TIM O'HARE ASSOCIATES
SOIL & LANDSCAPE CONSULTANCY

Mr John Coles
Bury Hill Landscape Supplies Ltd
The Estate Office
Old Bury Hill
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Nr Dorking
Surrey, RH4 3JU

7th December 2023
Our Ref: TOHA/23/1196/1/SS/Rev.1
Your Ref: see below

Dear Sirs

Soil Analysis Report: Bury Hill Horsham Yard – Urban Tree Soil (R)

We have completed the analysis and testing of the sample recently submitted, referenced *Urban Tree Soil (R)* and have pleasure reporting our findings.

The purpose of the analysis was to determine the suitability of the sample for use as an urban tree soil for tree planting in hard landscape environments.

This report presents the results of analysis for the sample submitted to our office, and it should be considered 'indicative' of the soil source. The report and results should therefore not be used by third parties as a means of verification or validation testing or waste designation purposes, especially after the soil has left the Bury Hill Landscape Supplies Ltd site.

SAMPLE EXAMINATION

The topsoil sample was described as a grey (Munsell Colour 10YR 6/1), slightly moist, friable, non-calcareous SAND with a single grain structure. The sample was stone-free and contained a low proportion of organic fines and occasional woody fragments. No unusual odours, deleterious materials, roots or rhizomes of pernicious weeds were observed.

Plate 1: Urban Tree Soil (R) Sample

ANALYTICAL SCHEDULE

The sample was submitted to the laboratory for a range of physical and chemical analyses in accordance with the following schedule:

Geotechnical Properties

- permeability;
- total, air-filled and capillary porosity;
- bulk density;
- California Bearing Ratio (CBR).

Horticultural Properties

- detailed particle size distribution;
- stone content;
- moisture content;
- pH value;
- calcium carbonate;
- electrical conductivity value;
- exchangeable sodium percentage;
- major plant nutrients (N, P, K, Mg);
- organic matter content;
- C:N ratio.

Environmental Properties

- heavy metals (Sb, As, B, Ba, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, V, Zn);
- total cyanide and total (mono) phenols;
- aromatic and aliphatic TPH (C5-C35 banding);
- speciated PAHs (US EPA16 suite);
- benzene, toluene, ethylbenzene, xylene (BTEX);
- asbestos.

The results are presented on the attached Certificate of Analysis and an interpretation of the results is given below.

RESULTS OF ANALYSIS

Particle Size Distribution and Stone Content

The sample fell into the *sand* texture class. The grading of the sand indicates a narrow particle size distribution with a predominance of *medium sand* (0.25-0.50mm). This is acceptable for tree soils as sufficient porosity levels are maintained in a compacted state and the risk of particle interpacking is minimised.

The sample was stone-free and as such, stones will not restrict the use of the soil.

Permeability and Porosity

The permeability of the sample when in a compacted state (Standard Compaction) was high (135 mm/hr) and satisfactory for tree planting in hard landscape situations.

The total porosity result recorded was satisfactory for urban tree soil in a compacted state, but this comprised mainly capillary pores. This indicates that the sample should have a reasonable water-holding capacity, however, the low proportion of larger, air-filled pores suggests that, in its compacted state, there could be reduced aeration for root function.

California Bearing Ratio

A re-compacted California Bearing Ratio (CBR) was completed as part of the engineering testing undertaken on the sample. The sample was re-compacted using the 2.5kg rammer at the as received moisture content and the sample returned a minimum CBR of 6%. Assuming that the in-situ compaction method selected during installation provides similar levels of compaction to that of the laboratory test, the in-situ performance of the material should be able to achieve a similar result, provided it is compacted at the same moisture content (8%).

As the performance of the soil will be linked to the moisture content at time of compaction, further work may be required in order to correlate the change in engineering performance of the material over the range of moisture contents at which the soil is likely to be placed and compacted.

We recommend a more conservative approach with the performance of the material, and, as opposed to a CBR of 6%, we would quote "should achieve a CBR in excess of 5%..." The 5% CBR is important as this is the lower limit for the sub-grade for the minimum construction thickness.

pH and Calcium Carbonate Values

The sample was strongly alkaline in reaction (pH 8.5) and non-calcareous ($CaCO_3$ <1%).

