WILLOWBROOK SOUTH

CARDIFF PARTNERING HOUSING PROJECT

TOPSOIL RESOURCE SURVEY AND SOIL RESOURCE PLAN

Prepared on behalf of:

WATES CONSTRUCTION LTD

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CONTENTS

1.0 INTRODUCTION

Tim O'Hare Associates LLP was commissioned by Wates Construction Ltd to undertake a Soil Resource Survey and Soil Resource Plan for the Willowbrook South development, Cardiff.

The authority to carry out the work was confirmed via an email message from Stuart Jones (Wates Residential), dated 8th September 2020, and receipt of the formal appointment for (via email, dated 5th November 2020).

1.1 Purpose

TOHA understands that a residential development is to be constructed at this site, which will comprise the construction of a number of houses, with associated infrastructure, soft landscaping and residential back gardens.

As part of the development strategy, the site topsoil will be stripped and stored in a temporary stockpile(s) before it is re-used for landscape purposes, including residential back gardens.

The existing site comprises grassland and areas of dense scrubland with mature trees and, as such, contains significant reserves of topsoil and subsoil. However, there is currently no information available on the horticultural quality, variability and suitability of the soil for landscape purposes within this development.

The ground investigation (*Terrafirma – Geotechnical and Geo-Environmental Report – Land Adjacent to Willowbrook Drive, St Mellons, Cardiff – Report Ref. 13601 – Date: May 2016*) identified that asbestos in the form of Chrysotile fibres was present in one sample of made ground (subsoil layer), concluding that remedial measures will be required to address the asbestos. After a discussion with Stuart Jones of Wates Construction Ltd, it was understood that no remediation works have taken place to date. As such, it was agreed that the subsoil / made ground layer would not be disturbed and that the scope of these works would be limited to the 'topsoil' resource only (via email from Rebecca Hollands of Tim O'Hare Associates to Stuart Jones, date 15/09/2020).

Therefore, the purpose of this *Topsoil Resource Survey* is to assess the quality of the site topsoil and to advise on its suitability for re-use for the proposed landscape types, including residential back gardens.

The report also provides soil management advice e.g. soil stripping, stockpiling, potential soil amelioration and cultivation. This will form the basis of the *Soil Resource Plan* chapter within this report in accordance with the *DEFRA Construction Code of Practice for the Sustainable Use of Soils on Construction Sites (2009)*.

1.2 Actions

Tim O'Hare Associates LLP has evaluated the quality and suitability of the soils for landscape construction by desk study review, on-site investigation and laboratory analysis.

This report issues the findings of the Topsoil Resource Survey for the Willowbrook South, Cardiff development site, including the site observations and soil descriptions, results and interpretation of all analyses, discussion on soil's quality and suitability for the proposed landscape scheme and recommendations for handling, treating and re-using the soils for landscape construction.

2.0 DESK STUDY REVIEW

2.1 Documents Reviewed

Prior to commencing the site investigation work, the following documents were reviewed:

- *Soil Map of England and Wales – Sheet 2 – Wales (1:250,000);*
- *British Geological Survey Website (Geology of Britain);*
- *Terrafirma – Land Adjacent to Willowbrook Drive, St Mellons, Cardiff – Geotechnical and Geo-Environmental Environmental Report – Report Ref. 13601 – Date: May 2016;*
- *Wates Construction Ltd – Willowbrook Drive South Site – Layout Design, Step 5;*
- *UtiliMap – Willowbrook Site 3 and 4 – Topographical Survey (3 of 4) – Drawing No. ACAD-WILLOWBROOK-SITE-3-&4-RevR1 – Date: May 2019;*
- *UtiliMap – Willowbrook Site 3 and 4 – Topographical Survey (4 of 4) – Drawing No. ACAD-WILLOWBROOK-SITE-3-&4-RevR1 – Date: May 2019.*

2.2 Summary of Findings

Soils

The Soil Map of England and Wales classifies the soils within the survey area as: *Unsurveyed (Urban)*. Soils within urban and industrial areas are potentially subject to a wide range of natural and anthropologic influences and impacts, and can include building materials and soils which have been imported from outside of the subject site. In horticultural terms, this can result in variable soil conditions with regards to soil chemistry, fertility status and physical condition, including compaction and the presence of foreign matter within the soil matrix.

The area adjacent to site is dominated by the following soil classification:

Major Group	*Brown soils*
Group	*Argillic brown earth*
Subgroup	*Stagnogleyic argillic brown earth*
Series	*SALWICK (572m)*

Brown soils are soils in which pedogenic processes have produced dominantly brownish or reddish subsurface horizons with no prominent mottling or greyish colours above 40cm depth. *Stagnogleyic argillic brown earths* have mottled, slowly permeable subsoil.

The *SALWICK* series is composed of '*deep reddish fine loamy soils with slowly permeable subsoils and slight seasonal waterlogging. Some deep well drained coarse loamy soils. Some fine loamy soils affected by groundwater*.'

Geology

The British Geology Survey shows that the bedrock geology of the area is part of the *Lower Devonian Rocks – Mudstone, Siltstone and Sandstone*, comprising Sedimentary Bedrock formed approximately 398 to 416 million years ago in the Devonian Period.

Superficial deposits comprised of *Till – Diamicton*, formed up to 3 million years ago in the Quaternary Period.

Ground Investigation Report

The *Terrafirma – Land Adjacent to Willowbrook Drive, St Mellons, Cardiff – Geotechnical and Geo-environmental Environmental Report* comprised of 5 No. trial pits within the Willowbrook South site. A summary of the ground conditions encountered is presented in the table below:

Depth (m)	Thickness (m)	Description
GL – 0.50/1.60	0.50-1.60	Grass over very soft, dark brown, slightly sandy silty CLAY; OVER firm locally very stiff, dark greyish brown, variably sandy locally slightly gravelly silty CLAY or clayey SILT (MADE GROUND).
0.90/1.60 – 1.10/>1.90	0.20-0.30	Firm, dark grey, locally mottled black, slightly sandy organic clayey SILT or silty CLAY (RELICT TOPSOIL?). (TP13, TH14 and TP15 only)
0.50/1.30 - 1.10 /2.30	1.10-2.30	Firm, mottled, light orangish brown, dark orangish brown, dark brown and dark grey, slightly sandy locally sandy slightly gravelly locally gravelly absent silty CLAY locally clayey SILT (GLACIAL TILL).
1.10/2.30- >2.30/>2.70	-	Stiff to very stiff, dark reddish brown, slightly sandy slightly gravelly CLAY (ST MAUGHANS FORMATION).

The following topsoil depths were recorded:

Trial Pit Ref.	Topsoil Depth (mm)	Trial Pit Ref.	Topsoil Depth (mm)
TP9	300	TP14	200
TP10	400	TP15	200
TP13	200	**Average Depth:**	**260**

A number of soil samples were taken and sent for chemical testing, including metals and metalloids, in-organics, organic chemicals and asbestos. The majority of substances tested for were found to be present at concentrations below their respective human health threshold levels.

