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LONDON BOROUGH OF BARNET

A report on a Tier 2 hydrological risk assessment for the proposed development of Barnet Cemetery and Memorial Gardens, Milespit Hill, London, NW7 2RR.

14th May 2022

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Please note: The aim of this report is to appraise the current conditions on site at the site specified in 'Physical Site Survey' below only. This is not a design document and does not include detailed design or design information and should not be used for this purpose. TGMS accepts no design liability or responsibility for subsequent works based on the information contained within this report.

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1 EXECUTIVE SUMMARY MILESPIT HILL CEMETERY

KEY: **No action required** **Action may be required** **Action required**

1.1 Site information

	1	**Objective:** To undertake a Tier 2 hydrological risk assessment for the proposed development of Barnet Cemetery and Memorial Gardens, Milespit Hill, London, NW7 2RR.
	2	**Site Visits:** A detailed site investigation was conducted on the 30th of March 2022 in parallel with a ground investigation by Harrison Group Environmental Limited.
	3	**Site location and access:** The site comprises an area of land which is located immediately north of Mill Hill cemetery. The site can be accessed through the existing cemetery via Milespit Close, however an overgrown entrance off Milespit Hill is to be developed as a dedicated entrance to the new cemetery.
	4	**Current land use:** The site comprises former grazing land and some woodland which has been fallow for many years, and is bounded by residential properties to the east and west, fallow land and The Mount to the north, and the existing cemetery to the south.
	5	**Hydrology:** The site is situated at an elevation of between 85–100 m AOD. The ground surface slopes towards the south. The nearest significant stream/river, Folly Brook, is located 1.3 km north of the site and Dollis Brook is located 1.5 km southeast of the site. Small, local drainage ditches are present starting 300 m north-west, but sinking downslope, 100 m south-west, of the site.
	6	**Climate:** Climate data obtained from the Flood Estimation Handbook (FEH) indicate that the standard-period average annual rainfall (SAAR) is 682 mm for this location; significantly lower than the national average of 885 mm/year.
	7	**Drainage catchment:** Catchment data obtained from the Flood Estimation Handbook (FEH) Web Service indicate that the site forms part of a 0.51 km^2 catchment with an outlet 900 m to the south near Devonshire Road.
	8	**Predicted land drainage rates:** The predicted drainage rates for the soft landscaping areas of the site are less than the Greenfield runoff rates, and so installation of a new drainage scheme in grave plot areas, should one be required, would not cause significantly faster or greater flow than the Greenfield condition. Drainage design should account for at least the 1:30 return period outfall rate of 6.8 l/s/ha for the site over a 24-hour period.
	9	**Risk of flooding from rivers and seas:** Based on information obtained from Gov.uk, the site has a very low risk of flooding from rivers and seas with a probability of flooding of less than 1 in 1000 years (<0.1%).
	10	**Risk of flooding from surface water:** Based on information obtained from Gov.uk, the majority of the site has a very low risk of flooding from surface water with a probability of flooding of less than 1 in 1000 years (<0.1%) aside from three fingers of potential flow; most significantly along the eastern boundary with the Woodcote Avenue where the flood risk is greater than 1 in 30 years (>3.3%). Grave plots should not be located in these areas
	11	**Groundwater vulnerability:** Based on information obtained from magic.defra.gov.uk, the site is not located within a Groundwater Source Protection Zone.
	12	**Landfill:** Based on information from data.gov.uk, the site is not located in an area of historic or permitted landfill.
	13	**Soil map:** According to Sheet 6 of the Soil Survey of England and Wales (SSEW) 1:250,000 soil map (1983), the indigenous soil in this area forms part of the WINDSOR Association. The geological origin of this Soil Association is tertiary clay, and it is characterised by slowly permeable seasonally waterlogged clayey soils mostly with brown subsoils.
	14	**Geology:** Data from the British Geological Survey indicate that the site is underlain by the London Clay Formation of Eocene age with an estimated thickness of 60 – 70 m. It typically comprises stiff, poorly laminated, blue-grey, silty clay where fresh at depth, weathering to a soft to firm brown clay near the surface where oxidised. It may contain some fine sand as thin beds, partings or pockets, together with a few thin beds of shells. At the base there may be a thin pebble bed of black rounded flint pebbles.
	15	**Hydrogeology:** The London Clay Formation, which is present at surface of the site, is a low permeability aquitard that is likely to only contain limited quantities of groundwater in the upper more weathered layers and/or in sandier horizons. The regionally important chalk aquifer is present at depth below the site, but due to the thickness of London Clay (60-70 m) the cemetery development is not likely to impact upon it.
	16	**Water well records:** The Environment Agency stipulates that no interments shall occur within (1) 50 m of any well, spring or borehole, irrespective of that water's current use, or (2) 250 m of any

		well, spring or borehole where the water is intended for human consumption or used in food production. The are no records of wells or boreholes within 50 m of the site, however two boreholes, (TQ29SW40 and TQ29SW33/A-D) lie within 200 m of the site boundary. TQ29SW33/A-D was sunk in August 1949 to a depth of only 7.62 m into clay and therefore unlikely to be used for human consumption or food production. It is recommended that enquiries are made to establish whether TQ29SW40 (sunk in 1990 to a depth of 150 m) is still operational and, if so, whether the water is used for human consumption or food production. If it is, interments should not take place within a radius of 250 m from it.
	17	**Soils:** The site typically comprises 0.30 m of CLAY or SILTY CLAY LOAM topsoil over slowly permeable CLAY or CLAY LOAM subsoil which extends beyond the maximum sampling depth of 10.50 m.
	18	**Dipwell monitoring:** No groundwater was observed in three of five dipwells during subsequent monitoring on 11/04/2022 and 25/04/2022, however the water level in two dipwells (WS3 and WS7) rose from 2.19 m bgl to 1.28 m bgl, and 2.34 m bgl to 1.48 m bgl between 11/04/2022 and 25/04/2022 respectively. It is concluded that the source of the water observed in WS3 and WS7 is from isolated permeable lenses holding limited volumes of water, and that the true free groundwater lies at depths significantly below maximum anticipated burial depth. If the grave depth required for a double burial is 1.83 m (6 feet), then an unsaturated zone of at least 2.83 m below ground level will be required in order to meet the Environment Agency's minimum criterion of one metre of unsaturated soil beneath maximum interment depth. It is concluded that this site meets this criterion
	19	**Revised risk assessment:** A desk-based risk assessment of the site conducted by Peter Mitchell Associates (April 2019) has been revised following the input of information emanating from this detailed site investigation. It is concluded that the site Vulnerability Ranking can be reduced from 'Moderate' to 'Low'. Although the calculated level of risk remains 'High', given the presence of the deep, slowly permeable clay that underlies the site, and that no active mitigation measures are deemed necessary to prevent pollution, it is concluded that the risk to the environment can be considered to be 'Low'.

Dr Richard Earl – May 2022

2 INTRODUCTION AND OBJECTIVES

TGMS has been commissioned by London Borough of Barnet to undertake a Tier 2 hydrological risk assessment for the proposed development of Barnet Cemetery and Memorial Gardens, Milespit Hill, London, NW7 2RR.

It is understood that the site had planning consent which has expired, but with little reference to hydrogeology, and so a re-application with a new design is anticipated. As part of this process, there will be a need to undertake on-site investigations and liaise with the Environment Agency.

2.1 Tier 1 risk assessment

A desk-based Tier 1 hydrogeological risk assessment conducted by Peter Mitchell Associates (April 2019) concluded that the proposed development of this site as a cemetery would constitute a 'High' potential risk to groundwater. Although the site Vulnerability Ranking derived in that assessment was midway between 'Low' and 'Moderate', the overall risk to groundwater was adjusted up to 'High' mainly as a result of:

- The proximity of the site to a Groundwater Source Protection Zone 2.
- The absence of Drift covering the site.
- The number of anticipated interments per year (160).

The Environment Agency's published view is that:

Proposals for new cemetery developments for greater than 100 burials per year are considered to be high risk even in a lower sensitivity groundwater scenario. Such proposals will only be agreed by the Environment Agency where a developer can demonstrate through detailed risk assessment that, given the site specific setting and the engineering methods proposed, groundwater pollution will be avoided.

British Geological Survey records indicate that the site is underlain by around 42 m of the London Clay Formation. A detailed site investigation and Tier 2 hydrological risk assessment is required to establish the extent to which the clay offers protection to groundwater and surrounding areas from any potential contamination from burials.

2.2 Objectives

The proposed cemetery development area is conveniently located near the existing cemetery however as the level of risk of water contamination is considered to be 'High', it is recommended that the following detailed site investigations are conducted in order to gain a better understanding of the degree of risk and potential for mitigating it:

1. Using the existing levels survey to provide a basis for establishing the most appropriate locations for excavating test pits down to a maximum depth of 3.5 m and installing dip wells to monitor groundwater levels.
2. An assessment of the soil profile pits, and to 'window sample' material removed during the boring of the dip wells, in terms of the type, condition and physical properties of the soil exposed. The results would be used to determine factors that may influence the appropriateness of the site for burial purposes and the vulnerability of the environment to contamination from the proposed development.
3. To determine appropriate options for mitigating risk to groundwater by improving the surface and subsurface drainage status.
4. To liaise with representatives of the Environment Agency on the findings of the investigations in order to determine the most appropriate course of action for London Borough of Barnet.

2.3 Environment Agency Guidance

Since the 14th of March 2017, the Environment Agency's guidance on groundwater protection and controlling the risks posed by cemeteries has been published on www.gov.uk. The following new guidance was published on the 1st of April 2022:

2.3.1 Protecting groundwater from human burials (published 1st April 2022)

This guidance is for local councils or other cemetery operators. It covers cemetery developments from 1 April 2022 which need new planning permission under section 57 of the Town and Country Planning Act 1990. The guidance applies to proposals to:

- *develop a new cemetery*
- *expand an existing cemetery*

Expanding an existing cemetery means extending the geographical area of a site to an extent that you need new planning permission under section 57 of the Town and Country Planning Act 1990.

<u>When you do not need an environmental permit</u>
Local councils (or other cemetery operators) do not need to apply for an environmental permit for existing cemeteries if:

- *they do not need to use active mitigation measures to prevent pollution*
- *they are not planning to expand a cemetery area after 1 April 2022 which needs new planning permission under section 57 of the Town and Country Planning Act 1990*
- *they are planning to expand a cemetery area after 1 April 2022 which needs new planning permission, but the risk assessment shows that the expansion is not high risk and the Environment Agency has agreed this*
- *the Environment Agency has told them, as part of their planning application, that they do not need a permit*

You also do not need an environment permit if all burials on existing sites are of human ashes from crematoria.

Active mitigation measures to prevent pollution to the environment could include, for example:

- *ongoing groundwater monitoring*
- *active groundwater drainage controls to allow burials*

All existing cemeteries that do not need an environmental permit should still aim to meet the minimum good practice groundwater protection requirements.

<u>Minimum good practice groundwater protection requirements</u>
If you operate an existing cemetery, or are proposing a new cemetery that does not require a permit, you should aim to meet the following minimum good practice groundwater protection requirements.

Requirement 1
You should not carry out any human burials within:

- *a groundwater SPZ1*
- *10m of the nearest land drain*
- *30m from the nearest watercourse (which includes ditches and open land drains which may run dry for part of the year) or any other surface water*
- *50m of any well, spring or borehole, irrespective of that water's current use*

- *250m of any well, spring or borehole where the water is intended for human consumption or used in food production*
- *areas identified as having karstic groundwater flow characteristics (following any required groundwater risk assessment) – these areas are highly vulnerable to pollution because groundwater can flow rapidly through the many fissures and fractures present in these rocks.*

Requirement 2
You should not carry out any human burials on land which is liable to flooding.

Requirement 3
You should make the base of each grave at least 1 metre above the highest anticipated annual groundwater level.

Requirement 4
You should not dig graves in unaltered or unweathered bedrock. This is solid rock which can be buried or exposed at the earth's surface, and which has not been altered by physical or chemical reactions (or both) such as exposure to the weather.

When you will need an environmental permit
From 1 April 2022, you will need to apply for an environmental permit for a new cemetery development or extension to an existing cemetery if any of these apply:

- *it presents a high risk to the environment due to its proposed location*
- *your site needs active pollution prevention mitigation measures or operational burial controls to protect the water environment*
- *the Environment Agency told you during the coronavirus pandemic that you would need to apply for a permit*
- *you submitted a planning application on or after 1 April 2022 and the Environment Agency told you that you would need to apply for a permit*

3 PHYSICAL SITE SURVEY

Dr Richard Earl of TGMS attended site during detailed site investigations conducted by Harrison Group Environmental Limited on the 29th and 30th of March 2022. Dr Richard Earl, who will act as Lead Consultant for the project, is a Chartered Engineer specialising in soil and water engineering, with over 30 years of relevant professional experience.

3.1 Site location and access

Barnet Cemetery and Memorial Gardens	Grid reference (site centre);
Milespit Hill	OS X (Eastings) 523130
London	OS Y (Northings) 192098
NW7 2RR	Nearest Post Code NW7 2RR

The site comprises an area of land which is located immediately north of the existing cemetery and is outlined in red on the aerial view below. The site can be accessed through the existing cemetery via Milespit Close, however an overgrown entrance off Milespit Hill is to be developed as a dedicated entrance to the new cemetery (Figure 1).

Figure 1. Site location (within the red line – courtesy of Peter Mitchell Associates). TP1 to TP5 mark the approximate locations of the test pits observed during the site investigation. BH1 to BH3 and WS1 to WS7 mark the approximate locations of cable percussive boreholes and dynamic continuous sampling boreholes (courtesy of Harrison Group Environmental Ltd).

The site comprises former grazing land and some woodland which has been fallow for many years, and is bounded by residential properties to the east and west, fallow land and The Mount to the north, and the existing cemetery to the south (Figures 2 to 7).

Figure 2. General view near the existing cemetery.

Figure 3. General view towards Woodcote Avenue.

Figure 4. General view towards the north-eastern corner.

Figure 5. General view along the northern boundary.

Figure 6. Access gate from Milespit Hill in the north-western corner.

Figure 7. General view across the south-west of the site.

3.2 Hydrology, climate, geology and hydrogeology

3.2.1 Hydrology

Mill Hill Cemetery is situated at 75 – 85 m above OD with the potential development site (situated to the north) situated at an elevation of between 85 – 100 m above OD. The ground surface slopes towards the south. The nearest significant stream/river, Folly Brook, is located 1.3 km north of the site and Dollis Brook is located 1.5 km southeast of the site. Small, local drainage ditches are present starting 300 m northwest, but sinking downslope, 100 m southwest, of the site.

3.2.2 Rainfall

Climate data obtained from the Flood Estimation Handbook (FEH) indicate that the standard-period average annual rainfall (SAAR) is 682 mm for this location; significantly lower than the national average of 885 mm/year.

3.2.3 Drainage catchment

Catchment data obtained from the Flood Estimation Handbook (FEH) Web Service indicate that the site forms part of a 0.51 km^2 catchment with an outlet 900 m to the south near Devonshire Road (Figure 8).

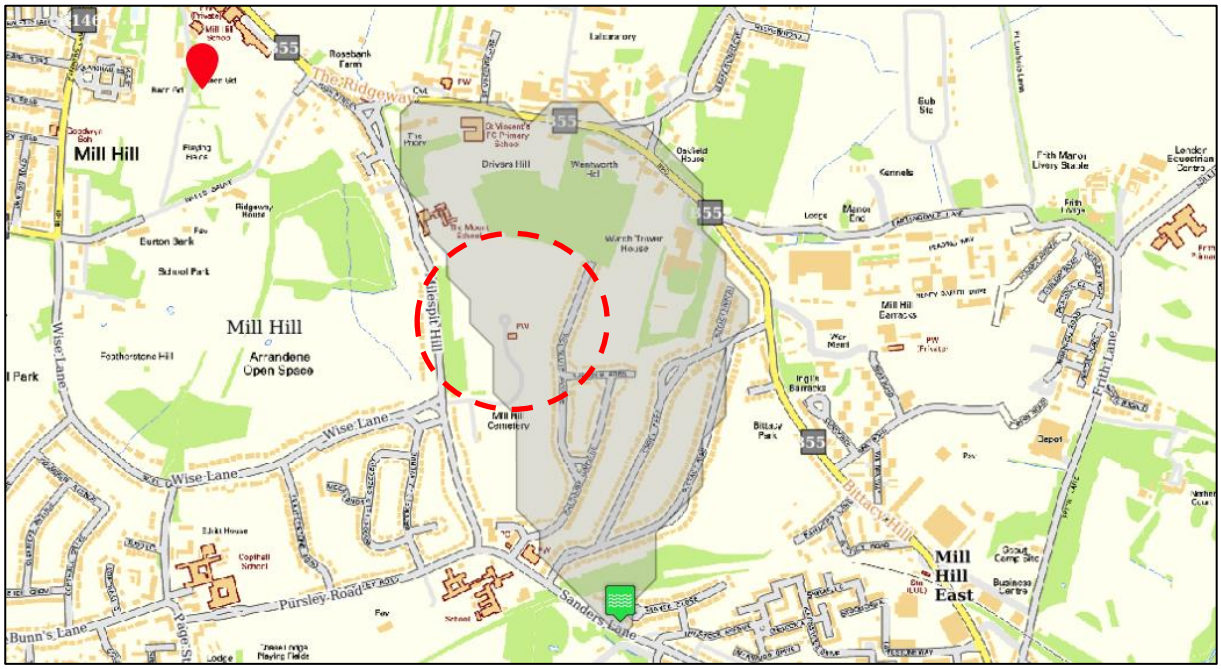


Figure 8. Land drainage catchment (grey polygon) for the site (red circle) and catchment outlet (green marker).

The predicted drainage rates for the soft landscaping areas of the site are less than the Greenfield runoff rates (Table 1), and so installation of a new drainage scheme in grave plot areas, should one be required, would not cause significantly faster or greater flow than the Greenfield condition. Drainage design should account for at least the 1:30 return period outfall rate of 6.8 l/s/ha for the site over a 24-hour period.

Table 1. Greenfield run off rate (FEH method) and drainage outfall rates (ADAS 345 Method) for the proposed extension area for 6 hr and 24 hr duration events for the return periods shown.

Return period	Greenfield Runoff Rate (FEH method) (l/s/ha)	Drainage Outfall Rate (6 hr FEH rainfall event) l/s/ha)	Drainage Outfall Rate (24 hr FEH rainfall event) (l/s/ha)
1:1	5.19	2.0	2.8
1:30	14.04	5.4	6.8
1:100	19.48	7.5	9.5

3.2.4 Risk of flooding from rivers and seas

Based on information obtained from Gov.uk (Figure 9), the site has a very low risk of flooding from rivers and seas with a probability of flooding of less than 1 in 1000 years (<0.1%).

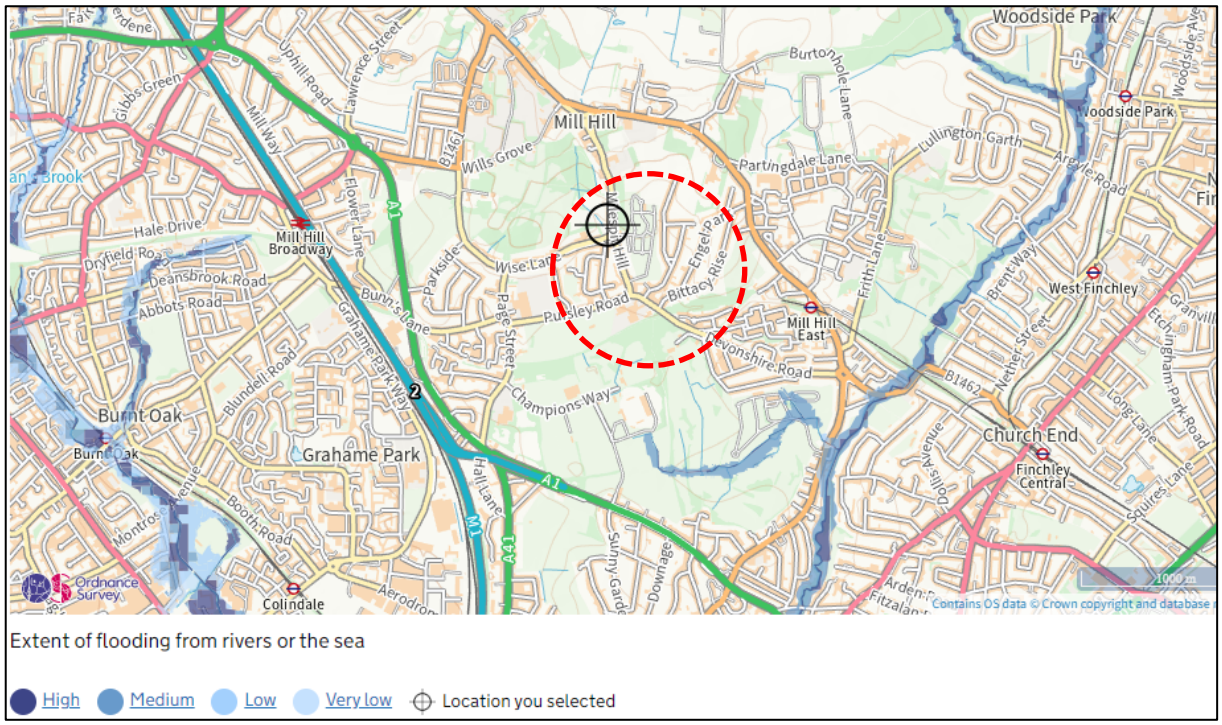


Figure 9. Risk of flooding from rivers or the sea, image courtesy of Gov.uk.

3.2.5 Risk of flooding from surface water

Based on information obtained from Gov.uk (Figure 10), the majority of the site has a very low risk of flooding from surface water with a probability of flooding of less than 1 in 1000 years (<0.1%) aside from three fingers of potential flow; most significantly along the eastern boundary with the Woodcote Avenue where the flood risk is greater than 1 in 30 years (>3.3%). Grave plots should not be located in these areas.

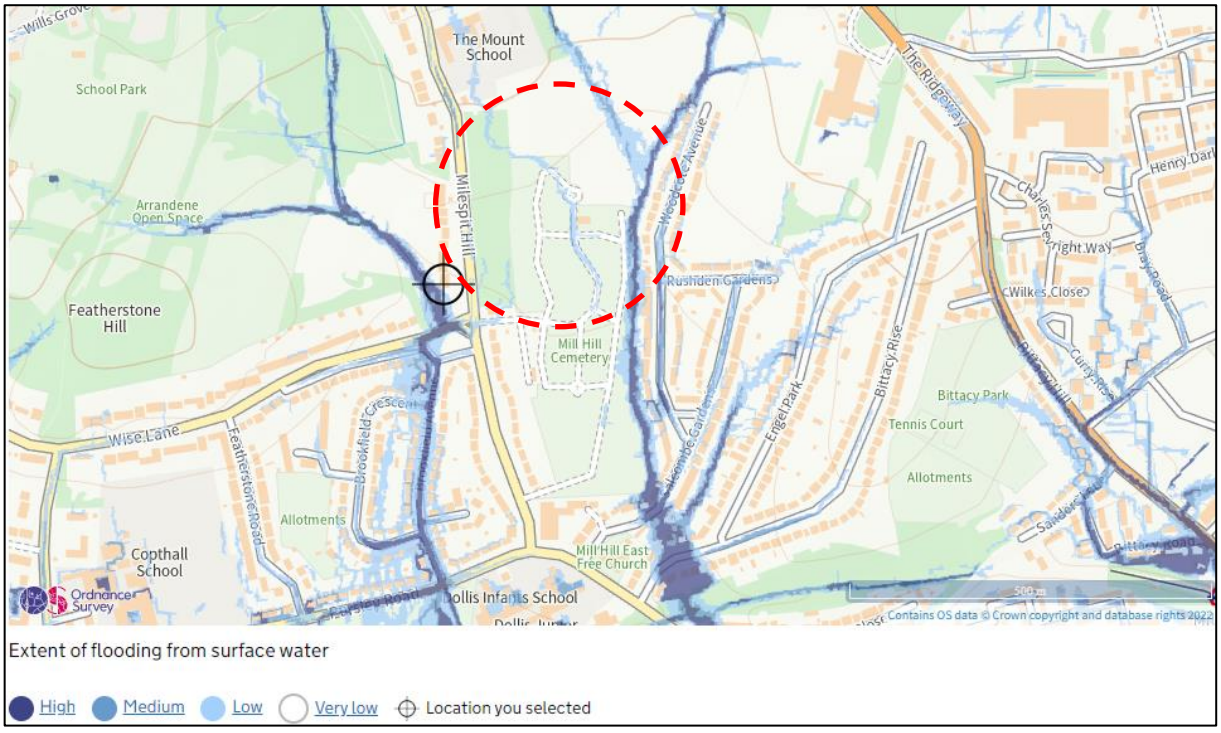


Figure 10. Risk of flooding from surface water. Image courtesy of Gov.uk

3.2.6 Groundwater vulnerability

Based on information obtained from magic.defra.gov.uk, the site is not located within a Groundwater Source Protection Zone (Figure 11).