The main source of the 'alkalinity' is likely to be the potassium ions from the compost in the sample. As such, this pH value would be considered suitable for most tree species, including those that are intolerant of calcareous (chalky) soils.

Electrical Conductivity Values

The electrical conductivity (salinity) values (water and $CaSO_4$ extracts) were low, which indicates that soluble salts were not present at levels that would be harmful to plants.

Organic Matter and Fertility Status

The sample was adequately supplied with organic matter and most major plant nutrients; however, it contained a low level of total nitrogen.

This nutrient deficiency may be addressed by a routine fertiliser application. It may also be prudent to enhance the soil's nutrient retention capacity by incorporating an appropriate soil conditioner.

The C:N ratio was acceptable for landscape purposes.

Potential Contaminants

In the absence of site-specific assessment criteria, the concentrations of potential contaminants in relation to the soil's proposed end use. This includes human health, environmental protection and metals considered toxic to plants. In the absence of site-specific assessment criteria, the concentrations that affect human health have been compared with the *residential without home grown produce* land use in the Suitable For Use Levels (S4Uls) presented in *The LQM/CIEH S4Uls for Human Health Risk Assessment* (2015) and the DEFRA SP1010: *Development of Category 4 Screening Levels* (C4SLs) *for Assessment of Land Affected by Contamination – Policy Companion Document* (2014).

Of the remaining potential contaminants determined, none exceeded their respective guideline values.

Phytotoxic Contaminants

Of the phytotoxic (toxic to plants) contaminants determined (copper, nickel, zinc), none was found at levels that exceeded the maximum permissible levels.

CONCLUSION

The purpose of the analysis was to determine the suitability of the soil sample for use as an *urban tree soil* for tree planting in hard landscape environments.

From the visual examination and laboratory analysis undertaken, the sample can be described as strongly alkaline, non-saline, non-calcareous, stone-free SAND with a narrow particle size distribution. The material contained sufficient levels of organic matter and most major plant nutrients, but was deficient in total nitrogen. Of the potential contaminants determined, none exceeded their respective guideline values.

Based on our findings, the horticultural and geotechnical properties of the soil represented by this sample would be considered suitable for an *urban tree soil* for tree planting in hard landscape environments. The deficiency in total nitrogen should be addressed by a routine fertiliser application, with nutrient retention improved with an appropriate soil conditioner.

In order to minimise the risk of anaerobic (oxygen depleted) soil conditions developing within the tree pit, this rootzone should not be placed deeper than 600mm. A suitable washed sand, preferably with the same particle size distribution as this sample, should be used beneath the *urban tree soil*.

RECOMMENDATIONS

Fertiliser for Planting

To address the nutrient deficiencies and to help promote effective tree establishment, we recommend applying and incorporating the compound, controlled release fertiliser *ICL Osmocote PrePlant* (17%N:9%P_2O_5:10%K_2O:2%MgO+TE) at a rate of 70 g/m^2 into the upper 400 mm layer of rootzone <u>prior to consolidation of this layer</u>

Soil Conditioner

To improve the water and nutrient retention capacities of this soil, we recommend application and incorporation of a suitable soil conditioner, e.g. *TerraCottem "Universal"*, at the manufacturer's recommended rate into each layer of the rootzone <u>prior to consolidation.</u>

Determination of Compaction Methods and Equipment

In order to identify the appropriate compaction method for installation of the *Urban Tree Soil*, the test data for the material has been compared against the requirements from The Manual of Contract Documents for Highway Works, Specifications for Highway Works [SHW]: Volume 1: Table 6/1, 6/2 and 6/4.