A total of 2 No. samples collected from the Made Ground were tested for asbestos. A positive asbestos result (Chrysotile fibres) was recorded in sample TP14 0.40-0.50m. The ground investigation report states that it cannot be confirmed whether the asbestos is an isolated or site wide issue due to the low number of tests conducted, however it concluded that remediation work will be required to address the asbestos issue.

Proposed Landscape Uses

The supplied *Wates Construction Ltd – Willowbrook Drive South Site – Layout Design, Step 5* drawing shows that the proposed landscape scheme is to include the following planting environments:

- Tree planting;
- Native tree planting;
- Ornamental hedge planting;
- Residential back gardens;
- Amenity grass areas.

The soil requirements of the anticipated landscape types are considered below.

Tree Planting

Semi-mature trees are demanding planting types. Good, aeration and drainage around the rootball, as well as moderate to high fertility status are critical at planting and during the establishment period. Without these properties, trees will very quickly suffer and possibly die during their first few growing seasons after planting. Given their demanding nature, all rootballed trees should be planted with well-aerated and free-draining soils to the full rooting depth (normally considered to be 1.0m).

Native Tree Planting

Native trees, planted as whips or transplants are considered to be a less demanding planting type. As such, a broader range of soil types may be re-used for these, provided the species selected do not require any specific growing conditions. The soils must possess a satisfactory structure to support plant growth. The topsoil and subsoil should have suitable pH and drainage characteristics for the selected species.

Ornamental Hedges

Container grown hedging plants normally require shallower depths of soil than trees and the plants themselves can be variable in their specific soil requirements. Ornamental hedges are not usually tolerant of adverse soils conditions and would normally require soils which are fertile, well drained and aerated.

Amenity Grass

The soil requirements for amenity grass areas depend on the level of anticipated usage, whereby grass in 'low use' areas, e.g. road verges, is a robust planting type that does not require a specialist soil type. Grass in 'high use' areas, e.g. residential back gardens, requires soil that is resistant to wear and compaction. However, in both instances, the topsoil and subsoil should possess adequate structures, without excessive compaction, to allow sufficient drainage and aeration to sustain healthy grass growth.

Residential back gardens are considered to be a 'sensitive' end-use in relation to concentrations of potential contaminants (e.g. heavy metals, hydrocarbons). As such, the contaminant levels in the soils used should comply with the project's environmental requirements.

3.0 SITE INVESTIGATION

3.1 Site Visit

The site visit took place on Wednesday 16th September 2020, during a period of warm and dry weather.

The site is located to the north east of Cardiff and to the south of St Mellons, and was accessed off Crickhowell Road. Residential properties (including Crickhowell Road and Trefaser Crescent) bordered the majority of the site, with the exception of the proposed Wates Construction Ltd *Willowbrook North* development and Willowbrook Drive which bordered the site to the north east.

The site was open and flat, and the majority of the site comprised grassland with numerous linear corridors of very dense scrub, including mature trees and brambles. A site compound comprising compacted hardcore for material storage was also present within the south eastern corner of the site (opposite Rhodfa Crughywel). The areas of dense scrub restricted access to these parts of the site and it was also not possible to examine the soil profile within the site compound area with hand tools. This therefore limited the locations available for examination to the grass areas only.

Within the scrub areas and grass areas along the south western edge of site, frequent foreign matter was observed including glass bottles, fragments of ceramic, lengths of plastic and metal and general household litter. In addition, a heap of waste soil and stone was present which was littered in the above, as well as a sack of what looked like carpet trimmings.

Plate 1: View from the south western tip of the site to the north east.

Plate 2: View from the centre of site to the north west.

Plate 3: View of the centre of the site.

Plate 4: View of south eastern corner of site to the south.

Plate 5: The site compound located within the south eastern corner of the site.

Plate 6: Heap of waste on the grass area along the south western edge of site.

Plate 7: House hold waste including glass bottles observed within the scrub along the south western edge of site.

3.2 Soil Conditions

The topsoil was examined by constructing a total of 12 No. hand-dug trial holes (TH) at representative locations within the survey area. Trial holes were excavated to a maximum depth of approximately 200m in order to avoid disturbing the subsoil layer. The sample locations are shown on the site plan in **Appendix 1**.

At each trial hole, the topsoil was examined with reference to the Soil Survey Field Handbook. Important physical soil characteristics were recorded, including soil texture, structure, compaction, waterlogging, anaerobism, stone content and the presence of deleterious materials. At the same time, representative topsoil samples were taken for laboratory analysis.

3.3 Soil Descriptions

A single *Topsoil* was encountered on site and was typically described as a brown to dark brown (Munsell colour 10YR 4/3 to 3/3), slightly moist, friable, non-calcareous to very slightly calcareous CLAY LOAM with a well developed, fine to medium subangular blocky structure.

The *Topsoil* was moderately stony, including occasional subrounded and subangular stones up to 70mm in diameter. Shards of glass up to 20mm in length were encountered within the topsoil at TH5 (2 No.), TH6 (1 No.) and TH7 (3 No.), as well as a fragment of charcoal at TH4.

Plate 8: Trial pit at TH9.

Plate 9: Typical *Topsoil* arisings.

Plate 10: Shards of glass encountered within TH7.

3.4 Soil Sampling

A total of 2 No. composite samples of *Topsoil* were collected from site. The following table provides the locations of the sub-samples for each of the 2 No. composite samples.

Sample Reference	Sub-Sample Trial Hole Locations
Topsoil	
Topsoil Sample 1	TH1, TH2, TH3, TH10, TH11, TH12
Topsoil Sample 2	TH4, TH5, TH6, TH7, TH8, TH9

The trial hole locations can be viewed on the site plan located within **Appendix 1**.

4.0 LABORATORY ANALYSIS

4.1 Analytical Schedule

A total of 2 No. representative samples of *Topsoil* were submitted to the laboratory for analysis. The samples were analysed in accordance with the following schedule:

- particle size analysis (% sand, silt, clay);
- stone content (2-20mm, 20-50mm, >50mm);
- pH value;
- electrical conductivity values;
- exchangeable sodium percentage;
- major plant nutrients - N, P, K, Mg;
- organic matter content;
- C:N ratio.

The results are presented on the Certificates of Analyses in **Appendix 2** and an interpretation of the results is given below.

4.2 Results of Analysis

Particle Size Analysis

The *Topsoil* samples fell into the *clay loam* texture class, which is usually considered suitable for general landscape applications provided the soil's physical condition is maintained.

Such soils usually have good water and nutrient retention capacities, but they are also prone to structural degradation and compaction during handling, and especially when plastic in consistency. Any damage to the structural condition of this soil is likely to reduce its drainage and aeration properties.

Stone Content

The stone contents of the *Topsoil* samples were moderate, including occasional stones up to 70mm in diameter. It would be advisable to remove all stones greater than 50mm for residential back gardens and landscape planting purposes and greater than 20mm for areas of seeded amenity grass, for example by raking, picking or burying.

pH and Electrical Conductivity

The *Topsoil* samples were slightly acid to slightly alkaline in reaction (pH 6.5-7.4), with a pH range that would be considered ideal for general landscape purposes.

The electrical conductivity (salinity) values were low, indicating that soluble salts were not present at levels that would be harmful to plants.

