



Land at Midland Road, Royston For Kier Living Northern

Report no: 2321/3

Date: August 2017



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APPENDICES

Appendix A – Drawings

Drawing	Revision	Title
2321/1	-	Site location plan
2321/2	-	Proposed site layout
2321/3	-	Site features
2321/7	-	Revised conceptual site model
2321/8	-	Location of historical buildings

Appendix B – Lithos protocol for importation & use of soil cover

Appendix C – Lithos Tier 1 screening values

Appendix D – Protocol for the placement of non-engineered fill

REMEDIATION STRATEGY FOR LAND AT MIDLAND ROAD, ROYSTON

1 INTRODUCTION

1.1 The commission and brief

- 1.1.1 Lithos Consulting Limited have been commissioned by Kier Living Northern to prepare a Remediation Strategy for land off Midland Road, Royston.
- 1.1.2 Lithos have already issued the following report:
- *'Geoenvironmental Appraisal of land at Midland Road, Royston'*, Lithos Report No. 2321/2, dated June 2017
- 1.1.3 The appointed Remediation Contractor will need to familiarise themselves with the above Report, and comply with all relevant recommendations contained therein.
- 1.1.4 This document outlines the remediation objectives necessary to protect environmental receptors, and render the site suitable for the proposed development. A Method Statement should be prepared in order to detail how the objectives will be achieved.
- 1.1.5 The Method Statement should be accompanied by a Designer's Risk Assessment in accordance with the CDM Regulations, 2015. The Method Statement and Risk Assessment should be submitted to, and approved by the Engineer.

1.2 The proposed development

- 1.2.1 The proposed development comprises 77 traditional 2 and 3 storey domestic dwellings, associated gardens, POS and adoptable roads and sewers. A site layout has been provided by Geoff Perry Associates Ltd (Drawing ref. A729/01 Rev F, dated April 2017) which is reproduced as Drawing 2321/2 (a copy of which is presented in Appendix A).
- 1.2.2 The houses will be founded on strip or trench fill footings in firm to stiff clay or competent rock.
- 1.2.3 Access to the development will be from 'The Lane' to the east.
- 1.2.4 The Local Planning Authority have agreed planning permission for redevelopment of this site. There are several Conditions associated with remediation, most notably:
- Condition 14(iii): *"an appraisal of remedial options, and proposal of the preferred option(s)"*
- 1.2.5 This report has been prepared to satisfy the requirements of the above Condition.

2 Background

2.1 Site description

- 2.1.1 The site comprises a single parcel of land which is broadly rectangular in shape with two 'spurs' of land; one in the south-western corner and one in the east. The spurs are surfaced by tarmac, and comprise access points for the site.
- 2.1.2 Historically the site was occupied by a school which has recently been demolished.
- 2.1.3 Site details are summarised below.

Detail	Remarks
Location	5.5 km north east of Barnsley town centre
NGR	SE 362 116
Area	2.1 hectares (5.2 acre)
Known live services	Underground electrical, water and gas utilities

- 2.1.4 A location plan and current salient features are shown on Drawings 2321/1 and 2321/3 in Appendix A.

2.2 Ground investigation

- 2.2.1 Lithos' investigation comprised a desk study including review of historical and geological plans, and an intrusive investigation (22 trial pits and 5 rotary probeholes).

Made Ground

- 2.2.2 Made Ground was encountered across the site between 0.1m and 1.8m depth, typically to <1m.
- 2.2.3 This made ground is a heterogeneous mixture of materials but, the bulk of the made ground can be categorised as one of 5 broad types:
- **Made Ground Topsoil:** silty sand with gravel of limestone, mudstone, sandstone, concrete, brick etc encountered in 23 trial pits, typically 200mm thickness. Locally with gravel of tarmacadam and whole bricks.
 - **Ash & Clinker:** Restricted to beneath tarmac in south east of site. From 0.2m to 0.4m depth (average 0.35). Comprises ash sand with gravel of clinker and burnt shale.
 - **Cohesive Made Ground:** From 0.6m to 1.8m (TP11) depth (typically to 0.9m). Clay with some gravel of brick, sandstone, concrete and clinker.
 - **Granular Made Ground:** from 0.3m to 1.3m (TP07) depth (typically 0.9m). Predominantly sandy cobbles of sandstone, occasionally gravel of limestone and occasional tarmacadam, silty sand or sand
 - **Sub-Base:** From 0.3m to 0.7m depth (typically 0.5m). Sand with gravel of limestone, brick and concrete.
- 2.2.4 In addition, **tarmac** to 0.15m thickness was encountered in the south-east (area of former hard surfaced sports courts).
- 2.2.5 The excavation of two stockpiles in the far north west identified Made Ground Topsoil (sandy clay with variable amounts of anthropogenic material including half bricks, timber and cobbles of concrete).

Obstructions

- 2.2.6 No obstructions were encountered within any of Lithos' exploratory excavations; this suggests that former school building foundations have been removed.
- 2.2.7 However, it would be prudent to assume that some relict foundations/services may remain in place beneath the site, specifically within the footprints of former buildings.
- 2.2.8 The footprint of former buildings are shown on Drawing 2321/8 in Appendix A.

Natural ground

- 2.2.9 Natural ground was encountered in each of the exploratory holes, and typically comprised the following strata.
- **Topsoil:** silty sandy clay, recorded in 3 of the exploratory holes between 0.2m and 0.3m thickness
 - **Cohesive residual soil:** Stiff clay with gravel of sandstone encountered in the majority of exploratory holes up to 3m depth, typically to <2m
 - **Granular residual soil:** clayey gravel of sandstone recorded in 4 of the exploratory holes
 - **Coal Measures bedrock:** Sandstone with Mudstones and Siltstones
 - **Coal:** was recorded in TP113 between 1.1m and 1.4m depth and between 2.0m and 2.2m depth in PH201
- 2.2.10 Bedrock was encountered from 1.2m to 2.8m depth, typically from 1.5m depth, in the majority of the exploratory holes.
- 2.2.11 Trial pits were typically terminated in bedrock, with between 0.1m to 0.5m of penetration achieved with the backhoe excavator before refusal.

Groundwater

- 2.2.12 A minor seepage of groundwater was encountered within the Granular Made Ground in TP107 at 1.1m depth. All other excavations remained dry during excavation.

Mining

- 2.2.13 The site lies within a Low Risk Area.
- 2.2.14 A total of 5 deep probeholes were drilled to between 29m and 33m depth to determine whether the site is underlain by unrecorded shallow mine workings.
- 2.2.15 Neither the Royston Coal Seam nor any evidence of workings (voids, broken ground etc) were encountered in any of the deep probeholes. Consequently, surface stability is not considered to be at risk from the collapse of shallow mineworkings.
- 2.2.16 A thin coal was recorded between 1.1m and 1.4m depth in TP113 in the far east and between 2.0m and 2.2m depth in PH201 in the very far south-east of the site. This seam is not consistent across the site and is also considered to be of insufficient thickness and depth to have been worked by underground methods.

Hazardous gas

- 2.2.17 The Public Health England UK radon map and the Landmark report indicate that the site is in an area where between 5% and 10% of homes are estimated to be above the action level, and **basic** radon protection measures are required in new dwellings.
- 2.2.18 Potential sources of ground gas within close proximity to the site include:
- A former quarry, located 225m to the west,
 - A former landfill, recorded beyond the site's north eastern boundary
- 2.2.19 At the time of writing, monitoring is ongoing, and a hazardous gas risk assessment will be issued on completion of monitoring.

Contamination

- 2.2.20 Assessment of the site investigation data enabled formulation of a conceptual model, which is presented as Drawing 2321/7 in Appendix A.
- 2.2.21 Made ground underlies the majority of the site, which is typically less than 1.0m thick and predominantly comprises Granular Made Ground, Sub-base and Cohesive Made Ground.
- 2.2.22 This made ground is essentially 'clean', however, it contains materials (eg brick, concrete, timber), which would generally be considered undesirable as a near-surface material in garden areas.
- 2.2.23 Ash & Clinker was identified beneath an area of tarmac hardstand (former sports courts) in the south east, and is considered potentially combustible. It has also yielded elevated concentrations of Benzo(a)pyrene, and is considered to be potentially combustible.
- 2.2.24 In terms of the proposed redevelopment plausible pollutant linkages, and feasible remediation options, are summarised below:

Receptors	Pathways	Contaminants	Remediation options
Human health (Future residents) ◇	Ingestion	Hydrocarbons in the Ash & Clinker	Isolation of Ash & Clinker beneath 1,000mm clean cover or areas of hardstand. Or, Excavation and removal from site.
	Dermal contact		
	Inhalation (dust and/or vapours)		
	Infiltration of water supply pipes	hydrocarbons in the Ash & Clinker	Excavation and removal from site, isolation beyond areas of proposed water pipes. Water company may still insist of "protectaline" pipework
Buildings	Migration & accumulation of explosive gas	Methane	Gas monitoring ongoing
	Contact with "aggressive" soil and/or groundwater	Sulphate in natural & made ground	Design sulphate class DS-1, ACEC classification of AC-1 for sub-surface concrete
Sulphate in the Ash & Clinker		Design sulphate class DS-2, ACEC classification of AC-2 for sub-surface concrete	
Groundwater	Surface water run-off	hydrocarbons in the Ash & Clinker	Isolation of Ash & Clinker beneath 1,000mm clean cover or areas of hardstand. Or, Excavation and removal from site.

◇ transient risks to construction workers will be addressed by the adoption of appropriate health and safety measures in accordance with the Health and Safety at Work Act 1974 and regulations made under the Act including for example the COSHH Regulations.

3 RISK ASSESSMENT & TARGET CONCENTRATIONS

- 3.1 Clean-up criteria relevant to the limited contamination encountered at this site are not driven by risks to controlled waters, therefore in the absence of a site-specific Quantitative Risk Assessment, it is conservatively proposed that Lithos' generic soil screening values for a residential-with-gardens end use (assuming gardens with 600mm clean soil cover) be adopted as remedial targets for hydrocarbon contamination in soils on this site.
- 3.2 Information on the derivation and use of these screening values is presented in Appendix C.