From reference to the results of the grading analysis and SHW Table 6/2, the closest grading classification of the material would be as either a **Class 1B** uniformly graded general fill, or a **Class 6D** starter layer. From reference to SHW Table 6/1, the appropriate method of compaction is given as Table 6/4 Method 3 for Class 1B and Method 4 for Class 6d. Method compaction allows the selection of a variety of compaction plant which by trial have been proven to be acceptable to compact the specific soil type. The key compaction criteria for these soils is that they should achieve a minimum of 95% of the appropriate Maximum Dry Density so long as the methodology listed in Table 6/4 is strictly adhered to. Due to the variety of the different compaction equipment listed within SHW Table 6/4 only compaction plant suitable for Method 3 and 4 have been recorded and for ease of reference the data has been reproduced below in Table 1.

From a further assessment of the results of the grading analysis and associated engineering testing, it is suggested that unless the grading of the parent material changes and becomes both coarser and more single-sized in nature, then **Method 4** compaction should be selected in preference to Method 3.

Given the restricted access to the material when it is being placed and compacted within the tree pits, it is considered likely that only the **Vibro Tamper** will prove to be suitable, and as such reference to the mass of the equipment should be used in order to determine the maximum depth of layer, and minimum number of passes.

It is understood that the nominal mass of a typical Vibro Tamper would be over 75kg and less than 100kg. As such and from reference to Table 1 below, Vibro Tamper ref no 3, the maximum depth of placement layer should be 175mm with a minimum number of 3 passes. This compaction should be equivalent to the use of a 2.5kg rammer within the laboratory and in turn should return similar densities to the sample tested at the same moisture content.

Summary of Compaction as per SHW Table 6/4 Method 3 and Method 4

Type of Compaction Plant	Ref. No.	Category	Method 3		Method 4	
			Depth of Layer [mm]	Minimum no of Passes	Depth of Layer [mm]	Minimum no of Passes
Smooth wheeled roller [or vibratory roller operating without vibration]		Mass per metre width of roll:				
	1	Over 2100kg up to 2700kg	125	10	175	4
	2	Over 2700kg up to 5400kg	125	8	200	4
Grid Roller		Mass per m width of roller:				
	1	Over 2700kg up to 5400kg	150	10	250	4
Deadweight tamping roller		Mass per metre width of roll:				
	1	Over 4000kg up to 6000kg	250	4	350	4
	2	Over 6000kg	300	3	400	4
Pneumatic-tyred roller		Mass per wheel:				
	1	Over 1000kg up to 1500kg	150	10	240	4
Vibratory tamping roller		Mass per metre width of a vibrating roll:				
	1	Over 700kg up to 1300kg	150	12	100	10
	2	Over 1800kg up to 1800kg	175	12	175	8
Vibratory roller		Mass per metre width of a vibratory roll:				
	3	Over 700kg up to 1300kg	150	6	125	10
	4	Over 1300kg up to 1800kg	200	10	175	4
Vibrating plate compactor		Mass per m² of base plate:				
	2	Over 1100kg up to 1200kg	100	6	75	10
	3	Over 1200kg to 1400kg	150	6	150	8
Vibro tamper		Mass:				
	1	Over 50kg up to 65kg	150	3	125	3
	2	Over 65kg up to 75kg	200	3	150	3
	3	Over 75kg up to 100kg	225	3	175	3
	4	Over 100kg	225	3	250	3

We hope this report meets with your approval and provides the necessary information. Please do not hesitate to contact the undersigned if we can be of further assistance.

Yours faithfully

Harriet MacRae
BSc MSc
Graduate Soil Scientist

Matthew Heins
BSc (Hons) MISoilSci
Senior Soil Scientist

For & on behalf of Tim O'Hare Associates LLP

TIM O'HARE ASSOCIATES
SOIL & LANDSCAPE CONSULTANCY

Client:	**Bury Hill Landscape Supplies Ltd**
Project	**Bury Hill Horsham Yard - Urban Tree Soil (R)**
Testing:	**Geotechnical Properties**
Date:	**07/12/2023**
Job Ref No:	**TOHA/23/1196/1/SS**