Organic Matter and Nutrient Status

The *Topsoil* samples were adequately supplied with organic matter, total nitrogen and extractable magnesium, and were deficient in extractable phosphorus and extractable potassium. These nutrient deficiencies may be addressed by a routine fertiliser application.

The C:N ratio results of the *Topsoil* samples are considered acceptable for landscape purposes.

5.0 DISCUSSION

A residential development is to be constructed at the Willowbrook South site, which will comprise the construction of a number of residential units, with associated infrastructure, soft landscaping and residential back gardens.

This survey is limited to the topsoil resource only on account of the presence of asbestos within the subsoil (*Terrafirma - Geotechnical and Geo-environmental Environmental Report*). As such, the purpose of this investigation is to assess the quality of the site topsoil by visual examination and laboratory analysis and to advise on its suitability for re-use for landscape purposes, including residential back gardens.

The site comprised areas of very dense vegetation and a site compound, which limited the examination locations to grass areas only.

5.1 Summary of Findings

From the site visit and subsequent laboratory analysis, 1 No. *Topsoil* type was encountered and was found to be reasonably consistent in composition across the site. This survey excavated trial holes to 200mm below ground level only and did not determine the *Topsoil* depth on account of the risk of asbestos within the subsoil. The ground investigation report however concluded that the *Topsoil* ranged in depth from 200-400mm, with an average depth of 260mm.

The *Topsoil* was described as a slightly acid to slightly alkaline, non-saline, non-calcareous to very slightly calcareous CLAY LOAM with a well developed structure and moderate stone content, including occasional stones up to 70mm in diameter. The *Topsoil* contained moderately high levels of organic matter, total nitrogen and extractable magnesium and low levels of extractable phosphorus and extractable potassium.

At TH5 (2 No.), TH6 (1 No.) and TH7 (3 No.), shards of glass up to 20mm in length were encountered within the topsoil. In addition, within the scrub and grass areas along the south western edge of site, frequent foreign matter was observed at the surface including glass bottles, fragments of ceramic, lengths of plastic and metal and general household litter, as well as a heap of waste soil and stone which was littered with the above.

5.2 Soil Suitability for Re-Use

Sharps and Foreign Matter

The presence of sharp materials within the *Topsoil* presents a health and safety risk for end-users and, as such, would limit the places where they may be used safely. For example, it would not be acceptable for areas where end-users are likely to come into direct contact with this soil, including back gardens and amenity grass within Public Open Space. Please note, the presence of 'sharps' in the *Topsoil* makes the topsoil non-compliant with the British Standard for Topsoil (*BS3882:2015*), which is an NHBC requirement.

If it is still desirable to use the site won *Topsoil* within residential back gardens and other 'sensitive' landscape types, consideration will need to be given to encapsulating the site won *Topsoil* with a 'sharps-free' imported topsoil (150mm thickness). This option should provide a physical barrier between the site topsoil and end-users. An element of hand picking/raking may also be beneficial to remove as many sharps as possible prior to spreading the Imported Topsoil.

Horticultural Quality

Based on our findings, the *horticultural* properties of the *Topsoil* would be considered suitable for the proposed landscape purposes, provided the physical condition of the soil is maintained. The extractable phosphorus and extractable potassium deficiencies should be rectified by a routine fertiliser application.

Any large stones and debris should be removed from the topsoil surface where it is to be used for 'non-sensitive' grass areas (e.g. roadside verges).

5.3 Re-use of the Site Topsoil – Summary

A summary of the re-use potential of the site *Topsoil* for particular landscape types is given in the table below. **The *Topsoil* would not be acceptable for areas where end-users are likely to come into direct contact with this soil.** It is important to note that for all planting and seeding, the soils must be uncompacted and have an adequate structural condition.

Planting Environment	***Topsoil***
Tree Planting (≥16cm girth)	O S
Tree Planting (<16cm girth)	✓ S
Ornamental Hedge	O S
Amenity Grass (high foot traffic – including residential back gardens)	✓ S
Amenity Grass (low foot traffic)	✓S

✓ Suited to this landscape type **provided** the topsoil and subsoil are adequately structured, uncompacted, aerated and drained.

O May be suitable, provided soil is in its optimum condition with additional soil management / improvement measures.

S Suitable only **provided** topsoil containing sharps would not present a hazard to end-users or this topsoil is placed under 150mm sharps-free Imported Topsoil.

5.4 Compliance with British Standard for Topsoil

The *Topsoil* was **not** compliant with the requirements of the British Standard for Topsoil *(BS3882:2015 – Specification for Topsoil – Table 1, Multipurpose Topsoil),* on account of the presence of sharps, stones >50mm and deficiencies in extractable phosphorus and extractable potassium.

5.5 Imported Topsoil

The site won *Topsoil* is only considered suitable for re-use in either 'non-sensitive' end-locations or as a lower topsoil layer beneath 150mm of clean imported topsoil. A suitably sandy, free-draining topsoil should be imported in accordance with the Imported Topsoil Specification in **Appendix 3** for the construction of the residential back gardens and other sensitive end-locations.

5.6 Soil Structure & Physical Degradation

It is essential to provide a structured, uncompacted soil profile for the successful establishment and subsequent growth of plants and grass. Adequate soil structure is a key element for healthy plant growth to ensure aeration and drainage within the rootzone. Where the site's development programme requires the soils to be disturbed by activities such as excavation, storage and respreading, soil structure can easily be destroyed by compaction. Any damage to soil structure will reduce the drainage rate of these soils.

Almost all soils are physically degraded during intensive handling and the potential quality and the ultimate suitability of the site soils for re-use will depend on how well their soil structures are preserved during the earthworks phase. This topsoil is particularly prone to structural damage if handled and moved when wet. In this situation, the larger (air containing) soil pores are destroyed and replaced by smaller (water retentive) pores. This will restrict gaseous exchange with the atmosphere and cause the topsoil to become anaerobic (oxygen depleted). In addition, the lack of larger pores prevents effective drainage and results in an increased risk of waterlogging.

5.7 Topsoil Handling & Programming

If the site topsoil is to be re-used successfully, structural degradation must be kept to a minimum. In order to achieve this, it is considered best practice to only handle the topsoil when it is reasonably dry and friable in consistency.

The most appropriate time to carry out the topsoil strip will therefore be during the summer months (May/June to September/October), and then only when the topsoil is dry. If the topsoil is dry when it goes into the temporary stockpile, it can be kept dry until it is respread.

If the development's programme requires the topsoil to be handled when moist/wet and plastic, it is inevitable that significant damage is likely to occur to its structure. This damage will be potentially irreparable (particularly in the short to medium term), and planning the programme of earthworks should therefore be carefully considered by the project team at the earliest stage.

Should the topsoil become damaged through wet handling, it may still be possible to repair the damage provided there is sufficient time and dry weather. It will therefore be essential that the *Topsoil Respreading Phase* take place during a summer season, to allow enough time for the soil to dry out effectively and be thoroughly cultivated before soil cultivation and planting/seeding/turfing takes place in autumn (grass seeding) and winter (planting).