4 EARTHWORKS LEVELS, REGRADE & ANTICIPATED FOUNDATIONS

- 4.1.1 The Geoenvironmental Appraisal Report (Report 2321/2, dated June 2017), indicates that all plots will be founded on conventional footings either on residual soils (clays, gravels) or in bedrock.
- 4.1.2 The foundation solution outlined above assumes that ground levels would not change significantly from those existing at the time. However, final site levels will be determined by Kier Living, in conjunction with their Earthworks Contractor and Engineering Designer.
- 4.1.3 Any digital terrain modelling undertaken by the Earthworks Contractor should be designed with a view to enabling a "materials balance" (i.e. volume of cut to broadly equals the volume of fill), and be made available to Kier Living's Engineering Designer. The digital terrain modeller should consider:
- Whether or not processed arisings/treated soils are retained on site
 - The thickness of the soil cover required in garden areas
 - Implications for foundations (i.e. Those indicated in the geoenvironmental appraisal report may no longer be the most appropriate)
- 4.1.4 Final site levels should then be issued by the Engineering Designer, via an External Works Drawing, which should show:
- Proposed finished floor levels
 - Proposed finished road levels
 - Garden & driveway levels and gradients

5 REMEDIATION STRATEGY (General)

5.1 Aims

5.1.1 Remediation aims are to:

- Resolve contamination issues in order to protect environmental receptors, and render the site suitable for the proposed development
- Provide a stable development platform (to agreed levels and gradients) for subsequent construction of the proposed development and associated infrastructure
- Satisfy requirements of the Local Planning Authority and the National House Building Council (NHBC)

5.2 Overview

5.2.1 The following remediation works are required:

- General site clearance of surface materials and vegetation
- Topsoil strip and stockpile, with screening to remove unsuitable materials (oversize, timber etc) where necessary
- Break-up of tarmac hardstand with crushing for re-use or removal from site
- Excavation of Ash & Clinker with isolation beneath hardstand, a minimum 1,000mm clean cover in garden/landscaped areas, or export from site
- General site re-grade to provide a suitable development platform
- Provision of a minimum 300mm thick cover layer of 'clean' soils in all garden and landscaped areas underlain by residual made ground

5.3 Site set-up, organisation and safety

5.3.1 Site cabins and welfare facilities are to be established at a location to be agreed with the Engineer. All welfare facilities must be established in accordance with the relevant health & safety statutory requirements.

5.3.2 All site personnel should undergo a site-specific health and safety induction prior to commencement of work on site.

5.3.3 Access into excavations etc. must be controlled and undertaken in accordance with the CDM Regulations 2015, most notably Regulation 22, to mitigate risk of collapse or asphyxiation.

5.3.4 During the remediation works, all personnel on site will comply with guidance provided in the Health and Safety Executive (HSE) document "Protection of Workers and the General Public during the Redevelopment of Contaminated Land". In summary, the following should be provided:

- Protective clothing, footwear and gloves. (Personnel should be instructed in why and how they are to be used)
- Hand-washing and boot-washing facilities
- Designated smoking areas

5.3.5 If at any time during the works personnel begin to feel unwell, they are to inform the Engineer, who will determine appropriate action.

5.3.6 All visitors to site must enter and register at the main Site Office.

5.4 Contractor's responsibilities

5.4.1 Prior to the commencement of any works the Contractor, in agreement with the Engineer, should:

- Comply with any requirements of Kier Living's contract documentation
- Establish the boundaries of the site and the working areas
- Undertake a dilapidation survey of site boundaries, adjacent properties and highways, via dated photographs or video footage
- Liaise with the Local Authority regarding working hours, noise/dust/odour control, and protected trees
- Complete a full services search and liaise with all relevant utility companies regarding work in close proximity to their apparatus
- Prepare a detailed Method Statement outlining how the objectives of this Remediation Strategy will be achieved (and obtain approvals)
- Inform the Engineer of any risk, identified and assessed, which could impact upon the Engineer's activities
- Prepare the necessary COSHH statements and Health & Safety Plan in accordance with CDM regulations

5.4.2 The Contractor should satisfy the Health & Safety Executive with regard to all matters concerning the health, safety and welfare of persons on the site.

5.4.3 The Contractor should ensure that:

- Personnel, plant, materials and other equipment related to the contract are confined within the boundaries of the site.
- Any live services lying within the site boundary are marked and protected, or appropriate arrangements made to truncate them.
- Good practices relating to personal hygiene are adopted.
- Suitable precautions are implemented at all times to prevent off-site migration of pollutants via airborne dust and vapours.
- Suitable precautions are taken to prevent the spread of mud and debris on public highways.
- Refuelling of mobile plant is undertaken in a designated area. Above ground oil storage tanks should comply with the requirements of Pollution Prevention Guideline PPG2. A spill kit should be kept on site, adjacent to the designated refuelling area. (Lithos are aware that some of the EA PPG documents have been withdrawn from the gov.uk website. However, PPGs provided a summary of current UK guidance; the principles are still relevant and provide a useful, concise overview).

5.5 Materials Management Plan

- 5.5.1 This project will involve the re-use of both natural and made ground soils on site. Therefore, the Contractor will need to prepare a Materials Management Plan (MMP) in accordance with the CL:AIRE Code of Practice (v2, March 2011).
- 5.5.2 The MMP will document how all of the materials to be excavated during the proposed site preparatory and remediation earthworks are to be dealt with. In summary, the MMP should provide:
- Details of the parties that will be involved with the implementation of the MMP
 - A description of the materials in terms of potential use and relative quantities of each category
 - The specification for use of materials against which proposed materials will be assessed, underpinned by an appropriate risk assessment related to the place where they are to be used
 - Details of where and, if appropriate, how these materials will be stored
 - Details of the intended final destination and use of these materials
 - Details of how these materials are to be tracked
 - Contingency arrangements that must be put in place prior to movement of these materials
 - Verification Plan
- 5.5.3 The MMP should include consideration of the following factors:
- Any risks posed by the excavated materials to both human health and the environment
 - Suitability for use
 - Certainty of use
 - Anticipated quantities of materials
- 5.5.4 The MMP should also detail how materials will be tracked throughout the earthworks in order that the subsequent Verification Report can provide an auditable trail. The tracking system must include:
- Annotated plans of the site(s) identifying different excavation areas, stockpile locations, treatment areas (if applicable) and placement locations
 - Inspection procedures
 - Registered waste carrier and non-waste haulier
 - Tracking form / control sheets
 - Treatment results (if applicable)
 - Delivery tickets for non-waste materials (if moving from one site to another)
 - Acceptance procedures for non-waste materials
- 5.5.5 Finally, the MMP will have to set out a Verification Plan that identifies how the placement of materials is to be recorded and the quantities of material to be used. It will contain a statement on how the use of the materials relate to the remediation or design objectives.
- 5.5.6 Once completed, the MMP will need to be reviewed by a Qualified Person (QP), who will sign a Declaration for submission to CL:AIRE and send a copy to Kier Living.

5.6 Engineering supervision and verification

- 5.6.1 Site works should be supervised throughout by a suitably qualified Engineer, who will report to a Project Manager. Supervision may be part-time for certain activities, but must be full-time during the removal of any grossly contaminated soil/fill (including the Ash & Clinker) and any placement of fill to an engineering specification.
- 5.6.2 The Engineer will ensure that the requirements of this Remediation Strategy are complied with in a safe and orderly manner.
- 5.6.3 The responsibilities of the Engineer should include, but not be limited to, the following:
- Ensuring that all site personnel are suitably qualified and given an appropriate induction at the beginning of their first day
 - Supervision of the remediation and ground preparatory works
 - Advice on the correct handling of materials and conditions encountered
 - Guidance on the appropriate protective clothing and safety equipment that is to be made available and used
 - Ensuring that personal hygiene arrangements are adequate
 - Retrieval of soil and water samples and the subsequent scheduling of appropriate laboratory analysis to enable verification of various aspects of the works, and to advise the Project Manager of progress
 - Liaison with statutory authorities as required
- 5.6.4 The Engineer will maintain records of the works to include the following:
- Daily record sheets to include a summary of the day's activities
 - Date and weather conditions
 - Plant, personnel and visitors present
 - Aspects relating to Health and Safety, Environmental Control, or non-compliance with either this Remediation Strategy or the Contractor's Method Statement
 - Site surveys as necessary to record the locations of demolition, excavation and filling activity
 - Test results
- 5.6.5 On satisfactory completion of all the works the Engineer will prepare a Verification Report, in accordance with CLR 11 '*Model Procedures for the Management of Land Contamination*'. Copies of the Verification Report will be issued to the Kier Living, the Local Authority and NHBC.
- 5.6.6 The Verification Report will stand as certification that the remediation and ground preparatory works have been carried out in accordance with this Remediation Strategy.

5.6.7 The Verification Report will include:

- A summary of the preparatory & remediation works undertaken, including any works associated with unforeseen ground conditions
- Verification test results associated with Ash & Clinker or "hot-spot" treatment, including plans showing sample locations & levels, and the extent of any Ash & Clinker or "hot-spot" excavations
- Details of the fate of any arisings excavated from areas of Ash & Clinker or any "hot-spot"
- Verification test results associated with proposed source materials for clean cover
- Moisture content and plate bearing test results associated with ground improvement beneath proposed highways
- Copies of any correspondence with Regulators relating to specific aspects of the remediation works
- Reference to the MMP and associated tracking system, including alterations made and why
- Reference to waste transfer documentation, including return loads (if applicable)
- Signed delivery tickets (if applicable)
- Record of quantity of materials used
- A signed copy of the Qualified Person's Declaration

5.6.8 The Verification Report will also provide recommendations with respect to:

- Foundation Solution(s)
- Gas Measures
- Placement of Soil Cover
- Handling of Contaminated Soils

5.6.9 The above recommendations will take account of the actual remediation works undertaken, and may differ significantly from recommendations originally presented in the site investigation report.

6 REMEDIATION STRATEGY (specific objectives)

6.1 Contingency for unknowns

- 6.1.1 Even after an appropriate preliminary investigation and ground investigation, with exploratory holes on a closely spaced grid (say trial pits at 30m centres), a geoenvironmental appraisal is typically based on inspection of the ground underlying less than 0.5% of the total site area (and much less at depths in excess of about 3.5m). Consequently, there is always a possibility that unanticipated ground conditions will be encountered during the remediation works.
- 6.1.2 If unanticipated ground is encountered during the remediation works, the Contractor should immediately seek further advice from the Engineer.
- 6.1.3 In order to assess the nature of any unanticipated grossly contaminated soil/fill, and (if necessary) allow revision of this Strategy document, it should be placed in temporary stockpiles on hardstand or Visqueen, suitably covered and bunded.
- 6.1.4 Analysis of at least 6 samples, for an appropriate range of determinands should be undertaken. On receipt of the results, the Engineer will liaise with the Contractor regarding the most appropriate remediation option.