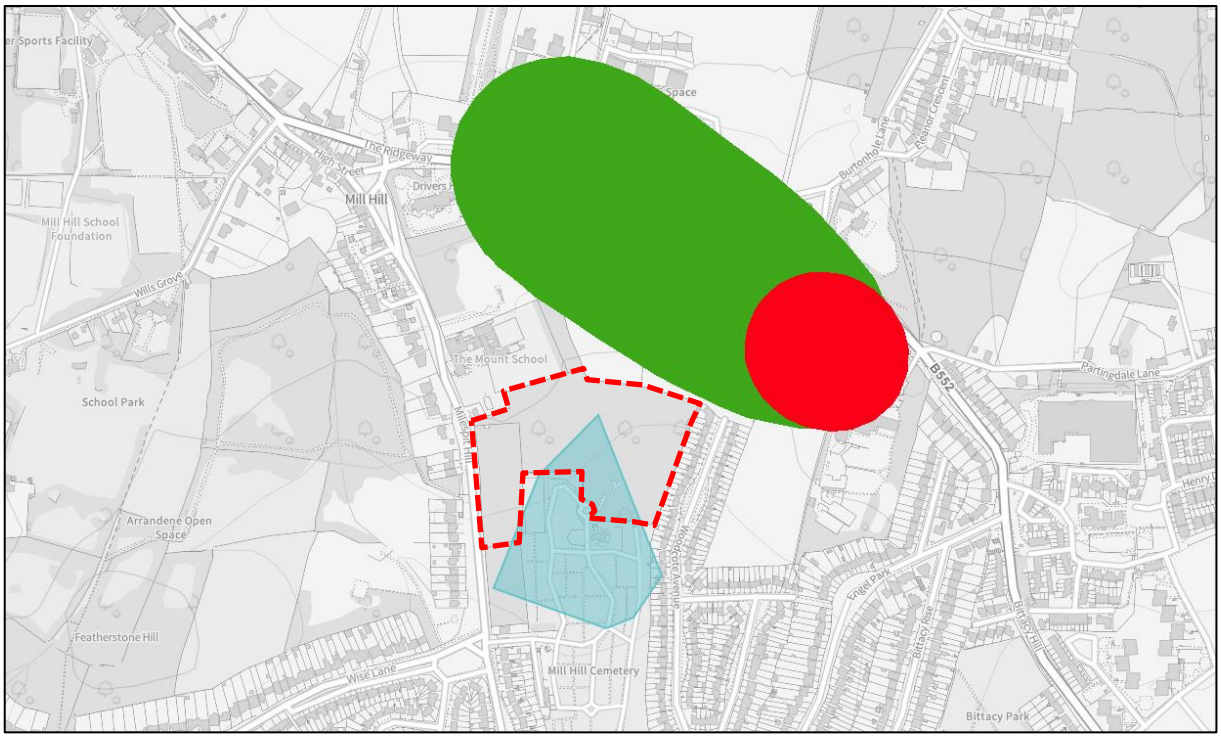


Figure 11. Groundwater source protection zones.

Key: = *Inner Zone*
= *Outer Zone*
= *Total Catchment*

3.3 Soils and geology

3.3.1 Soil map

According to Sheet 6 of the Soil Survey of England and Wales (SSEW) 1:250,000 soil map (1983), the indigenous soil in this area forms part of the WINDSOR Association. The geological origin of this Soil Association is tertiary clay, and it is characterised by slowly permeable seasonally waterlogged clayey soils mostly with brown subsoils.

3.3.2 Landfill

According to data.gov.uk, the site is not located in an area of historic landfill (Figure 12) or permitted landfill (Figure 13).

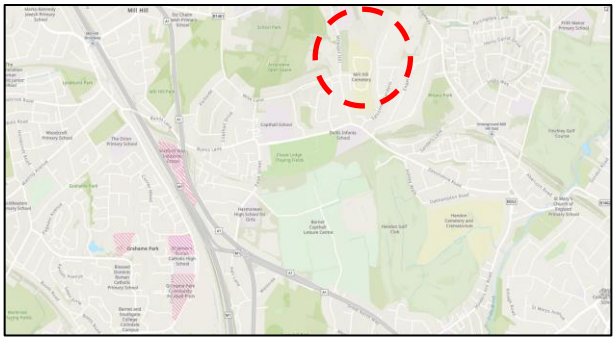


Figure 12. Historic landfill.

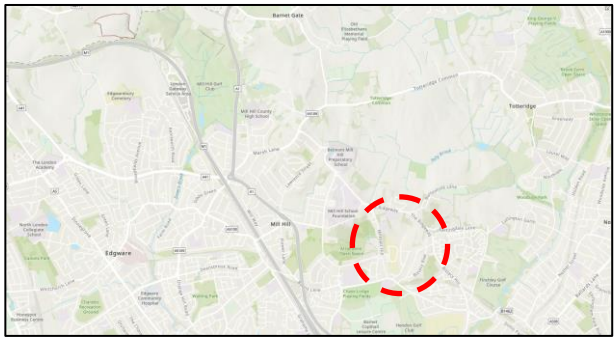


Figure 13. Permitted landfill.

3.3.3 Geology

With reference to the Tier 1 report by Peter Mitchell Associates, and the BGS report commissioned as part of the Tier 1 assessment), the site comprises the following:

Artificial ground

This is ground at or near the surface that has been modified by man. It includes ground that has been deposited (Made Ground) or excavated (Worked Ground), or some combination of these: Landscaped Ground or Disturbed Ground.

No artificial ground has been recorded at the site, although it has been developed (post 1938, based on historic OS maps*), therefore you can expect to find disturbed ground to about 2m for the burial plots together with thin made ground for the roadways and minor landscaping. There are some small buildings including a chapel and there are likely to be some utility services.

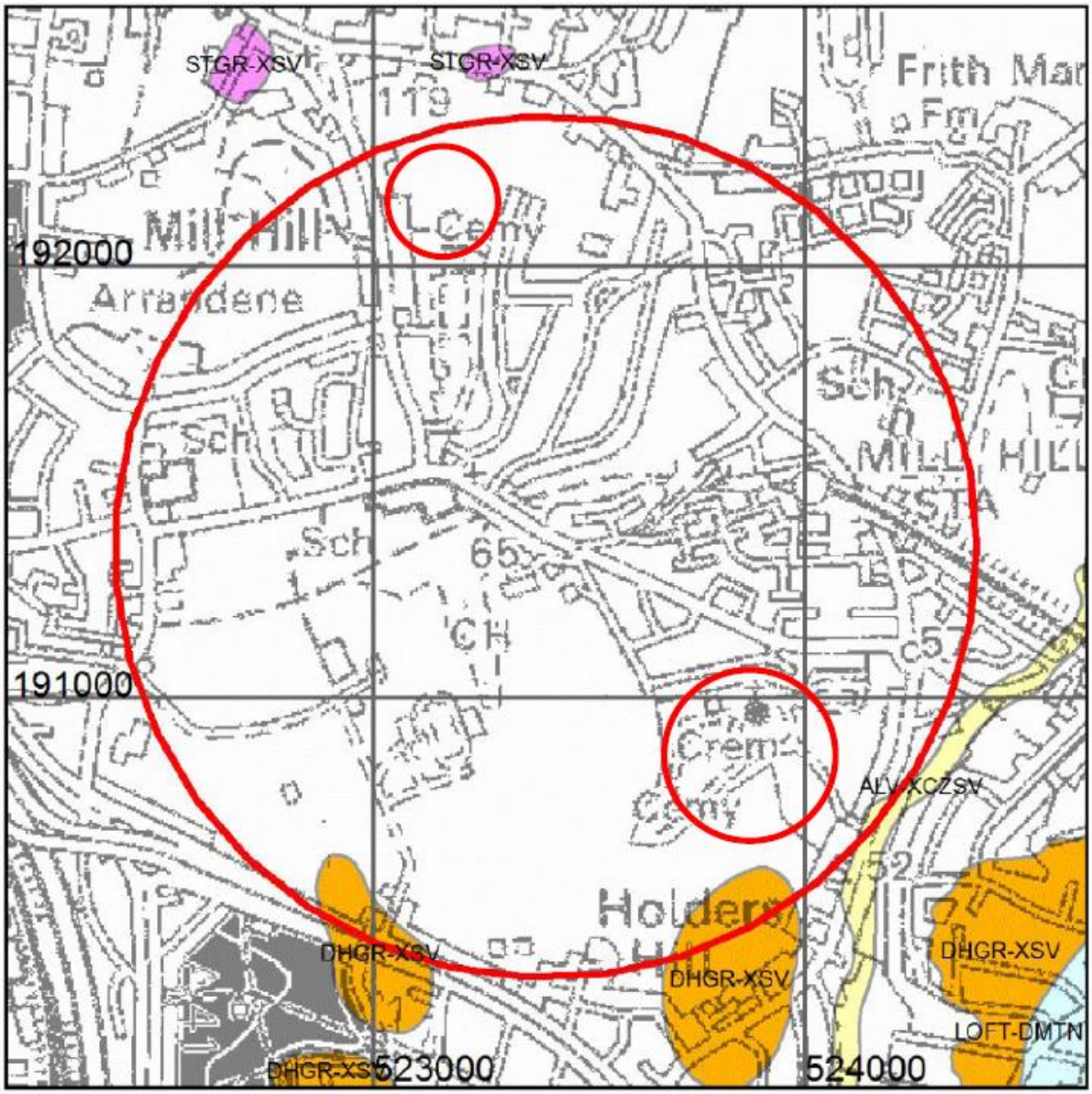
N.B. the BGS comments* concerning the site appear to refer to the existing Mill Hill Cemetery, rather than to the adjacent undeveloped land, which is the subject of this report.

Superficial Deposits (Drift)

These are relatively young geological deposits, formerly known as 'Drift', which lie on the bedrock in many areas. They include deposits such as unconsolidated sands and gravels formed by rivers, and clayey tills formed by glacial action. They may be overlain by landslide deposits or by artificial deposits, or both. Superficial deposits, particularly if they have low permeability, are helpful for cemetery developments in slowing the downward migration of any contaminants that may be released from the decomposition of burials into the underlying bedrock.

The map extract below shows the presence and extent of the superficial deposits on the site (Figure 14).

With reference to Figure 14, no superficial deposits have been mapped across the site here but there may be a thin patchy layer of Head. Head is a Quaternary deposit comprising soft ochreous brown clay or sandy clay, and formed by the local reworking (under the influence of gravity) of weathered bedrock. It is unlikely to be more than a metre thick if present.

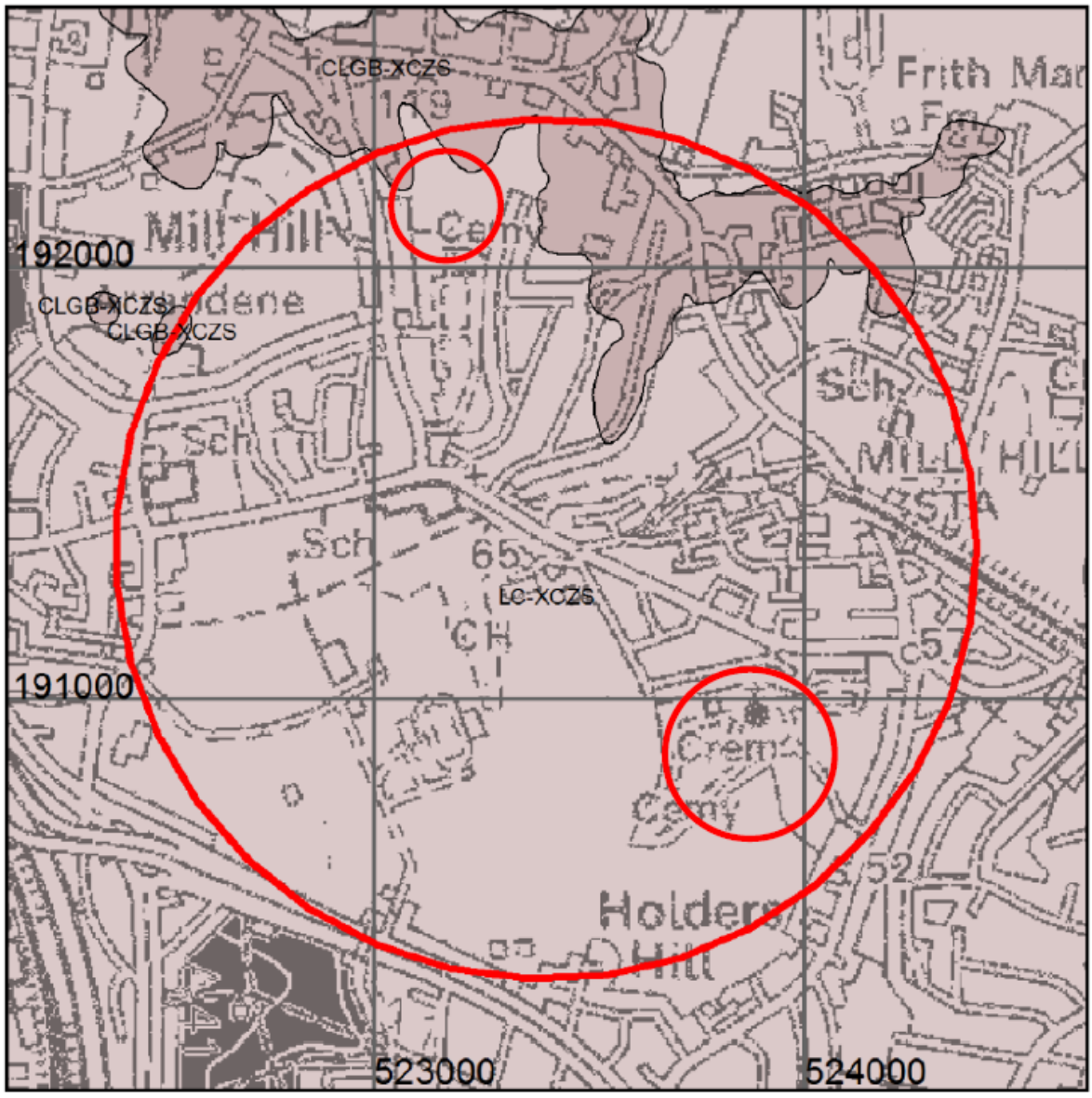


Map colour	Computer Code	Name of geological unit	Composition
	ALV-XCZSV	ALLUVIUM	CLAY, SILT, SAND AND GRAVEL
	LOFT-DMTN	LOWESTOFT FORMATION	DIAMICTON
	DHGR-XSV	DOLLIS HILL GRAVEL MEMBER	SAND AND GRAVEL
	STGR-XSV	STANMORE GRAVEL FORMATION	SAND AND GRAVEL

Figure 14. Presence and extent of superficial deposits
(Source; Tier 1 hydrogeological risk assessment, PMA (April 2019), not to scale)

Bedrock Geology
Bedrock forms the ground underlying the whole of an area, commonly overlain by superficial deposits, landslide deposits or artificial deposits, in any combination. The bedrock formations were formerly known as the 'Solid Geology'.

A diagram showing the bedrock geology in the area is presented in Figure 15:



Map colour	Computer Code	Name of geological unit	Rock type
	CLGB-XCZS	CLAYGATE MEMBER	CLAY, SILT AND SAND
	LC-XCZS	LONDON CLAY FORMATION	CLAY, SILT AND SAND

Figure 15. Bedrock geology.
(Source; Tier 1 hydrogeological risk assessment, PMA (April 2019), not to scale)

With reference to Figure 15, the bedrock is the London Clay Formation of Eocene age with an estimated thickness of 60 – 70 m. It typically comprises stiff, poorly laminated, blue-grey, silty clay where fresh at depth, weathering to a soft to firm brown clay near the surface where oxidised. It may contain some fine sand as thin beds, partings or pockets, together with a few thin beds of shells. At the base there may be a thin pebble bed of black rounded flint pebbles.

In Borehole TQ29SW 183, located 850 m southeast of the site, records show that the London Clay Formation is 42 m thick and rests on 9 m of the Lambeth Group. Beneath the Lambeth Group, 6 m of the Thanet Sand Formation is recorded, resting on the Chalk Group which is 101.5 m thick to the base of the borehole.

There is a borehole located within the site, however no records are available, but the London Clay Formation is likely to be slightly thicker than in the borehole TQ29SW 183, 60 - 70 m thick, as the site is located at a slightly higher elevation.

The London Clay Formation is highly-susceptible to shrink-swell behaviour in response to changes in moisture content. Thin sand layers in the London Clay Formation may be prone to running sand conditions depending on the height of the local water table.

Rockhead depth
Bedrock is mapped at outcrop and rockhead is therefore expected to be at or near the surface but may be concealed by thin topsoil. Borehole TQ29SW 175, located 700 m southwest of the site shows a topsoil depth of 0.2 – 0.3 m. Borehole TQ29SW 183, located 850 m southeast of the site, records made ground, associated with urban development, to a depth of 2.5 m.

3.3.4 Hydrogeology

Aquifers
A diagram showing the aquifer designation map (bedrock) in the vicinity of the site is presented in Figure 16:

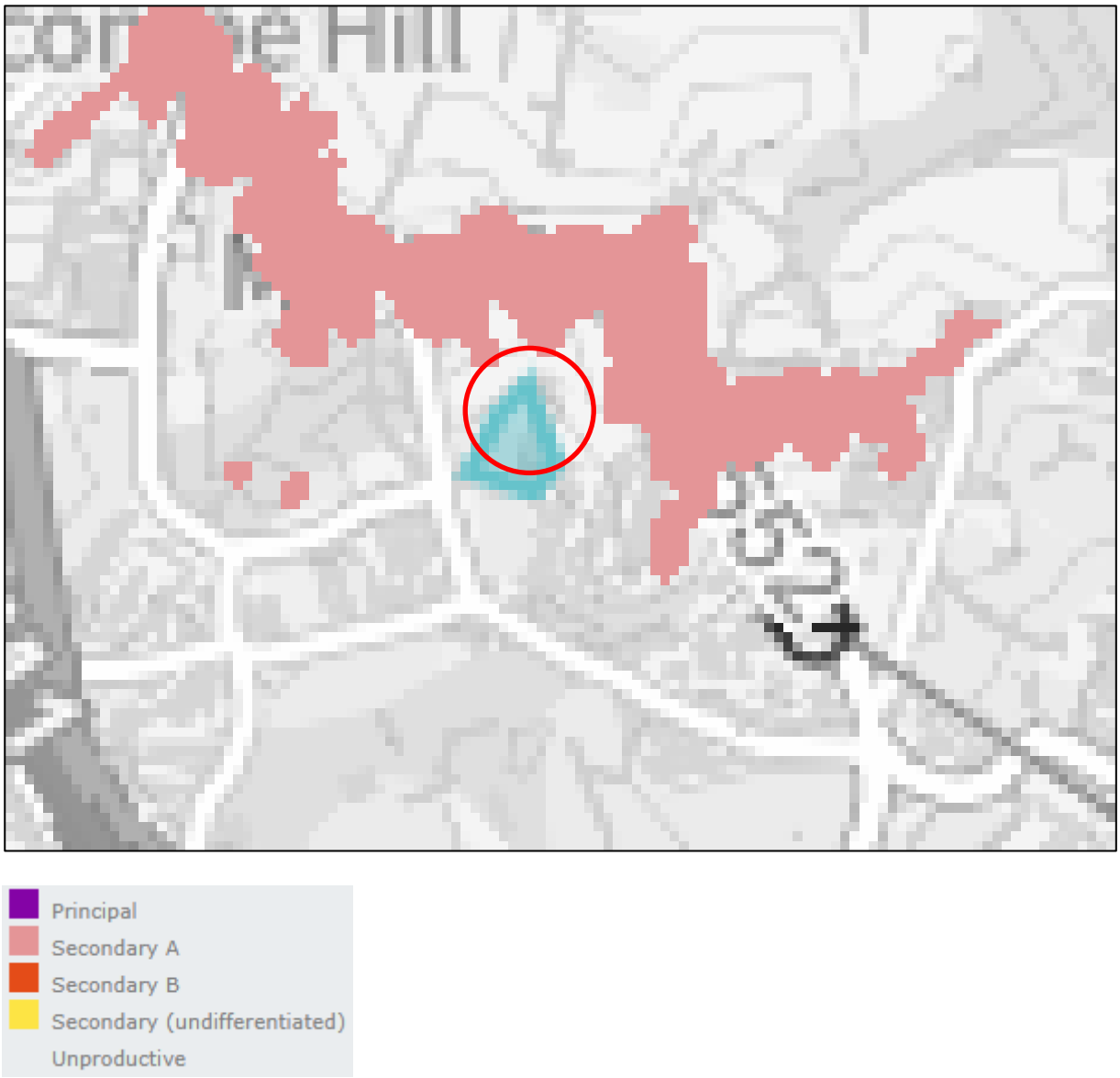


Figure 16. Aquifer designation map (bedrock).
(Source; magic.defra.gov.uk)

With reference to Figure 16, a 'Secondary A' bedrock aquifer (formerly referred to as a Minor Aquifer) lies to the north of the site. These are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.

The site lies outside of a bedrock aquifer.