If the project's programme results in wet topsoil being respread for planting/seeding/turfing in the wetter/colder, winter or following spring months, there will be no opportunity to recondition and prepare the topsoil to address the structural degradation caused by the stripping/stockpiling process. Planting into such adverse conditions is likely to result in plant/lawn failures and greater instances of flooded back gardens and other low lying areas of the development.

6.0 SOIL RESOURCE PLAN

6.1 Outline Requirements

6.1.1 This section highlights the sequential treatments for the recovery, storage and re-use of the existing topsoil resource.

6.2 General Soil Handling

6.2.1 It is important to avoid soil physical degradation during all phases of soil handling (e.g. stripping, storage, respreading and amelioration). Soil handling operations should ideally be carried out when the soil is reasonably dry and non-plastic (friable) in consistency.

6.2.2 The soils (topsoil and subsoil) should not be unnecessarily compacted by trampling or trafficking by site machinery.

6.2.3 If, during the course of the earthworks, the soil is structurally damaged, it should be suitably cultivated to relieve the compaction and restore the structure prior to any planting, seeding or turfing.

6.3 Foreign Matter Removal

6.3.1 An intensive walkover should be conducted in order to hand pick and remove all sharps and debris currently located on site.

6.3.2 All foreign matter picked up should be removed from site and disposed of at a suitably licensed waste facility.

6.4 Pre-treatment of Existing Vegetation

6.4.1 It is good practice to minimise the quantity of vegetation entering the storage stockpiles in order to minimise the formation of anaerobic conditions during storage. As such, in advance of soil stripping, the topsoil should be cleared of surface vegetation by a method suited to the vegetation type present.

6.4.2 Where necessary, the grass should be close mown (< 100mm) and the cuttings collected where necessary for removal to a suitable green-waste recycling facility.

6.4.3 Trees/hedgerows should be pre-treated before soil stripping, in two stages:

1. Each tree/hedgerow should be felled/cut and removed from site, including all branches/brash.
2. Stumps and associated large roots (> 20mm diameter) should be lifted using a suitable excavator fitted with a hydraulic grab.
3. All woody materials (tree trunks, stumps, branches and brash, etc.), including wood chippings, should be removed from site to a suitable green-waste material processing facility for recycling.

6.4.4 To minimise anaerobism during storage and preserve the quality of the topsoil as a growing medium, coarse woody materials should not be incorporated with the soils during stripping. This includes any chippings left on the surface after clearance of trees/hedgerows.

6.5 Topsoil Stripping

6.5.1 The loose tip method, using dump trucks and hydraulic excavators, should be used to strip, transport and stockpile the topsoil.

6.5.2 The loose-tipping method involves the use of a tracked hydraulic excavator, fitted with a flat edged grading bucket to strip the topsoil and load it into a dump truck.

6.5.3 The dump truck, running along a pre-designated route, then transports the topsoil to the desired stockpile location.

6.5.4 This operation should be monitored to ensure that the topsoil is recovered without the inclusion of other soils (subsoil) or wastes. Cross contamination with other soil could significantly degrade the quality of the topsoil.

6.5.5 Any stones, waste or non-topsoil materials (>50mm) should be removed from areas to be stripped prior to topsoil stripping.

6.5.6 Stripping should ideally be carried out whilst the soil is reasonably dry and friable. However, if due to construction programme constraints topsoil stripping needs to be carried out whilst the topsoil is wet, an alternative method for topsoil stockpiling will be used (Figure 2).

6.6 Depth of Topsoil Strip

6.6.1 The depth of strip should be set at 260mm to enable the majority of the topsoil to be recovered without the inclusion of significant quantities of subsoil.

6.6.2 When using an excavator to strip the topsoil, the colour differences between the topsoil and subsoil may be able to be seen by the machine operator carrying out the soil strip so that some discretion can be made.

6.6.3 Where the colour differences between the topsoil and subsoil are not visible to the machine operator, the topsoil strip should be set to the relevant stated depth above.

6.7 Topsoil Stockpiling

6.7.1 The topsoil should be stockpiled prior to re-spreading into 'non-sensitive' landscape areas when they become available.

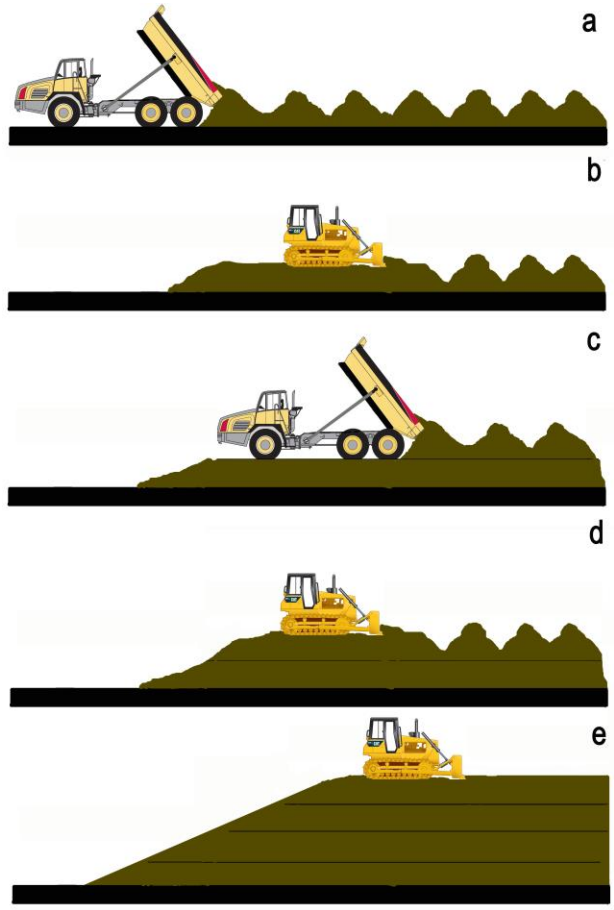
6.7.2 The site-won *Topsoil* should be stored separately from the any imported soils. It may be advisable to clearly sign the stockpiles.

6.7.3 The topsoil should be stored in an area of the site where it will not interfere with other site operations so that it can be left undisturbed during other construction activities. The area that is to be used for storing the topsoil will be cleared of vegetation, in-situ topsoil and any waste arising from the development e.g. building rubble and fill materials.

6.7.4 The topsoil should be transported to the storage area in a dump truck and be 'loose tipped' in a series of heaps, starting at the furthest point and working back towards the storage area access.

6.7.5 There are two options for stockpiling the topsoil depending on the **moisture content** and **plasticity**. These are referred to here as *dry soil stockpiling* and *wet soil stockpiling*.

6.7.6 The dry stockpiling method is illustrated below (*Figure 1*).



The process requires the topsoil to be transported to the storage area in a dump truck, and 'loose tipped' in a line of heaps to form a windrow (a).

Once the heaps cover the storage area, a tracked dozer (e.g. D6 Caterpillar or tracked excavator) should level the heaps to form a level, stable platform for dump trucks to travel across to tip a second layer of topsoil. (b and c) This sequence should be repeated until the maximum stockpile height is achieved (d).