6.2 Site clearance

- 6.2.1 Any trees currently under a preservation order should be identified and agreed with relevant authorities prior to the commencement of the works. All trees subject to a TPO should be clearly identified and protected by fencing in accordance with BS5837: 2012.
- 6.2.2 The site should then be cleared of all residual debris, any vegetation, shrubs, bushes and unprotected trees as instructed by Kier Living.
- 6.2.3 Topsoil/Made Ground Topsoil, typically 200mm thick, is present across much of the site (beyond the car park and former school building footprint). Overgrown stockpiles of topsoil were also identified in the far north west of the site.
- 6.2.4 Testing suggests this material should be chemically suitable for re-use on site. Given the nature of the topsoil present on this site it would be expected to be suitable to support plant growth. However, no testing in accordance with BS3882:2015 Specification for Topsoil (N-P-K, clay content etc) has been undertaken to date.
- 6.2.5 Topsoil should be stripped and placed in a temporary stockpile. The Engineer may instruct analysis (pH, metals, asbestos ID and speciated PAH) of further samples from the topsoil stockpile in order to confirm its suitability for re-use.

6.3 Asbestos

- 6.3.1 No asbestos fibres were identified during the intrusive works and subsequent laboratory testing in any of the soils at the site.
- 6.3.2 However, localised fragments of asbestos cement sheeting may be encountered during the site remediation and preparatory works. All suspected asbestos-containing material should be recovered by hand and placed in double sealed bags, within a sealed skip for off-site disposal at a suitably licensed landfill site. Personnel involved in this activity should be equipped with appropriate personal protective equipment, including dust masks (minimum FFP3).

6.4 Monitoring & grouting of boreholes

- 6.4.1 Hazardous Gas wells installed in 8 probeholes across the site will be monitored on a further 5 occasions with the last date of monitoring anticipated towards the end of December 2017. The Contractor should ensure these boreholes are protected by the erection of secure herras-type fence, until such time as agreed with the Engineer.
- 6.4.2 On completion of monitoring the wells should be sealed with bentonite/cement grout to prevent the possibility of gas migration from depth.

6.5 Turnover of made ground

- 6.5.1 The uppermost 2m of made ground beneath plots and highways should be subject to "turnover" (excavation, screening/sorting and replacement in engineered layers). Deeper excavation may be required in order to:
- "Chase out" relict foundations and structures.
 - Remove the Ash & Clinker (see Section 6.6)
- 6.5.2 Further details of specific operations associated with turnover are described in the following sections.

6.6 Excavation of contaminated soil/fill

Tarmac hardstand

- 6.6.1 An area of tarmac hardstand (c. 2,000m²) forming former sports courts is present in the south-east. These materials will require grubbing up with either disposal off site (see Section 6.6) or crushing and screening for use as aggregate in unbound pavements (see Sections 6.10 and 6.12).
- 6.6.2 Excavated tarmac should be segregated from the general excavation arisings; see Section 6.15 if off-site disposal is proposed.

Ash & Clinker

- 6.6.3 Ash & Clinker (c. 200mm thick) underlies the former tarmac sports courts an area of c. 2,000m²). Due to its combustibility and elevated concentrations of contaminants near-surface Ash & Clinker is to be removed from proposed garden areas, and either placed beneath plots / areas of hardstand, or exported from site.
- 6.6.4 If the Ash & Clinker is retained on site, it should be placed in approximate 300mm thick layers, wetted and subjected to compaction, comprising at least 2 passes with a towed vibratory roller of at least 2,900 kg per metre width. Compaction will help to prevent the material drying out and reduce the ingress of oxygen, thereby providing further mitigation against the risk of spontaneous combustion.

6.7 General excavation

- 6.7.1 Excavation of made ground will be undertaken in a controlled manner, working from a line agreed with the Engineer in linear panels.
- 6.7.2 Excavated material should be removed from each panel and screened to remove oversize (>200mm) and other unsuitable (e.g. anthropogenic or biodegradable materials), prior to replacement.
- 6.7.3 Any stockpiles of Ash & Clinker or Tarmac should be assumed to contain elevated concentrations of contaminants, and it should be ensured that such materials are not allowed to cross-contaminate any clean soils.
- 6.7.4 Each panel should be inspected by the Engineer, and have its depth and extent recorded by survey, prior to backfilling (see Section 6.14).
- 6.7.5 Any excavated and screened material that needs to be stockpiled temporarily should be placed in areas designated by the Engineer. Any stockpile of made ground should be kept separate from those of natural materials so as not to generate significant quantities of unsuitable material.
- 6.7.6 Prior to re-use of existing topsoil (particularly made ground topsoil and topsoil identified in existing stockpiles) it may be necessary to remove unsuitable materials (oversize, timber etc) through screening and/or hand picking.

6.8 Control of water

- 6.8.1 Groundwater should be controlled in accordance with CIRIA report 113 "Control of Groundwater for Temporary Works".
- 6.8.2 Arrangements should be made to prevent ponding in any excavation "hollows"; the Contractor should ensure that ground levels are of sufficient gradient to enable the collection of surface water run-off in sumps or grips.
- 6.8.3 Pumping from over-excavated sumps may be required to maintain satisfactory working conditions.
- 6.8.4 The Contractor should make all necessary arrangements to prevent off-site migration of contaminated sediment via surface water run-off. This will necessitate the installation of surface water grips, and removal, sealing-off, or diversion of all redundant former site drains (and any land drains).
- 6.8.5 A Silt Management Plan should be prepared by the Contractor, describing the mitigation measures that will be put in place to intercept direct run-off from any disturbed areas, stockpiles etc, thereby preventing any potential impact of adjacent land and nearby watercourses. Surface water run-off will probably require treatment (as a minimum to allow settlement of fines) prior to consented discharge.
- 6.8.6 It is possible that perched waters will be encountered during the remediation earthworks; most commonly associated with redundant drains and buried structures.
- 6.8.7 It should be noted that significantly elevated concentrations of hydrocarbons and heavy metals are often associated with sediment within the former drainage network below brownfield sites such as this, and that these, if released, pose potential risk to waters.
- 6.8.8 Any potentially contaminated water should not be allowed to escape to other areas until the results of the analysis are available and, if required, a suitable means of water treatment has been agreed.

- 6.8.9 Water collected in sumps should be passed through a series of oil/water separators to remove any oily contamination. Oils trapped in the absorbent medium should be disposed of to a suitably licensed landfill site.
- 6.8.10 Treated water should then be tankered off-site, or be discharged to sewer, subject to analytical results and local water treatment company consent.

6.9 Removal of below ground obstructions

- 6.9.1 All foundations associated with existing buildings and other relict structures should be chased out and grubbed-up, in order to remove potential obstructions to new foundations and infrastructure.
- 6.9.2 Drawing 2321/8 shows the location of all significant buildings etc recorded on historical OS plans. No significant obstructions were encountered during the intrusive investigation, however, the presence of some relict foundations etc cannot be ruled out.
- 6.9.3 Where relict structures are found to retain fluid contaminants, they should be drained first. The drained fluids should be stored in appropriate, sealed tanks/containers and analysed for a range of determinands to be agreed with the Engineer. Fluids may then be tankered off-site, or be discharged to sewer, subject to analytical results and local water treatment company consent.
- 6.9.4 Deep excavations for the removal of structures etc will be unstable in the short term (most notably in any made ground or granular soils) and continuous side support will be necessary.
- 6.9.5 Where significantly deep foundations (e.g. piles) cannot be removed by conventional means, they are to be cut at a depth to be agreed with the Engineer and the position of the remaining lower section is to be accurately recorded by survey.
- 6.9.6 Suitable materials derived from grubbing-up should be stored in a location on site, to be agreed with the Engineer, prior to crushing (see Section 6.10). Any unsuitable materials should be removed to a suitably licensed landfill site (see Section 6.15).

6.10 Crushing

- 6.10.1 Production of a selected granular fill should be possible if suitable materials (generated by grubbing-up of tarmac hardstand, oversize materials, foundations and other relict structures) are crushed.
- 6.10.2 The crushed product should be screened to remove any unsuitable elements and stockpiled for re-use during the subsequent construction works. Generation of a Class 6 material as defined in the Highways Agency Specification (Series 600) should be possible.
- 6.10.3 6F2 graded material can contain up to 50% recycled tarmac/asphalt (provided it does not pose a contamination risk to controlled waters). Recycled tarmac can be crushed to yield a 6F3 selected granular material, provided the recovered bitumen content is less than 10% (determined in accordance with BS598-102:2003).
- 6.10.4 The Engineer should check the suitability of crushed product for re-use, instruct the removal of any unsuitable material and schedule appropriate confirmatory geotechnical or chemical testing.
- 6.10.5 A minimum of 3 samples (or 1 sample per 500m³, whichever is the greater) should be taken from any stockpile of specific crushed product and sent to a UKAS accredited laboratory for analysis to assess whether the material conforms to the requirements as defined in Series 800 of the Highways Agency Specification for Highway Works.

6.11 Backfill of excavations

- 6.11.1 Excavations (to remove relict structures, contamination etc) should be backfilled as necessary to achieve the desired levels, with suitable materials and compacted in accordance with Lithos' Protocol for the placement of non-engineered fill; copy included in Appendix D.
- 6.11.2 However, where an excavation conflicts with the footprint of a proposed highway, compaction in accordance with the Specification for Highway Works will be required (see Section 6.12).
- 6.11.3 The site surface should be initially left 300mm below proposed finished garden levels to allow for placement of the cover. In areas of highways the ground surface will be left approximately 600mm below finished road level.
- 6.11.4 The anticipated backfill materials (predominantly made ground) were adequately characterised by the site investigation (see Lithos Report 2321/2, dated June 2017). Consequently, further testing of backfill materials is not anticipated.
- 6.11.5 Nonetheless, excavated arisings will be inspected by the Engineer, and any suspicious material or material yielding evidence of significant contamination (based on visual\olfactory observations), will be placed in temporary stockpiles from which an adequate number of samples will be taken (typically a minimum of 6 samples). The samples will be scheduled for an appropriate suite of contaminants in order to characterise the material and decide its fate.
- 6.11.6 Any material considered unsuitable for use as backfill should be exported from site (see Section 6.15).