A diagram showing the aquifer designation map (superficial drift) in the vicinity of the site is presented in Figure 17:

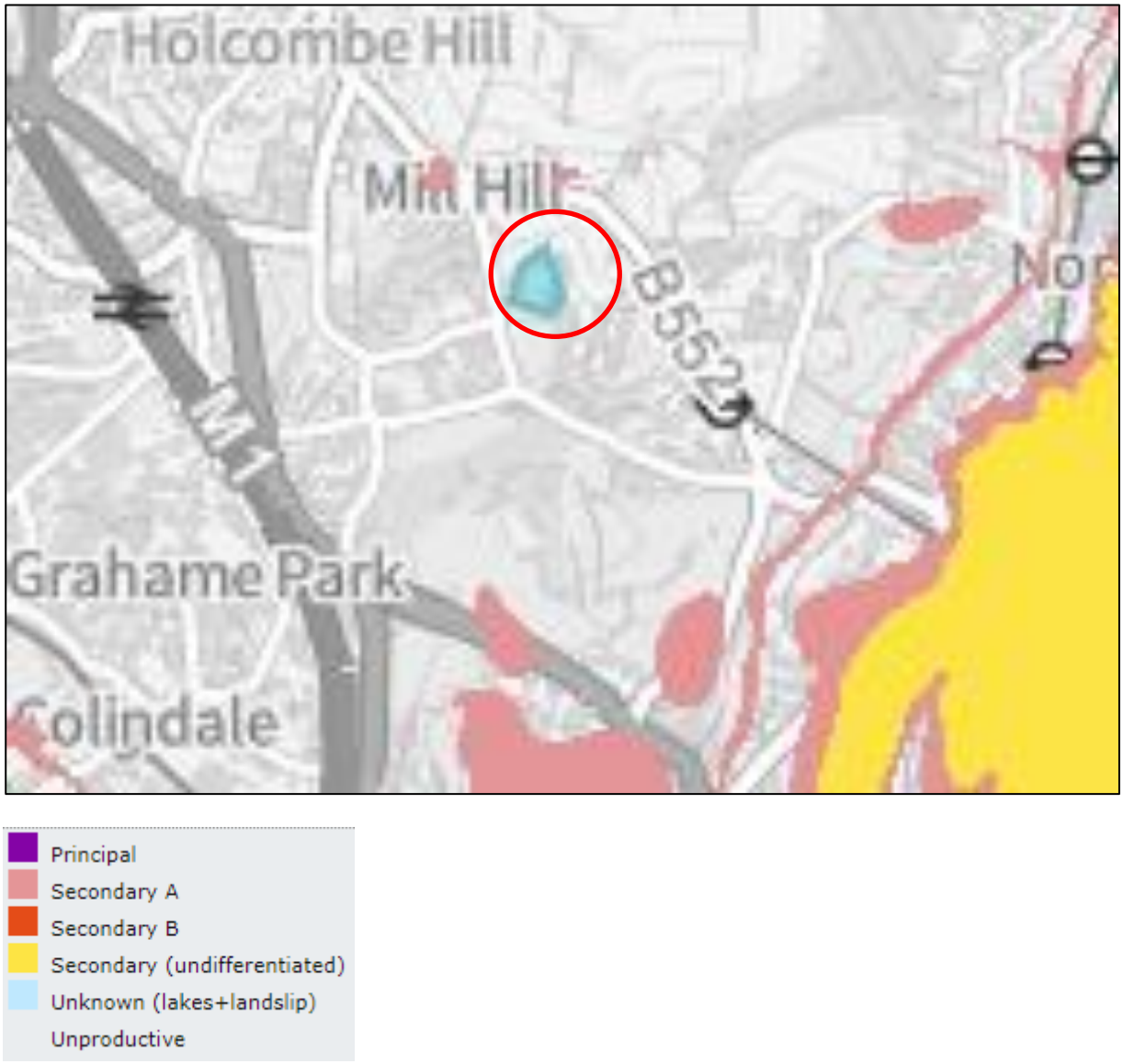


Figure 17. Aquifer designation map (superficial drift).
(Source; magic.defra.gov.uk)

With reference to Figure 17, the site lies outside of a superficial aquifer.

A diagram showing the groundwater vulnerability map in the vicinity of the site is presented in Figure 18:

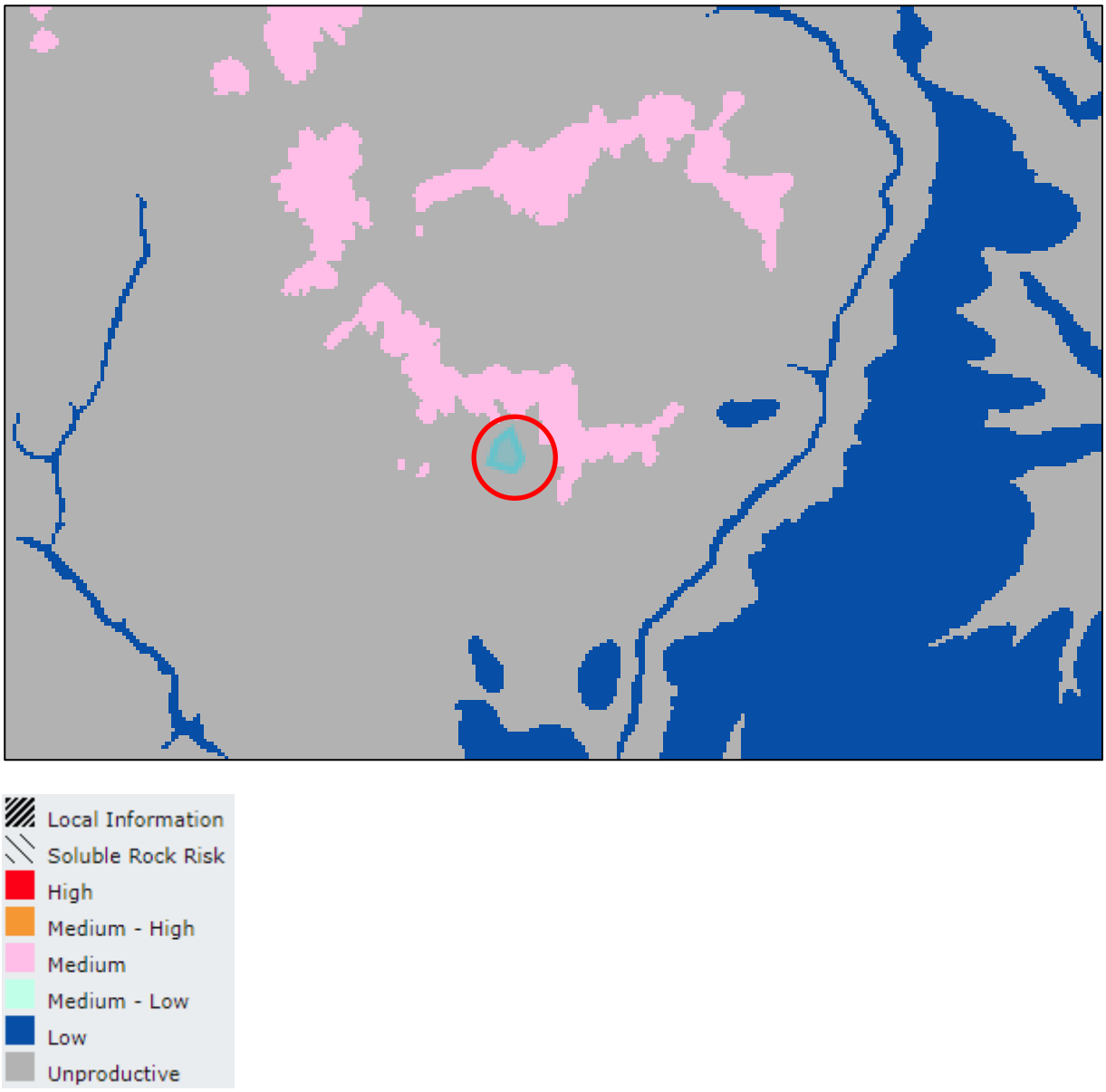


Figure 18. Groundwater vulnerability map.
(Source; magic.defra.gov.uk)

With reference to Figure 18, the site lies outside an area of groundwater vulnerability.

The London Clay Formation, which is present at surface of the site, is a low permeability aquitard that is likely to only contain limited quantities of groundwater in the upper more weathered layers and/or in sandier horizons.

The regionally important chalk aquifer is present at depth below the site, but due to the thickness of London Clay (60-70 m) the cemetery development is not likely to impact upon it.

A summary of hydrogeological considerations is presented in Table 2

Table 2 Summary of hydrogeological considerations.

Geological unit	Groundwater potential	Water level and strikes	Quality	*Environment Agency Groundwater vulnerability classification
Dollis Hill Gravel Member	Variably permeable with intergranular flow (only present at Site 1)	Thin perched aquifer with near surface water	Vulnerable to surface contamination	Secondary aquifer with medium vulnerability
London Clay Formation	Low permeability fissured clay. Some water might be present in upper weathered horizons and in sandy beds, where present	Small amount of perched water may be present in upper weathered horizons. Some water could be encountered in sandy beds and could rise above where struck	Any water present is likely to be hard with high sulphate concentration	Unproductive strata. However some groundwater flow may still occur in the upper weathered, or more permeable, horizons and this should be taken into consideration when considering persistent pollutants

(Source; Tier 1 hydrogeological risk assessment, PMA (April 2019))

3.3.5 Borehole locations

The location of boreholes within the vicinity of the site is presented in Figure 19.

Figure 19. Borehole location map.
(Source; Tier 1 hydrogeological risk assessment, PMA (April 2019))

With reference to Figure 19, one of the nearest boreholes is TQ29SW173, within the existing Mill Hill Cemetery. Unfortunately, as noted in the BGS report, the borehole record is not available. TQ29SW40 was sunk on 4/5/1990 to a depth of 150 m below ground level. The borehole log records rest water level at 106 m below ground level. This groundwater was found in the chalk underneath approximately 90m depth of London Clay.

The Environment Agency stipulates that no interments shall occur within:

- 50 m of any well, spring or borehole, irrespective of that water's current use
- 250 m of any well, spring or borehole where the water is intended for human consumption or used in food production

The are no records of wells or boreholes within 50 m of the site, however two boreholes, (TQ29SW40 and TQ29SW33/A-D) lie within 200 m of the site boundary. TQ29SW40 is referred to above, and TQ29SW33/A-D was sunk in August 1949 to a depth of only 7.62 m into clay and therefore unlikely to be used for human consumption or food production. It is recommended that enquiries are made to establish whether TQ29SW40 is still operational and, if so, whether the water is used for human consumption or food production. If it is, interments should not take place within a radius of 250 m from it.

3.4 Soil profile examination and soil sampling

In order to explore the underlying soil type and structure further, five profile pits were excavated by Harrison Group Environmental Ltd (HGE) and observed by TGMS at the locations indicated on Figure 1. In addition, HGE excavated three cable percussive boreholes and seven dynamic continuous sampling boreholes to maximum depths of 10.50 m and 5.45 m respectively.

3.4.1 Trial Pit Profile Description

A summary of the soil characteristics prevailing in each test pit is presented in the following section.

Figure 20. Digger used to excavate test pits.

In order to facilitate the excavation of pits down to at least 1 m below maximum anticipated burial depth, a JCB 3CXeco excavator was used for the assessment (Figure 20).

Pits were excavated in ~1 m stages to enable soil to be sampled for subsequent laboratory analysis and to allow the suitability of the soil encountered to be assessed. Following excavation, the pits were allowed to remain open for up to 30 minutes to provide sufficient time for any subsurface water present to percolate into the pits.

TP1 was located to the east of the site near the boundary with Woodcote Avenue (Figure 1). The excavation at TP1 revealed a profile that comprised 0.30 m of SILTY CLAY LOAM topsoil over yellow stoneless mottled plastic CLAY with a mudstone seam at 3.00 m where minor seepage was observed. The CLAY became stiffer and greyer with depth, and extended beyond the maximum sampling depth of 4.00 m (Figure 23). (Figure 21).

Figure 21. SILTY CLAY LOAM topsoil over CLAY subsoil – TP1

Figure 22. Soil samples from 0.1 m to 4.09 m – TP1.

Samples extracted from 0.1 m, 1.0 m, 2.0 m, 3.0 m and 4.0 m are presented in (Figure 22).

TP2 was located towards the north-eastern boundary of the site (Figure 1). The excavation at TP2 revealed a profile that comprised 0.30 m of brown CLAY topsoil over yellow stoneless mottled plastic CLAY with a mudstone seam at 3.00 m where minor seepage was observed. The CLAY became stiffer and greyer with depth, and extended beyond the maximum sampling depth of 4.00 m (Figure 23). No permeable lenses or seepage was observed.

Samples extracted from 0.1 m, 1.0 m, 2.0 m, 3.0 m and 4.0 m are presented in Figure 24.

Figure 23. CLAY topsoil over CLAY subsoil – TP2.

Figure 24. Soil samples from 0.1 m to 4.0 m – – TP2.

TP3 was excavated towards the south-eastern boundary of the site near the existing cemetery (Figure 1). The excavation at TP3 revealed a profile that comprised 0.30 m of brown CLAY topsoil over yellow stoneless mottled plastic CLAY with occasional mudstone which became stiffer and greyer with depth, and extended beyond the maximum sampling depth of 4.00 m (Figure 25). Minor seepage from permeable lenses was observed at 3.00 m and 3.60 m, but flow soon ceased.

Samples extracted from 0.1 m, 1.0 m, 2.0 m, 3.0 m and 4.0 m are presented in Figure 26.

Figure 25. CLAY topsoil over CLAY subsoil – TP3. Note minor seepage in base.

Figure 26. Soil samples from 0.1 m to 4.0 m – – TP3.

TP4 was excavated towards the middle of the southern boundary of the site (Figure 1). The excavation at TP4 revealed a profile that comprised 0.30 m of brown CLAY LOAM topsoil over yellow stoneless mottled plastic CLAY became stiffer and greyer with depth and contained a layer of flint cobbles between 3.8 and 4.0 m bgl (Figure 27). Minor seepage from a permeable lens was observed at 3.80 m, but flow soon ceased.

Samples extracted from 0.1 m, 1.0 m, 2.0 m, 3.0 m and 4.0 m are presented in Figure 28

Figure 27. CLAY LOAM topsoil over CLAY subsoil – TP4. Note minor seepage in base.

Figure 28. Soil samples from 0.1 m to 4.0 m – – TP4.

TP5 was excavated towards the centre of the site (Figure 1). The excavation at TP5 revealed a profile that comprised 0.30 m of brown, friable CLAY LOAM topsoil over yellow stoneless mottled plastic CLAY became stiffer and greyer with depth (Figure 29). No permeable lenses or seepage were observed.

Samples extracted from 0.1 m, 1.0 m, 2.0 m, 3.0 m and 4.0 m are presented in Figure 30

Figure 29. CLAY LOAM topsoil over CLAY subsoil – TP5.

Figure 30. Soil samples from 0.1 m to 4.0 m – – TP5.

3.4.2 Percussive boreholes

Figure 31. Dando 2000 Cable Percussive Rig.

Three cable percussive boreholes were excavated by HGE at the locations indicated in Figure 1 (BH1 to BH3) using a Dando 2000 Cable Percussive Rig (Figure 31).

BH1 was located between TP1 and TP3. Arisings were found to comprise 0.25 m of slightly sandy slightly gravelly CLAY topsoil over sandy slightly gravelly CLAY to 7.50 m over slightly sandy CLAY which extended beyond the maximum sampling depth of 10.45 m. A dipwell was installed in the borehole, but no groundwater was encountered.

BH2 was located towards the centre of the northern site boundary. Arisings were found to comprise 0.25 m of brown slightly sandy slightly gravelly CLAY over brown slightly sandy slightly gravelly CLAY subsoil to 1.50 m over slightly sandy CLAY to 7.90 m over dark grey CLAY which extended beyond the maximum sampling depth of 10.50 m.

BH3 was located towards the north-eastern corner of the site. Arisings were found to comprise 0.30 m of slightly sandy slightly gravelly CLAY topsoil over slightly sandy CLAY to 3.40 m over orangish brown mottled greyish blue CLAY to 8.70 m over Stiff dark grey silty CLAY which extended beyond the maximum sampling depth of 10.45 m. A dipwell was installed in the borehole, but no groundwater was encountered during the installation.

No groundwater was observed any of the three boreholes during subsequent monitoring on 11/04/2022 and 25/04/2022.

3.4.3 Dynamic continuous sampling boreholes

Seven window sampling boreholes were installed by HGE at the locations indicated in Figure 1 (WS1 to WS7) using a Premier Compact 120 Rig.

WS1 was located midway along the eastern boundary near Milespit Hill. Arisings were found to comprise 0.30 m of slightly gravelly sandy CLAY topsoil over slightly sandy slightly gravelly CLAY subsoil to 0.70 m over slightly sandy gravelly CLAY to 1.10 m over slightly sandy CLAY which extended beyond the maximum sampling depth of 5.45 m. A dipwell was installed in the borehole, but no groundwater was encountered.

WS2 was located towards the south-western corner of the site. Arisings were found to comprise 0.30 m of slightly gravelly sandy CLAY topsoil over slightly gravelly CLAY subsoil to 1.90 m over sandy CLAY to 2.65 m over slightly sandy CLAY which extended beyond the maximum sampling depth of 5.45 m. A dipwell was installed in the borehole, but no groundwater was encountered.

WS3 was located towards the north-western corner of the site. Arisings were found to comprise 0.25 m of very sandy clayey GRAVEL over gravelly fine to coarse SAND subsoil to 1.55 m over light grey slightly sandy CLAY which extended beyond the maximum sampling depth of 5.45 m. A dipwell was installed in the borehole and groundwater was struck at 3.10.

WS4 was located along the northern boundary near TP2. Arisings were found to comprise 0.35 m of slightly sandy slightly gravelly CLAY over slightly sandy CLAY subsoil which extended beyond the maximum sampling depth of 5.45 m. No groundwater was encountered.

WS5 was located in the eastern half of the site to the east of TP4 and TP5. Arisings were found to comprise 0.3 m of slightly sandy slightly gravelly CLAY over slightly sandy slightly gravelly CLAY subsoil to 4.50 m over firm to stiff orangish brown mottled bluish grey slightly sandy CLAY which extended beyond the maximum sampling depth of 5.45 m. No groundwater was encountered.

WS6 was located towards the south-eastern corner of the site near TP3. Arisings were found to comprise 0.35 m of slightly sandy slightly gravelly CLAY topsoil over slightly sandy slightly gravelly CLAY subsoil which extended beyond the maximum sampling depth of 5.45 m. A dipwell was installed in the borehole, but no groundwater was encountered.

WS7 was located towards the north-western corner of the site between WS1 and WS3. Arisings were found to comprise 0.30 m of slightly sandy slightly gravelly CLAY topsoil over slightly sandy slightly gravelly CLAY subsoil to 3.80 m over stiff greyish blue mottled orangish brown slightly sandy CLAY which extended beyond the maximum sampling depth of 5.45 m. A dipwell was installed in the borehole, but no groundwater was encountered.

No groundwater was observed in WS1, WS2 or WS6 during subsequent monitoring on 11/04/2022 and 25/04/2022, however the water level in WS3 and WS7 rose from 2.19 m bgl to 1.28 m bgl, and 2.34 m bgl to 1.48 m bgl between 11/04/2022 and 25/04/2022 respectively. It is concluded that the

source of the water observed in WS3 and WS7 is from isolated permeable lenses holding limited volumes of water, and that the true free groundwater lies at depths significantly below maximum anticipated burial depth.

If the grave depth required for a double burial is 1.83 m (6 feet), then an unsaturated zone of at least 2.83 m below ground level will be required in order to meet the Environment Agency's minimum criterion of one metre of unsaturated soil beneath maximum interment depth. It is concluded that this site meets this criterion.

3.4.4 Soil Texture

The results from a soil textural analysis of soil samples extracted from the five test pits are presented in Table 3. The results generally concur with observations made during the site investigation.

Table 3. Soil Texture (Sand 2.00 – 0.063 mm; Silt 0.063 mm – 0.002 mm; Clay < 0.002 mm)

TP	Depth (m)	Sand (%)	Silt (%)	Clay (%)	Classification
1	0.10	15.7	52.3	32.0	SILTY CLAY LOAM
	1.00	8.6	39.4	52.0	CLAY
	2.00	2.9	20.1	77.0	CLAY
	3.00	1.7	20.2	78.1	CLAY
	4.00	2.2	23.9	73.9	CLAY
2	0.10	17.4	45.0	37.6	CLAY
	1.00	1.7	17.6	80.7	CLAY
	2.00	6.6	1.6	91.8	CLAY
	3.00	2.5	30.6	66.9	CLAY
	4.00	1.6	20.4	78.0	CLAY
3	0.10	16.1	39.3	44.7	CLAY
	1.00	9.1	42.5	48.4	CLAY
	2.00	4.1	24.3	71.6	CLAY
	3.00	2.1	7.1	90.8	CLAY
	4.00	1.6	12.3	86.1	CLAY
4	0.10	23.2	42.3	34.5	CLAY LOAM
	1.00	25.2	16.8	58.0	CLAY
	2.00	3.9	10.3	85.8	CLAY
	3.00	10.4	6.9	82.7	CLAY
	4.00	5.5	8.8	85.7	CLAY
5	0.10	24.3	41.6	34.1	CLAY LOAM
	1.00	0.5	17.3	82.2	CLAY
	2.00	4.1	5.7	90.2	CLAY
	3.00	3.4	7.4	89.2	CLAY
	4.00	5.8	17.6	76.6	CLAY

3.4.5 Topsoil Nutrient Status

Samples of topsoil were sent to a contract laboratory for analysis of nutrient status (Table 3).

Table 3. Topsoil nutrient and pH status.

TP	Depth	pH	Phosphorus (ppm)	Index	Potassium (ppm)	Index	Magnesium (ppm)	Index
1	0.00 – 0.30	5.2	7	0.7	224	2.9	503	6.6
2	0.00 – 0.30	6.0	9	0.9	284	3.3	819	7.5
3	0.00 – 0.30	4.6	8	0.8	114	1.9	432	6.3
4	0.00 – 0.30	4.7	9	0.9	256	3.1	324	5.7
5	0.00 – 0.30	4.4	9	0.9	143	2.2	177	4.0

Indices of 2 and above indicate that there is sufficient supply of a particular nutrient. With reference to Table 3, the nutrient status of the topsoil is deficient in the major nutrient Phosphorus (which can

be adjusted with an appropriate fertiliser formulation), and has an excess of Magnesium which could cause interference to the availability of Potassium. Soil pH of 4.4 to 6.0 is below the recommended range for supporting most grasses likely to be growing in a cemetery environment. A strongly acidic environment will reduce soil nutrient availability and the efficiency of any applied fertilisers or organic materials. A sub optimum pH will also impact on soil microbial populations and rates of activity. Note that for reasons of soil chemistry, this analysis does not include nitrogen which is often limiting to grass plant growth. During the cemetery construction phase, it is recommended that lime is incorporated into the topsoil to bring the pH up to a more neutral reaction.

3.4.6 Soil and water summary

In summary, the site typically comprises 0.30 m of CLAY or SILTY CLAY LOAM topsoil over slowly permeable CLAY or CLAY LOAM subsoil which extends beyond the maximum sampling depth of 10.50 m.

Observations during the excavation of test pits, and subsequent monitoring of dipwells and boreholes indicate that the site meets meet the Environment Agency's minimum criterion of one metre of unsaturated soil beneath maximum interment depth (aside from some minor seepage from isolated lenses. Moreover, given the presence of deep CLAY subsoil beneath the site, the site also meets the Environment Agency's criterion that graves should not be dug in unaltered or unweathered bedrock.

4 RISK ASSESSMENT

A desk-based risk assessment of the site was conducted by Peter Mitchell Associates (April 2019) using the methodology presented in the Environment Agency R & D Technical Report P223, ISBN 1 85705 0215 (1999) and subsequent guidance on groundwater protection and controlling the risks posed by cemeteries published on www.gov.uk. A summary of the findings, and revisions to this assessment based on observations made during the detailed site investigations (in red type), are presented below.

4.1 Site Vulnerability Assessment

Pertinent criteria, associated comment and assigned score are presented in Tables 5, 6 and 7.

Table 5. Site vulnerability criteria and comment

Criteria	Comment
Drift Type	Absent. CLAY or SILTY CLAY LOAM topsoil over slowly permeable CLAY or CLAY LOAM subsoil which extends beyond the maximum sampling depth of 10.50 m.
Drift Thickness	N/A. CLAY or SILTY CLAY LOAM topsoil over slowly permeable CLAY or CLAY LOAM subsoil which extends beyond the maximum sampling depth of 10.50 m.
Depth to Water Table	>25 m in Chalk below London Clay. Agreed (>50 m).
Flow Mechanism	Potential intergranular flow within upper weathered horizons of the very low permeability London Clay, which is an aquiclude. Intergranular.
Aquifer	Non aquifer. Agreed.
Abstraction and SPZ	Outside any SPZ. Agreed.
Watercourses & springs	Two streams join within the site and flow out to Dollis Brook. Some of the site lies within 30 m of a watercourse, whilst much of the site lies within 70 m of a watercourse. Disagree, no watercourses abut or abound the site.
Drains	None known. None observed.