Assuming that the topsoil is reasonably dry and friable during the stripping and storage operation, it will be heaped to a maximum of 6.0 metres (health and safety permitting).

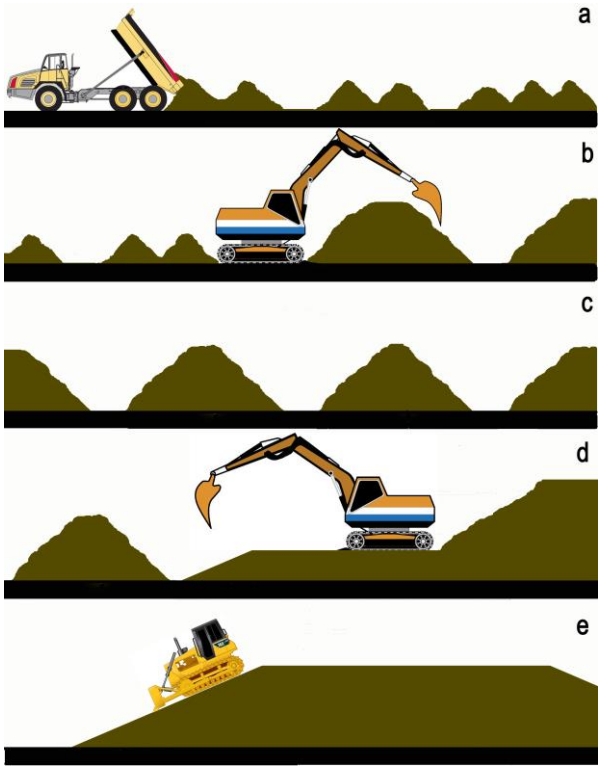
To protect from wet weather once the final height is achieved, the excavator or blade should re-grade the sides and top of the stockpile to firm the surface by tracking across it to form a smooth gradient. The aim is to seal in the dry topsoil and reduce rainfall infiltration. (e).

If the topsoil is to be stored for more than 3 months, a quick germinating fescue/clover seed mix should be sown over the sides and top of the stockpile to stabilise the surface and reduce the risk of erosion.

Once the stockpile has been completed the area should be cordoned off with secure fencing to prevent any disturbance or contamination by other construction activities.

Figure 1: Dry Stockpiling Method.

6.7.7 The wet stockpiling method is illustrated below (*Figure 2*); the wet soils are tipped for temporary storage as windrows until the topsoil has dried out. This technique minimises the amount of compaction caused by stockpiling as well as maximising the surface area of the stockpile to enable to soil to dry out. The reconditioning operation would ideally be timed during the summer months (May to September), to allow enough time for the topsoil to dry out effectively.



The soil is tipped in a line of heaps to form a 'windrow', starting at the furthest point in the storage area and working back toward the access point (a).

Any additional windrows are spaced sufficiently apart to allow tracked plant to gain access between them so that the soil can be heaped up to a maximum height of 2.5m (b). To avoid compaction no machinery, even tracked plant, traverses the windrow.

Once the soil has dried out and is non-plastic in consistency (this usually requires several weeks of dry and windy or warm weather), (c) the windrows can be combined to form a larger stockpile(s) with a maximum height of 6.0m, using a tracked excavator (d).

The surface of the stockpile should be re-graded and compacted (e) by a tracked machine (dozer or excavator) to reduce rainwater infiltration.

Figure 2: Wet Stockpiling Method.

6.8 Subsoil Grading and Preparation

6.8.1 Prior to any subsoil preparation works, the location and depth of all services shall be determined and clearly marked out to ensure that all services are avoided and not damaged.

6.8.2 Any concrete haunching at the edges of landscape areas should be trimmed to the required minimum. The trimmings should be collected and removed off-site to a suitably licensed waste recycling facility.

6.8.3 Subsoil should be placed and graded in accordance with the Engineer's requirements. Grade to smooth flowing contours to achieve the desired formation levels and falls and the specified finished levels of topsoil.

6.8.4 Any large stones and other debris larger than 75mm brought to the surface during subsoil spreading should be stone picked or raked and removed. The stones should either be re-used on site or they should be removed off-site to a suitably licensed waste facility.

6.8.5 It is likely that the subsoil will have been heavily compacted following the construction period. Therefore, the subsoil should be loosened to a depth of at least **400mm at 300mm centres** to break up any panning.

6.8.6 The small, inaccessible areas (residential back gardens, field boundaries, corners of the site, steep slopes or adjacent to roads and pathways), a tracked excavator, fitted with a single tine ripper attachment (ripper tooth) should be used to loosen the subsoil. A toothed bucket is not an acceptable alternative.

Plate 11: Excavator arm fitted with a Single Tine Ripper Attachment

Plate 12: Single Tine Ripper working

6.8.7 Repeated passes may be needed to break up the subsoil sufficiently. This will be largely dependent on the strength of the soil and its resistance to cultivation at the time of the operation.

6.8.8 Any large stones and other debris >75mm brought to the subsoil surface by this cultivation should be stone picked or raked and removed. The stones (and other debris) should be removed off-site to a suitably licensed waste recycling facility.

6.8.9 Following decompaction and stone picking, any large subsoil clods should be broken up using a toothed excavator bucket and then the subsoil surface should be roughly levelled and lightly firmed (without recompacting) to provide a sensible surface to place the topsoil.

6.9 Topsoil Respreading

6.9.1 The aim of this operation is to respread the site won and/or imported topsoil and to minimise and eliminate any soil compaction caused during the process.

6.9.2 Site-won topsoil should be placed to a maximum depth of 300mm post firming for locations where sharps will not present a hazard to end-users, and 150mm where the topsoil can be placed under 150mm sharps-free imported topsoil.

6.9.3 Following topsoil respreading (site won or imported), the soil profile shall comprise a minimum of 400mm decompacted soil (topsoil and subsoil combined) for handover to the Landscape Contractor. The aim of the decompaction operation is to break up compacted soil layers, prior to the final topsoil cultivation.

6.9.4 Prior to commencement, the Groundworks Contractor shall set out a proposed Method Statement to respread topsoil onto prepared (ripped) subsoil based on the following guidelines.

- The topsoil should be respread using a combination of tracked excavator and dump truck.
- During topsoil spreading, all plant should work from the subsoil layer only.
- Trafficking over the ripped subsoil with either tracked or wheeled vehicles will cause further compaction. Therefore, all operations should be organised to minimise trafficking over ripped subsoil.
- Trafficking by wheeled vehicles is more damaging to soils than tracked equipment and should therefore be kept to an absolute minimum. Dump trucks should run on pre-designated access routes only. Drivers should be disciplined to keep to these routes at all times.
- A larger excavator (e.g. 8 tonne) with a longer reach may be beneficial to reduce tracking over the subsoil. Wherever possible, the reach of the excavator should be utilised to minimise tracking on the subsoil.
- Following topsoil spreading, the access routes should be decompacted to break up the compaction caused during placement, e.g. by ripping using the excavator fitted with the single rigid tine attachment to a **minimum depth of 400 mm at 300 mm centres**.