6.12 Highways

- 6.12.1 The Contractor should consult the adopting authority regarding preparation of the ground beneath new highways (as outlined below, or in any proposed alternative specification) in advance of the works. The Contractor should also agree acceptable performance criteria, with the Engineer and the adopting authority.
- 6.12.2 However, it is considered that the following options would be suitable to enable the construction of the highways.
- 6.12.3 The full thickness (up to a maximum of 2m - from existing ground level or proposed highway formation, whichever is the lower) of made ground should be excavated from beneath new highway footprints. Highways should then be raised to formation level, either with:
- Suitable aggregate placed & compacted in accordance with The Highways Agency Specification for Highway Works (SHW) Series 600, or
 - Suitable screened & selected site-won material, placed & compacted in accordance with SHW Series 600. Unsuitable materials include any soft or wet materials, biodegradables including topsoil, wood, scrap metal, frozen & oversize material.
- 6.12.4 Some refinement of the above advice might be possible after highways design (with consideration of the proposed formation level cf existing ground level), and via inspection (and usually CBR testing) of the proposed formation during site preparatory groundworks.
- 6.12.5 Any residual made ground materials in the base of the excavation (i.e. in areas where the thickness of made ground exceeds 2m) should be inspected and (where necessary) any soft spots removed and replaced with suitable engineered fill.

6.12.6 In the footprint of proposed highways, the contractor, under supervision, must ensure that relict obstructions are removed to a minimum of 500mm below deepest sewer invert. The resultant sub-formation should then be proof rolled, in accordance with the Specification for Highway Works.

6.13 Boundary issues

6.13.1 Kier Living's Designer should ensure that proposed levels tie in with the surrounding infrastructure, and ground levels of adjacent properties (after allowance for the placement of any required soil cover).

6.13.2 Advice should be sought from the Engineer if mobile contamination is encountered close to the site's boundaries.

6.14 Surveying

6.14.1 The Contractor should arrange for the following survey work as directed by the Engineer:

- All setting out necessary to allow the works to proceed
- Recording of the depth and lateral extent of excavations to remove obstructions, contaminated soils etc
- Recording of the positions of any relict obstructions (i.e. piles) left in-situ
- Recording the depth & extent of each excavation panel during turnover of made ground, prior to backfilling
- Recording of natural ground levels, where natural ground encountered during the earthworks
- Recording the final location of potentially combustible soils (Ash & Clinker)
- Recording the locations and volumes of all stockpiles of suitable materials left on site for Kier Living 's use during the development works
- As-built survey of the finished surface on completion of the remediation contract

6.14.2 The Contractor should supply the results of this survey work (disc & hard copy) to the Engineer for inclusion in the Verification Report.

6.15 Export to landfill

6.15.1 Excavation arisings that are unsuitable for retention and re-use on site should be placed in temporary stockpiles on hardstand or polythene sheeting and be suitably covered to minimise the potential for dust/odour nuisance, and prevent surface water run-off.

6.15.2 Any material exported from site to landfill should be hauled by a registered waste carrier in accordance with the requirements of the Duty of Care Regulations, 1991 and the Landfill (England & Wales) Regulations 2002.

6.15.3 A transfer note should be completed, signed and retained by the parties involved. The transfer note should include the volume of waste, the nature of the material and a statement of its chemical composition, details of the source and destination sites, and details of the haulier.

6.15.4 In order to protect the general public from dust and vapour emissions, wagons that are to be used for the haulage of the contaminated material from the site must be sheeted. In addition, the Contractor must ensure that no fluids seep from the wagons.

6.15.5 In order to provide the landfill facility with information regarding chemical composition of the waste, further analysis of any material that requires removal from site may be required.

Waste classification

- 6.15.6 Characterisation of stockpiled materials generated during the site preparatory works is likely to be required if off-site disposal is proposed.
- 6.15.7 It should be noted that the classification and assessment of waste soils under the Environment Agency's Technical Guidance WM3¹, is a complex process.
- 6.15.8 It is critical if material is to be exported from site that this is allocated an appropriate waste code, following the steps within WM3. Waste carriers transporting, and sites accepting, this material should have a corresponding code within their permits. It is the responsibility of those generating the waste (i.e. the site), to ensure that the waste is handled and disposed of appropriately.
- 6.15.9 With respect to asbestos, waste soils will be classed hazardous if the soil mass contains more than 0.1% asbestos fibres that are free and dispersed. However, WM3 states that where the waste contains identifiable pieces of asbestos (i.e. any particle of a size that can be identified as potentially being asbestos by a competent person if examined by the naked eye), then the waste is hazardous if the concentration of asbestos in the pieces alone is 0.1%. If a stockpile of soil contained rare fragments of broken asbestos-cement sheeting, the whole stockpile would be classed as hazardous unless all the fragments could be picked-out (even though the concentration of asbestos in the soil mass might be orders of magnitude less than 0.1%).
- 6.15.10 Tarmac assessment is based on the amount of coal tar present, this will vary depending on the age of the tarmac. The assessment is based on the amount of benzo(a)pyrene, and has a concentration limit of 50mg/kg.
- 6.15.11 Following excavation and stockpiling, sampling will be required prior to disposal.
- 6.15.12 Tarmac is likely to fall within waste code 17 03 02:
- 17 - Construction and Demolition wastes,
 - 03 - bituminous mixtures, coal tar and tarred products
 - 02 - bituminous mixtures other than those mentioned in 17 03 01
- 6.15.13 This is a mirror non-hazardous entry. This code along with this supporting report, in particular the laboratory results, should be used to complete a paper trail documenting disposal routes for tarmac.
- 6.15.14 Contractors exporting waste from the site should review the site investigation data and make their own assessment. Alternatively, Lithos could undertake this assessment once exported waste streams have been identified.

¹ Technical Guidance WM3 – Guidance on the classification and assessment of waste. Environment Agency 2015

6.16 Placement of soil cover

- 6.16.1 Clean inert soil will be placed over the made ground in proposed garden and landscaped areas (but not beneath hardstanding). This cover layer is to comprise 300mm of "clean" subsoil and topsoil.
- 6.16.2 Following the proposed earthworks regrade, some gardens may be underlain by natural soils only, and where this is the case placement of 150mm of topsoil will suffice.
- 6.16.3 Some subsoil suitable for use as cover material may be sourced on site, subject to the Engineer's approval. The Engineer will assess accessibility, suitability, the conceptual site model (most notably the creation of new pathways by which mobile contaminants could impact controlled waters), and engineering implications (for example, increased foundation depth) before allowing any excavation of in-situ natural soils for re-use as clean cover
- 6.16.4 Topsoil and subsoil quality should be assessed in accordance with Lithos' Protocol for Soil Importation, copied in Appendix B.
- 6.16.5 This Protocol includes chemical assessment criteria which should not be exceeded.

6.17 Hazardous gas protection

- 6.17.1 The site lies in a radon affected area therefore as a minimum basic radon protection measures will be required for all plots.
- 6.17.2 At the time of writing, monitoring is ongoing, and a hazardous gas risk assessment will be issued on completion of monitoring. This will necessitate an update of this Remediation Strategy, with specific requirements regarding gas protective measures.

Appendix A
Drawings



The Site
SE 363 117

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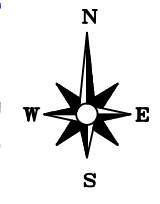
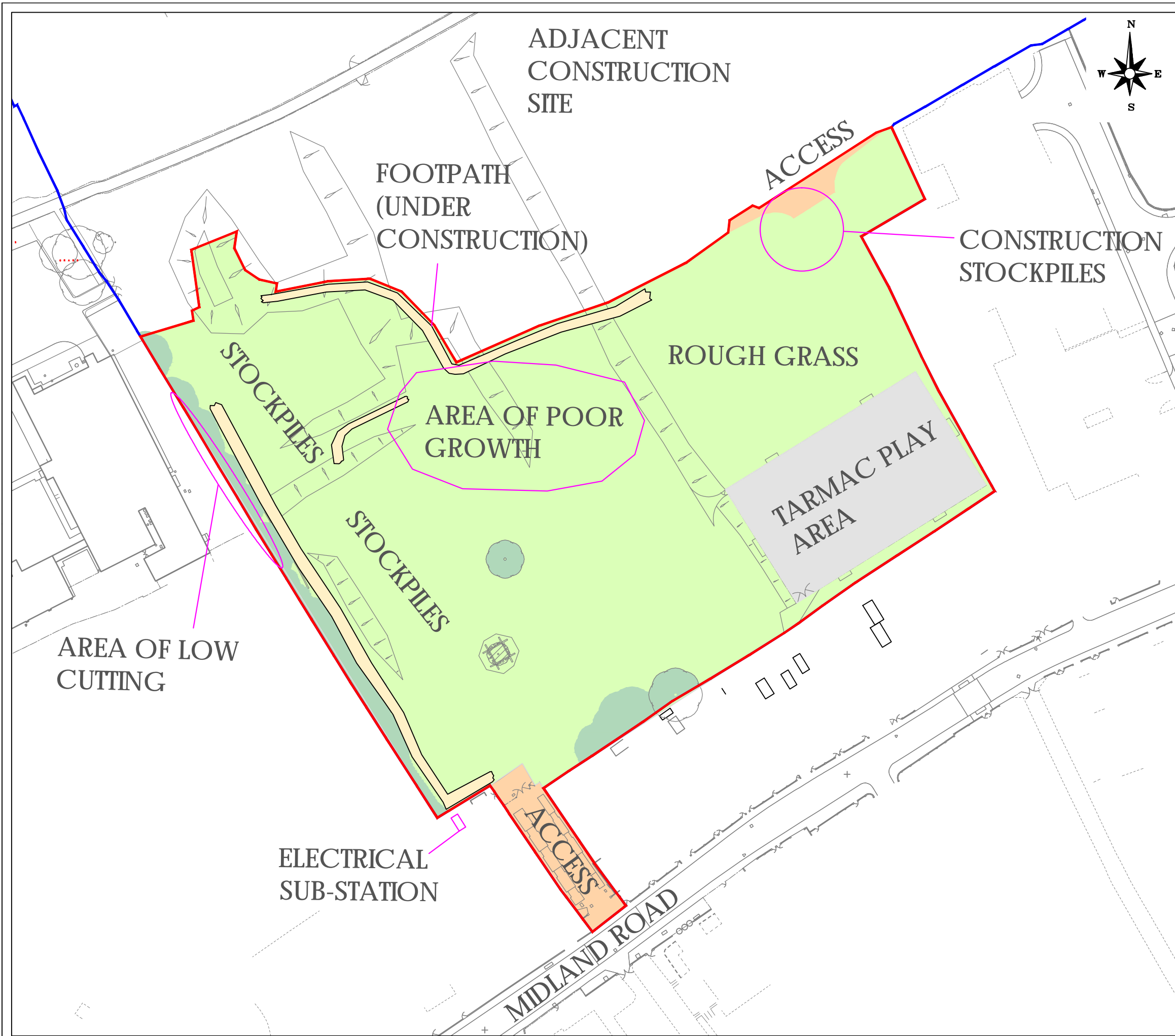
info@lithos.co.uk
www.lithos.co.uk
Tel 01937 545330