Table 6. Site vulnerability assessment score sheet

Factor	Site Characteristics	Ranking	Score		
Drift type	Absent. CLAY or SILTY CLAY LOAM topsoil over slowly permeable CLAY or CLAY LOAM.	Very High Very Low	10 2	- -	9 1
Drift thickness	N/A. CLAYEY subsoil extends beyond 10.50 m.	Very High Very Low	10 2	- -	9 1
Depth to water table	>25 m. >50 m.	Very Low Very Low	2 2	- -	1 1
Flow mechanism	Intergranular. Intergranular.	Very Low Very Low	2 2	- -	1 1
Aquifer	Non aquifer. Agreed.	Very Low Very Low	2 2	- -	1 1
Abstraction and Source Protection Zone	Outside Zone III. Agreed.	Very Low Very Low	2 2	- -	1 1
Watercourses & springs	< 30m to >100m. No watercourses.	Moderate Very Low	6 2	- -	5 1
Land Drains	None known. Agreed.	Very Low Very Low	2 2	- -	1 1
Total (range)			36 16	- -	28 8

Table 7. Site vulnerability assessment

Vulnerability	Range	Actual
Low vulnerability	8 – 32	X
Moderate vulnerability	32 – 56	X
High Vulnerability	56 – 80	

4.2 Vulnerability Class

Based upon the total ranking score indicated, the site may be classified with a vulnerability class of:

Low: [X] Moderate: [X] High: [ ]

4.3 Scale of Development

Estimates provided by London Borough of Barnet indicate that the number of full earth burials anticipated in the cemetery extension is likely to be around 110 new graves and 50 re-openers.

4.4 Level of Risk

The EA determine the appropriate level of risk assessment required by considering a combination of the scale of development (i.e. number of burials) and the vulnerability class of the site using a nomograph reproduced in Figure 32.

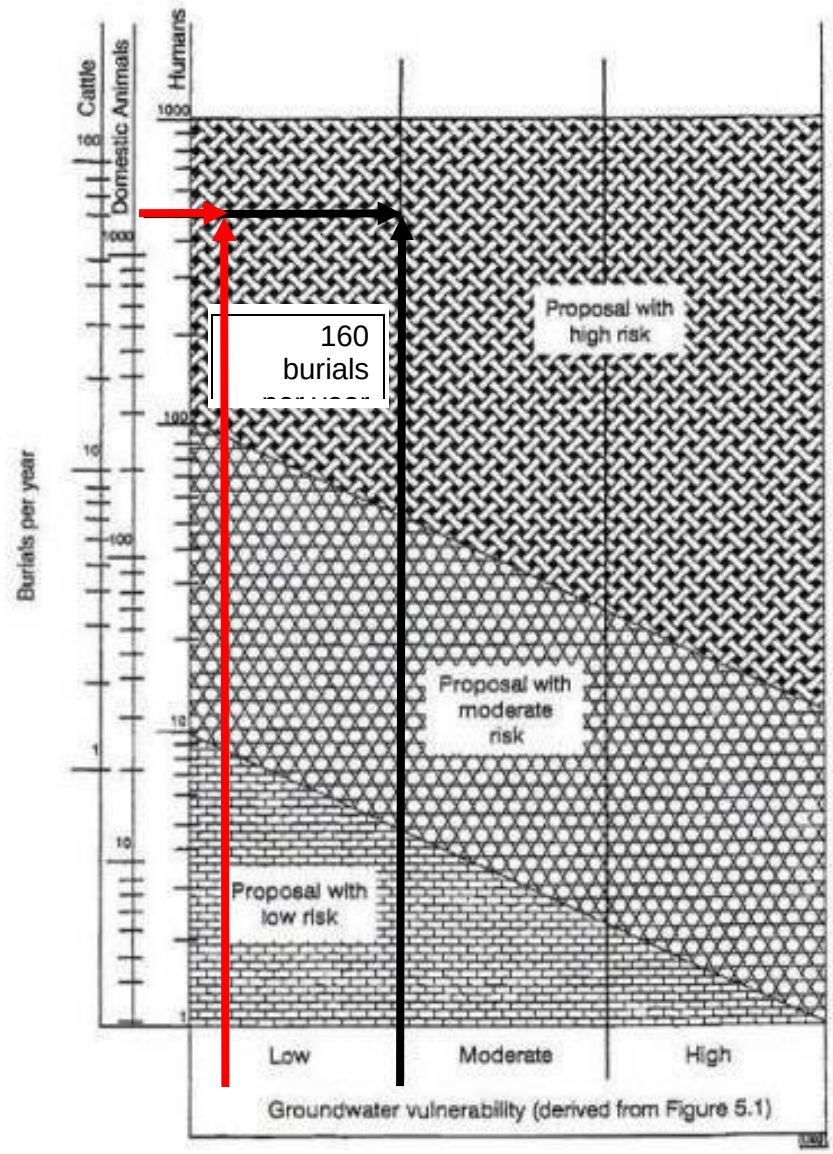


Figure 5.2 Schematic relationship between burial rates, vulnerability class and level of risk

R&D Technical Report P223 37

Figure 32. Schematic relationship between burial rates, vulnerability class and level of risk (from EA R & D Technical Report P223 (1999).

With reference to Figure 32, following the detailed site investigation, it is concluded that the site Vulnerability Ranking can be reduced from 'Moderate' to 'Low', but the level of risk from Figure 32 remains 'High'.

Although the calculated level of risk is 'High', given the presence of the deep, slowly permeable clay that underlies the site, and that no active mitigation measures are deemed necessary to prevent pollution, it is concluded that the risk to the environment can be considered to be 'Low'.

5 SUMMARY AND RECOMMENDATIONS

5.1 Summary

1. **Objective:** To undertake a Tier 2 hydrological risk assessment for the proposed development of Barnet Cemetery and Memorial Gardens, Milespit Hill, London, NW7 2RR.

2. **Site Visits:** A detailed site investigation was conducted on the 30th of March 2022 in parallel with a ground investigation by Harrison Group Environmental Limited.

3. **Site location and access:** The site comprises an area of land which is located immediately north of Mill Hill cemetery. The site can be accessed through the existing cemetery via Milespit Close, however an overgrown entrance off Milespit Hill is to be developed as a dedicated entrance to the new cemetery.

4. **Current land use:** The site comprises former grazing land and some woodland which has been fallow for many years, and is bounded by residential properties to the east and west, fallow land and The Mount to the north, and the existing cemetery to the south.

5. **Hydrology:** The site is situated at an elevation of between 85 – 100 m above OD. The ground surface slopes towards the south. The nearest significant stream/river, Folly Brook, is located 1.3 km north of the site and Dollis Brook is located 1.5 km southeast of the site. Small, local drainage ditches are present starting 300 m northwest, but sinking downslope, 100 m southwest, of the site.

6. **Climate:** Climate data obtained from the Flood Estimation Handbook (FEH) indicate that the standard-period average annual rainfall (SAAR) is 682 mm for this location; significantly lower than the national average of 885 mm/year.

7. **Drainage catchment:** Catchment data obtained from the Flood Estimation Handbook (FEH) Web Service indicate that the site forms part of a 0.51 km^2 catchment with an outlet 900 m to the south near Devonshire Road.

8. **Predicted land drainage rates:** The predicted drainage rates for the soft landscaping areas of the site are less than the Greenfield runoff rates, and so installation of a new drainage scheme in grave plot areas, should one be required, would not cause significantly faster or greater flow than the Greenfield condition. Drainage design should account for at least the 1:30 return period outfall rate of 6.8 l/s/ha for the site over a 24-hour period.

9. **Risk of flooding from rivers and seas:** Based on information obtained from Gov.uk, the site has a very low risk of flooding from rivers and seas with a probability of flooding of less than 1 in 1000 years (<0.1%).

10. **Risk of flooding from surface water:** Based on information obtained from Gov.uk, the majority of the site has a very low risk of flooding from surface water with a probability of flooding of less than 1 in 1000 years (<0.1%) aside from three fingers of potential flow; most significantly along the eastern boundary with the Woodcote Avenue where the flood risk is greater than 1 in 30 years (>3.3%). Grave plots should not be located in these areas.

11. **Groundwater vulnerability:** Based on information obtained from magic.defra.gov.uk, the site is not located within a Groundwater Source Protection Zone.

12. **Landfill:** Based on information from data.gov.uk, the site is not located in an area of historic or permitted landfill.

13. **Soil map:** According to Sheet 6 of the Soil Survey of England and Wales (SSEW) 1:250,000 soil map (1983), the indigenous soil in this area forms part of the WINDSOR Association. The geological origin of this Soil Association is tertiary clay, and it is characterised by slowly permeable seasonally waterlogged clayey soils mostly with brown subsoils.

14. **Geology:** Data from the British Geological Survey indicate that the site is underlain by the London Clay Formation of Eocene age with an estimated thickness of 60 – 70 m. It typically comprises stiff, poorly laminated, blue-grey, silty clay where fresh at depth, weathering to a soft to firm brown clay near the surface where oxidised. It may contain some fine sand as

thin beds, partings or pockets, together with a few thin beds of shells. At the base there may be a thin pebble bed of black rounded flint pebbles.

15. **Hydrogeology:** The London Clay Formation, which is present at surface of the site, is a low permeability aquitard that is likely to only contain limited quantities of groundwater in the upper more weathered layers and/or in sandier horizons. The regionally important chalk aquifer is present at depth below the site, but due to the thickness of London Clay (60-70 m) the cemetery development is not likely to impact upon it.

16. **Water well records:** The Environment Agency stipulates that no interments shall occur within (1) 50 m of any well, spring or borehole, irrespective of that water's current use, or (2) 250 m of any well, spring or borehole where the water is intended for human consumption or used in food production. The are no records of wells or boreholes within 50 m of the site, however two boreholes, (TQ29SW40 and TQ29SW33/A-D) lie within 200 m of the site boundary. TQ29SW33/A-D was sunk in August 1949 to a depth of only 7.62 m into clay and therefore unlikely to be used for human consumption or food production. It is recommended that enquiries are made to establish whether TQ29SW40 (sunk in 1990 to a depth of 150 m) is still operational and, if so, whether the water is used for human consumption or food production. If it is, interments should not take place within a radius of 250 m from it.

17. **Soils:** The site typically comprises 0.30 m of CLAY or SILTY CLAY LOAM topsoil over slowly permeable CLAY or CLAY LOAM subsoil which extends beyond the maximum sampling depth of 10.50 m.

18. **Dipwell monitoring:** No groundwater was observed in WS1, WS2 or WS6 during subsequent monitoring on 11/04/2022 and 25/04/2022, however the water level in WS3 and WS7 rose from 2.19 m bgl to 1.28 m bgl, and 2.34 m bgl to 1.48 m bgl between 11/04/2022 and 25/04/2022 respectively. It is concluded that the source of the water observed in WS3 and WS7 is from isolated permeable lenses holding limited volumes of water, and that the true free groundwater lies at depths significantly below maximum anticipated burial depth. If the grave depth required for a double burial is 1.83 m (6 feet), then an unsaturated zone of at least 2.83 m below ground level will be required in order to meet the Environment Agency's minimum criterion of one metre of unsaturated soil beneath maximum interment depth. It is concluded that this site meets this criterion.

19. **Revised risk assessment:** A desk-based risk assessment of the site conducted by Peter Mitchell Associates (April 2019) has been revised following the input of information emanating from this detailed site investigation. It is concluded that the site Vulnerability Ranking can be reduced from 'Moderate' to 'Low'. Although the calculated level of risk remains 'High', given the presence of the deep, slowly permeable clay that underlies the site, and that no active mitigation measures are deemed necessary to prevent pollution, it is concluded that the risk to the environment can be considered to be 'Low'.

6 OTHER ITEMS

Issues for consideration that can arise from the construction of cemeteries and cemetery extensions can be summarised as follows:

- **Services** – It is recommended that the client obtains up to date service plans of the site prior to any development works. It is important to note that the presence of services may inhibit the scope of works.
- **Planning permission** – Where soil importation and re-grading earthworks are required resulting in a change of levels, it may be prudent to obtain guidance from the local planning department as to whether planning permission is necessary.
- **Land drainage outfall** – When discharging into existing drainage infrastructure or natural watercourses, it may be necessary to obtain the relevant permissions including discharge consents and/or land drainage consent from the Environment Agency, landowner or local authority. These procedures can significantly delay proceedings and prior investigation may be necessary at the feasibility stage. It is the responsibility of the Client to obtain the appropriate consents.
- **Cut and fill** – Cut and fill involves significant earthmoving using large plant machinery e.g. dozers, excavators and dumper trucks. The nature of the works invariably changes the soil structure which can become compacted and, as a consequence, create very low surface water infiltration rates. Settlement of levels is also not uncommon as Contractors try to achieve a balance between avoiding over-consolidation, reducing the risk of settlement whilst maintaining infiltration rates.
- **Settlement of drain lines** – Land drains can be prone to differential settlement (i.e. there can be some sinkage over the drain lines) as the soil surrounding the drain pipe dries out and shrinks; this is perfectly normal in new constructions. Whilst topping up drain lines is usually covered by the Contractor during the first 12-months following construction, it is possible that drains may continue to sink to some extent after this time. Therefore, there should be some allowance within the maintenance programme to ensure that drains are kept topped up.

7 CONFIDENTIALITY

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18840/5				**PARTICLE SIZE DISTRIBUTION** **SAND / SILT / CLAY** Test Report Number 18840/E Page 1 of 2
100%				Milespit: TP1, 0.1M
				*** No stones present *****
07/04/22				Sample Received Date & Sample Test Date
moist				Sample Moisture (very wet, wet, moist, dry, n/a)
plastic				Sample Consistency (hard, friable, plastic, n/a)
high				Sample Homogeniety (high, medium, low, n/a)
				Particle Size Distribution – ASTM F1632-03 (Reapproved 2018)
15.7				% Sand 0.05 to 2.00 mm
52.3				% Silt 0.002 to 0.05 mm
32.0				% Clay less than 0.002 mm
Silty Clay Loam				Soil Classification

ASTM Method: F1632-03 (Reapproved 2018)
"Particle Size Analysis and Sand Shape Grading of Golf Course Putting Green and Sports Field Root Zone Mixes"

Professional Sportsturf Design (NW) Ltd, trading as TGMS
Wigan Road, Leyland, Lancashire, PR25 5XW

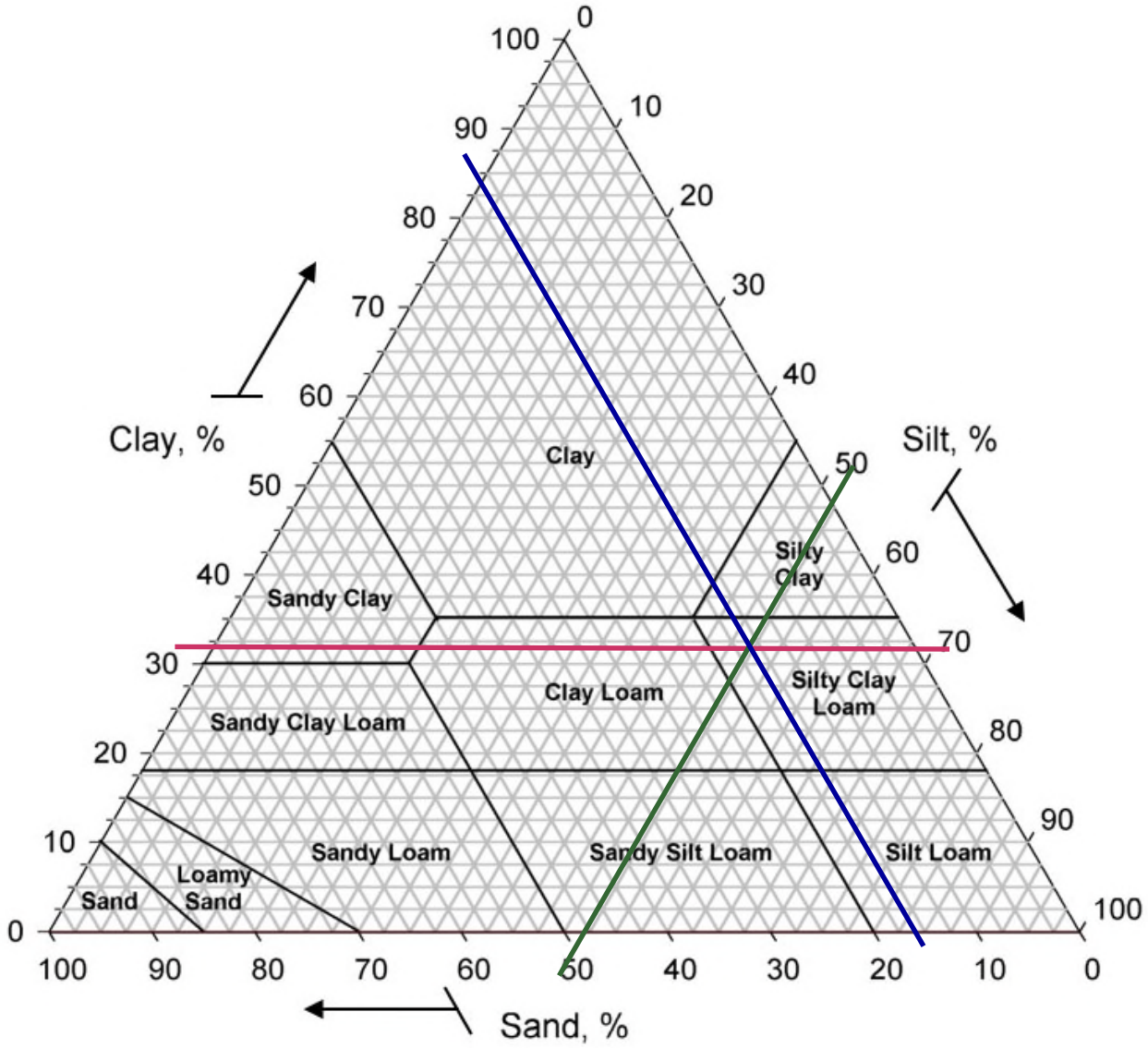
Approved by: Sara Singleton-Price **Date: 13th April 2022**

Managing Director, for European Turfgrass Laboratories Ltd

EUROPEAN TURFGRASS LABORATORIES

Triangle of Texture : Soil Classification

Date of Issue: Sept 2019, Revision 1,
Issuing Authority: Sharon Singleton-Bruce



Soil Sample: TGMS

Test Report 18840/E

			After removal of gravel			
Sample	**% Gravel**		**% Sand**	**% Silt**	**% Clay**	**Soil Texture Classification**
Milespit: TP1, 0.1M	-		15.7	52.3	32.0	**Silty Clay Loam**

Signed: Sharon Singleton-Bruce

Date: **13th April 2022** **for European Turfgrass Laboratories Ltd**

EUROPEAN TURFGRASS LABORATORIES
GEOTECHNICAL (PUTTING GREEN MATERIALS) CERTIFICATE NO. 903-01
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18840/6				**PARTICLE SIZE DISTRIBUTION** **SAND / SILT / CLAY** Test Report Number 18840/F Page 1 of 2
100%				Milespit: TP1, 1.0M
				*** Stones present > 16mm *****
07/04/22				Sample Received Date & Sample Test Date
moist				Sample Moisture (very wet, wet, moist, dry, n/a)
plastic				Sample Consistency (hard, friable, plastic, n/a)
high				Sample Homogeniety (high, medium, low, n/a)
				Particle Size Distribution – ASTM F1632-03 (Reapproved 2018)
8.6				% Sand 0.05 to 2.00 mm
39.4				% Silt 0.002 to 0.05 mm
52.0				% Clay less than 0.002 mm
Clay				Soil Classification

ASTM Method: F1632-03 (Reapproved 2018)
"Particle Size Analysis and Sand Shape Grading of Golf Course Putting Green and Sports Field Root Zone Mixes"

Professional Sportsturf Design (NW) Ltd, trading as TGMS
Wigan Road, Leyland, Lancashire, PR25 5XW

Approved by: Sara Singleton-Price **Date: 14th April 2022**

Managing Director, for European Turfgrass Laboratories Ltd

EUROPEAN TURFGRASS LABORATORIES

Triangle of Texture : Soil Classification

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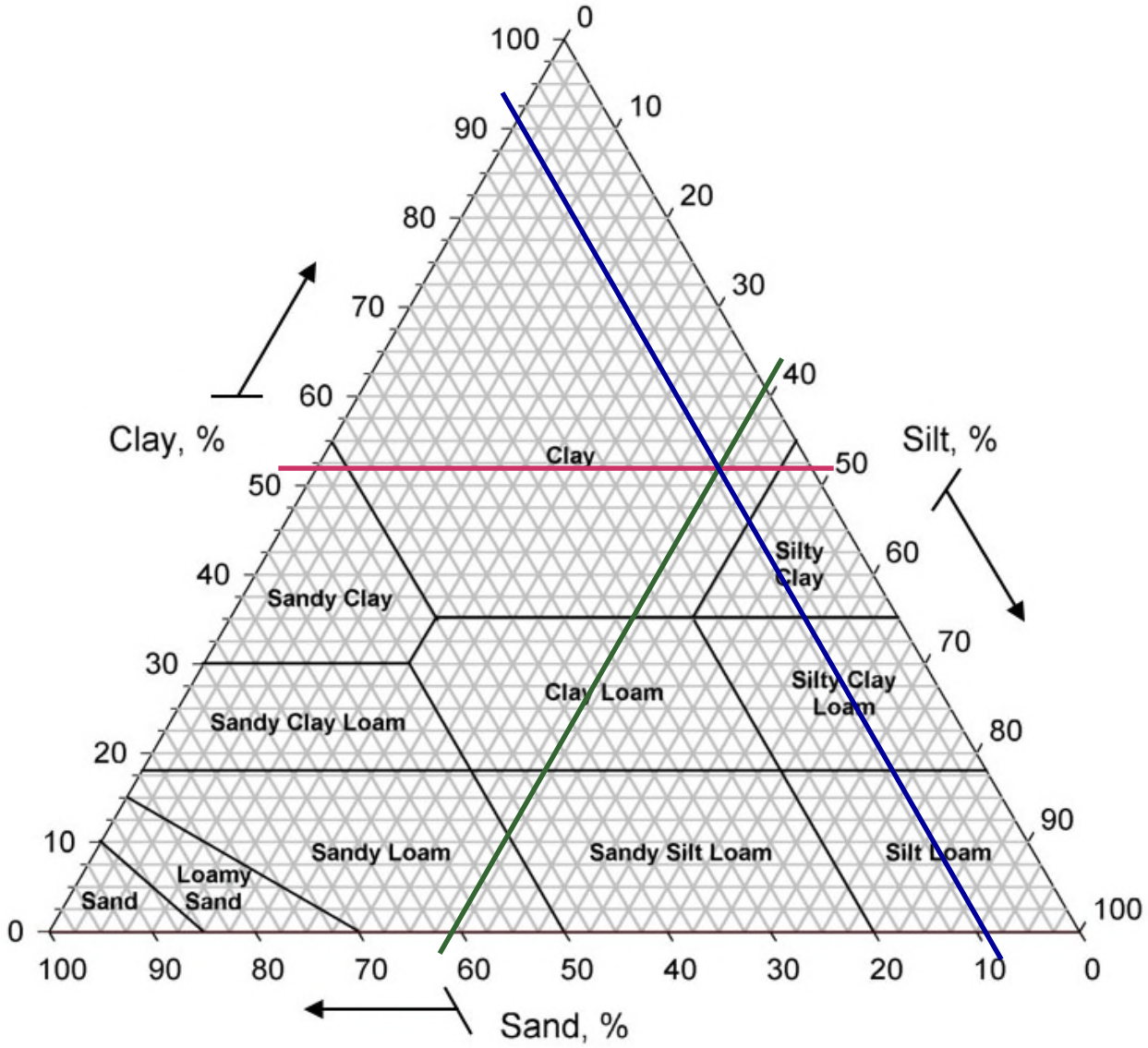