6.9.5 The proposed Method Statement shall be submitted to the Wates Construction Ltd site management team for review.

6.9.6 A photographic record shall be made of all operations and submitted to the Wates Construction Ltd site management team upon completion of the approved topsoil spreading in each area.

6.9.7 An example sequence of the required operations is presented below for reference.

Example Sequence of Operations: Subsoil Decompaction and Topsoil Spreading

1. The subsoil is prepared by ripping, working backwards towards the area access point.
2. Prior to respreading the topsoil, a minimum number of access routes are clearly designated.
3. Running on the designated access routes, the dump truck deposits topsoil in a number of small heaps.
4. Running on the designated access routes, the excavator respreads the topsoil to the required thickness.
5. The excavator decompacts the access routes using the rigid tine to provide a minimum 400mm loosened soil.

6.9.8 Before commencing any turfing, the Landscape Contractor shall check and record the topsoil depth in each Plot to confirm it meets the minimum requirement of **300mm**.

6.9.9 The Landscape Contractor shall confirm in writing to Wates Construction Ltd that they are satisfied with the quality and condition of the topsoil in each Plot for lawn turf, before commencing any turfing.

6.9.10 Once the site-won topsoil has been placed, a walkover of the plot should be conducted to handpick any fragments of glass and ceramic that may be visible on the topsoil surface, prior to spreading imported topsoil (see below).

6.10 Imported Topsoil

6.10.1 Once the processes described within **Section 6.9** have been completed, the plots and landscape areas would be considered ready for the placement of the *Imported Topsoil* where required – see the table on page 25.

6.10.2 The imported topsoil should be placed and prepared as per the guidelines provided within **Section 6.9**.

6.11 Topsoil Depths

6.11.1 The topsoil depths after firming and settlement are summarised in the table below. Here the soil should be 'firmed' to reduce future settlement, without causing over-compaction. Suitable methods may include the back of the excavator bucket or 'toe and heel' by operatives.

Landscape Type	Topsoil Depth (mm)	Soil Type
Tree Planting (≥16cm girth)	See Landscape Architects' soil profile drawings	Site-won Topsoil or Imported Topsoil*
Tree Planting (<16cm girth)	300	Site-won Topsoil
Ornamental Hedge (in front of resident's gardens)	300	150mm Imported Topsoil* 150mm Site won Topsoil
Amenity Grass (high foot traffic – including residential back gardens)	300	150mm Imported Topsoil* 150mm Site won Topsoil
Amenity Grass (low foot traffic)	300	Site-won Topsoil or Imported Topsoil

* See *Specification for Imported Topsoil* – **Appendix 3.**

6.12 Final Topsoil Cultivation

6.12.1 After respreading and regrading the approved topsoil, any large, compacted lumps should be broken down using suitable tillage equipment to produce a fine tilth suitable for planting (<40mm), turfing and seeding (<10mm).

6.12.2 For small confined areas such as individual back gardens, examples of appropriate equipment to use for this cultivation include *pedestrian power harrow* or *rotavator.*

Plate 13: Pedestrian power harrow


Plate 14: Pedestrian rotavator

6.12.3 Within each area/plot, cultivation should begin at the point farthest from the plot access, working backwards. Once the approved topsoil has been cultivated, **no further machinery should traffic over the soil surface.** Unnecessary foot trafficking must also be minimised.

6.12.4 Any undesirable material brought to the surface during this exercise should be removed by picking or hand raking. For example, fill materials and stones larger than 50mm in any dimension.

6.13 Soil Ameliorants – Residential Back Gardens

6.13.1 Prior to laying turf a Pre-Seeding Grass Fertiliser should be applied, following the manufacture's recommendations.

6.14 Soil Ameliorants – Public Open Space (Site-Won Topsoil)

6.14.1 For tree and shrub planting, we recommend applying and incorporating the compound, slow release fertiliser *ICL Enmag CRF* (11%N:21%P_2O_5:9%K_2O:6%MgO) at a rate of 100 g/m^2 and to a depth of 200mm.

6.14.2 For amenity grass areas, a Pre-Seeding Grass Fertiliser should be applied, following the manufacture's recommendations.

6.15 Turf Installation

6.15.1 Lay new turf (with foot traffic only) in accordance with Turfgrass Growers Association (TGA) specification (www.turfgrass.co.uk).

6.15.2 As soon as the turf is anchored into the approved topsoil and the prevailing weather conditions are suitable, the surface of the lawn should be spiked to a **minimum depth of 75mm**. This will improve aeration and drainage through the turf layer. This can be achieved using a powered pedestrian aerator.

Plate 15: Pedestrian aerator

Plate 16: Pedestrian aerator fitted with solid tines

6.16 Site Inspections

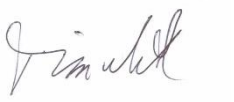
6.16.1 To help ensure the site soil resource is managed appropriately, site inspections will be conducted by a qualified Soil Scientist during the key earth work and landscape stages, including the following:

- Topsoil stripping and storage;
- Subsoil preparation;
- Tree pit construction (if applicable);
- Topsoil placement, preparation and amelioration, including stone reduction or fertiliser application.

6.16.2 An inspection report will be produced after each site visit to provide comment on the physical condition of the soils (e.g. their structure and moisture content) and methods used, and compliance with the Soil Management Plan and the site's soft landscape specification. The reports would also highlight any changes or remedial works as necessary.

6.16.3 All inspection reports will be made available to the Client and the Local Planning Authority.

We would like to thank Wates Construction for entrusting our practice with this commission. We trust this report meets with your approval and provides the necessary information. Please do not hesitate to contact the undersigned if you require further assistance.