CLIENT
KIER LIVING

JOB TITLE
**MIDLAND ROAD,
ROYSTON**

DRAWING TITLE
**SITE LOCATION
PLAN**

DRAWN	MAR	DATE	28 06 16
CHECKED	REG	DATE	28 06 16
STATUS	FOR COMMENT <input type="checkbox"/>	DRAFT	<input type="checkbox"/>
	FOR APPROVAL <input type="checkbox"/>	FINAL	<input checked="" type="checkbox"/>
SCALE	1:25,000	SHEET	A4
DRAWING NO.	2321/1	REVISION	



NOTES

- GRASS & OVERGROWN AREAS
- TARMAC FOOTPATHS
- TARMAC HARDSTAND (ACCESS ROADS)
- TARMAC PLAY AREA
- APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE



info@lithos.co.uk
www.lithos.co.uk
Tel 01937 545330

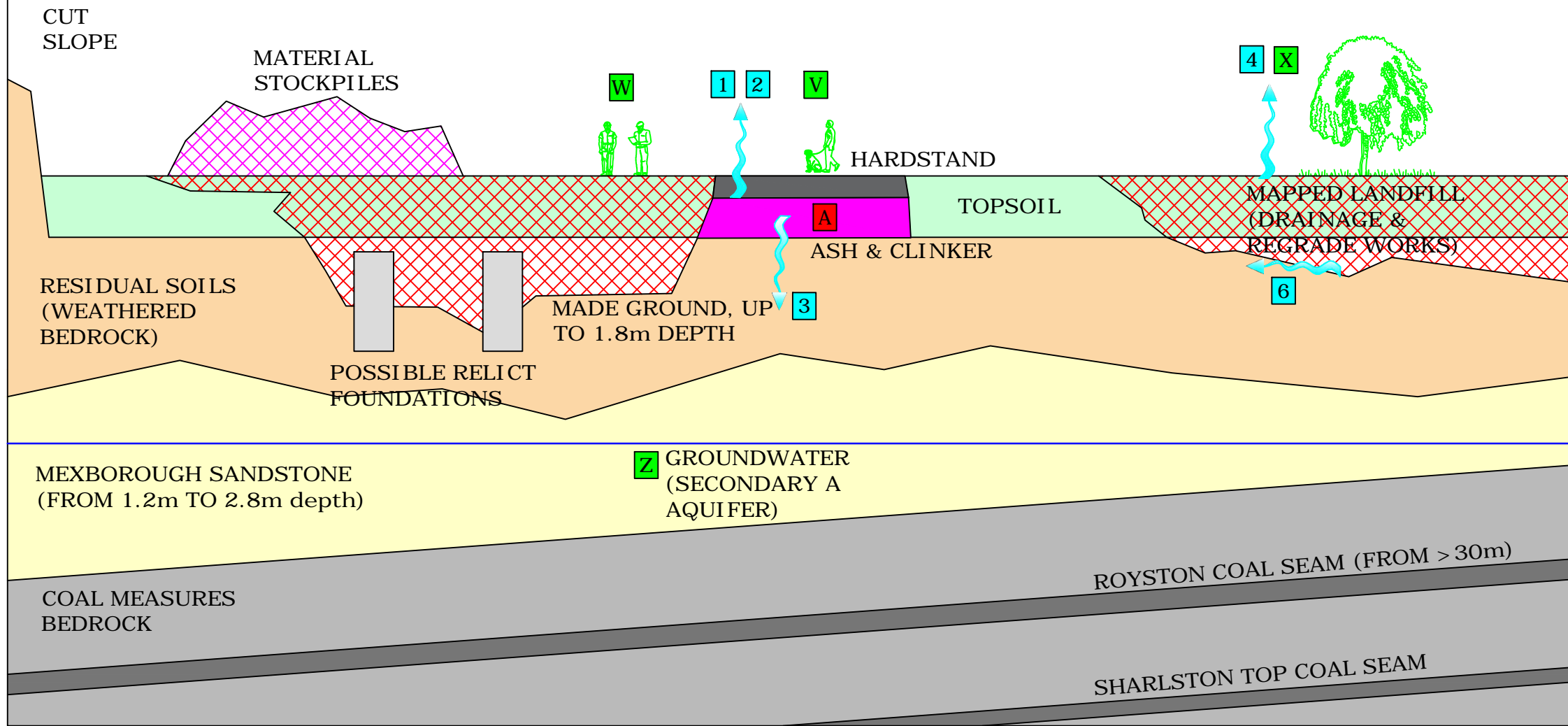
KIER LIVING
NORTHERN LTD

MIDLAND ROAD,
ROYSTON

SITE FEATURES

DRAWN GLM	DATE 25/07/2016	STATUS FOR COMMENT <input type="checkbox"/> FOR APPROVAL <input type="checkbox"/> DRAFT <input type="checkbox"/> FINAL <input checked="" type="checkbox"/>
CHECKED REG	DATE 25/07/2016	
SCALE 1:1,000	SHEET A3	DRAWING NO. 2321/3
		REVISION

EXTENT OF PROPOSED DEVELOPMENT



SOURCES	
A	ASH & CLINKER

PATHWAYS	
1	DERMAL CONTACT
2	INGESTION/INHALATION
3	LEACHING OF CONTAMINANTS
4	UPTAKE BY PLANTS
6	MIIGRATION OF HAZARDOUS GAS

RECEPTORS	
V	END USERS (RESIDENTS)
W	SITE WORKERS
X	VEGETATION
Y	SURFACE WATERS

NOTES

REV.	DESCRIPTION	DATE



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CLIENT

KIER LIVING
NORTHERN LTD

JOB TITLE

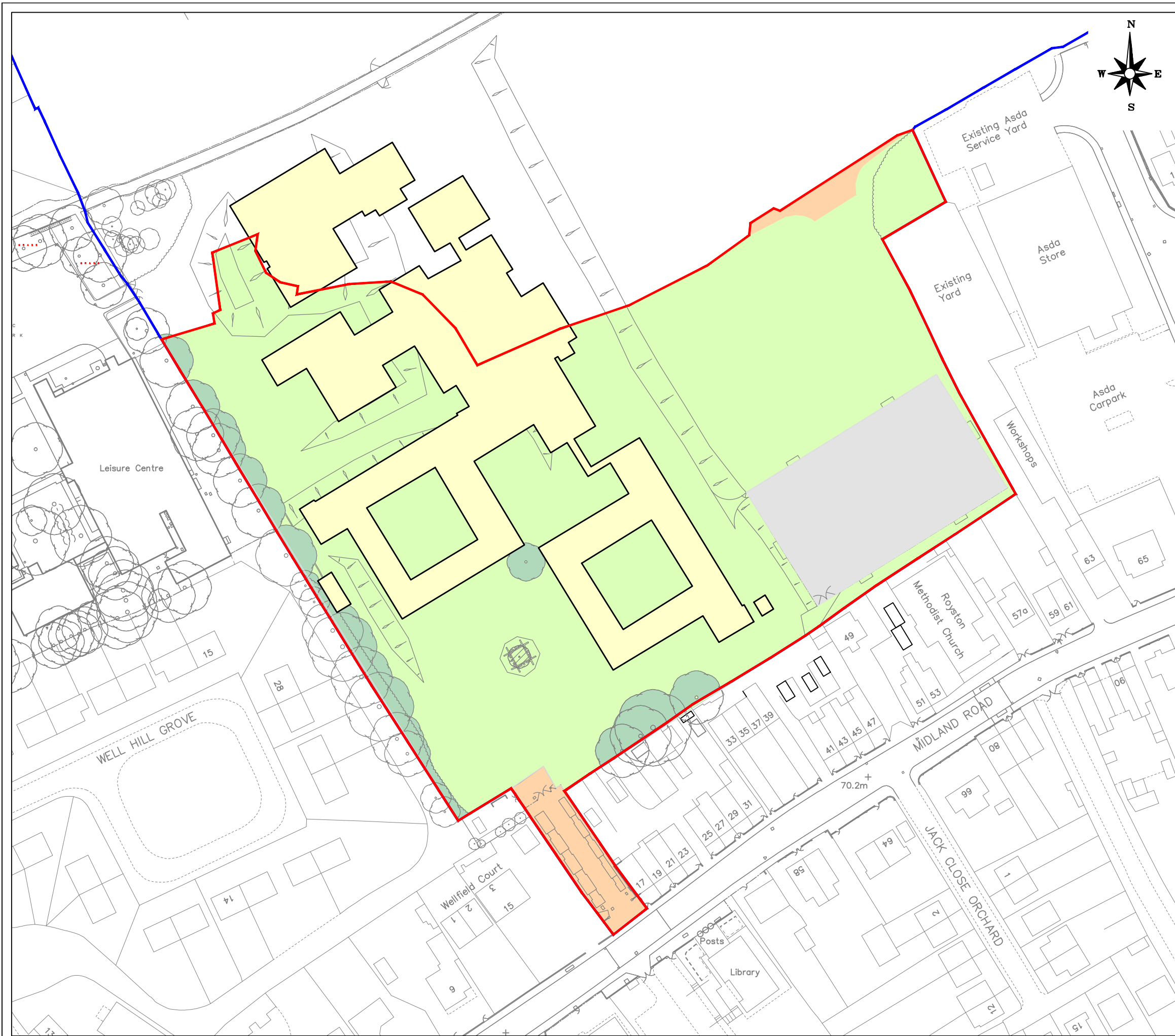
MIDLAND ROAD,
ROYSTON

DRAWING TITLE


REVISED CONCEPTUAL SITE MODEL


DRAWN	DATE	STATUS
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REG	22 06 17	FOR APPROVAL <input type="checkbox"/>
		DRAFT <input type="checkbox"/>
		FINAL <input checked="" type="checkbox"/>