Soil Sample: TGMS

Test Report 18840/F

			After removal of gravel			
Sample	**% Gravel**		**% Sand**	**% Silt**	**% Clay**	**Soil Texture Classification**
Milespit: TP1, 1.0M	4.0		8.6	39.4	52.0	**Clay**

Signed: Sharon Singleton-Bruce

Date: **14th April 2022** **for European Turfgrass Laboratories Ltd**

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18840/7				**PARTICLE SIZE DISTRIBUTION** **SAND / SILT / CLAY** Test Report Number 18840/G Page 1 of 2
100%				Milespit: TP1, 2.0M
				*** No Stones Present *****
07/04/22				Sample Received Date & Sample Test Date
moist				Sample Moisture (very wet, wet, moist, dry, n/a)
plastic				Sample Consistency (hard, friable, plastic, n/a)
high				Sample Homogeniety (high, medium, low, n/a)
				Particle Size Distribution – ASTM F1632-03 (Reapproved 2018)
2.9				% Sand 0.05 to 2.00 mm
20.1				% Silt 0.002 to 0.05 mm
77.0				% Clay less than 0.002 mm
Clay				Soil Classification

ASTM Method: F1632-03 (Reapproved 2018)
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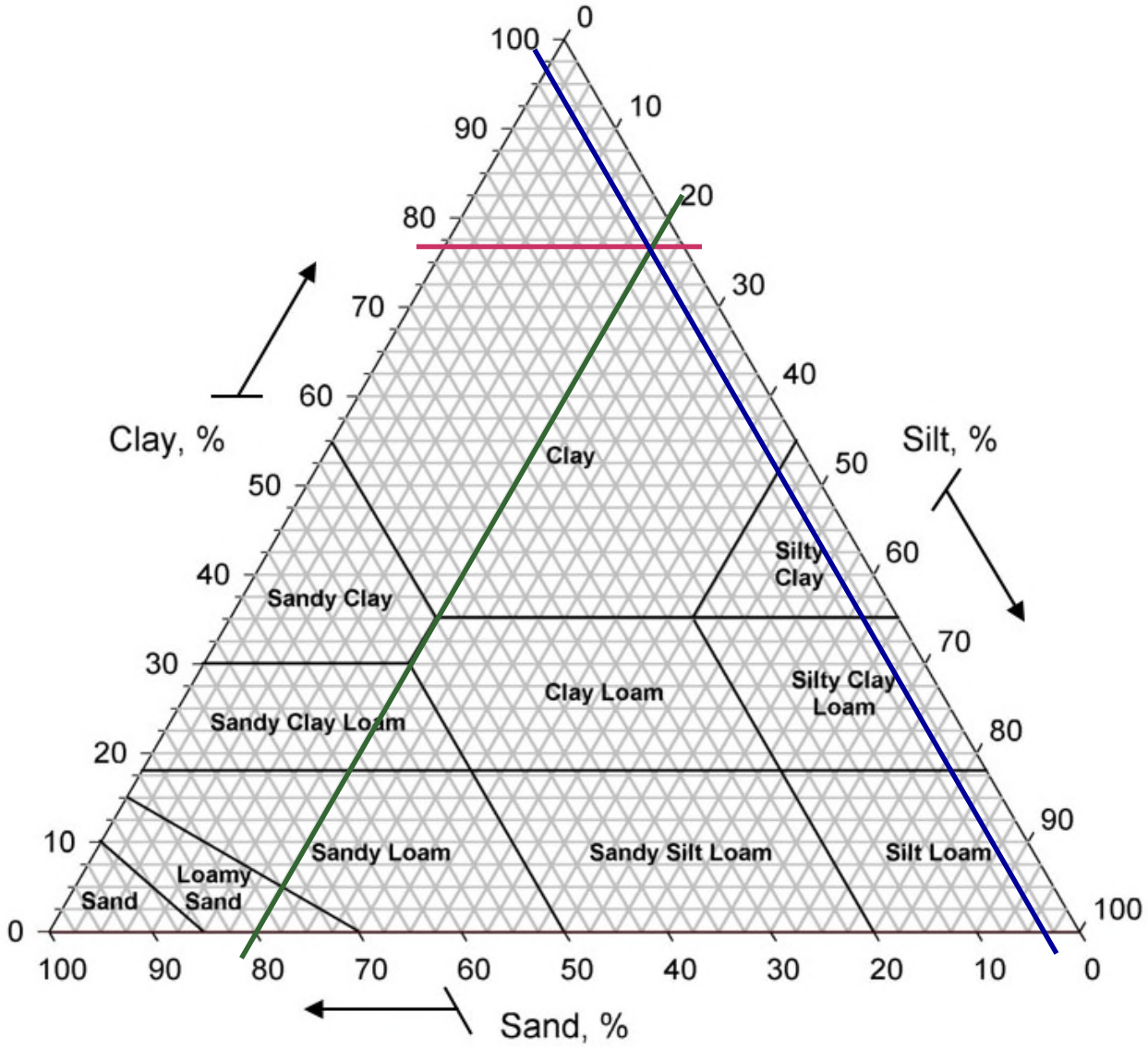

Soil Sample: TGMS

Test Report 18840/G

			After removal of gravel			
Sample	**% Gravel**		**% Sand**	**% Silt**	**% Clay**	**Soil Texture Classification**
Milespit: TP1, 2.0M	-		2.9	20.1	77.0	**Clay**

Signed: Sharon Singleton-Bruce

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18840/8				**PARTICLE SIZE DISTRIBUTION** **SAND / SILT / CLAY** Test Report Number 18840/H Page 1 of 2
100%				Milespit: TP1, 3.0M
				*** No Stones Present *****
07/04/22				Sample Received Date & Sample Test Date
moist				Sample Moisture (very wet, wet, moist, dry, n/a)
plastic				Sample Consistency (hard, friable, plastic, n/a)
high				Sample Homogeniety (high, medium, low, n/a)
				Particle Size Distribution – ASTM F1632-03 (Reapproved 2018)
1.7				% Sand 0.05 to 2.00 mm
20.2				% Silt 0.002 to 0.05 mm
78.1				% Clay less than 0.002 mm
Clay				Soil Classification

ASTM Method: F1632-03 (Reapproved 2018)
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Approved by: Sara Singleton-Price **Date: 14th April 2022**

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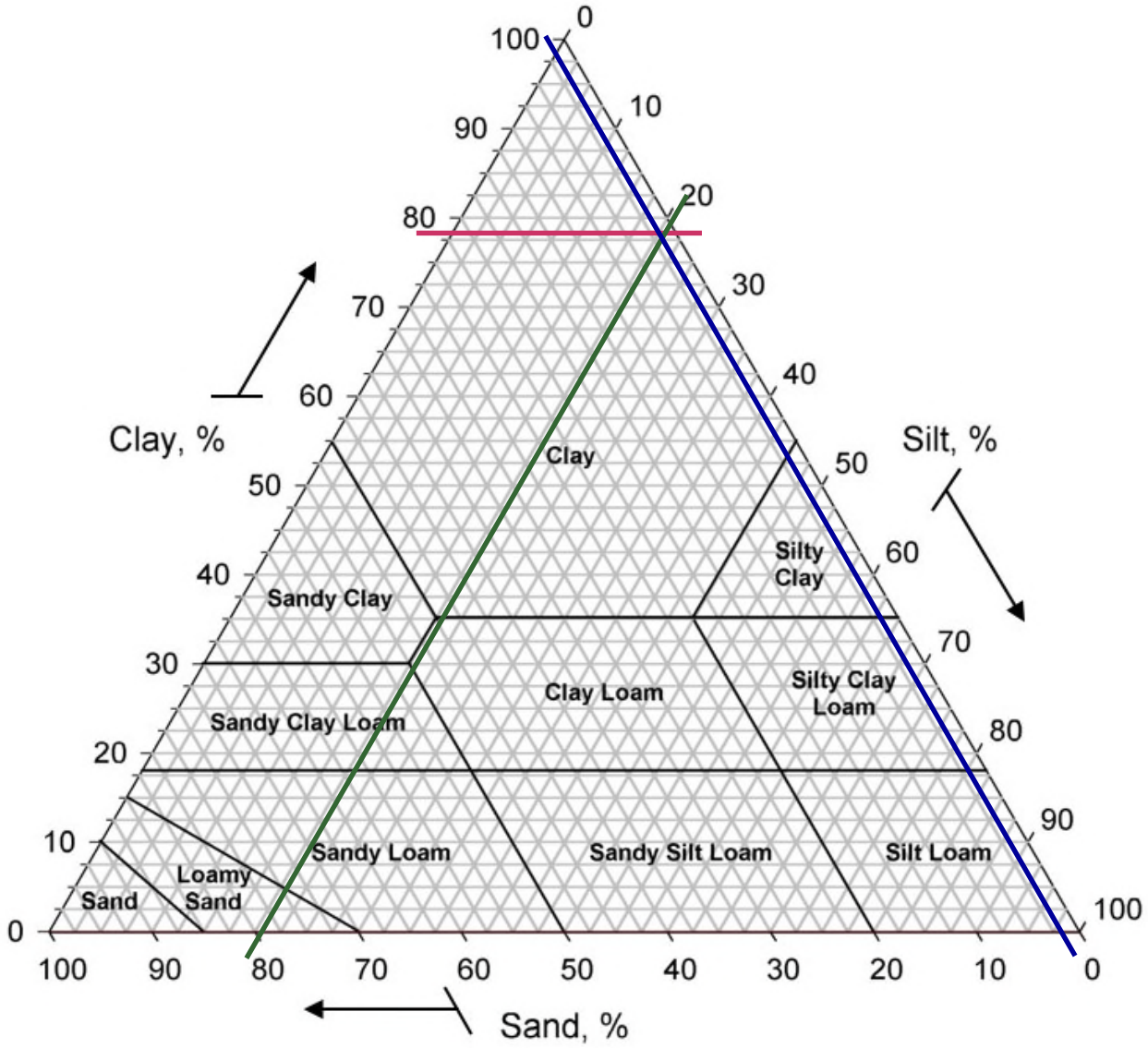

Soil Sample: TGMS

Test Report 18840/H

			After removal of gravel			
Sample	**% Gravel**		**% Sand**	**% Silt**	**% Clay**	**Soil Texture Classification**
Milespit: TP1, 3.0M	-		1.7	20.2	78.1	**Clay**

Signed: Sharon Singleton-Bruce

Date: **14th April 2022** **for European Turfgrass Laboratories Ltd**

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18840/9				**PARTICLE SIZE DISTRIBUTION** **SAND / SILT / CLAY** Test Report Number 18840/I Page 1 of 2
100%				Milespit: TP1, 4.0M
				*** No Stones Present *****
07/04/22				Sample Received Date & Sample Test Date
moist				Sample Moisture (very wet, wet, moist, dry, n/a)
plastic				Sample Consistency (hard, friable, plastic, n/a)
high				Sample Homogeniety (high, medium, low, n/a)
				Particle Size Distribution – ASTM F1632-03 (Reapproved 2018)
2.2				% Sand 0.05 to 2.00 mm
23.9				% Silt 0.002 to 0.05 mm
73.9				% Clay less than 0.002 mm
Clay				Soil Classification

ASTM Method: F1632-03 (Reapproved 2018)
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Approved by: Sara Singleton-Price **Date: 14th April 2022**

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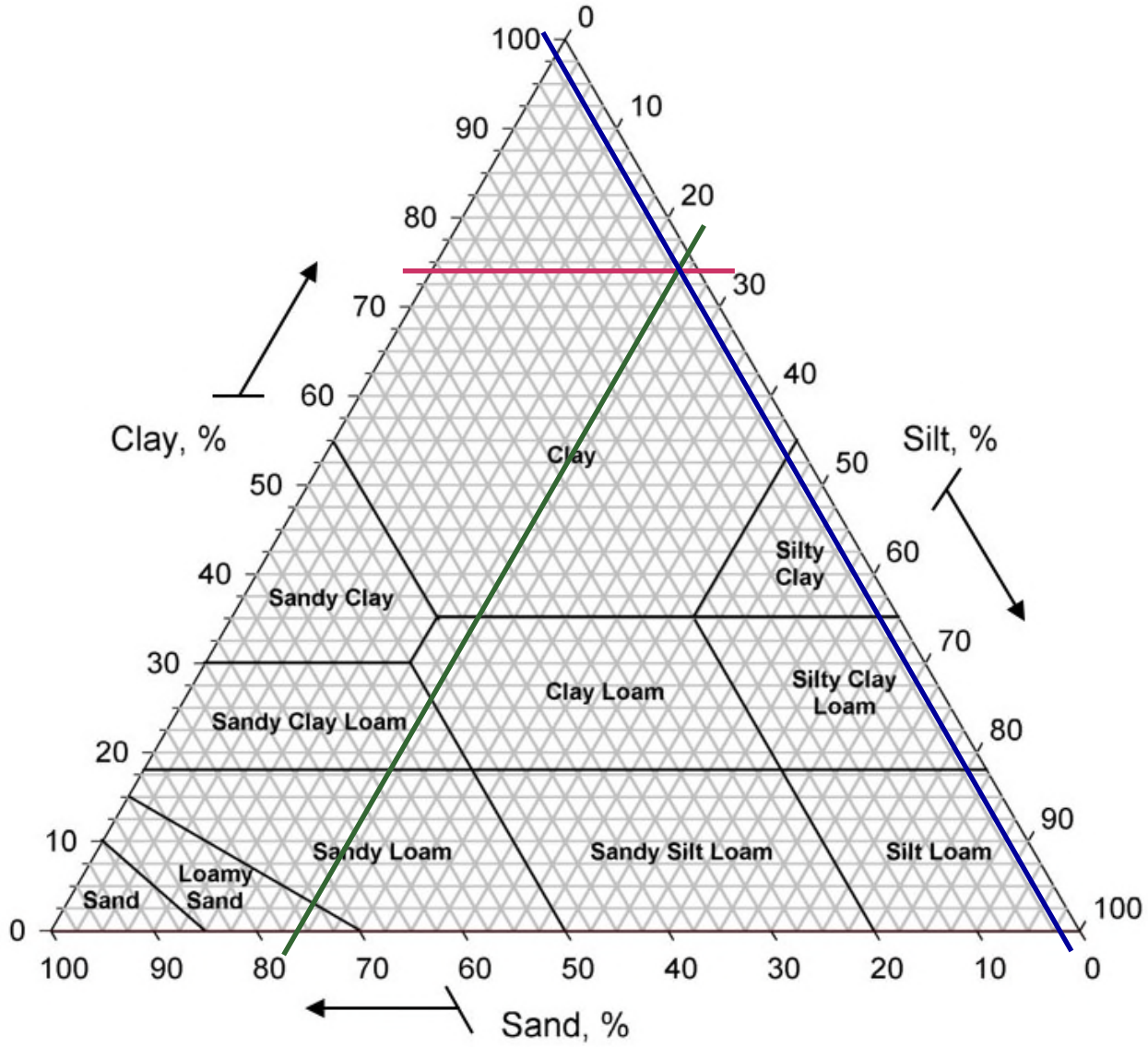

Soil Sample: TGMS

Test Report 18840/I

			After removal of gravel			
Sample	**% Gravel**		**% Sand**	**% Silt**	**% Clay**	**Soil Texture Classification**
Milespit: TP1, 4.0M	-		2.2	23.9	73.9	**Clay**

Signed: Sharon Singleton-Bruce

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18840/10				**PARTICLE SIZE DISTRIBUTION** **SAND / SILT / CLAY** Test Report Number 18840/J Page 1 of 2
100%				Milespit: TP2, 0.1M
				*** No Stones Present *****
07/04/22				Sample Received Date & Sample Test Date
moist				Sample Moisture (very wet, wet, moist, dry, n/a)
plastic				Sample Consistency (hard, friable, plastic, n/a)
high				Sample Homogeniety (high, medium, low, n/a)
				Particle Size Distribution – ASTM F1632-03 (Reapproved 2018)
17.4				% Sand 0.05 to 2.00 mm
45.0				% Silt 0.002 to 0.05 mm
37.6				% Clay less than 0.002 mm
Clay / Silty Clay				Soil Classification

ASTM Method: F1632-03 (Reapproved 2018)
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Approved by: Sara Singleton-Price **Date: 14th April 2022**

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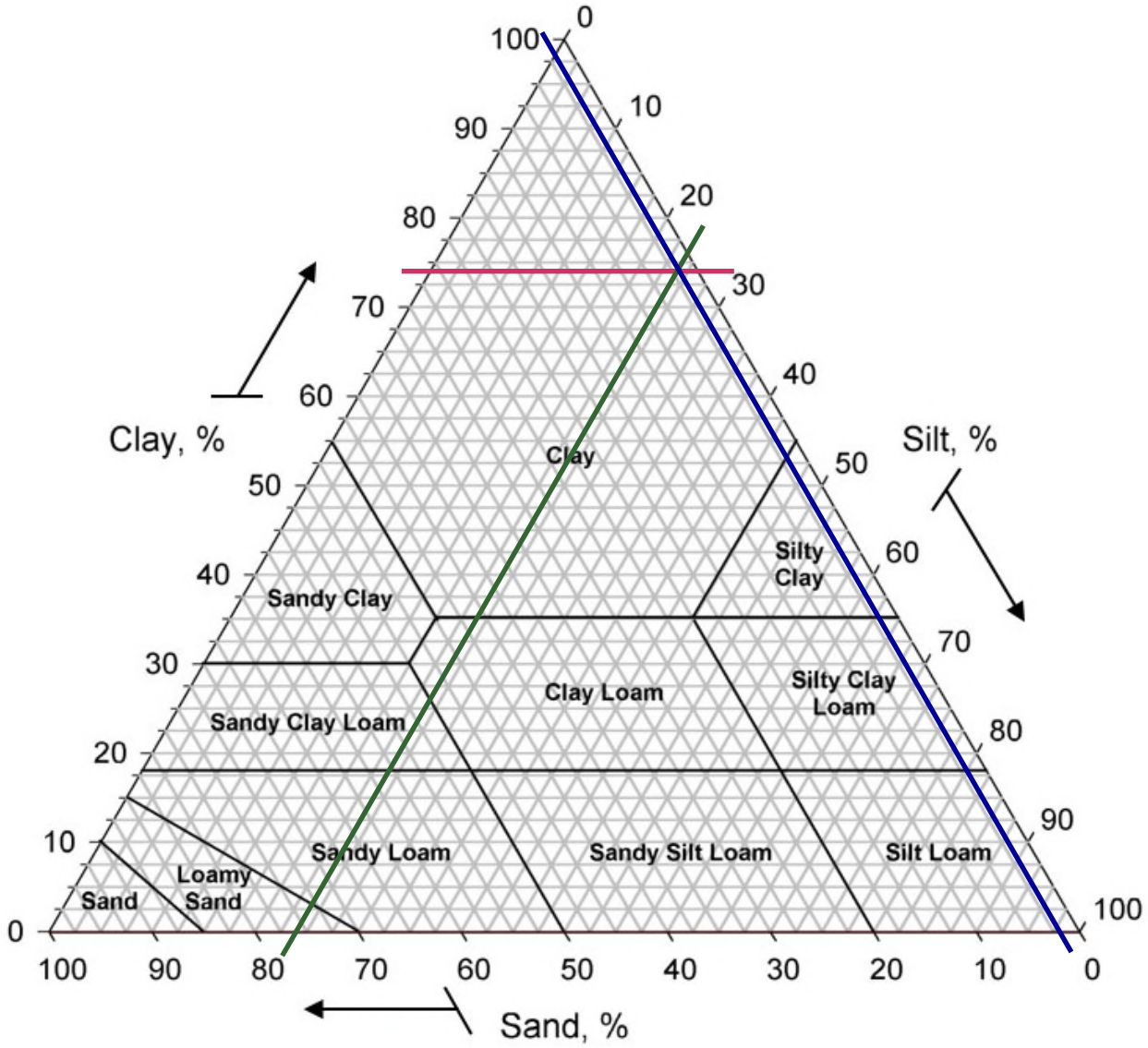

Soil Sample: TGMS

Test Report 18840/J

			After removal of gravel			
Sample	**% Gravel**		**% Sand**	**% Silt**	**% Clay**	**Soil Texture Classification**
Milespit: TP2, 0.1M	-		17.4	45.0	37.6	**Clay**

Signed: Sharon Singleton-Bruce

Date: **14th April 2022** **for European Turfgrass Laboratories Ltd**

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18840/11				**PARTICLE SIZE DISTRIBUTION** **SAND / SILT / CLAY** Test Report Number 18840/K Page 1 of 2
100%				Milespit: TP2, 1.0M
				*** No Stones Present *****
07/04/22				Sample Received Date & Sample Test Date
moist				Sample Moisture (very wet, wet, moist, dry, n/a)
plastic				Sample Consistency (hard, friable, plastic, n/a)
high				Sample Homogeniety (high, medium, low, n/a)
				Particle Size Distribution – ASTM F1632-03 (Reapproved 2018)
1.7				% Sand 0.05 to 2.00 mm
17.6				% Silt 0.002 to 0.05 mm
80.7				% Clay less than 0.002 mm
Clay				Soil Classification

ASTM Method: F1632-03 (Reapproved 2018)
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Approved by: Sara Singleton-Price **Date: 14th April 2022**

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Triangle of Texture : Soil Classification

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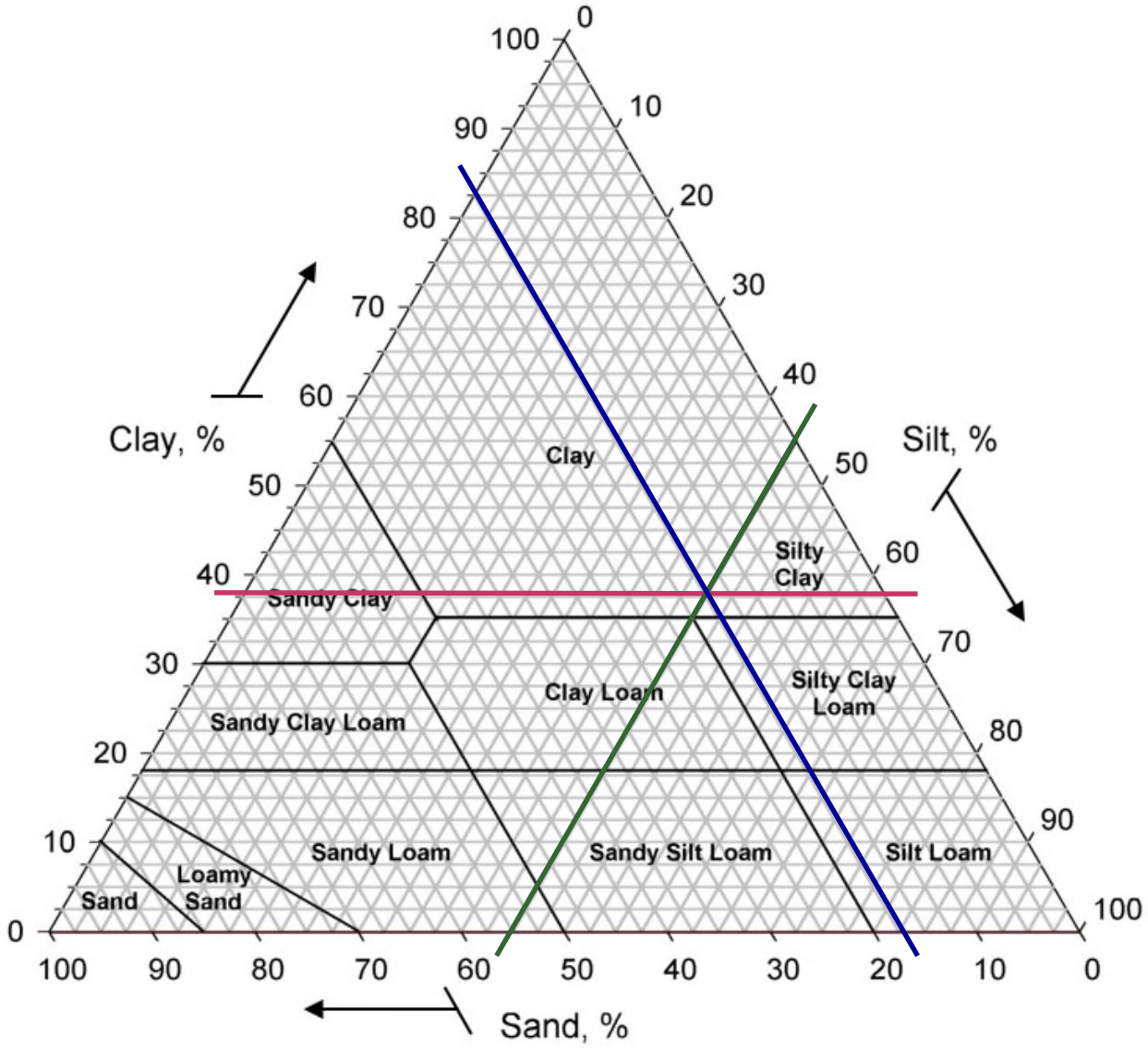

