sup>2</sup> /MN
9.00	35 $\pm$ 3	210 kN/m <sup>2</sup>	21000 m <sup>2</sup> /MN
11.00	38 $\pm$ 6	228 kN/m <sup>2</sup>	22800 m <sup>2</sup> /MN
13.00	50 $\pm$ 0	300 kN/m <sup>2</sup>	30000 m <sup>2</sup> /MN
15.00	50 $\pm$ 0	300 kN/m <sup>2</sup>	30000 m <sup>2</sup> /MN
17.00	50 $\pm$ 1	300 kN/m <sup>2</sup>	30000 m <sup>2</sup> /MN
18.00	50	300 kN/m <sup>2</sup>	30000 m <sup>2</sup> /MN

The estimated undrained shear strengths correspond with 'stiff' to 'very stiff' cohesive soils.

It should be noted that these values are based on averaged N values without consideration of the effects of overburden.

The estimations of undrained shear strength were broadly consistent with the shear stresses determined through the multi-staged triaxial testing undertaken within the clay soils the results of which are presented within Appendix A4 together with all other laboratory testing certificates.

Two U100 samples (BH1 at 6.00m and BH2 at 14.00m) failed prior to sampling due to the presence of silt laminations and cobbles.

## 8.3 Foundation Design

On the basis of observations made on site together with results of in-situ and laboratory test it is considered that the natural clay deposits would be considered favourable for founding upon however, given the anticipated loadings and the depths to which spread foundations would need to be extended a piled foundation solution will likely provide a more economic foundation solution for the New Central Library & Digital Media Centre.

### 8.3.1 Piled Foundations

**Pile Type:** In light of the ground conditions revealed either a driven or bored piled solution is considered technically feasible within the development.

**Potential Constraints:** The proximity of nearby structures may preclude the use of a driven system owing to undue vibration and noise. Additionally, as part of the enabling works consideration should be given to the presence of below ground obstructions including; relic piles, relic brick structures and relic concrete slabs. Investigations into the presence of relic piles were undertaken as part of the fieldworks operations with around 30 piles located, of a total in the region of 100. During this investigation the presence of additional, potential obstructions was identified. Consequently, where feasible, these below ground obstructions should be pre-dug and removed from site or else, for the existing piles, located and recorded to facilitate the installation of the proposed piles and avoid clashes respectively.

**Temporary Casing:** Owing to the presence of perched groundwater lenses within the natural clay deposits it is recommended that bored piles are cased throughout. Alternatively, the adoption of Continuous Flight Auger (CFA) or Continuous Helical Displacement (CHD) piles would likely negate the need for casing.

**Chiselling:** Very stiff to hard clay deposits were determined within all cable percussion borehole locations and therefore allowance should be made for chiselling these deposits to achieve design depths.

**Design Criteria:** Reference should be made to Table 8.2 and the appended geotechnical testing results to finalise design criteria. It should be noted that the design procedure for piles varies across the pile types within an ever evolving discipline. It is therefore recommended that the advice of a specialist contractor is sought to confirm design criteria.

**Environmental Risk Assessment:** Given the low levels of potential contamination determined within the site shallow soils and the termination of the piles within the clay deposits the risk associated with preferential pathways being created through the use of a piled foundation solution.

#### **8.4 Ground Floor Slabs**

In their current condition the sub-grade (made-ground) is not considered suitable for founding upon due to the potential for undue total and differential settlement. Consideration should therefore be given to the adoption of suspended ground floor slabs. Alternatively, consideration could be given to improving the ground as part of the enabling works, e.g. site turnover and re-compaction of either site-won or imported granular material achieving an agreed grading specification.

#### **8.5 Settlement and Heave Considerations**

Considering the predominantly granular nature of the made-ground soils ground heave will not be a significant issue and therefore there doesn't appear to be a requirement to incorporate heave protection measures in the design of pile/beam foundations.

Furthermore, the plasticity of the natural clay deposits has been shown to be either at or less than 20% and therefore the potential for heave will be limited and pile design undertaken accordingly.

#### **8.6 Excavations**

General advice on excavation support is given in CIRIA Report No 97: Trenching Practice. On the basis of observations on site, together with the results of in-situ and laboratory tests, it is considered that some excavations are unlikely to stand unsupported in the short term.

Side support for safety purposes should be provided to all excavations which appear unstable, and those in excess of 1.20m deep, in accordance with Health and Safety Regulations. Excavations below 1.20m requiring personnel access will require closed side support.

Groundwater should not be expected in excavations for foundations or services and if and where encountered pumping is considered to be a suitable control measure. The presence of water bearing granular lenses was noted within 3.00m depth of the site surface and where revealed, pumping should be avoided to reduce loosening of the surrounding soils. Whilst unlikely, the use of well-pointing may need to be considered as an alternative de-watering strategy.

General advice on de-watering is given in CIRIA Report No C515: Groundwater Control.

## 8.7 Concrete Design

In accordance with BRE Special Digest 1 the site has been classified as brownfield land that is unlikely to contain pyrite and laboratory testing undertaken accordingly on both the made-ground and underlying natural strata.

