Part 2: DESIGN BASIS REPORT

This section of the report provides an interpretation of the findings detailed in Part 1, in the form of a ground model, and then provides advice and recommendations with respect to foundation options and contamination issues.

5.0 INTRODUCTION

It is understood that consideration is being given to the construction of ten two-storey dwellings in three blocks In addition new paths, car parking and small gardens are to be provided with each house. It is anticipated that the proposed development is likely to impose relatively light to moderate loadings.

6.0 GROUND MODEL

The previous desk study indicates that the site does not have a potentially contaminative history. On the basis of the fieldwork, the ground conditions at this site can be characterised as follows.

- A variable thickness of made ground is present to depths of between 0.3 m and 2.0 m;
- the made ground generally comprises black and brown silty sandy clay and clayey sand with extraneous material including limestone gravel, cobbles of sandstone and brick, fragments of coal, ash, clinker, tile, plastic wood and slate;
- beneath the made ground stiff sandy gravelly clay is present and was proved to extend to depths of up to 5.45 m;
- groundwater was not encountered;
- the contamination analyses have indicated that the ash and clinker scattered through the made ground contains elevated concentrations of arsenic, lead, total PAH and species thereof that that are of concern to a residential end use; and
- laboratory analysis has confirmed that fragments of corrugated cementitious boarding contain white (chrystile) asbestos.

7.0 ADVICE AND RECOMMENDATIONS

The ground conditions suggest that shallow and deep spread foundations should be suitable for the proposed buildings.

7.1 Spread Foundations

Plot Nos 7 to 10 (and possibly 5 and 6): Moderate width strip or pad foundations bearing on the firm Glacial Till should be placed at a minimum depth of 1.25 m, assuming that no restrictions are applied on planting of shrubs in the vicinity of foundations, and that a no planting zone is applied in accordance with Table 4 of NBHC Standards Chapter 4.2 (2014).

If trees are excluded within the zone of influence shown in Table 2 of the NHBC guidance, the minimum depth can be reduced to 0.9 m subject also to the further advice on new tree and shrub planting as detailed in the NHBC guidelines. Medium volume change potential has been adopted to remain conservative given the proximity of the more mature trees. The foundations may be designed to apply a net allowable bearing pressure of 150 kN/m^2. This value incorporates an adequate factor of safety against bearing capacity failure and should ensure that settlement remains within normal tolerable limits. The recommended bearing pressure takes account of the variable nature of the soils and any foundations should be nominally reinforced where they span clay and granular material to protect against differential settlement.

If trees are to be planted in close proximity to the new buildings founding depths should be deepened in accordance with NHBC guidelines and using the mature height of the tree. Medium shrinkability clay should be assumed.

Plot Nos 1 to 4 (and possibly 5 and 6): The deeper made ground in this area will prohibit shallow foundations but with the Glacial Till present at between 1.8 m and 2.0 m then consideration could be given to trench filled foundations bearing within the Glacial Till. A similar bearing pressure to the above may be adopted and the same restrictions in respect of NHBC guidelines will need to be provided for.

7.2 Retaining Walls

In order to level the site or to reduce its gradient, a retaining wall is proposed to be located roughly mid-slope. It is understood that consideration is being given to either traditional gravity or gabion basket retaining walls. The following parameters are suggested for the design of these retaining walls.

Stratum	Bulk Density (kg/m^3)	Effective Cohesion (c' – kN/m^2)	Effective Friction Angle (ϕ' – degrees)
Made ground	1700	Zero	27
Glacial Till	1950	Zero	25

7.3 Excavations

On the basis of the observations made on site, it is anticipated that shallow and moderate depth excavations within the Glacial Till are likely to remain stable in the short and medium term. Groundwater ingress may be expected in the medium to long term but conventional sump pumping techniques should be able to control such inflows.

However, if deeper excavations are necessary or if excavations are to remain open for prolonged periods it is recommended that provision be made for battered side slopes or lateral support. Where personnel are required to enter excavations, a risk assessment should be carried out and temporary lateral support or battering of the excavation sides considered in order to comply with normal safety requirements.