Soil Sample: TGMS

Test Report 18840/K

			After removal of gravel			
Sample	**% Gravel**		**% Sand**	**% Silt**	**% Clay**	**Soil Texture Classification**
Milespit: TP2, 1.0M	-		17.4	45.0	37.6	**Clay / Silty Clay**

Signed: Sharon Singleton-Bruce

Date: **14th April 2022** **for European Turfgrass Laboratories Ltd**

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18840/12				**PARTICLE SIZE DISTRIBUTION** **SAND / SILT / CLAY** Test Report Number 18840/L Page 1 of 2
100%				Milespit: TP2, 2.0M
				*** No Stones Present *****
07/04/22				Sample Received Date & Sample Test Date
moist				Sample Moisture (very wet, wet, moist, dry, n/a)
plastic				Sample Consistency (hard, friable, plastic, n/a)
high				Sample Homogeniety (high, medium, low, n/a)
				Particle Size Distribution – ASTM F1632-03 (Reapproved 2018)
6.6				% Sand 0.05 to 2.00 mm
1.6				% Silt 0.002 to 0.05 mm
91.8				% Clay less than 0.002 mm
Clay				Soil Classification

ASTM Method: F1632-03 (Reapproved 2018)
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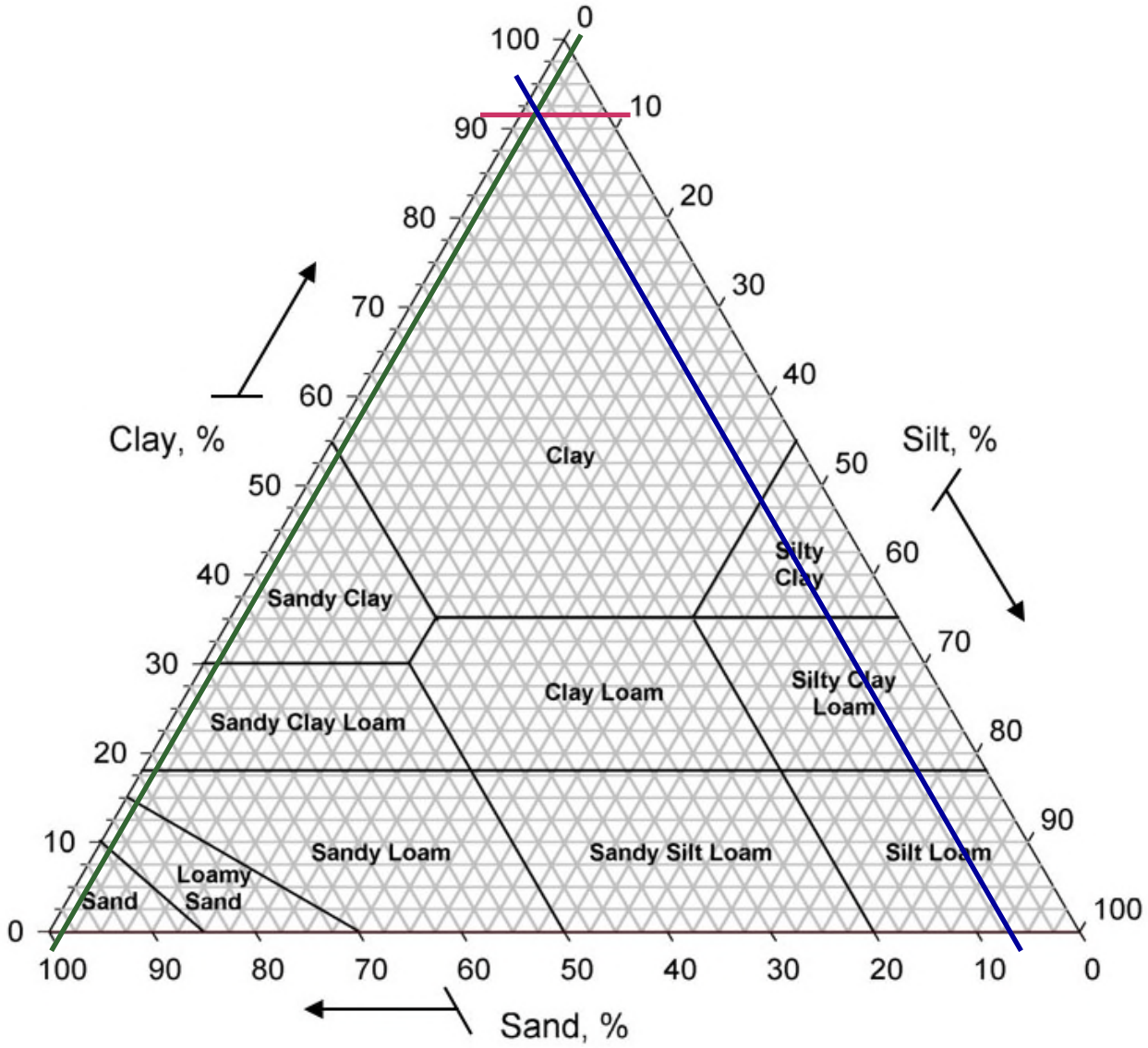

Soil Sample: TGMS

Test Report 18840/L

			After removal of gravel			
Sample	**% Gravel**		**% Sand**	**% Silt**	**% Clay**	**Soil Texture Classification**
Milespit: TP2, 2.0M	-		6.6	1.6	91.8	**Clay**

Signed: Sharon Singleton-Bruce

Date: **14th April 2022** **for European Turfgrass Laboratories Ltd**

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18840/13				**PARTICLE SIZE DISTRIBUTION** **SAND / SILT / CLAY** Test Report Number 18840/M Page 1 of 2
100%				Milespit: TP2, 3.0M
				*** No Stones Present *****
07/04/22				Sample Received Date & Sample Test Date
moist				Sample Moisture (very wet, wet, moist, dry, n/a)
plastic				Sample Consistency (hard, friable, plastic, n/a)
high				Sample Homogeniety (high, medium, low, n/a)
				Particle Size Distribution – ASTM F1632-03 (Reapproved 2018)
2.5				% Sand 0.05 to 2.00 mm
30.6				% Silt 0.002 to 0.05 mm
66.9				% Clay less than 0.002 mm
Clay				Soil Classification

ASTM Method: F1632-03 (Reapproved 2018)
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Approved by: Sara Singleton-Price **Date: 15th April 2022**

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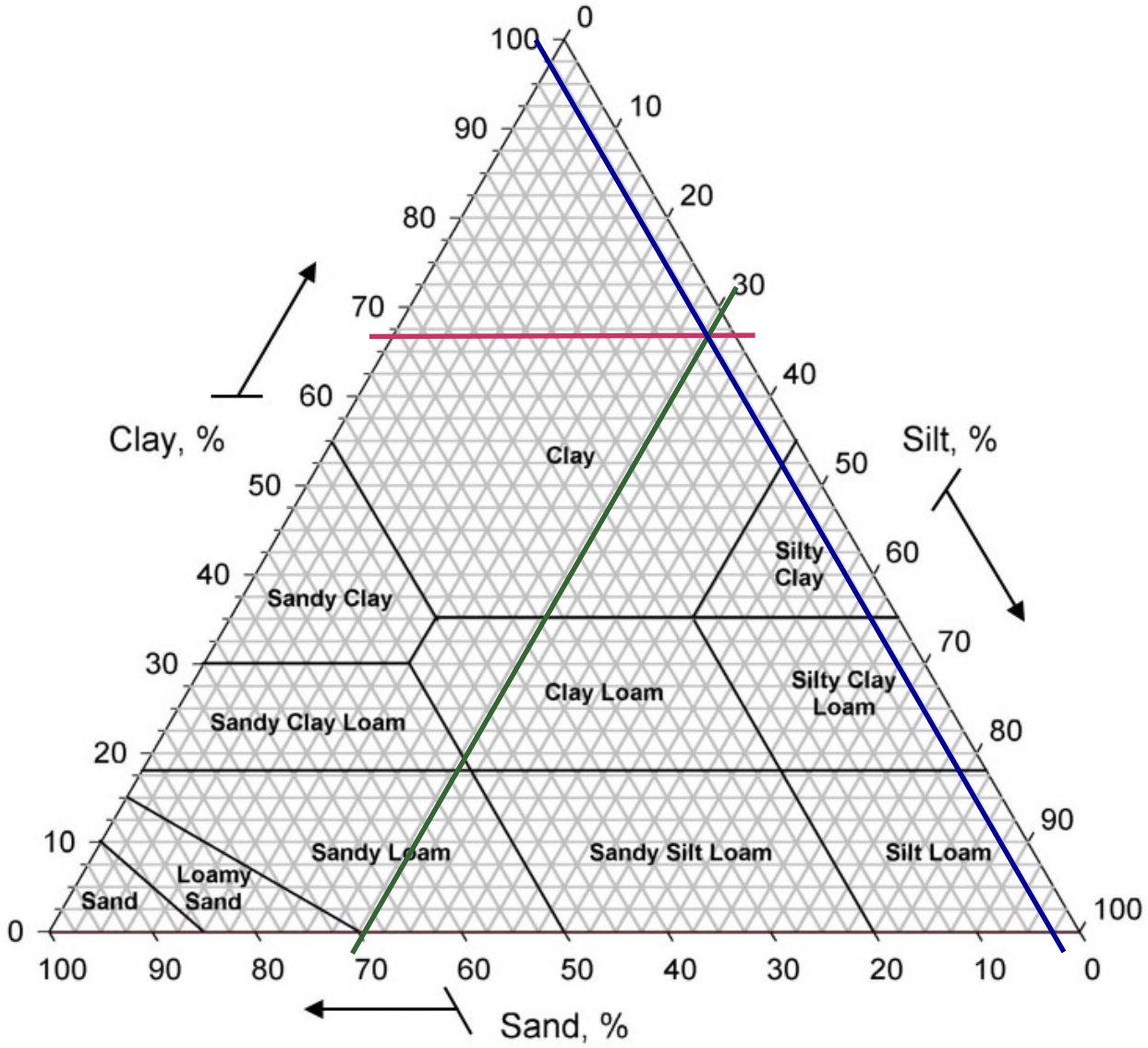

Soil Sample: TGMS

Test Report 18840/M

			After removal of gravel			
Sample	**% Gravel**		**% Sand**	**% Silt**	**% Clay**	**Soil Texture Classification**
Milespit: TP2, 3.0M	-		2.5	30.6	66.9	**Clay**

Signed: Sharon Singleton-Bruce

Date: **15th April 2022** **for European Turfgrass Laboratories Ltd**

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18840/14				**PARTICLE SIZE DISTRIBUTION** **SAND / SILT / CLAY** Test Report Number 18840/N Page 1 of 2
100%				Milespit: TP2, 4.0M
				*** No Stones Present *****
07/04/22				Sample Received Date & Sample Test Date
moist				Sample Moisture (very wet, wet, moist, dry, n/a)
plastic				Sample Consistency (hard, friable, plastic, n/a)
high				Sample Homogeniety (high, medium, low, n/a)
				Particle Size Distribution – ASTM F1632-03 (Reapproved 2018)
1.6				% Sand 0.05 to 2.00 mm
20.4				% Silt 0.002 to 0.05 mm
78.0				% Clay less than 0.002 mm
Clay				Soil Classification

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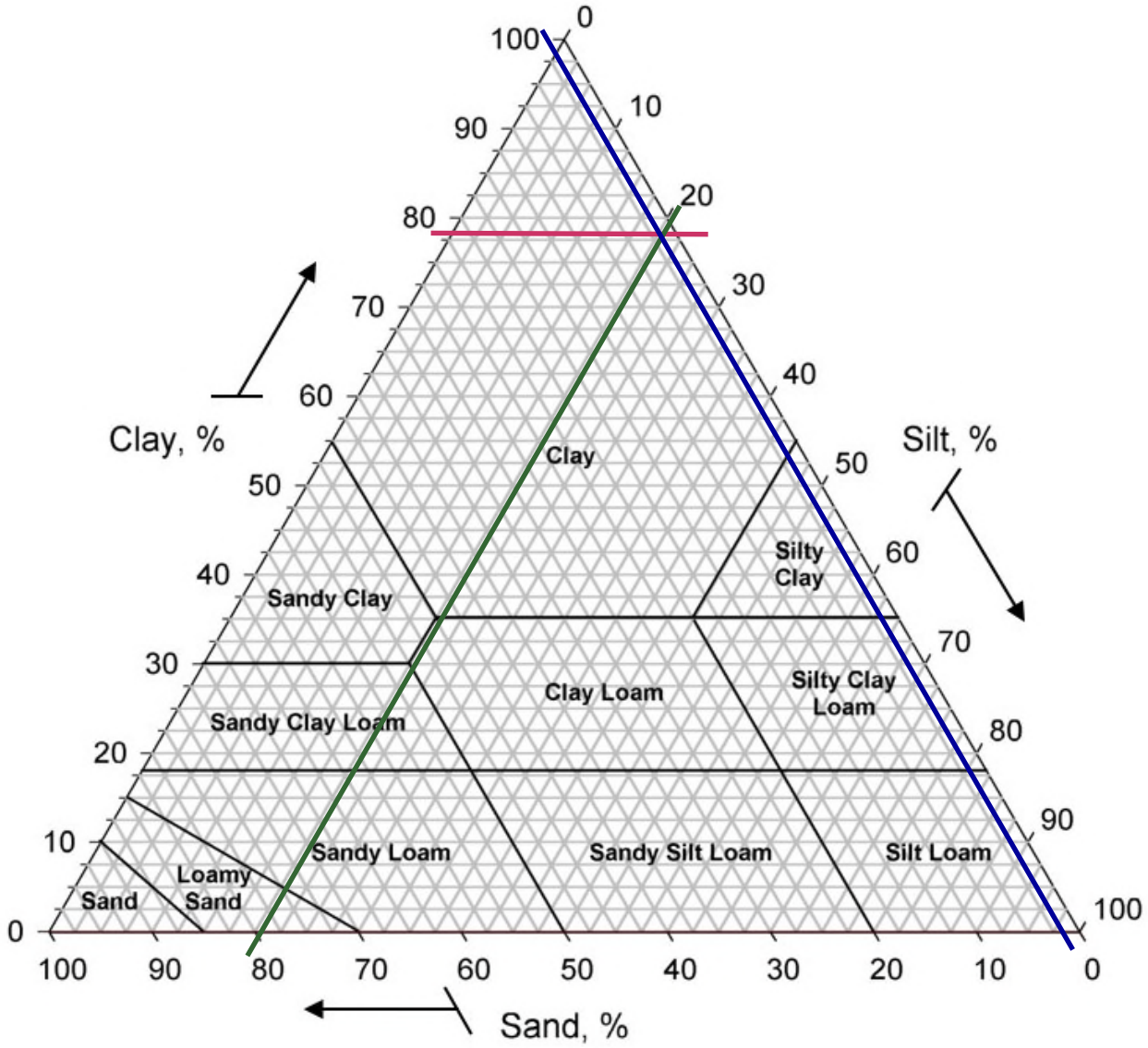

Soil Sample: TGMS

Test Report 18840/N

			After removal of gravel			
Sample	**% Gravel**		**% Sand**	**% Silt**	**% Clay**	**Soil Texture Classification**
Milespit: TP2, 4.0M	-		1.6	20.4	78.0	**Clay**

Signed: Sharon Singleton-Bruce

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18840/15				**PARTICLE SIZE DISTRIBUTION** **SAND / SILT / CLAY** Test Report Number 18840/O Page 1 of 2
100%				Milespit: TP3, 0.1M
				*** Stones present > 6mm **
07/04/22				Sample Received Date & Sample Test Date
moist				Sample Moisture (very wet, wet, moist, dry, n/a)
friable				Sample Consistency (hard, friable, plastic, n/a)
high				Sample Homogeniety (high, medium, low, n/a)
				Particle Size Distribution – ASTM F1632-03 (Reapproved 2018)
16.1				% Sand 0.05 to 2.00 mm
39.2				% Silt 0.002 to 0.05 mm
44.7				% Clay less than 0.002 mm
Clay				Soil Classification

ASTM Method: F1632-03 (Reapproved 2018)
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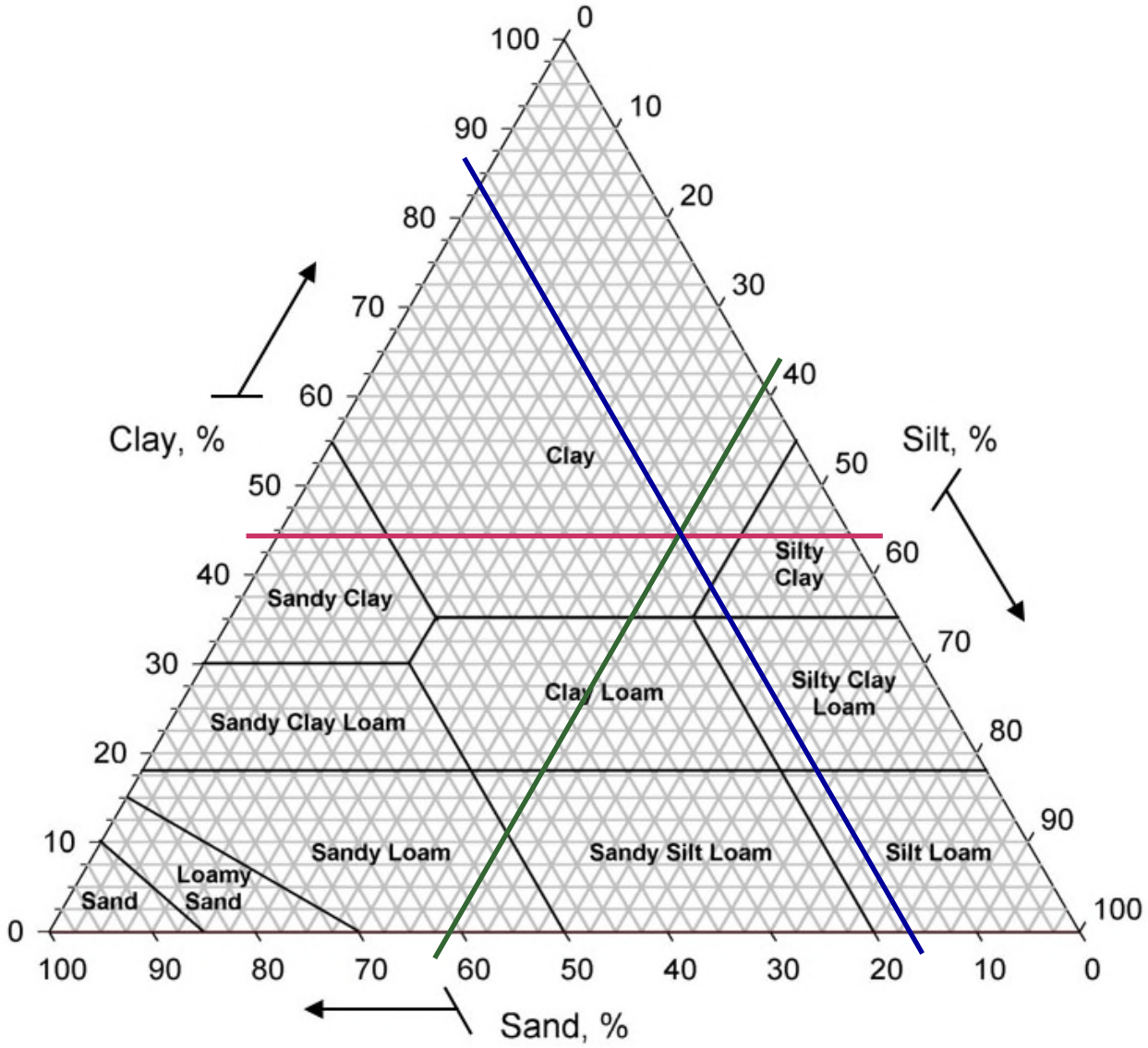

Soil Sample: TGMS

Test Report 18840/O

			After removal of gravel			
Sample	**% Gravel**		**% Sand**	**% Silt**	**% Clay**	**Soil Texture Classification**
Milespit: TP3, 0.1M	1.2		16.1	39.2	44.7	**Clay**

Signed: Sharon Singleton-Bruce

Date: **15th April 2022** **for European Turfgrass Laboratories Ltd**

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18840/16				**PARTICLE SIZE DISTRIBUTION** **SAND / SILT / CLAY** Test Report Number 18840/P Page 1 of 2
100%				Milespit: TP3, 1.0M
				*** Stones present > 6mm **
07/04/22				Sample Received Date & Sample Test Date
moist				Sample Moisture (very wet, wet, moist, dry, n/a)
plastic				Sample Consistency (hard, friable, plastic, n/a)
high				Sample Homogeniety (high, medium, low, n/a)
				Particle Size Distribution – ASTM F1632-03 (Reapproved 2018)
9.1				% Sand 0.05 to 2.00 mm
42.5				% Silt 0.002 to 0.05 mm
48.4				% Clay less than 0.002 mm
Clay				Soil Classification

ASTM Method: F1632-03 (Reapproved 2018)
"Particle Size Analysis and Sand Shape Grading of Golf Course Putting Green and Sports Field Root Zone Mixes"

Professional Sportsturf Design (NW) Ltd, trading as TGMS
Wigan Road, Leyland, Lancashire, PR25 5XW