Sample Reference		**Accreditation**	**Urban Tree Soil (R)**
Clay (<0.002mm)	%	UKAS	8
Silt (0.002-0.05mm)	%	UKAS	0
Very Fine Sand (0.05-0.15mm)	%	UKAS	0
Fine Sand (0.15-0.25mm)	%	UKAS	8
Medium Sand (0.25-0.50mm)	%	UKAS	60
Coarse Sand (0.50-1.0mm)	%	UKAS	23
Very Coarse Sand (1.0-2.0mm)	%	UKAS	1
Total Sand (0.05-2.0mm)	%	UKAS	92
Texture Class (UK Classification)	--	UKAS	S
Stones (2-20mm)	% DW	GLP	0
Stones (20-50mm)	% DW	GLP	0
Stones (>50mm)	% DW	GLP	0

Determination of Permeability and Porosity - K H Volume 10.7 method			
Initial Height	mm	UKAS	129.7
Initial Diameter	mm	UKAS	100.1
Particle Density	Mg/m^3	UKAS	2.58
Initial Bulk Density	Mg/m^3	UKAS	1.67
Final Bulk Density	Mg/m^3	UKAS	1.89
Initial Moisture Content	%	UKAS	8
Final Moisture Content	%	UKAS	24
Initial Dry Density	Mg/m^3	UKAS	1.54
Final Dry Density	Mg/m^3	UKAS	1.53
Total Porosity (Initial)	%	UKAS	40.2
Total Porosity (Final)	%	UKAS	40.8
Air Filled Porosity (Initial)	%	UKAS	27.7
Air Filled Porosity (Final)	%	UKAS	4.6
Capillary Porosity (Initial)	%	UKAS	12.5
Capillary Porosity (Final)	%	UKAS	36.1
Permeability	mm/hr	UKAS	135

California Bearing Ratio - BS 1377-4:1990:Method 7.4			
Moisture Content (Initial)	%	UKAS	8
Moisture Content (Top)	%	UKAS	8
Moisture Content (Base)	%	UKAS	8
Moisture Content (Mean)	%	UKAS	8
Initial Bulk Density	Mg/m3	UKAS	1.69
Initial Dry Density	Mg/m3	UKAS	1.56
CBR Top	%	UKAS	6
CBR Base	%	UKAS	7

Determination of Permeability and Porosity - K H Volume 10.7 method

Notes
Material recompacted at the 'as-received' moisture with a 2.5kg rammer
Sample is assumed to be fully saturated when a rate of steady flow is achieved
Permeability is determined when sample achieved a state of steady flow

Determination of California Bearing Ratio - BS 1377-4:1990:Method 7.4

Notes
Material recompacted at the 'as-received' moisture with a 2.5kg rammer
Sample tested in an unsoaked condition
Applied Seating Load (top) : 48N
Applied Seating Load (base) : 48N
Applied Surcharge : 10.0kg

S = SAND

Visual Examination

The topsoil sample was described as a grey (Munsell Colour 10YR 6/1), slightly moist, friable, non-calcareous SAND with a single grain structure. The sample was stone-free and contained a low proportion of organic fines and occasional woody fragments. No unusual odours, deleterious materials, roots or rhizomes of pernicious weeds were observed.

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Harriet MacRae
BSc MSc
Graduate Soil Scientist

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

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Client:	**Bury Hill Landscape Supplies Ltd**
Project	**Bury Hill Horsham Yard - Urban Tree Soil (R)**
Testing:	**Urban Tree Soil Analysis**
Date:	**07/12/2023**
Job Ref No:	**TOHA/23/1196/1/SS**