SCALE	SHEET	DRAWING NO.	REVISION
Not to scale	A3	2321/7	



NOTES

 FOOTPRINT OF FORMER SCHOOL BUILDINGS

 APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE



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Tel 01937 545330

**KIER LIVING
NORTHERN LTD**

**MIDLAND ROAD,
ROYSTON**

**LOCATION OF HISTORICAL
BUILDINGS**

DRAWN	GLM	DATE	29 06 16	STATUS	FOR COMMENT	<input type="checkbox"/>
CHECKED	REG	DATE	29 06 16	FOR APPROVAL	DRAFT	<input type="checkbox"/>
				FINAL		<input checked="" type="checkbox"/>
SCALE	1:1000	SHEET	A3	DRAWING NO.	2321/8	REVISION

Appendix B

Lithos Protocol for Import & Use of Soil Cover

1 INTRODUCTION

- 1.1 Isolation of made ground in garden and landscaped areas beneath a cover of "clean" subsoil, and topsoil is often recommended on residential developments; most notably when the made ground contains inorganic (and non-volatile organic) contaminants at concentrations above guidance threshold values. A cover solution is not appropriate for volatile or semi-volatile organic contaminants (fuels, solvents etc); removal or treatment will usually be required.
- 1.2 The thickness of cover is dependent on the nature and degree of contamination (and sometimes the Local Authority whose area the site lies within), but typically between 600mm and 1,000mm is required. Where contamination is more significant a granular hard-dig layer or geotextile marker membrane may also be required at the base of the cover.
- 1.3 If the made ground is essentially "clean", but contains materials generally considered undesirable as near-surface material in garden areas (e.g. oversize materials such as construction/demolition rubble) then, in accordance with NHBC Standards Chapter 9.2, a 300mm thick soil cover should be adequate. If the made ground is essentially "clean" and comprises reworked natural soil, the only cover likely to be required is topsoil.
- 1.4 The "clean" soil cover blocks potential linkages between the contaminated made ground and future residents. Soil cover is not required beneath drives, garages or houses.
- 1.5 The **CML initiative**, which came into force on 1st April 2003, requires housebuilders to submit to NHBC (or other warranty provider) a validation report confirming the thickness and quality (i.e. contaminant-free) of the placed soil cover. Validation reports should normally be prepared by independent geoenvironmental consultants.
- 1.6 Failure to submit cover validation reports promptly will delay issue of the cover note by the warranty provider, which will subsequently delay the release of mortgage funds and hence legal completion; i.e. the financial implications are significant. Consequently, it is essential that cover validation is requested at least 2 weeks prior to the anticipated finalling date.
- 1.7 Soil cover is usually placed many weeks after completion of the preparatory/remediation works, and issue of the associated Verification Report, typically at a relatively late stage in the construction programme.
- 1.8 Prior to placement of soil cover, the appointed remediation contractor and/or groundworker should ensure that ground levels are low enough to accommodate the required cover thickness, taking account of any boundary issues, and without compromising the DPC and any sub-floor ventilation.
- 1.9 Ideally soil **quality** should be determined by sampling of the **source** at least 7 working days before importation to the development site. Samples could be obtained from stockpiles on site, which may on occasion comprise surplus natural ground development arisings. Soil samples could be obtained from gardens after placement, but this is not recommended.
- 1.10 Clearly, if soil cover is imported and placed before confirmation of its suitability, no guarantee can be given that validation work will yield the desired results. It may therefore be necessary to excavate and export the placed soil cover and/or import further "clean" soil.

- 1.11 Where soils have been tested at source and temporarily stockpiled on site, stockpiles should be fenced-off and marked as containing certified topsoil/subsoil. The soil should be inspected prior to placement to confirm that it is the same material as previously tested, and that it has not been cross-contaminated with miscellaneous arisings generated during the construction works.
- 1.12 Soil **thickness** can only be checked after placement; this should be done before turfing / landscaping, but ideally after scaffolding has been dismantled.
- 1.13 **Sampling Frequency (to check Soil Quality):** The number of samples tested will be dependent on the nature of the source, and the quantity of material to be imported. However, in accordance with current YAHPAC (Yorkshire & Humberside Pollution Advisory Council) guidance (Verification Requirements for Cover Systems: Technical Guidance for Developers, Landowners & Consultants; Version 3.2, October 2014), the testing frequency should be as follows:

Nature of source	Number of samples (from any single source material)	
	Up to 1,000m ³	Per additional 1,000m ³
Greenfield	At least 3, with at least 1 sample per 250m ³	2
Brownfield	At least 6, with at least 1 sample per 100m ³	2
Crushed product	At least 3, with at least 1 sample per 500m ³	2

- 1.14 On a typical development with gardens comprising a total area of 100m² (front and rear), and a soil cover thickness of 600mm including 100mm topsoil, for a brownfield source this testing frequency equates to approximately one topsoil sample per ten plots and one subsoil sample per two plots. Given the requirement to test a minimum number of samples from any one source, the testing frequency effectively increases for sites with only a small number of plots.
- 1.15 **Inspection Frequency (to check Soil Thickness):** The number of inspection pits excavated to check cover thickness (and collect samples, if testing at source has not been undertaken), should be dependent on the number of plots associated with the given development. The following frequencies are recommended:

No. plots within development	Frequency of inspection pits	Remarks
1 to 5	1 pit per plot	e.g. for 3 plots, dig 3 inspection pits
6 to 20	1 pit per 2 plots	e.g. for 9 plots, dig 5 inspection pits
21 to 30	1 pit per 3 plots	e.g. for 23 plots, dig 8 inspection pits
≥ 30	1 pit per 4 plots	e.g. for 39 plots, dig 10 inspection pits

- 1.16 Photographs should be taken of each inspection pit to show:
 - The thickness of cover material present
 - The presence of any geotextile marker or granular hard-dig layer (if required)
 - The position of each inspection pit in relation to the plot
- 1.17 **Soil Material Suitability:** Inspection pits should be excavated through the entire thickness of any proposed in-situ source material, or cover material (if inspection is post-placement). Stockpiles should be assessed from both the surface and by digging into the “core”, to ensure the material is reasonably homogenous.

- 1.18 The soil material should comply with the following requirements:
- Be clean and free of foreign debris, building waste materials, glass sharps, and contaminants
 - Topsoil should not have a gravel content of greater than 30% by dry weight and should generally have a maximum stone size of 50mm in any one direction
 - Subsoil should generally have a maximum stone size of 150mm in any one direction
 - Not have been sourced from an area within 7m laterally, or 3m vertically, of Japanese Knotweed plants, and not contain any Japanese Knotweed fragments (rhizomes, leaves, stems etc)
- 1.19 **Laboratory Analysis:** Whether samples are taken at source, from stockpiles on site, or from gardens after placement, they should be forwarded to an analytical laboratory for testing in accordance with one of the Schedules detailed in Table 1.
- 1.20 Imported topsoil should be subject to such testing, unless it is being sourced from a reputable commercial supplier able to provide robust certification (certificate date less than 2 months prior to import date). In addition, some analysis in accordance with BS3882 may occasionally be appropriate.

Table 1 – Test schedule

Source	Test schedule
Greenfield & Manufactured topsoil	pH, total metals (Cu, Ni, Zn, Cr III, Cr VI, As, Hg, Se, Cd & Pb), water soluble boron. TOC & speciated PAH Asbestos ID
Brownfield & Soil transfer stations	pH, total metals (Cu, Ni, Zn, Cr III, Cr VI, As, Hg, Se, Cd & Pb), water soluble boron. TOC, Speciated PAH & banded TPH* Asbestos ID
Crushed product	pH, total metals (Cu, Ni, Zn, Cr III, Cr VI, As, Hg, Se, Cd & Pb), water soluble boron. TOC & Speciated PAH Asbestos ID

Note: The schedules detailed above have been prepared in accordance with the Secondary Model Procedures. This document states that analysis should be relevant to potential sources and not merely a set list of parameters applied to each site.

* The YAHPAC guidance recommends speciated TPH (TPH CWG) analysis for brownfield sources, but this should not be necessary unless the banded TPH analysis fails the assessment criteria detailed in Table 2 below.

Where crushed product is used at least 600mm below finished garden level, only asbestos analysis will be required.

- 1.21 Additional determinands may be scheduled dependent on the history of the source site, although if this is considered necessary it may suggest the material is unlikely to be suitable for use as clean cover in gardens.

1.22 Chemical assessment (Tier 1) criteria for imported soils are provided in Table 2, these reflect exposure and toxicological amendments proposed within the C4SL report. Where no revised toxicological value has been published the former CLEA value has been adopted.

Table 2 - Chemical assessment criteria for imported soils

Contaminant	Source	Tier 1 assessment criteria (mg/kg)	Comments/notes
pH	CLEA		
As	C4SL	37	
Cd	C4SL	26	
Cr (III)	C4SL	3,000	
Cr (VI)	C4SL	21	
Pb	C4SL	200	
Ni	C4SL	127	Assessment of human health risk only.
Se	C4SL	434	
Hg	C4SL	199	Assumes mercury present as an inorganic compound (cf elemental metal or within organic compound). See Science Report SC050021/Mercury SGV.
B	Lithos	5	
Cu	DoE	80 to 200	Based on phytotoxic risks as plants are the more sensitive receptor (Cu is pH dependent).
Zn	DoE	200	
Benzo(a)pyrene	C4SL	5	
Naphthalene	C4SL	12	
GRO	C4SL	45	Conservative value based on value for aromatic fraction C7 to C8 range, but assuming indoor inhalation pathway still relevant (it shouldn't be).
DRO	C4SL	219	Conservative value based on value for aliphatic fraction C10 to C12 range, but assuming indoor inhalation pathway still relevant (it shouldn't be).
LRO	C4SL	1,000	Calculated value above hazardous waste screen in WM3, there 1,000mg/kg adopted. This may be reviewed on a site specific basis depending on the source and nature of transfer.

2 VALIDATION REPORTS

- 2.1 The analytical testing will usually be undertaken on a 3 or 5-day turnaround and the Client/Contractor will be notified of the soil's suitability (or otherwise) immediately after receipt of the results.
- 2.2 Interim plot validation certificates should be issued to warranty providers on a plot by plot (or block by block) basis as development proceeds. Once the full development has been completed these should be pulled together into a final verification report, for submission to the Local Authority to satisfy planning conditions.