The results of chemical tests in the made-ground soils indicate an average sulphate concentration in the soil of 243mg/l as a 2:1 water/soil extract with pH values in the range of 8.2 to 12.0.

The results of chemical tests in the natural clay soils indicate an average sulphate concentration in the soil of 172mg/l as a 2:1 water/soil extract with pH values in the range of 8.4 to 9.0.

On the basis of site observations it is considered groundwater be considered nominally mobile and consequently, based on the laboratory results presented above a Design Sulphate Class for the site shallow soils may be taken as DS-1 with an Aggressive Chemical Environment for Concrete (ACEC) class for the site of AC-1.

It is recommended that no significantly disturbed clay is placed against foundations.

## 8.8 Roads and Hardstanding Design

On the basis of site observations California Bearing Ratio (CBR) testing was not conducted across the New Central Library & Digital Media Centre site owing to the presence of boulders and the high cobble content likely to have skewed the results.

Across the adjacent car park site CBR testing was conducted in 4 no. locations (TPC1 to TPC2) at depths of between 0.50m and 0.60m below ground level and values recorded in the range of 19% to >37%. Owing to the presence of cobbles and to a lesser extent, boulders within the made-ground soils it is recommended that a value of no greater than 10% is adopted for preliminary design purposes.

Generally, any areas of soft or deleterious material in the site shallow soils should be excavated and replaced with a properly compacted granular fill.

Furthermore, it is recommended that the sub-grade (made-ground) be regarded as frost susceptible and therefore, in their current condition, a minimum of 450mm sub-base required within the pavement construction.

### **8.9 Water Supply Pipes**

With reference to the UKWIR publication 'Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites' document reference 10/WM/03/21 advice is given on the appropriate materials for these ground conditions.

The low levels of potential contamination do not indicate the presence of adverse toxic, corrosive or organic conditions within the made-ground soils on site.

It is therefore recommended that all construction materials may be adopted for water supply pipes.

The exact requirements are to be confirmed with the relevant utility supplier.

### **8.10 Soakaways**

Infiltration testing was not conducted as part of the ground investigation. Notwithstanding, the provision of soakaways is not considered viable given the presence of cohesive natural soils that are anticipated to have poor infiltration potential. Furthermore, the sand lens identified within BH1 is considered to be an isolated pocket and therefore suitable as a drainage site.

## 9.0 Pre-Remediation Constraints and Outline Remediation Strategy

This section of the report describes general constraints to development currently thought to exist on the site of interest.

### 9.1 Invasive Plants

The presence of the invasive plants, Japanese Knotweed and or Giant Hogweed, was not apparent during the fieldwork.

### 9.2 Services

Public Utility information has been obtained for the site.

### 9.3 Buildings and Hardstanding

The two development sites are currently clear with a former access point (hardstanding surface) and communications box present on the New Central Library & Digital Media Centre.

### 9.4 Land Condition and Outline Remediation

The revealed ground model is consistent with the development sites' former uses with demolition arisings present across both site areas.

The environmental chemistry results have been compared with the Tier 1 criteria for soils with respect to human health for the intended '*Commercial*' end use no exceedances recorded. Consequently, remedial action is not recommended.

The risk to the underlying Secondary A aquifer and the nearest surface water feature is considered to be Low considering: the low levels of potential soil contamination encountered within the site made-ground and natural soils and given the lack of nearby potable abstractions and the fact the site is not located within a Source Protection Zone.

The risk from ground gases is considered to be very low and consequently no gas protection measures recommended within the New Central Library & Digital Media Centre development.

The Radon Atlas for England and Wales confirms that radon protection measures are not required within the development.

## 9.5 Recommendations

The Phase 2 Ground Investigation has revealed overall lower risks to; end users of the site, controlled waters, construction materials and construction workers than those indicated by the Phase 1 Desk Study.

**Remedial Action(s):** The findings of the ground investigation indicate that no specific remedial action is recommended to mitigate against risk presented to end users or controlled waters.

**Gas Protection Measures:** The findings of the proposed six gas monitoring visits indicate that gas protection measures are not recommended within the New Central Library & Digital Media Centre development.

**Geotechnical Considerations:** Geotechnical advice is presented herein with recommendations made for a piled foundation solution. As part of the enabling works a reduced level excavation is recommended to remove the numerous below ground obstructions encountered during the ground investigation.

**Unexploded Ordnance:** The likelihood of encountering unexploded ordnance on both development sites is considered to be low either as a result of the proposed works (shallow excavations) or through an assessment based on available evidence. It is recommended that all operatives undertaking intrusive works are informed to the potential (low) presence of unexploded ordnance. The report does not recommend any special measures are adopted. Furthermore, in any event should unexploded ordnance be encountered on site the procedure is: *“stop work immediately, prevent access to the area and inform the police”*.

**PPE and Sanitary Facilities:** It is recommended that construction workers are to be provided with appropriate PPE and sanitary facilities with reference to the contaminants of concern observed in the site soils.

**Follow-on Reporting:** Whilst no specific remedial actions are recommended is recommended that a Developers Method Statement is produced to provide advice with respect to earthworks activities, imported soil specifications and, where necessary, materials management. Additionally, as detailed herein, consideration may be given to the production of an earthworks specification in support of the enabling works.