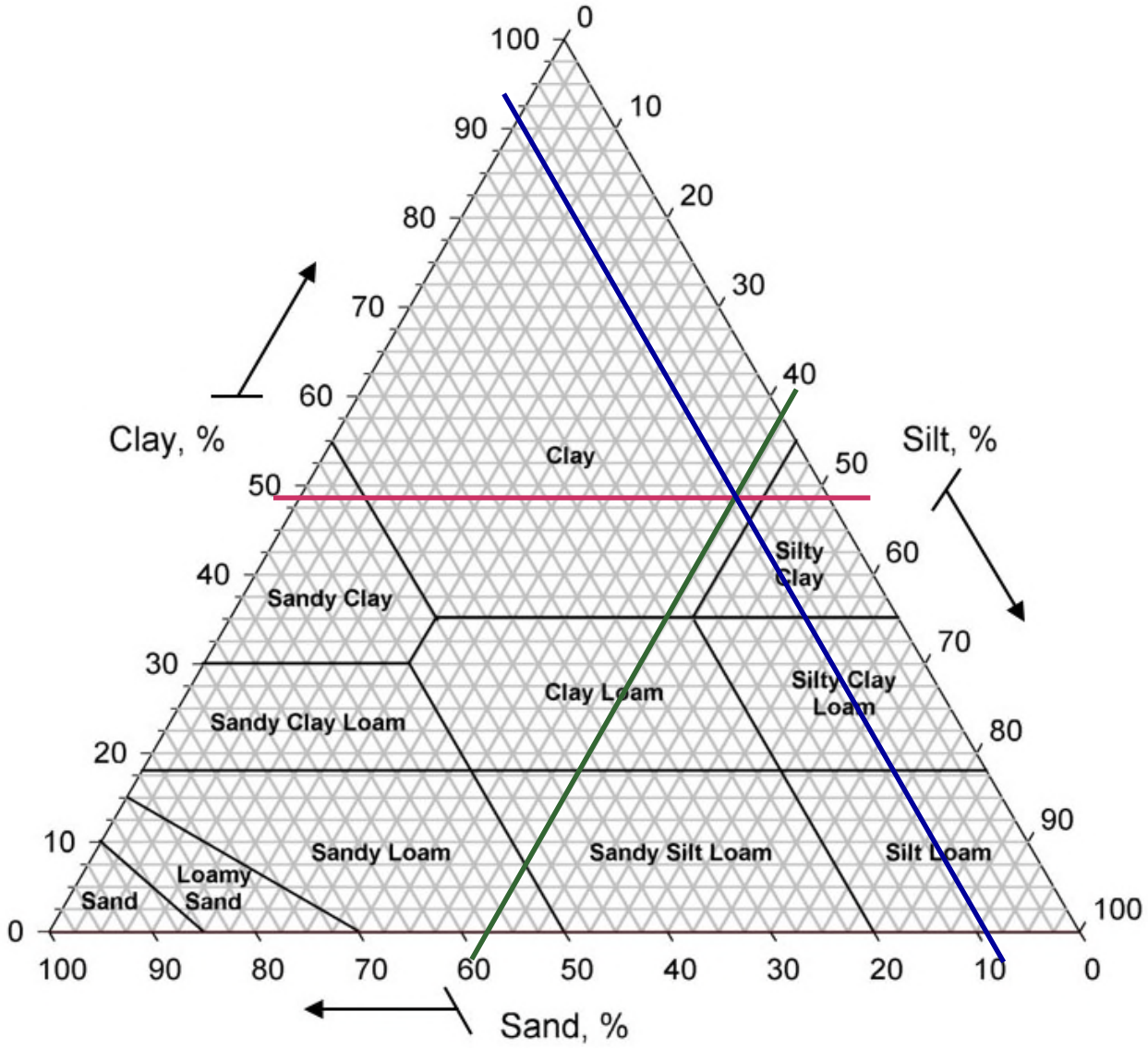
Approved by: Sara Singleton-Price **Date: 15th April 2022**

Managing Director, for European Turfgrass Laboratories Ltd

EUROPEAN TURFGRASS LABORATORIES

Triangle of Texture : Soil Classification

Date of Issue: Sept 2019, Revision 1,
Issuing Authority: Sharon Singleton-Bruce



Soil Sample: TGMS

Test Report 18840/P

			After removal of gravel			
Sample	**% Gravel**		**% Sand**	**% Silt**	**% Clay**	**Soil Texture Classification**
Milespit: TP3, 1.0M	0.4		9.1	42.5	48.4	**Clay**

Signed: Sharon Singleton-Bruce

Date: **15th April 2022** **for European Turfgrass Laboratories Ltd**

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18840/17				**PARTICLE SIZE DISTRIBUTION** **SAND / SILT / CLAY** Test Report Number 18840/Q Page 1 of 2
100%				Milespit: TP3, 2.0M
				*** No Stones Present *****
07/04/22				Sample Received Date & Sample Test Date
moist				Sample Moisture (very wet, wet, moist, dry, n/a)
plastic				Sample Consistency (hard, friable, plastic, n/a)
high				Sample Homogeniety (high, medium, low, n/a)
				Particle Size Distribution – ASTM F1632-03 (Reapproved 2018)
4.1				% Sand 0.05 to 2.00 mm
24.3				% Silt 0.002 to 0.05 mm
71.6				% Clay less than 0.002 mm
Clay				Soil Classification

ASTM Method: F1632-03 (Reapproved 2018)
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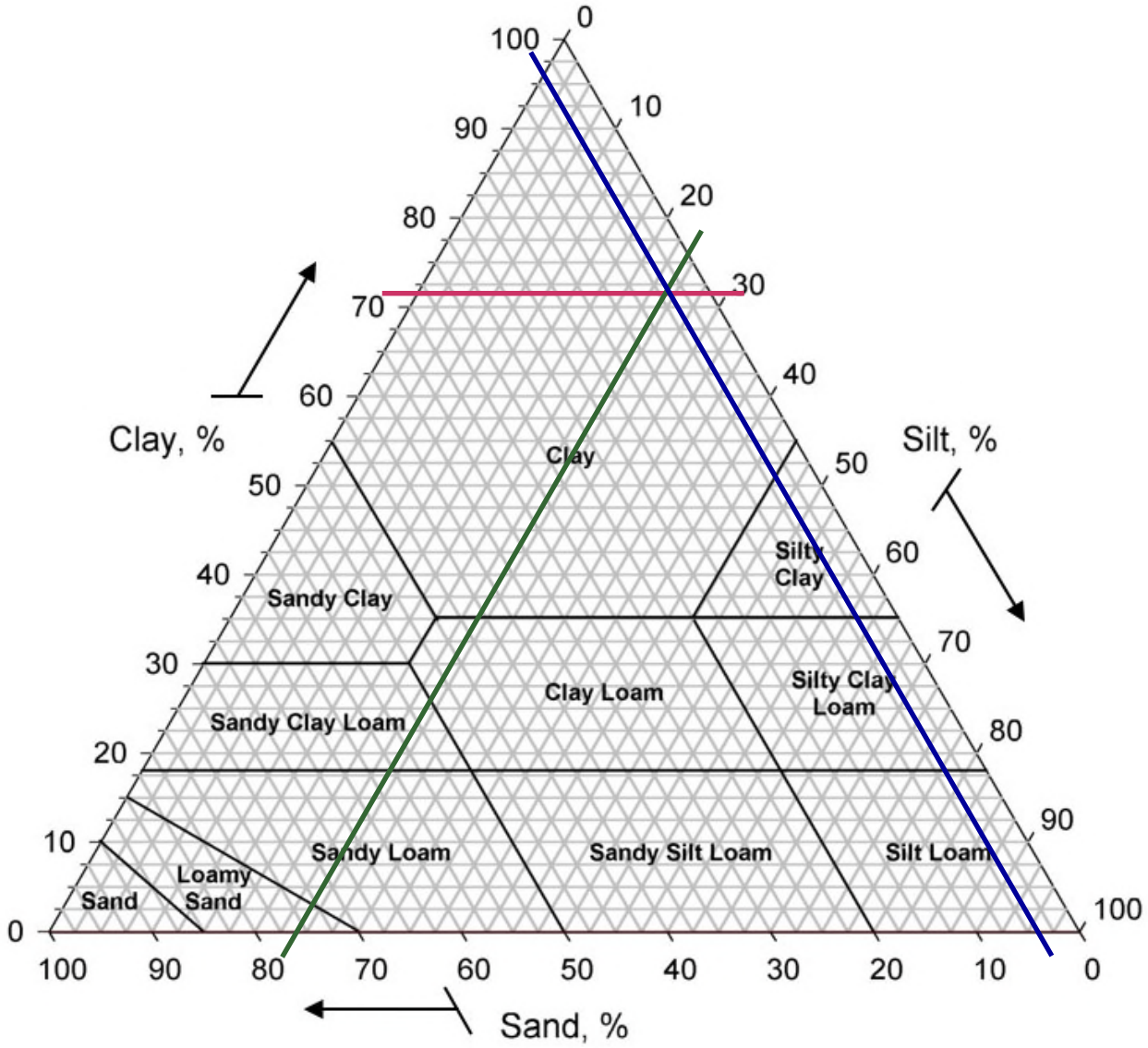

Soil Sample: TGMS

Test Report 18840/Q

			After removal of gravel			
Sample	**% Gravel**		**% Sand**	**% Silt**	**% Clay**	**Soil Texture Classification**
Milespit: TP3, 2.0M	-		4.1	24.3	71.6	**Clay**

Signed: Sharon Singleton-Bruce

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18840/18				**PARTICLE SIZE DISTRIBUTION** **SAND / SILT / CLAY** Test Report Number 18840/R Page 1 of 2
100%				Milespit: TP3, 3.0M
				*** No Stones Present *****
07/04/22				Sample Received Date & Sample Test Date
moist				Sample Moisture (very wet, wet, moist, dry, n/a)
plastic				Sample Consistency (hard, friable, plastic, n/a)
high				Sample Homogeniety (high, medium, low, n/a)
				Particle Size Distribution – ASTM F1632-03 (Reapproved 2018)
2.1				% Sand 0.05 to 2.00 mm
7.1				% Silt 0.002 to 0.05 mm
90.8				% Clay less than 0.002 mm
Clay				Soil Classification

ASTM Method: F1632-03 (Reapproved 2018)
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Triangle of Texture : Soil Classification

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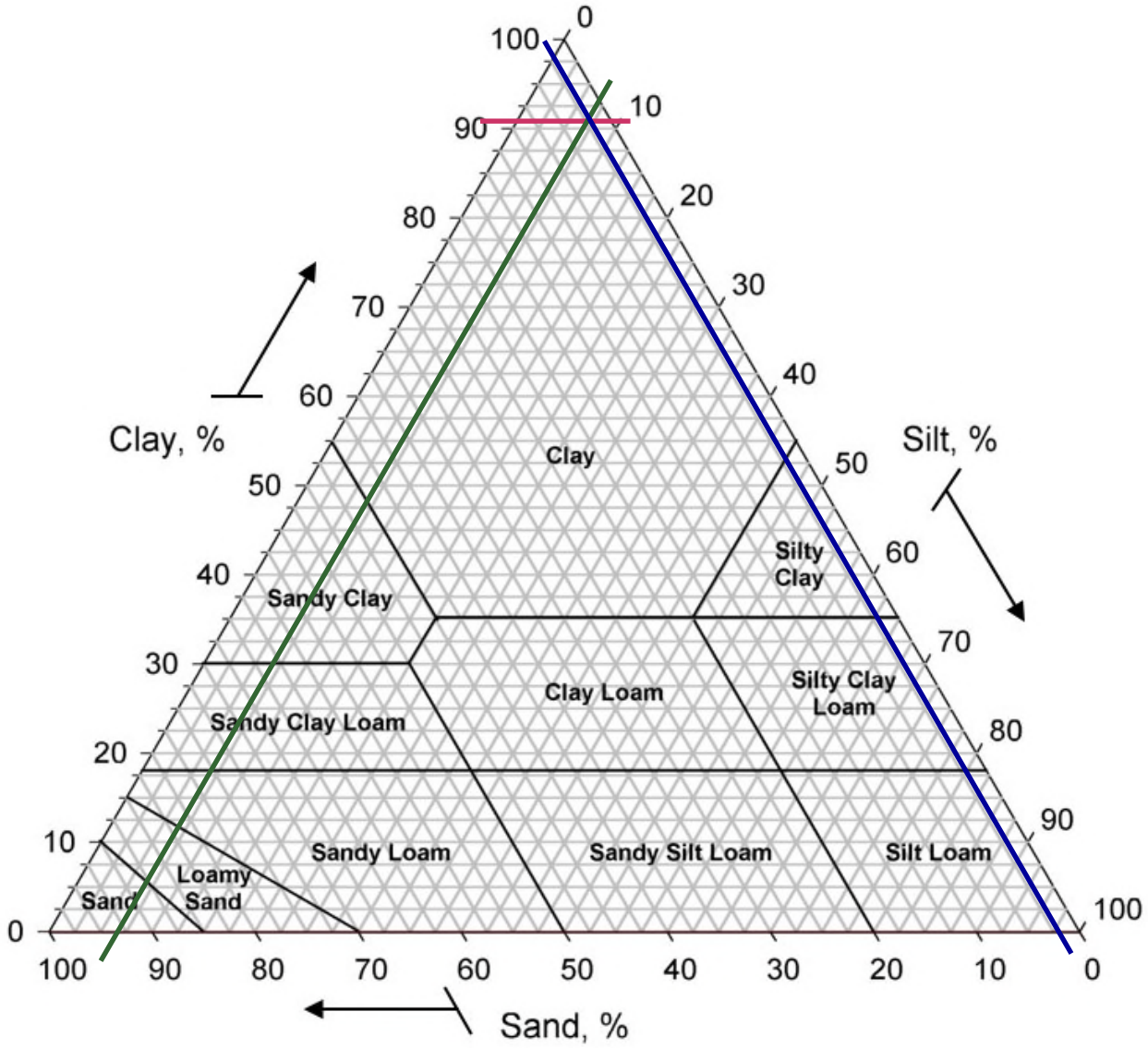

Soil Sample: TGMS

Test Report 18840/R

			After removal of gravel			
Sample	**% Gravel**		**% Sand**	**% Silt**	**% Clay**	**Soil Texture Classification**
Milespit: TP3, 3.0M	-		2.1	7.1	90.8	**Clay**

Signed: Sharon Singleton-Bruce

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18840/19				**PARTICLE SIZE DISTRIBUTION** **SAND / SILT / CLAY** Test Report Number 18840/S Page 1 of 2
100%				Milespit: TP3, 4.0M
				*** No Stones Present *****
07/04/22				Sample Received Date & Sample Test Date
moist				Sample Moisture (very wet, wet, moist, dry, n/a)
plastic				Sample Consistency (hard, friable, plastic, n/a)
high				Sample Homogeniety (high, medium, low, n/a)
				Particle Size Distribution – ASTM F1632-03 (Reapproved 2018)
1.6				% Sand 0.05 to 2.00 mm
12.3				% Silt 0.002 to 0.05 mm
86.1				% Clay less than 0.002 mm
Clay				Soil Classification

ASTM Method: F1632-03 (Reapproved 2018)
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Triangle of Texture : Soil Classification

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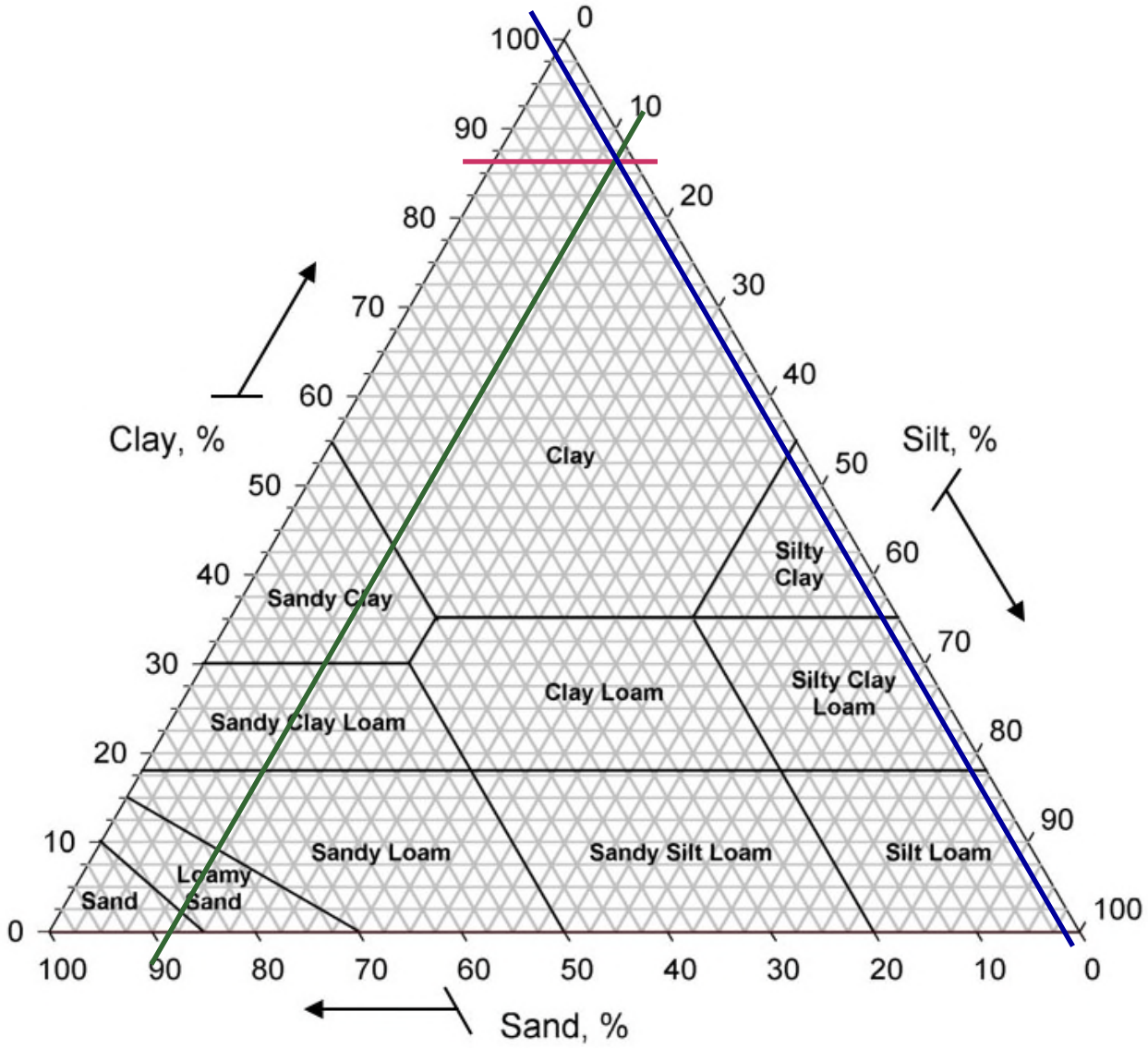

Soil Sample: TGMS

Test Report 18840/S

			After removal of gravel			
Sample	**% Gravel**		**% Sand**	**% Silt**	**% Clay**	**Soil Texture Classification**
Milespit: TP3, 4.0M	-		1.6	12.3	86.1	**Clay**

Signed: Sharon Singleton-Bruce

Date: **16th April 2022** **for European Turfgrass Laboratories Ltd**

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18840/20				**PARTICLE SIZE DISTRIBUTION** **SAND / SILT / CLAY** Test Report Number 18840/T Page 1 of 2
100%				Milespit: TP4, 0.1M
				*** Stones Present > 16mm **
07/04/22				Sample Received Date & Sample Test Date
moist				Sample Moisture (very wet, wet, moist, dry, n/a)
friable				Sample Consistency (hard, friable, plastic, n/a)
high				Sample Homogeniety (high, medium, low, n/a)
				Particle Size Distribution – ASTM F1632-03 (Reapproved 2018)
23.2				% Sand 0.05 to 2.00 mm
42.3				% Silt 0.002 to 0.05 mm
34.5				% Clay less than 0.002 mm
Clay Loam				Soil Classification

ASTM Method: F1632-03 (Reapproved 2018)
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Triangle of Texture : Soil Classification

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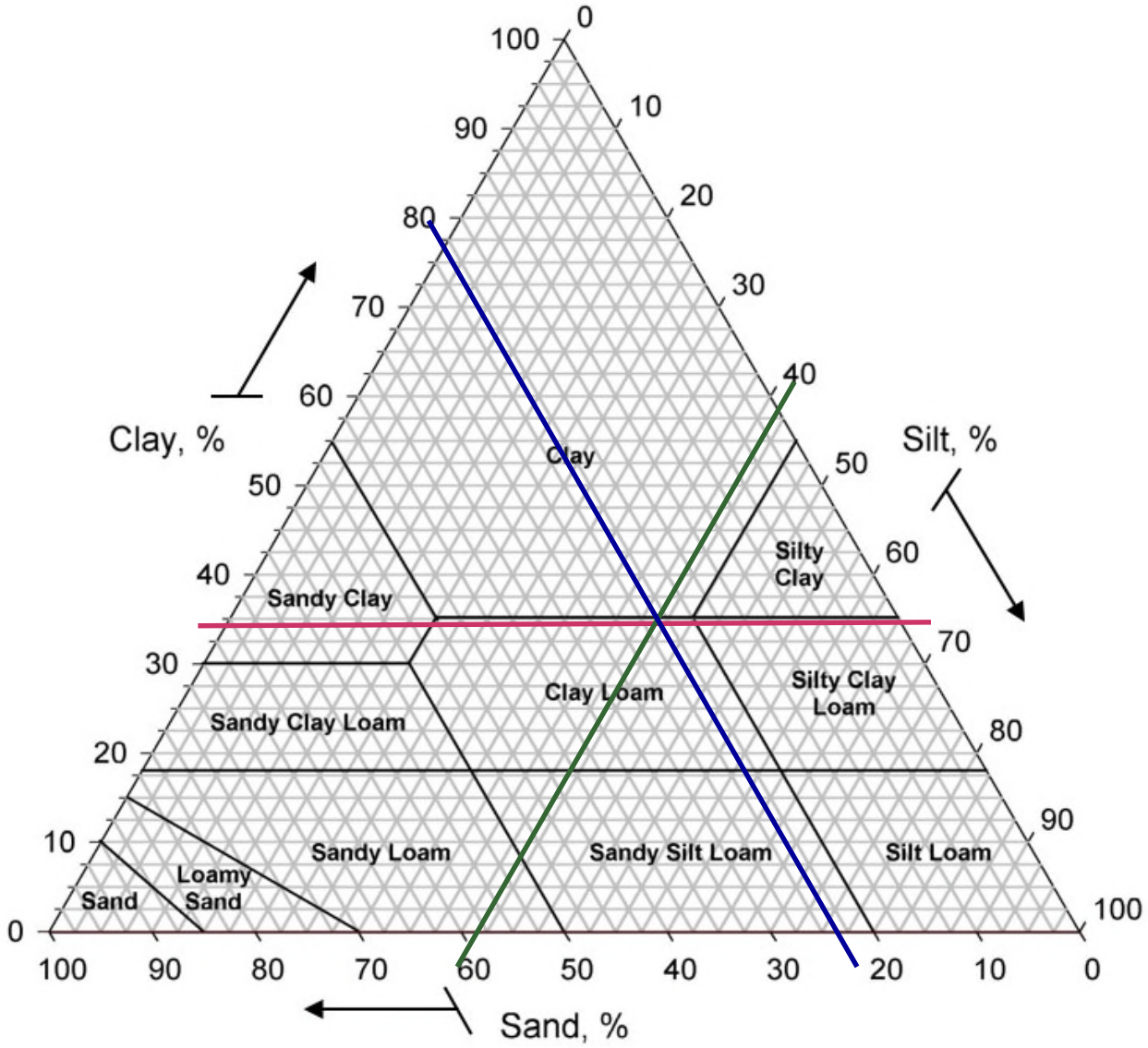

Soil Sample: TGMS

Test Report 18840/T

			After removal of gravel			
Sample	**% Gravel**		**% Sand**	**% Silt**	**% Clay**	**Soil Texture Classification**
Milespit: TP4, 0.1M	6.0		23.2	42.3	34.5	**Clay Loam**

Signed: Sharon Singleton-Bruce

Date: **16th April 2022** **for European Turfgrass Laboratories Ltd**

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18840/21				**PARTICLE SIZE DISTRIBUTION** **SAND / SILT / CLAY** Test Report Number 18840/U Page 1 of 2
100%				Milespit: TP4, 1.0M
				*** No Stones Present *****
07/04/22				Sample Received Date & Sample Test Date
moist				Sample Moisture (very wet, wet, moist, dry, n/a)
plastic				Sample Consistency (hard, friable, plastic, n/a)
high				Sample Homogeniety (high, medium, low, n/a)
				Particle Size Distribution – ASTM F1632-03 (Reapproved 2018)
25.2				% Sand 0.05 to 2.00 mm
16.8				% Silt 0.002 to 0.05 mm
58.0				% Clay less than 0.002 mm
Clay				Soil Classification

ASTM Method: F1632-03 (Reapproved 2018)
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Approved by: Sara Singleton-Price **Date: 19th April 2022**

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Triangle of Texture : Soil Classification