7.4 Ground Floor Slabs

For Block Nos 7 to 10, where trees will have been removed then the floor slabs may need to be suspended over a void in accordance with NHBC guidelines.

For the remaining blocks, where deep trench filled foundations are necessary then fully suspended floor slabs should be adopted.

7.5 Pavement Design

Pavements formed in the made ground should be designed on a California Bearing Ratio (CBR) value of 'less than 2 %'. Formation levels should be subject to a proof rolling exercise and any soft spots revealed should be excavated and replaced with suitably compacted granular fill or lean mix concrete. .

Where pavements are to be formed within the Glacial Till then a CBR value of 5 % may be adopted.

7.6 Effect of Sulphates

Low concentrations of soluble sulphate have been measured within the made ground and natural soils.

It is suggested that in the natural soils, buried concrete could be designed in accordance with Class DS-1 conditions of Table C2 of BRE Special Digest 1: SD1 Third Edition (2005). The measured pH conditions are mildly alkaline and on the basis of static groundwater conditions being assumed for buried concrete an ACEC classification of AC-1s may be adopted.

In any case, the guidelines contained in the above digest should be followed in the design of foundation concrete.

7.7 Disposal of Surface Water

The depth and nature of the cohesive essentially impermeable Glacial Till indicate that shallow soakaway drainage will not be possible for this site and surface water should be directed into the main pumped drainage system or indeed into Mearley Brook if the appropriate consents can be obtained.

7.8 Contamination Risk Assessment

The desk study findings indicate the site not to have had a potentially contaminative history as the site has apparently been woodland as far back as records are available. The results of the chemical analyses have indicated elevated concentrations of arsenic, lead and PAH within the samples of the made ground tested. The source of the contamination is considered to be the ash and clinker rich made ground.

The proposed residential end-usage of the site with domestic gardens represents a risk to end users from the contaminants measured. These risks, as well as groundwater and site workers are further assessed below.

7.8.1 End Users

Elevated concentrations of arsenic PAH and its carcinogenic constituent species have been measured within the made ground and are considered to represent typical post-war ash and clinker rich made ground. The use of such material was widespread in capping cohesive deposits during the 1960s and 1970s as it was an economical use of waste material. These concentrations are such that they pose a risk to human health. The affected material is of variable thickness and is widespread over the areas of the site proposed for gardens. At this

stage, it is recommended that it is removed from these relatively small areas and replaced or covered with certified clean imported material.

If covered, it is recommended at this stage that a cover of imported subsoil and topsoil of 600 mm in thickness should be specified to ensure successful plant growth, in accordance with recommendations from BRE[5]. It may be possible to reduce the final thickness of cover required, but this will need to be determined once final levels have been established and the concentrations of potential contaminants within the imported material are known.

In addition the presence of cementitious asbestos roofing has been confirmed and this material requires removal. Further there remains the potential for localised zones of oil stained soils to be present arising from illegal disposal; it would be prudent to allow a contingency for localised 'dig and dump' to deal with such pockets of contamination.

7.8.2 Groundwater

Groundwater has not been encountered within the investigation and is considered to be protected by the thickness of essentially impermeable Glacial Till. Further the risk posed to surface waters will be eliminated if the made ground is removed from garden areas and areas of soft landscaping.

7.8.3 Site Workers

Concentrations of potentially carcinogenic PAH have been measured in the soils that contain ash and clinker and chrysotile asbestos has been identified within the fragments of sheeting scattered over the site. Site workers should be made aware of the contamination and a programme of working should be identified to protect workers handling any soil. This would typically avoiding skin contact with the soil and providing facilities for workers to wash prior to consuming food or smoking in clean designated areas. In addition specialist advice should be sought in respect of the removal and disposal of the asbestos-cement fragments and boards. This may typically involve the hand-picking and double bagging of fragments during an initial site walkover during the early stages of site preparation. The method of site working should be in accordance with guidelines set out by HSE[6] and CIRIA[7] and the requirements of the Local Authority Environmental Health Officer.