Appendix C
Lithos Tier 1 Screening Values

Soil screening values used by Lithos

In March 2002 DEFRA and the Environment Agency published a series of technical papers (R&D Publications CLR 7, 8, 9 and 10) outlining the UK approach to the assessment of risk to human health from land contamination. In 2008 CLR 7, 9 and 10 and all corresponding SGV and Tox reports were withdrawn and superseded by new guidance including:

- Guidance on Comparing Soil Contamination Data with a Critical Concentration - CL:AIRE and CIEH, May 2008
- Evaluation of models for predicting plant uptake of chemicals from soil - Science Report – SC050021/SR
- Human health toxicological assessment of contaminants in soil - Science Report: SC050021/SR2
- Updated technical background to the CLEA model - Science Report: SC050021/SR3
- CLEA Software Handbook (Version 1.071), Science report: SC050021/SR4
- Compilation of data for priority organic pollutants for derivation of Soil Guideline Values - Science Report: SC050021/SR7

The approach set out in these documents represents current scientific knowledge and thinking; and includes the Contaminated Land Exposure Model (CLEAv1.06). The Environment Agency are in the process of using this updated approach to regenerate a selection of Soil Guideline Values (SGVs).

CLEA SGVs were derived for standard land use scenarios predominantly in the context of Part IIA, using a conceptual site model (CSM) defined in SR3. Lithos have incorporated amendments to the CSM used to derive SGVs, that more accurately reflect redevelopment within the planning regime; consequently, Lithos have not adopted any published SGV as a screening value.

The CLEA conceptual site model assumes a source located in a sandy loam, with 6% soil organic matter (SOM) - equivalent to 3.5% total organic carbon (TOC). However, where the average TOC value for a particular soil type is significantly lower than the 3.5%, evaluation of Lithos Screening Values should be undertaken and a site specific risk assessment will usually be required. Other CLEA default characteristics adopted by Lithos are:

Sandy Loam characteristics (source)	Default values adopted
Total porosity (fraction)	0.53
Water filled porosity (fraction)	0.33
Air filled porosity (fraction)	0.2

Lithos have derived Screening Values for four different CSMs (scenarios); these are:

- A - Residential with gardens, but no cover (or only up to 300mm)
- B - Residential with gardens and 600mm 'clean' cover
- C - Residential apartments with landscaping (i.e. no home grown produce)
- D - Commercial/industrial with landscaping
- E – Importation of soil cover

The **exposure** pathways considered for each scenario are detailed in the table below.

Scenario	Land use	Pathways	Justification
A	Residential with garden, but no cover (or only up to 300mm)	<ul style="list-style-type: none"> • Direct ingestion of soil • Dermal contact • Consumption of vegetables & soil attached to vegetables • Inhalation of indoor vapours and dust • Inhalation of outdoor vapours and dust 	Minimal cover – insufficient to break any pathways therefore all exposure pathways are relevant.
B	Residential with garden minimum 600mm cover	<ul style="list-style-type: none"> • Inhalation of indoor vapours • Inhalation of outdoor vapours 	The 600mm cover removes the risk from all pathways other than inhalation.
C	Residential apartments with landscaped areas and minimum 300mm cover	<ul style="list-style-type: none"> • Direct ingestion of soil • Dermal contact • Inhalation of indoor vapours and dust • Inhalation of outdoor vapours and dust 	All pathways applicable due to possible exposure from landscaped areas. However consumption of home grown produce not included as unlikely to be grown in landscaped areas. Where vegetables are to be grown site specific QRA may be required.
D	Commercial/ industrial with landscaped areas no cover	<ul style="list-style-type: none"> • Direct ingestion of soil • Dermal contact • Inhalation of indoor vapours and dust • Inhalation of outdoor vapours and dust 	All pathways applicable due to possible exposure from landscaped areas. Assumed the commercial development consists of offices to provide a conservative assessment.
E	Importation of soil for cover in garden and landscaped areas	<ul style="list-style-type: none"> • Direct ingestion of soil • Dermal contact • Consumption of vegetables & soil attached to vegetables • Inhalation of outdoor vapours and dust 	Material used as cover to break existing pathways therefore all direct and indirect pathways relevant; however cover is not placed below plots therefore indoor inhalation is not relevant.

Lithos have assumed the source of contamination is directly below the building foundations; i.e. a depth to source of 0.15m as opposed to the CLEA default of 0.65m. This assumption provides for a more conservative approach than the UK default. This adjustment has been included to account for sites where made ground is re-engineered to enable new buildings to be established on raft foundations. In such situations contamination may lie directly beneath the foundation.

The Soil Screening Values referred to in this document are **not** intended to be used when considering potential risks associated with:

- Existing land uses in the context of Part IIA of the Environment Protection Act 1990;
- End uses such as allotments, sports fields, children's playgrounds, care homes, hospitals etc; and
- Controlled waters

In December 2013 Defra published the results of research project SP1010 – Development of Category 4 Screening Levels (C4SLs) for Assessment of Land Affected by Contamination. The objective of this project was provide technical guidance in support of Defra's revised Statutory Guidance for Part 2A of the Environmental Protection Act 1990 (Part 2A). The revised Statutory Guidance, published in April 2012, introduced a new four-category system for classifying land under Part 2A where Category 1 includes land where the level of risk is clearly unacceptable, and Category 4 includes land where the level of risk posed is acceptably low. Project SP1010 aimed to deliver:

- A methodology for deriving C4SLs for four generic land-uses comprising residential, commercial, allotments and public open space; and
- Demonstration of the methodology, via derivation of C4SLs for 6 substances – arsenic, cadmium, chromium IV, lead, benzene & benzo(a)pyrene.

04 - Contamination analysis & interpretation (including WAC)

Generic notes – geoenvironmental investigations



The methodology for deriving both the previous Soil Guideline Values and the new Category 4 Screening Levels is based on the Environment Agency's Contaminated Land Exposure Assessment (CLEA) methodology. Development of C4SLs has been achieved by modifying the toxicological and/or exposure parameters used within CLEA (while maintaining current exposure parameters).

The Part 2A Statutory Guidance was developed on the basis that C4SLs could be used under the planning regime. However, policy responsibility for the National Planning Policy Framework falls to the Department for Communities and Local Government. Defra anticipate that, where they exist, C4SLs will be used as generic screening criteria, and Lithos consider C4SLs to be suitable for use as Tier 1 Screening Values. Lithos have discussed this matter with both NHBC and YAHPAC (collection of Yorkshire & Humberside local authorities) and received confirmation that they are satisfied with this approach.

With respect to **inorganic** determinands, Lithos derived Tier 1 values for the five Scenarios A to E are presented below:

Inorganic contaminant	Tier 1 assessment criteria (mg/kg) for Scenarios A to E							Comments/notes
	SGV*	C4SL*	A	B	C	D	E	
As	32	37	37	Use (A) in SI Report for initial "screen" If >5 x A, then consider increase of cover to 1,000mm	40	640	37	C4SL adopted
Cd	10	26	26		149	410	26	C4SL adopted
Cr			3,000		3,000	30,000	3,000	Assumes Cr is CrIII
Pb	450	200	200		310	2,330	200	C4SL adopted
Ni	130		127		127	1,700	127	Assessment of health risk only
Se	350		350		595	13,000	434	
Hg	170		169		238	3,640	199	Assumes in an inorganic compound
B			5		5	5	5	
Cu			80-200		80-200	80-200	80-200	Based on phytotoxic risks as plants are the more sensitive receptor (Cu is pH dependant)
Zn			200		200	200	200	

With respect to **organic** determinands, Lithos derived Tier 1 values for the five Scenarios A to E are presented below:

Organic contaminant (all sourced via CLEA)	Tier 1 assessment criteria (mg/kg) for Scenarios A to E							Comments/notes
	SGV*	C4SL*	A	B	C	D	E	
Benzene	0.33	0.87	0.9	0.9	3.3	98	N/A	C4SL adopted
Toluene	610		600	3,000	2,700	5,000	N/A	Calculated value over 10,000
Ethyl Benzene	350		350	932	843	5,000	N/A	
Xylenes	240		246	327	321	5,000	N/A	
Phenol	420		412	2,400	519	5,000	N/A	
PCBs			2	8	2	38	N/A	Based on toxicity of EC7
Benzo(a)pyrene		5	5	25	5.3	76	5	C4SL adopted. Where source is not a coal tar
Naphthalene			8	9	9	1,000	12	
Gasoline Range Organics			30	34	34	5,000	45	See 3-step assessment of TPH below
Diesel Range Organics			151	156	154	5,000	219	
Lubricating Range Org			1,000	5,000	2,000	5,000	1,000	

* For a residential end use

The significance of PAHs can be determined by considering indicator compounds. In most cases benzo(a)pyrene (BaP) is adopted as an indicator due to the amount of toxicological data available and has been used by various authoritative bodies to assess the carcinogenic risk of PAHs in food. A surrogate marker approach can be used to estimate the toxicity of a mixture of PAHs in soil using toxicity data for individual indicator compounds within that mixture. Exposure to the surrogate marker is assumed to represent exposure to all PAHs in that matrix. The surrogate marker approach relies on a number of assumptions:

- Surrogate marker (bap) must be present in all soil samples
- Profile of the different PAH relative to bap should be similar in all samples
- PAH profile in the soil samples should be similar to that used in the pivotal toxicity study¹

To assess the PAH profile in a soil sample, the ratio of the seven genotoxic PAHs (benz[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[g,h,i]perylene, chrysene, dibenz[a,h]anthracene and indeno[1,2,3-c,d]pyrene), relative to BaP, should be calculated. The ratio relative to BaP should lie within an order of magnitude above and below the mean ratio to BaP.

Naphthalene should also be considered separately against its generic screen. Whilst classed as a PAH, naphthalene is more volatile and mobile in the environment than most other PAHs. As such the significance of naphthalene cannot be considered within the surrogate marker approach.

Similarly, TPH cannot be assessed as a single "total" value, and reference has been made to the Environment Agency's document P5-080/TR3, "The UK approach for evaluating human health risks from petroleum hydrocarbons in soils". This document supports the assumptions and recommendations made by the US Total Petroleum Hydrocarbons Criteria Working Group (TPHCWG). The TPHCWG have broken down "TPH" into representative constituent fractions or "EC Bandings". The TPHCWG have derived a series of physiochemical and toxicological parameters for each of the bandings.

¹ SP1010 Appendix E, Provisional C4SLs for benzo(a)pyrene as a surrogate marker for PAHs, CL:AIRE 2013

The significance of speciated TPH results can be assessed by following the 3 steps outlined in the tables below.