Sample Reference		**Acreditation**	**Urban Tree Soil (R)**
pH Value (1:2.5 water extract)	units	UKAS	8.5
Calcium Carbonate	%	UKAS	< 1.0
Electrical Conductivity (1:2.5 water extract)	uS/cm	UKAS	522
Electrical Conductivity (1:2 $CaSO_4$ extract)	uS/cm	UKAS	2850
Exchangeable Sodium Percentage	%	UKAS	3.9
Organic Matter (LOI)	%	UKAS	1.6
Total Nitrogen (Dumas)	%	UKAS	0.05
C : N Ratio	ratio	UKAS	18
Extractable Phosphorus	mg/l	UKAS	32
Extractable Potassium	mg/l	UKAS	585
Extractable Magnesium	mg/l	UKAS	59
Total Antimony (Sb)	mg/kg	MCERTS	< 1.0
Total Arsenic (As)	mg/kg	MCERTS	1.6
Total Barium (Ba)	mg/kg	MCERTS	3.7
Total Beryllium (Be)	mg/kg	MCERTS	< 0.06
Total Cadmium (Cd)	mg/kg	MCERTS	< 0.2
Total Chromium (Cr)	mg/kg	MCERTS	2.6
Hexavalent Chromium (Cr VI)	mg/kg	MCERTS	< 1.8
Total Copper (Cu)	mg/kg	MCERTS	4.6
Total Lead (Pb)	mg/kg	MCERTS	3.5
Total Mercury (Hg)	mg/kg	MCERTS	< 0.3
Total Nickel (Ni)	mg/kg	MCERTS	1
Total Selenium (Se)	mg/kg	MCERTS	< 1.0
Total Vanadium (V)	mg/kg	MCERTS	3
Total Zinc (Zn)	mg/kg	MCERTS	7.2
Water Soluble Boron (B)	mg/kg	MCERTS	0.5
Total Cyanide (CN)	mg/kg	MCERTS	< 1.0
Total (mono) Phenols	mg/kg	MCERTS	< 1.0
Naphthalene	mg/kg	MCERTS	< 0.05
Acenaphthylene	mg/kg	MCERTS	< 0.05
Acenaphthene	mg/kg	MCERTS	< 0.05
Fluorene	mg/kg	MCERTS	< 0.05
Phenanthrene	mg/kg	MCERTS	< 0.05
Anthracene	mg/kg	MCERTS	< 0.05
Fluoranthene	mg/kg	MCERTS	< 0.05
Pyrene	mg/kg	MCERTS	< 0.05
Benzo(a)anthracene	mg/kg	MCERTS	< 0.05
Chrysene	mg/kg	MCERTS	< 0.05
Benzo(b)fluoranthene	mg/kg	MCERTS	< 0.05
Benzo(k)fluoranthene	mg/kg	MCERTS	< 0.05
Benzo(a)pyrene	mg/kg	MCERTS	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	MCERTS	< 0.05
Dibenzo(a,h)anthracene	mg/kg	MCERTS	< 0.05
Benzo(g,h,i)perylene	mg/kg	MCERTS	< 0.05
Total PAHs (sum USEPA16)	mg/kg	MCERTS	< 0.80
Aliphatic TPH >C5 - C6	mg/kg	MCERTS	< 0.020
Aliphatic TPH >C6 - C8	mg/kg	MCERTS	< 0.020
Aliphatic TPH >C8 - C10	mg/kg	MCERTS	< 0.050
Aliphatic TPH >C10 - C12	mg/kg	MCERTS	< 1.0
Aliphatic TPH >C12 - C16	mg/kg	MCERTS	< 2.0
Aliphatic TPH >C16 - C21	mg/kg	MCERTS	< 8.0
Aliphatic TPH >C21 - C35	mg/kg	MCERTS	< 8.0
Aliphatic TPH (C5 - C35)	mg/kg	MCERTS	< 10
Aromatic TPH >C5 - C7	mg/kg	MCERTS	< 0.010
Aromatic TPH >C7 - C8	mg/kg	MCERTS	< 0.010
Aromatic TPH >C8 - C10	mg/kg	MCERTS	< 0.050
Aromatic TPH >C10 - C12	mg/kg	MCERTS	< 1.0
Aromatic TPH >C12 - C16	mg/kg	MCERTS	< 2.0
Aromatic TPH >C16 - C21	mg/kg	MCERTS	< 10
Aromatic TPH >C21 - C35	mg/kg	MCERTS	< 10
Aromatic TPH (C5 - C35)	mg/kg	MCERTS	< 10
Benzene	mg/kg	MCERTS	< 0.005
Toluene	mg/kg	MCERTS	< 0.005
Ethylbenzene	mg/kg	MCERTS	< 0.005
o-xylene	mg/kg	MCERTS	< 0.005
p & m-xylene	mg/kg	MCERTS	< 0.005
Asbestos	ND/D	ISO 17025	Not-detected

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