7.8.4 Services

Consideration will need to be given to the protection of buried plastic services if they are to be laid within the made ground which contains ash and clinker. Such protective measures could comprise the over digging of the service trenches and their backfilling with clean material or the adoption of barrier pipe to provide protection for potable water supplies. Details of the proposed protection measures for buried services will in any case need to be approved by the EHO and the relevant service authority prior to the adoption of any scheme. It should be noted that it is possible that even if such ash and clinker rich material is to be removed from service trenches that barrier pipe may be required or that additional testing will need to be carried out to satisfy the Water Authority.

7.8.5 Invasive Species

Whilst the widespread presence of Japanese Knotweed and more localised presence of Himalayan Balsam were identified during the site investigation fieldwork, it is understood that the species have been eradicated by others and is therefore outside the scope of this

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5 BRE (2004) *Cover systems for land regeneration. Thickness of cover systems for contaminated land.* BRE pub 465

6 HSE (1992) HS(G)66 *Protection of workers and the general public during the development of contaminated land* HMSO

7 CIRIA (1996) *A guide for safe working on contaminated sites* Report 132, Construction Industry Research and Information Association

report.

7.9 Waste Disposal

Under the European Waste Directive, waste is classified as being either Hazardous or Non-Hazardous and landfills receiving waste are classified as accepting hazardous or non-hazardous wastes or the non-hazardous sub-category of inert waste in accordance with the Waste Directive. Waste classification is a staged process and this investigation represents the preliminary sampling exercise of that process. Once the extent and location of the waste that is to be removed has been defined, further sampling and testing may be necessary. The results from this ground investigation should be used to help define the sampling plan for such further testing, which could include WAC leaching tests where the totals analysis indicates the soil to be a hazardous waste or inert waste from a contaminated site. It should however be noted that the Environment Agency guidance WM3[8] states that landfill WAC analysis, specifically leaching test results, must not be used for waste classification purposes.

Any spoil arising from excavations or landscaping works, which is not to be re-used in accordance with the CL:AIRE[9] guidance, will need to be disposed of to a licensed tip. Waste going to landfill is subject to landfill tax at either the standard rate of £82.60 per tonne (about £150 per m^3) or at the lower rate of £2.60 per tonne (roughly £5 per m^3). However, the classifications for tax purposes and disposal purposes differ and currently all made ground and topsoil is taxable at the 'standard' rate and only naturally occurring soil and stones, which are accurately described as such in terms of the 2011 Order , would qualify for the 'lower rate' of landfill tax.

Based upon on the technical guidance provided by the Environment Agency it is considered likely that the soils encountered during this ground investigation, as represented by the eight chemical analyses carried out, would be generally classified as follows;

Soil Type	Waste Classification (Waste Code)	WAC Testing Required Prior to Landfill Disposal?	Comments
Made ground	Non-hazardous (17 05 04)	No	
Glacial Till	Inert (17 05 04)	Should not be required but confirm with receiving landfill	

Under the requirements of the European Waste Directive all waste needs to be pre-treated prior to disposal. The pre-treatment process must be physical, thermal, chemical or biological, including sorting. It must change the characteristics of the waste in order to reduce its volume, hazardous nature, facilitate handling or enhance recovery. The waste producer can carry out the treatment but they will need to provide documentation to prove that this has been carried out. Alternatively, the treatment can be carried out by an approved contractor. The Environment Agency has issued a position paper[10] which states that in certain circumstances, segregation at source may be considered as pre-treatment and thus excavated material may not have to be treated prior to landfilling if the soils can be segregated onsite prior to excavation by sufficiently characterising the soils insitu prior to excavation.

8 Environment Agency 2015. *Guidance on the classification and assessment of waste.* Technical Guidance WM3 First Edition
9 CL:AIRE March 2011. *The Definition of Waste: Development Industry Code of Practice* Version 2
10 Environment Agency 23 Oct 2007 *Regulatory Position Statement Treating non-hazardous waste for landfill - Enforcing the new requirement*