Rebecca Hollands
BSc MSc MISoilSci
Senior Soil Scientist

Tim White
BSc MSc MISoilSci CSci
Senior Associate

For & on behalf of Tim O'Hare Associates LLP

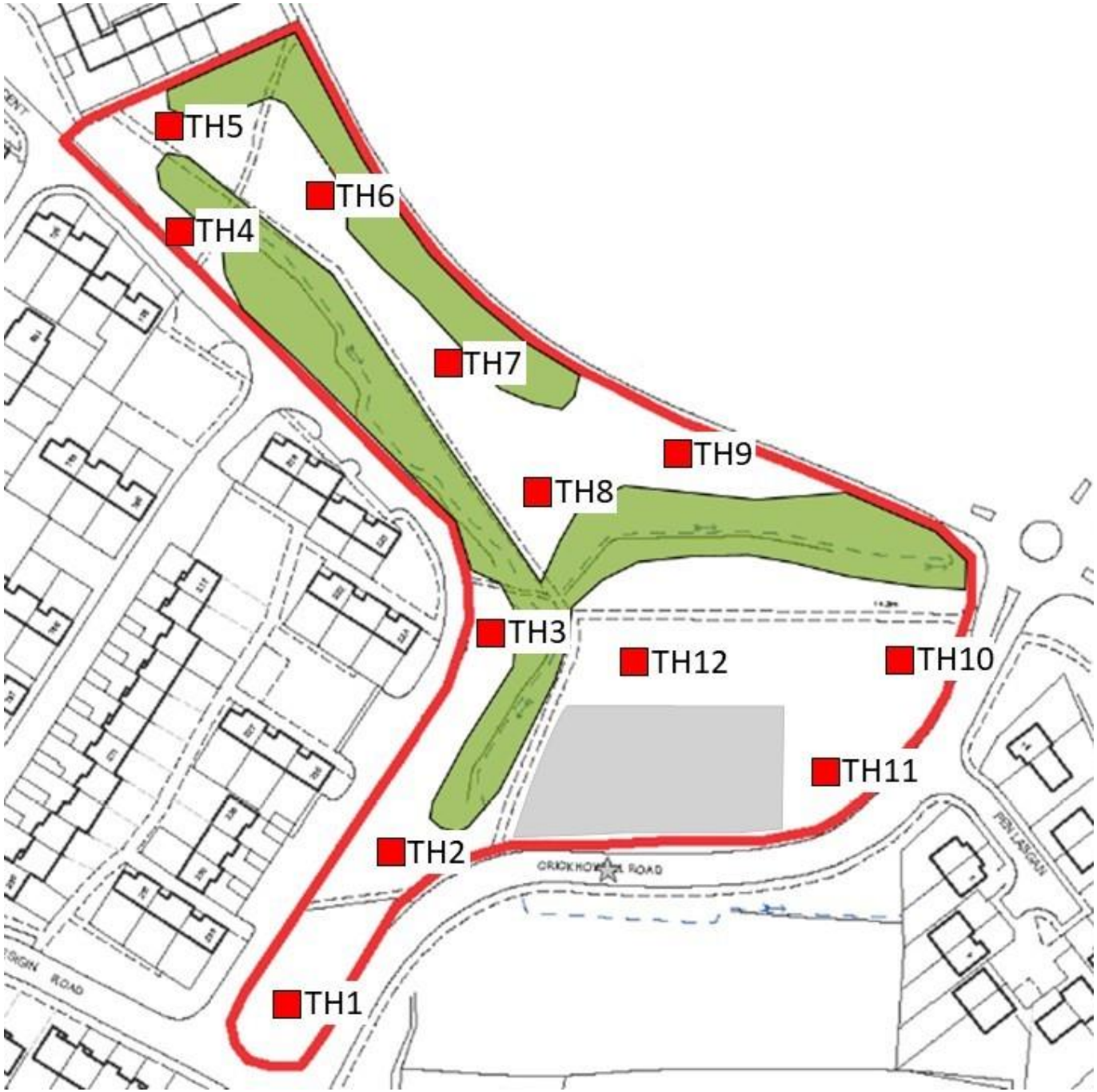
Report Qualifications

This interpretation of the soil conditions is based on observations made during the site investigation and the results of laboratory tests. This report presents TOHA's site observations and test results and interpretation of those observations and results. On any site there may be variations in soil conditions between these exploratory positions. TOHA can therefore not accept any responsibility for soil conditions that have not been exposed by this investigation.

This investigation considers the re-use of the site soils for landscape purposes for the Cardiff Partnering Housing Project – Willowbrook South site. It should not therefore be relied on for alternative end-uses or for other schemes. This report has been prepared solely for the benefit of TOHA's client Wates Construction. No warranty is provided to any third party and no responsibility or liability will be accepted for any loss or damage in the event that this report is relied upon by a third party or is used in circumstances for which it was not originally intended.

Appendix 1

Site Plan - Trial Hole Locations



Approximate Trial Hole Location

Approximate Site Compound Location

Site Boundary

TIM O'HARE ASSOCIATES
SOIL & LANDSCAPE CONSULTANCY

Client:	Wates Construction Ltd		
Project:	Willowbrook South		
Job ref no.:	TOHA/20/6184/RH		
Drawing no.:	6184/1		
Drawing title	Soil Resource Survey		
Date:	Oct '20	Scale:	NTS
Drawn by:	RH	Checked by:	TW

Tim O'Hare Associates LLP
Howbery Park Wallingford Oxfordshire OX10 8BA
T: 01491 822653 E:info@toha.co.uk
www.toha.co.uk

Appendix 2

Laboratory Analysis Results

TIM O'HARE ASSC
SOIL & LANDSCAPE CON

Client:	**Wates Construction Ltd**
Project:	**Willowbrook South**
Job:	**Soil Resource Survey - Topsoil**
Date:	**November 2020**
Job Ref No:	**TOHA/20/6184/RH**

Sample Reference			**Topsoil Sample 1**	**Topsoil Sample 2**
		Accreditation		
Clay (<0.002mm)	%	UKAS	26	27
Silt (0.002-0.063mm)	%	UKAS	33	36
Sand (0.063-2.0mm)	%	UKAS	41	37
Texture Class (UK Classification)	--	UKAS	CL	CL
Stones (2-20mm)	% DW	GLP	3	5
Stones (20-50mm)	% DW	GLP	6	7
Stones (>50mm)	% DW	GLP	10	4
pH Value (1:2.5 water extract)	units	UKAS	6.5	7.4
Electrical Conductivity (1:2.5 water extract)	uS/cm	UKAS	87	119
Electrical Conductivity (1:2 $CaSO_4$ extract)	uS/cm	UKAS	1999	1970
Exchangeable Sodium Percentage	%	UKAS	1.1	0.6
Organic Matter (LOI)	%	UKAS	6.9	6.9
Total Nitrogen (Dumas)	%	UKAS	0.29	0.30
C : N Ratio	ratio	UKAS	14	14
Extractable Phosphorus	mg/l	UKAS	6	11
Extractable Potassium	mg/l	UKAS	50	60
Extractable Magnesium	mg/l	UKAS	161	232

CL = CLAY LOAM

Rebecca Hollands
BSc MSc MISoilSci
Senior Soil Scientist

Results of analysis should be read in conjunction with the report they were issued with

Appendix 3

Imported Topsoil Specification

WILLOWBROOK SOUTH, CARDIFF

IMPORTED TOPSOIL SPECIFICATION

The information given below sets out the *Imported Topsoil* that shall be used in soft landscape areas and the criteria that it must achieve. The document also sets out the necessary protocols that must be followed to demonstrate compliance with the relevant criteria.

SOIL MATERIALS

100 SOIL MATERIALS GENERALLY
• Purity: Free of pests, disease, and fungus.
• Foreign matter: On visual inspection, free of fragments and roots of aggressive weeds, sticks, straw, subsoil, pieces of brick, concrete, glass, wire, large lumps of clay or vegetation, and the like.
• Contamination: Do not use subsoil contaminated with subsoil, rubbish or other materials that are:
- Corrosive, explosive or flammable.
- Hazardous to human or animal life.
- Detrimental to healthy plant growth.
• Objectionable odour: None.
• Give notice: If any evidence or symptoms of soil contamination are discovered on the site or in subsoil or planting media to be imported.

200 IMPORTING TOPSOIL
• The Contractor shall appoint an independent testing company to undertake the sampling and testing of the subsoil considered for importation.
• The Contractor shall await written approval from the Contract Administrator prior to importing subsoil to site.