Step	Result	Action
1. Consider indicator compounds: Are BTEX, naphthalene, benzo(a)pyrene above their respective Tier 1 values?	Yes	Remediation or dQRA required
	No	Proceed to Step 2
2. Consider individual TPH fractions: are they above respective screening values?	Yes	Remediation or dQRA required
	No	Proceed to Step 3
3. Assess Cumulative effects: Is the calculated Hazard Index for each source >1	Yes	Remediation or dQRA required
	No	TPH compounds pose no significant risk

Step 1 - Assessing indicator compounds

TPH fraction Indicator compound	End use specific screening value (mg/kg)			
	A: Residential no cover	B: Residential with 600mm cover	C: Residential no gardens	D: Commercial\ industrial
Benzene	0.9	0.9	3.3	98
Toluene	600	3,000	2,700	5,000
Ethyl Benzene	350	932	843	5,000
Xylenes	246	327	321	5,000
Naphthalene	8	9	9	1,000
Benzo(a)pyrene	5	25	5.3	76

Step 2 - Assessing individual TPH fractions

TPH fraction		End use specific screening value (mg/kg)			
		A: Residential no cover	B: Residential with 600mm cover	C: Residential with no gardens	D: Commercial/ industrial
Aliphatic 5-6	GRO	41	41	42	5,000 [^] per fraction
Aliphatic 6-8	GRO	125	125	125	
Aliphatic 8-10	GRO	31	31	32	
Aliphatic 10-12	DRO	151	156	154	
Aliphatic 12-16	DRO	500 [^]	500 [^]	500 [^]	
Aliphatic 16-21	DRO	1,000 [^]	5,000 [#]	1,000 [^]	
Aliphatic 21-35	LRO	1,000 [^]	5,000 [#]	1,000 [^]	
Aromatic 5-7	GRO	100	123	122	
Aromatic 7-8	GRO	30	34	34	
Aromatic 8-10	GRO	47	50	50	
Aromatic 10-12	DRO	215	287	266	
Aromatic 12-16	DRO	689	1,000 [*]	1,000 [*]	
Aromatic 16-21	DRO	1,000 [^]	5,000 [#]	1,000 [^]	
Aromatic 21-35	LRO	1,000 [^]	5,000 [#]	1,000 [^]	

* Calculated Screening Value exceeded soil saturation limit and could indicate free product, therefore calculated soil saturation limit adopted as a target

[^] Calculated Screening Value close to soil saturation limit, screening value selected by Lithos considering visual and olfactory impacts.

[#] Five times the screening value for Scenario A.

Step 3 - Assessing Cumulative Effects

$$HI = \sum_{F_i=1}^{16} HQ F_i = \frac{\text{Measured concentration } F_i \text{ (mg kg}^{-1}\text{)}}{SGV F_i \text{ (mg kg}^{-1}\text{)}}$$

where HI = Hazard Index
 HQ = Hazard Quotient
 F_i = Fraction_i
 SGV = Soil Guideline Value

Other screening values used by Lithos

Tier 1 risk assessment of **hazardous gas** is undertaken through reference to the following documents (and further information is presented in Generic Note No. 5 – Hazardous Gas):

- Approved Document C, Building Regulations 2000
- Boyle & Witherington (2007) – Guidance on evaluation on development proposals on sites where methane and carbon dioxide are present, incorporating “traffic lights”. Report Ref. 10627-R01-(02), for NHBC
- CIRIA C665 (2007) – Assessing risks posed by hazardous ground gases to buildings
- BS 8485:2015 – Code of Practice for the characterisation & remediation from ground gas in affected developments

With respect to the assessment of potential **phytotoxic effects** of contaminants, Lithos refer to “The Soil Code” (MAFF, 1998) for copper and zinc. The CLEA SGV is adopted for nickel due to its human health effects.

The potential risk to **building materials** is considered through reference to relevant BRE Digests, with particular emphasis on BRE Special Digest 1, ‘Concrete in aggressive ground’, 2005.

With respect to the interpretation of the **calorific values**, at present there are no accepted methods to assess whether a sample is combustible and under what circumstances it might smoulder. Some guidance is given in ICRCCL Note 61/84 “Notes on the fire hazards of contaminated land” which states that: “In general ... it seems likely that materials whose CV’s exceed 10MJ/kg are almost certainly combustible, while those with values below 2MJ/kg are unlikely to burn”.

04 - Contamination analysis & interpretation (including WAC)

Generic notes – geoenvironmental investigations



Tier 1 **groundwater** risk assessments are undertaken by comparing leachate or groundwater concentrations with the appropriate water quality standard. Tier 1 Screening Values have been discussed with the Environment Agency, and typically those in **bold** below are adopted.

Analyte	Source of Tier 1 Screening Value (µg/l)			
	Surface water (Abstraction for Drinking) 1996	Water Supply Regulations 2000	Water Framework Directive	EA Advice
Arsenic	50	10	50	
Selenium	10	10		
Cadmium	5	5	1.5	
Chromium	50	50	32	
Copper	50	2,000	28	
Lead	50	10	7.2	
Nickel		20	20	
Zinc	3,000		125	
Boron		1,000		
Mercury	1	1	0.07	
Petroleum Hydrocarbons				10
1,1,1-Trichloroethane			100	
1,1 Dichloroethane				100
1,2-Dichloroethane		3	10	
1,1-Dichloroethene				100
Benzene		1	10	
Ethylbenzene				10
Tetrachloroethene		10	10	
Toluene			50	
Trichloroethene		10	10	
Vinyl Chloride		0.5		
Trichloromethane			2.5	
Xylenes			30	
Chloroethane				100

Waste classification & WAC

In the context of waste soils generated by remediation and/or groundworks activities on brownfield sites, the following definitions (from the Landfill Regulations 2002) apply:

- Inert (e.g. uncontaminated 'natural' soil, bricks, concrete, tiles & ceramics)
- Non-Hazardous (e.g. soil excavated from a contaminated site which contains dangerous substances, but at concentrations below prescribed thresholds)
- Hazardous (e.g. soil excavated from a contaminated site which contains dangerous substances at concentrations above prescribed thresholds)

Dangerous substances include compounds containing a variety of determinants commonly found in contaminated soils on brownfield sites, for example arsenic, lead, chromium, benzene etc.

Landfill operators require Waste Acceptance Criteria (WAC) laboratory data, if soil waste is classified as **hazardous**, and such waste must have been subjected to pre-treatment. However, subject to WAC testing it may be possible to classify it as stable, non-reactive hazardous waste, which can be placed within a dedicated cell within the non-hazardous landfill.

Lithos typically only include WAC analysis in site investigation proposals and reports, if significant off-site disposal (of soil classified as hazardous waste) is anticipated, for example where redevelopment proposals include basement construction etc. If off-site disposal of soils classified as hazardous waste during redevelopment is anticipated, then WAC analysis should be scheduled at an early stage in the remediation programme. However, organic compounds (BTEX, TPH, PAH etc) are the most common contaminants that result in soils being classed as hazardous, and these contaminants can often be dealt with by alternative technologies (eg by bioremediation or stabilisation) and consequently retention on site is often possible.

It should be noted that **non-hazardous** soil waste can go to a non-hazardous landfill facility; no further testing (eg WAC) is required.

Appendix D

Protocol for the Placement of Non-Engineered Fill

1 INTRODUCTION

- 1.1 This protocol is aimed at providing general guidance to contractors in the placement of general earthworks fill materials in areas of a site that do not require high quality, controlled engineering eg Public Open Space. No guarantee can be made as to the degree of settlement that may occur in such fill masses; however, the protocol should mitigate significant differential settlements.
- 1.2 General fill will be either inert soil or contaminated soil that is deemed chemically suitable for reuse in certain specific site areas or beneath a specified 'clean' soil cover layer. All soft and compressible soils or existing fill shall, if comprising unsuitable fill be removed from site. Suitable fill materials may be compacted on site.
- 1.3 Unsuitable fill shall comprise:
- Cohesive soils having a liquid limit in excess of 90% or Plasticity Index in excess of 65%
 - Chalk having a fine fraction (<400µm) in excess of 10% at the borrow pit
 - Any material containing topsoil, wood, peat or lignite
 - Any material containing biodegradables
 - Any material containing scrap metal
 - Frozen or waterlogged substances
 - Material defined as unsuitable by the Engineer because of its type or level of contamination
 - Material which, by virtue of its particle size or shape, cannot be properly and effectively compacted (eg oversize material, gravels which are tabular and some slate wastes)
 - Expansive steel slag
 - Non-inert or contaminated material
 - Putresible waste
 - Materials containing minerals hostile to the built environment such as pyritic shales, gypsiferous clays, burnt colliery discard, pulverised fuel ash, spent oil shale or incinerator waste
- 1.4 The base of the area to be filled shall be proof rolled with a dead weight roller and all soft materials removed and replaced with compacted fill. Where unsuitable material has been excavated, the underlying ground shall be compacted to the same specification as adopted for subsequent compaction works.
- 1.5 Fill shall be placed and compacted in near-horizontal layers of maximum 200mm thicknesses and be brought up at a uniform rate so that all parts of the site or particular sections of the site reach finished (formation) level at the same time. Each layer will be subjected to nominal compaction, comprising at least two passes with a towed vibratory roller of at least 2,900 kg per metre width (or equivalent). If the compacted fill demonstrates excessive rutting, excessive roller 'bow-waving' or other soft behaviour then it shall be deemed unsuitable.
- 1.6 Cobbles, boulders, rock or waste fragments, the largest dimension of which is greater than two-thirds of the compacted layer thickness (or greater than 250mm in any dimension), shall not be incorporated into the fill.
- 1.7 When compacting fill in the vicinity of existing trenches, excavations, retaining walls or other structures all work shall be performed in such a way as to ensure that their existing stability is not impaired; this will require careful selection of both compaction plant and compaction method.

-
- 1.8 When placing fill against structures the Contractor must only use only the following types of compaction plant for fill within 2m of a structure:
- Vibratory roller, mass per metre width of roll not exceeding 1300 kg and total mass not exceeding 1000 kg
 - Vibrating plate compactor, mass not exceeding 1000 kg
 - Vibro-tamper, mass not exceeding 75 kg
- 1.9 If weather conditions are such that the fill is adversely affected, the Contractor shall cease work until such time as the fill can be placed and compacted to meet the protocol requirements. No fill shall be placed and left uncompacted at the end of the working day. Compacted fill shall be graded to falls to ensure free run-off of rainwater without ponding.
- 1.10 Drainage grips or trenches shall be excavated, as necessary, uphill of the area to be filled to prevent the area becoming flooded. Drainage shall be affected without causing siltation or erosion and water shall be disposed of. The area to be filled shall be graded to falls, and sump pumping or other suitable dewatering facilities shall be provided as necessary by the Contractor to keep the base of the excavation dry at all times.