210 DOCUMENTATION FOR IMPORTED TOPSOIL
The Contractor shall provide the Contract Administrator with the independent test report for each source and type of topsoil to be imported.
• Timing: At least 1 week prior to delivery.
• Each report shall contain the following information:
- Source name and location;
- Date of sampling;
- Visual examination;
- Certificate of Analysis;
- Interpretation of all results with comments on the suitability of the soil for the proposed landscape project:
- Recommendations for soil improvements, treatments, additives.
• Number of copies: 1 (in digital format)

220 SAMPLE AND TESTING - IMPORTED TOPSOIL

• The topsoil considered for importation shall be independently sampled while stockpiled off site at their source or manufacture location.

• The sample(s) shall be truly representative of the soil to be offered. One Composite Sample (made up of at least 10. No sub-samples) shall be taken for every 250m^3 of *Imported Topsoil,* with a minimum of 3 No. samples tested per source.

• Samples shall be analysed strictly in accordance with relevant Testing Schedule given in this specification.

• The samples shall be analysed and reported on a 5 working day turnaround and the Contractor should incorporate this into their programme.

• The sampled soil materials shall be temporarily stockpiled at the source location until the Contract administrator has provided written approval on its suitability for use within the project. Each source of *Imported Topsoil* that is to be used in this scheme shall be sampled, analysed and approved prior to delivery to site.

• The composite sample(s) shall be sent to an approved independent soil science consultancy with a request for each sample to be analysed strictly in accordance with the *Imported Topsoil Testing Schedule* clause below.

• An approved firm is: Tim O'Hare Associates LLP, Howbery Park, Wallingford, Oxon OX10 8BA Tel: 01491 822653 Email: info@toha.co.uk.

310 IMPORTED TOPSOIL - TESTING SCHEDULE

• Topsoil samples shall be tested prior to approval by the Contract Administrator. The following parameters shall be requested (methods in accordance with BS3882:2015 or as indicated):

1. Visual examination to record Munsell colour, moisture status, aerobic state, soil structure, texture, stoniness (size & shape), the presence of any deleterious materials
2. pH Value (1:2.5 soil/water extract)
3. Electrical Conductivity (1:2.5 soil/water extract)
4. Electrical Conductivity (1:2.5 soil/CaSO4 extract)
5. Exchangeable Sodium Percentage
6. Particle Size Analysis (clay, silt, 5 sands – ASTM sieve sizes)
7. Stone Content by % weight (2-20mm, 20-50mm, >50mm)
8. Total Nitrogen (% - Dumas Method)
9. Extractable Phosphorus, Potassium & Magnesium (RB427 Method)
11. Organic Matter (%)
12. Carbon: Nitrogen ratio (by calculation)
13. Saturated Hydraulic Conductivity (mm/hr) (Modified percolation test. (Saturated Hydraulic Conductivity on Manufactured Topsoil. Method based on *ASTM F1815:2011*. Percolation Test – 40cm tension)
14. Potential Contaminants – See parameters in Clause 400

Additional samples and/or additional testing (e.g. percolation) may be required if the initial results are not satisfactory or conclusive

330 IMPORTED TOPSOIL - COMPOSITION

• Quantity: Provide as necessary to complete the work. Make due allowance for settlement after laying.

• The topsoil shall comply with the following lower and upper limits:

Parameter	Unit	Lower Limit	Upper Limit
Clay (<0.002mm)	%	5	18
Silt (0.002-0.05mm)	%	5	20
Sand (0.05-2.0mm) Of which at least 45% shall fall into fine sand to medium sand range (0.15-0.50mm)	%	60	85
Stones (2-20mm)	%DW	--	20
Stones (>20mm)	%DW	--	0
pH Value	Unit	5.5	8.5
Electrical Conductivity (1:2.5 water extract)	µS/cm	--	1500
Electrical Conductivity (CaSO4 extract)	µS/cm	--	2800
Exchangeable Sodium Percentage	%	--	15
Organic Matter	%	4.0	8.0
Total Nitrogen	%	0.20	--
Carbon: Nitrogen Ratio	--	--	20:1
Extractable Phosphorus	mg/l	26	100
Extractable Potassium	240	240	1500
Extractable Magnesium	mg/l	80	600
Saturated Hydraulic Conductivity	mm/hr	10	--

400 ENVIRONMENTAL REQUIREMENTS

• The following Generic Assessment Criteria (GAC) shall be used as Tier 1 screening values for the assessment of soil(s) to be used, unless Site-Specific Assessment Criteria (SSAC) are provided for this project.

• In circumstances where any of these values are exceeded, further risk assessment and/or testing should be undertaken to confirm the significance of the non-compliance.

Parameter	Unit	Generic Assessment
Inorganic Arsenic	mg/kg	37
Boron (soluble)	mg/kg	290
Cadmium	mg/kg	11
Chromium (III)	mg/kg	910
Chromium (IV)	mg/kg	6
Copper	mg/kg	100
Lead	mg/kg	200
Continued…		

Mercury	mg/kg	1.2
Nickel	mg/kg	60
Selenium	mg/kg	250
Zinc	mg/kg	200
Phenol	mg/kg	280
Benzene	mg/kg	0.087
Toluene	mg/kg	130
Ethylbenzene	mg/kg	47
Xylene - m	mg/kg	59
Xylene - o	mg/kg	60
Xylene - p	mg/kg	56
Aliphatics C5-C6	mg/kg	42
Aliphatics C6-C8	mg/kg	100
Aliphatics C8-C10	mg/kg	27
Aliphatics C10-C12	mg/kg	130
Aliphatics C12-C26	mg/kg	1100
Aliphatics C16-C35	mg/kg	65,000
Aromatics C5-C7	mg/kg	70
Aromatics C7-C8	mg/kg	130
Aromatics C8-C10	mg/kg	34
Aromatics C10-C12	mg/kg	74
Aromatics C12-C16	mg/kg	140
Aromatics C16-C21	mg/kg	260
Aromatics C21-C35	mg/kg	1100
Acenaphthene	mg/kg	210
Acenaphthylene	mg/kg	170
Anthracene	mg/kg	2400
Benzo(a)anthracene	mg/kg	7.2
Benzo[a]pyrene	mg/kg	2.2
Benzo(b)fluoranthene	mg/kg	2.6
Benzo(g,h,i)perylene	mg/kg	320
Benzo(k)fluoranthene	mg/kg	77
Chrysene	mg/kg	15
Dibenzo[a,h]anthracene	mg/kg	0.24
Fluoranthene	mg/kg	280
Fluorene	mg/kg	170
Indeno(1,2,3-cd)pyrene	mg/kg	27
Naphthalene	mg/kg	2.3
Phenanthrene	mg/kg	95
Pyrene	mg/kg	620
Asbestos screen	Detected / Not Detected	Not Detected

GAC values derived from LQM CIEH S4ULs (2015) and BS3882:2015

SPECIFICATION QUALIFICATIONS

This document considers the proposal to use Imported Topsoil for landscaping purposes at the Willowbrook South, Cardiff site. This document should not therefore be relied on for alternative end-uses or for other schemes.

This specification has been prepared solely for the benefit of our client Wates Construction Ltd. No warranty is provided to any third party and no responsibility or liability will be accepted for any loss or damage in the event that this document is relied upon by a third party or is used in circumstances for which it was not originally intended.