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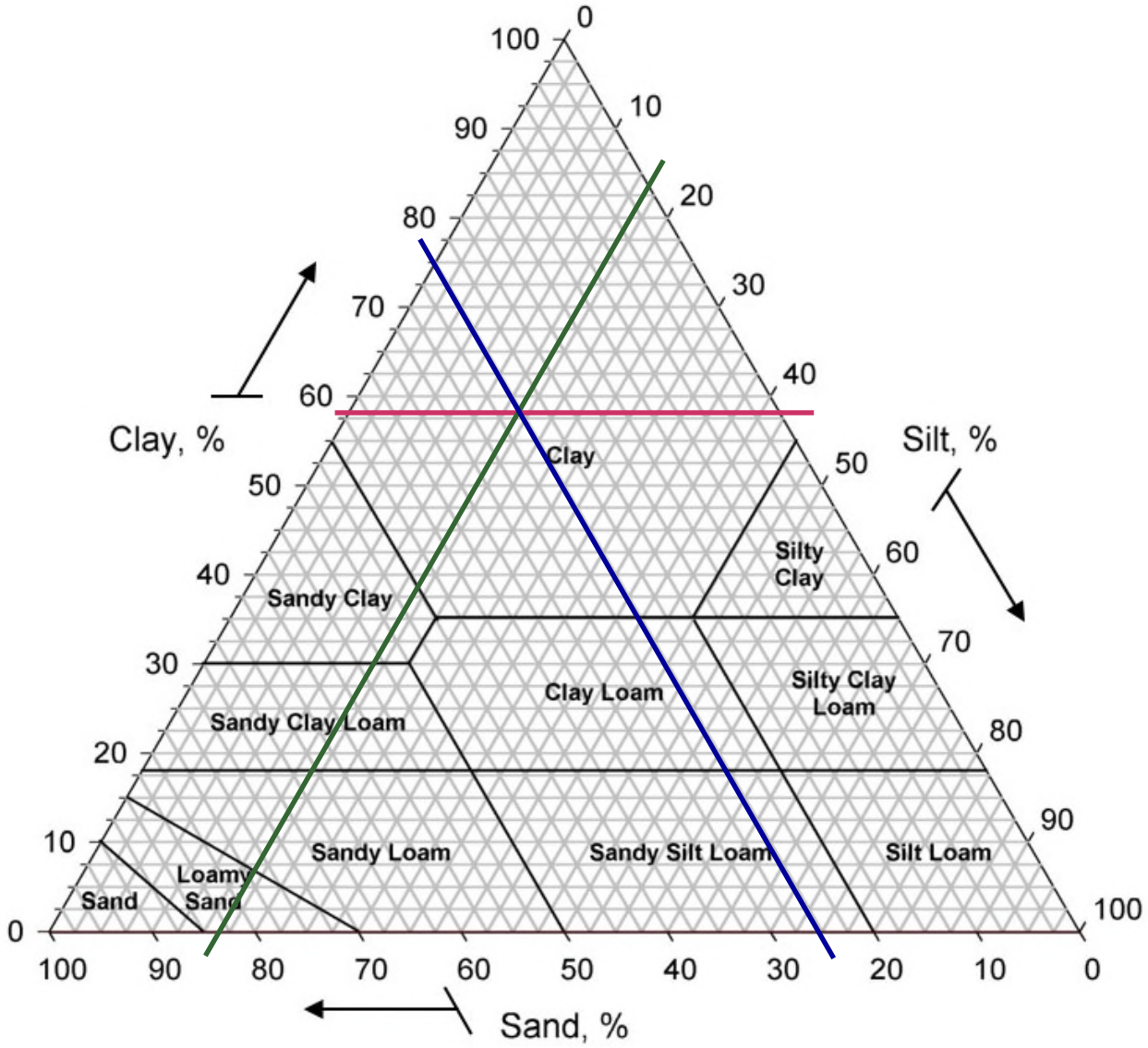

Soil Sample: TGMS

Test Report 18840/U

			After removal of gravel			
Sample	**% Gravel**		**% Sand**	**% Silt**	**% Clay**	**Soil Texture Classification**
Milespit: TP4, 1.0M	-		25.2	16.8	58.0	**Clay**

Signed: Sharon Singleton-Bruce

Date: **19th April 2022** **for European Turfgrass Laboratories Ltd**

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18840/22				**PARTICLE SIZE DISTRIBUTION** **SAND / SILT / CLAY** Test Report Number 18840/V Page 1 of 2
100%				Milespit: TP4, 2.0M
				*** No Stones Present *****
07/04/22				Sample Received Date & Sample Test Date
moist				Sample Moisture (very wet, wet, moist, dry, n/a)
plastic				Sample Consistency (hard, friable, plastic, n/a)
high				Sample Homogeniety (high, medium, low, n/a)
				Particle Size Distribution – ASTM F1632-03 (Reapproved 2018)
3.9				% Sand 0.05 to 2.00 mm
10.3				% Silt 0.002 to 0.05 mm
85.8				% Clay less than 0.002 mm
Clay				Soil Classification

ASTM Method: F1632-03 (Reapproved 2018)
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Triangle of Texture : Soil Classification

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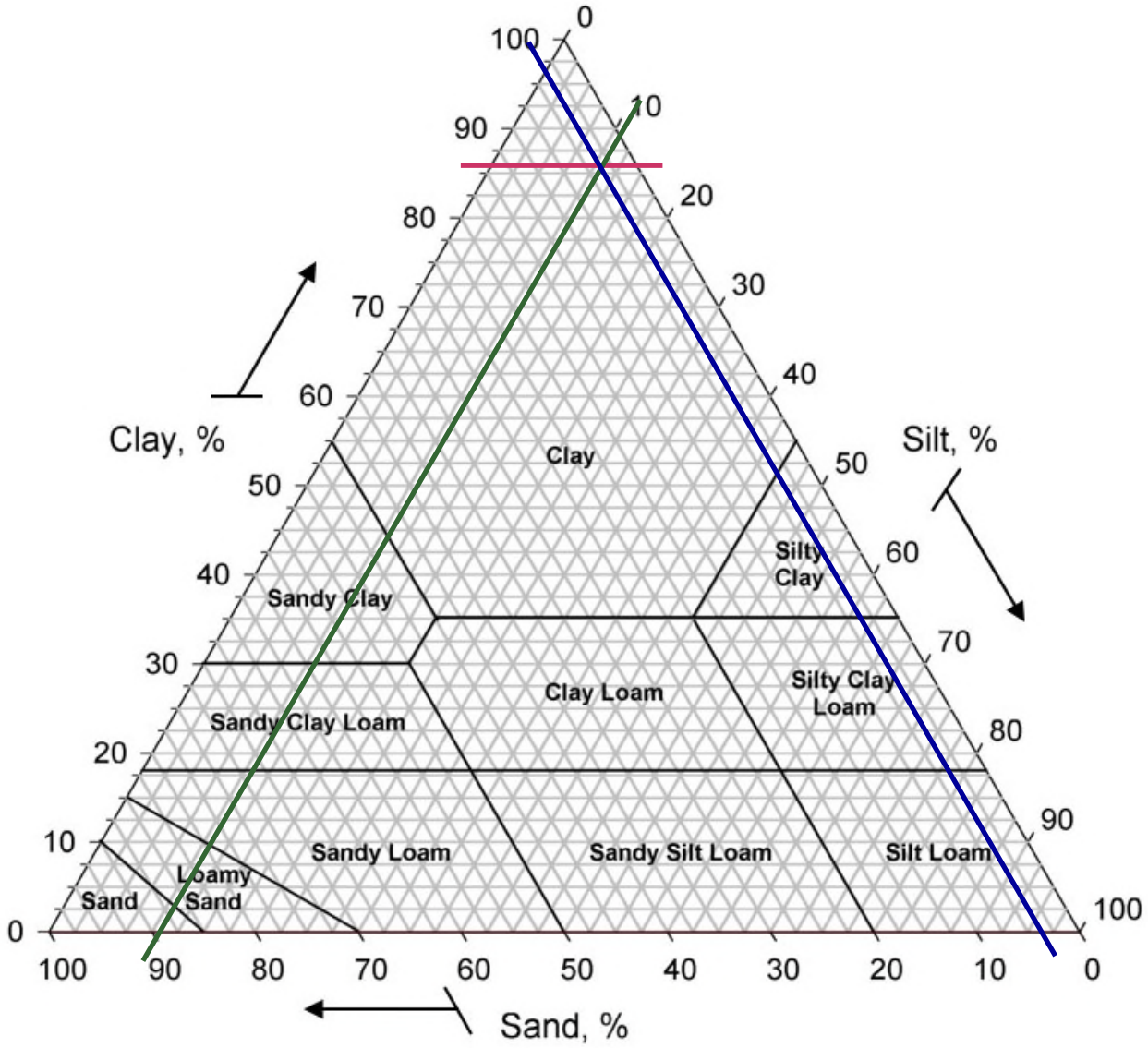

Soil Sample: TGMS

Test Report 18840/V

			After removal of gravel			
Sample	**% Gravel**		**% Sand**	**% Silt**	**% Clay**	**Soil Texture Classification**
Milespit: TP4, 2.0M	-		3.9	10.3	85.8	**Clay**

Signed: Sharon Singleton-Bruce

Date: **16th April 2022** **for European Turfgrass Laboratories Ltd**

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18840/23				**PARTICLE SIZE DISTRIBUTION** **SAND / SILT / CLAY** Test Report Number 18840/W Page 1 of 2
100%				Milespit: TP4, 3.0M
				*** No Stones Present *****
07/04/22				Sample Received Date & Sample Test Date
moist				Sample Moisture (very wet, wet, moist, dry, n/a)
plastic				Sample Consistency (hard, friable, plastic, n/a)
high				Sample Homogeniety (high, medium, low, n/a)
				Particle Size Distribution – ASTM F1632-03 (Reapproved 2018)
10.4				% Sand 0.05 to 2.00 mm
6.9				% Silt 0.002 to 0.05 mm
82.7				% Clay less than 0.002 mm
Clay				Soil Classification

ASTM Method: F1632-03 (Reapproved 2018)
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Triangle of Texture : Soil Classification

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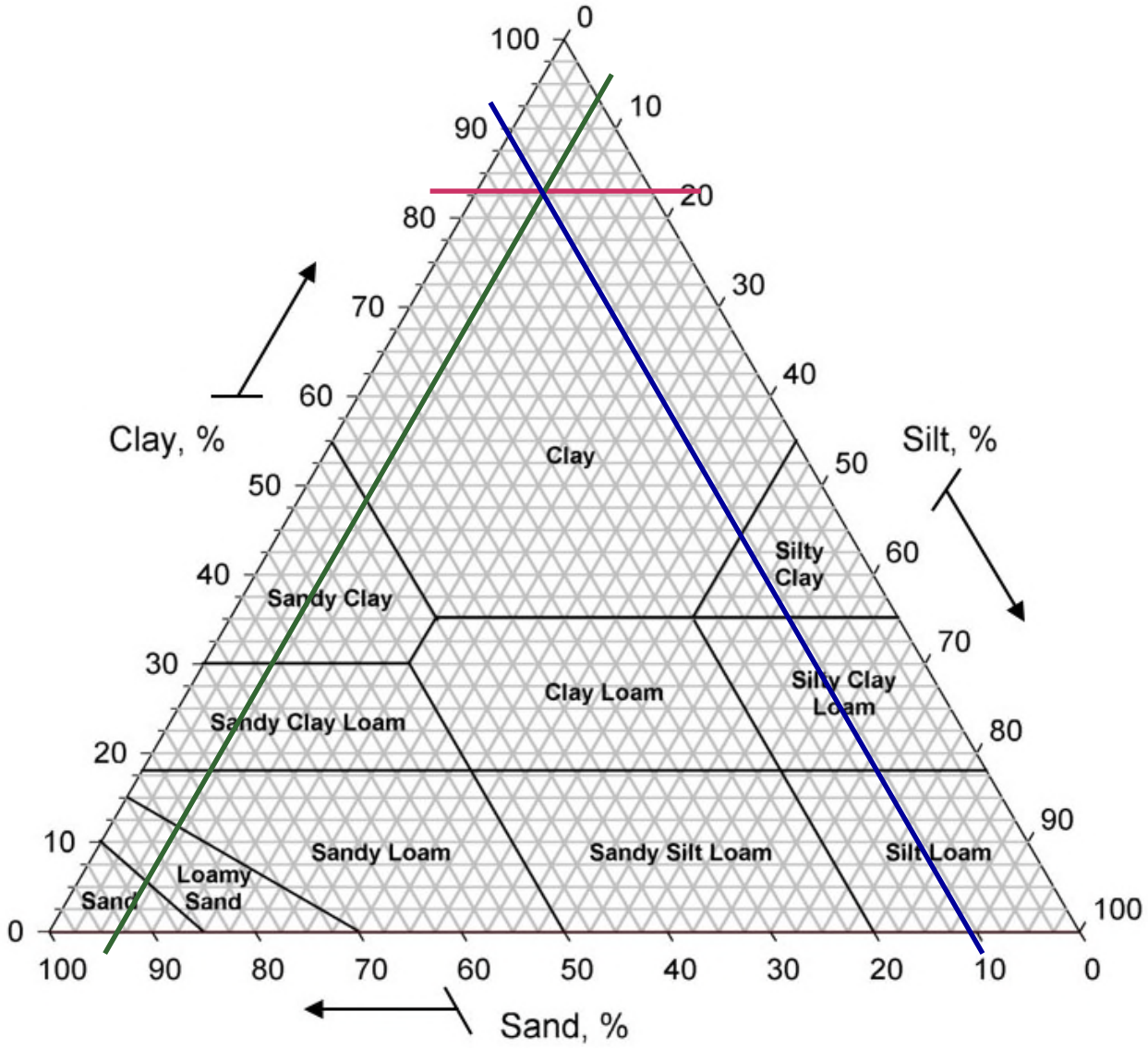

Soil Sample: TGMS

Test Report 18840/W

			After removal of gravel			
Sample	**% Gravel**		**% Sand**	**% Silt**	**% Clay**	**Soil Texture Classification**
Milespit: TP4, 3.0M	-		10.4	6.9	82.7	**Clay**

Signed: Sharon Singleton-Bruce

Date: **19th April 2022** **for European Turfgrass Laboratories Ltd**

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18840/24				**PARTICLE SIZE DISTRIBUTION** **SAND / SILT / CLAY** Test Report Number 18840/X Page 1 of 2
100%				Milespit: TP4, 4.0M
				*** No Stones Present *****
07/04/22				Sample Received Date & Sample Test Date
moist				Sample Moisture (very wet, wet, moist, dry, n/a)
plastic				Sample Consistency (hard, friable, plastic, n/a)
high				Sample Homogeniety (high, medium, low, n/a)
				Particle Size Distribution – ASTM F1632-03 (Reapproved 2018)
5.5				% Sand 0.05 to 2.00 mm
8.8				% Silt 0.002 to 0.05 mm
85.7				% Clay less than 0.002 mm
Clay				Soil Classification

ASTM Method: F1632-03 (Reapproved 2018)
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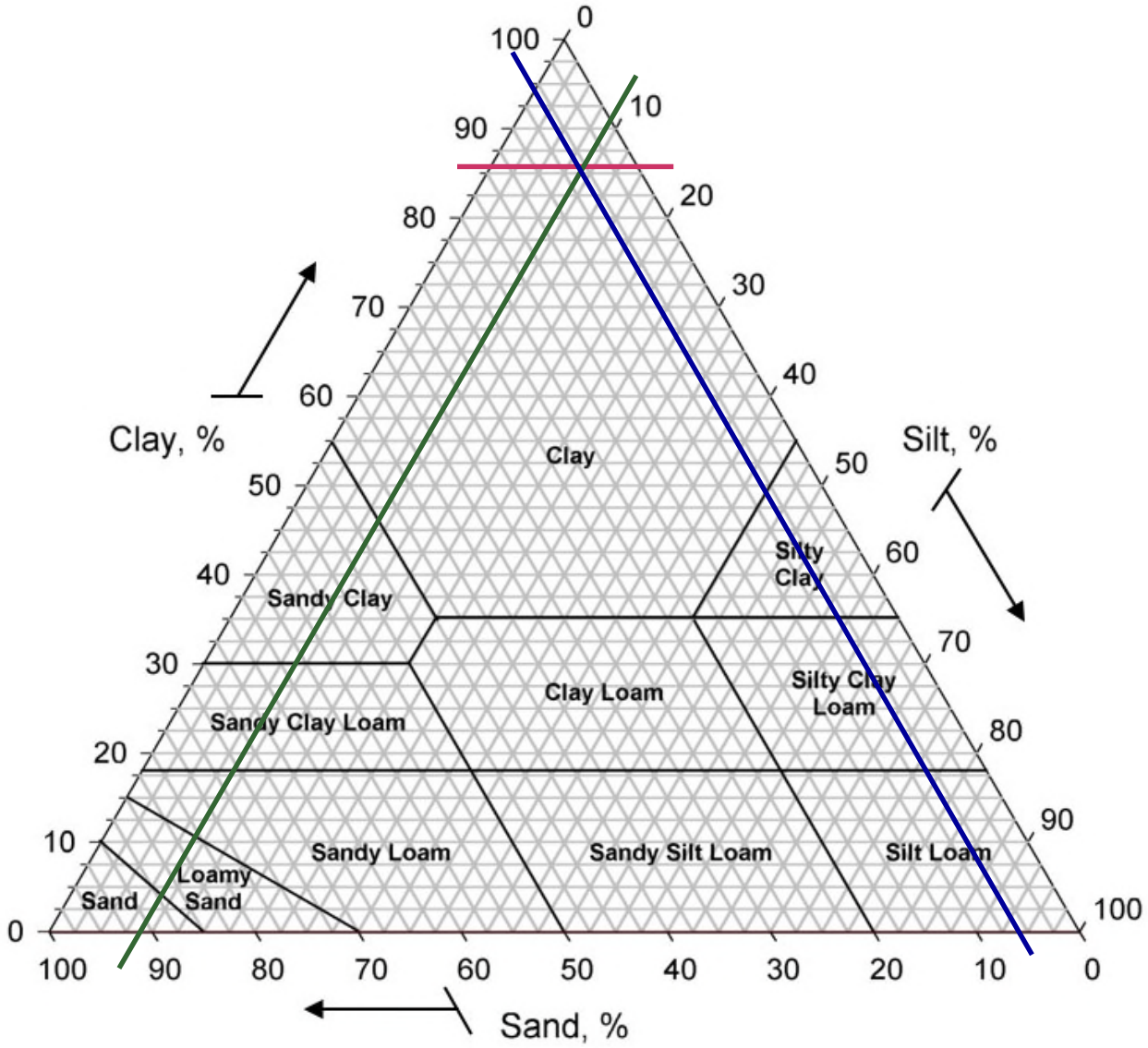

Soil Sample: TGMS

Test Report 18840/X

			After removal of gravel			
Sample	**% Gravel**		**% Sand**	**% Silt**	**% Clay**	**Soil Texture Classification**
Milespit: TP4, 4.0M	-		5.5	8.8	85.7	**Clay**

Signed: Sharon Singleton-Bruce

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18840/25				**PARTICLE SIZE DISTRIBUTION** **SAND / SILT / CLAY** Test Report Number 18840/Y Page 1 of 2
100%				Milespit: TP5, 0.1M
				*** Stones present > 8mm *****
07/04/22				Sample Received Date & Sample Test Date
moist				Sample Moisture (very wet, wet, moist, dry, n/a)
friable				Sample Consistency (hard, friable, plastic, n/a)
high				Sample Homogeniety (high, medium, low, n/a)
				Particle Size Distribution – ASTM F1632-03 (Reapproved 2018)
24.3				% Sand 0.05 to 2.00 mm
41.6				% Silt 0.002 to 0.05 mm
34.1				% Clay less than 0.002 mm
Clay Loam				Soil Classification

ASTM Method: F1632-03 (Reapproved 2018)
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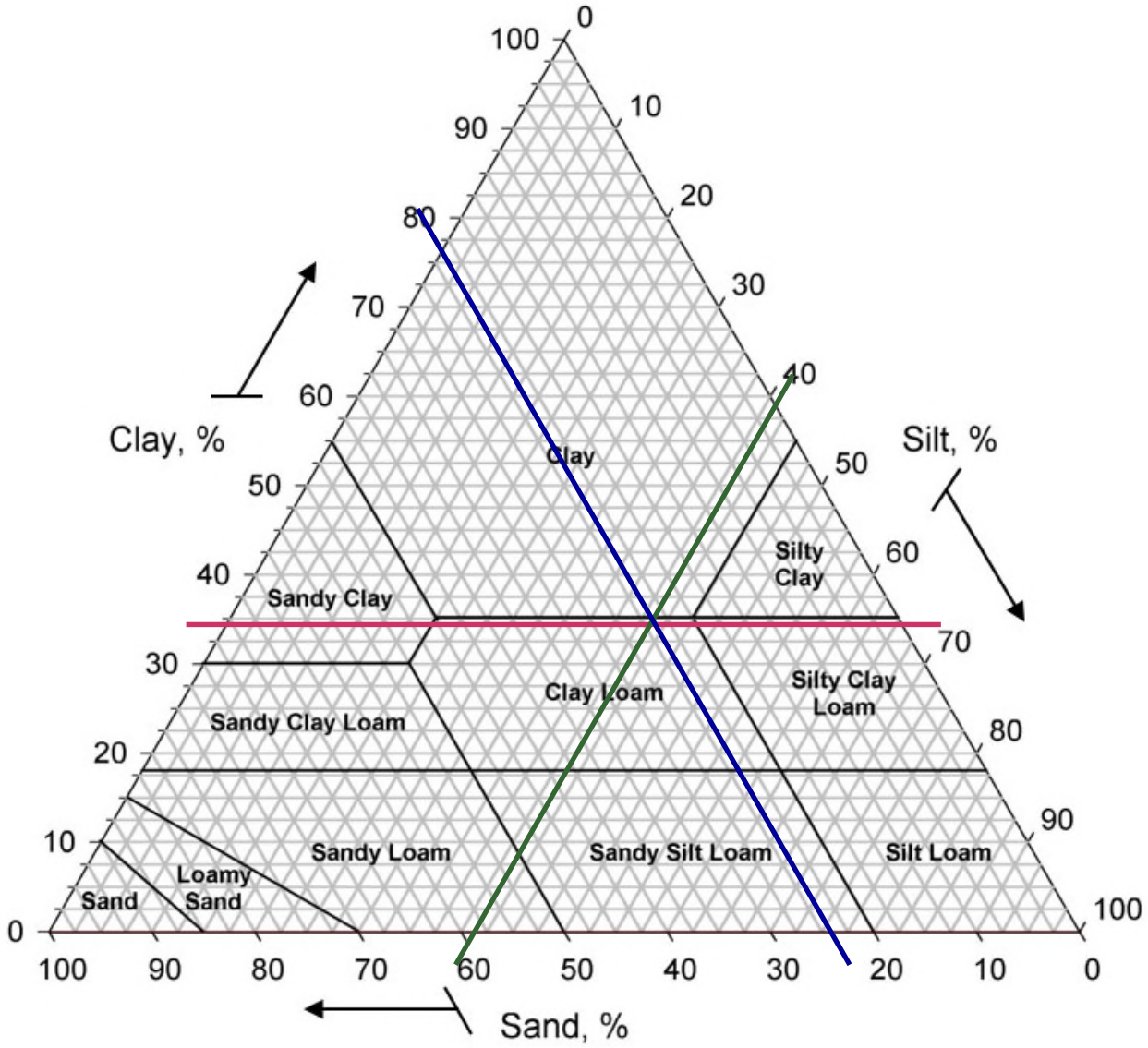

Soil Sample: TGMS

Test Report 18840/Y

			After removal of gravel			
Sample	**% Gravel**		**% Sand**	**% Silt**	**% Clay**	**Soil Texture Classification**
Milespit: TP5, 0.1M	1.9		24.3	41.6	34.1	**Clay Loam**

Signed: Sharon Singleton-Bruce

Date: **19th April 2022** **for European Turfgrass Laboratories Ltd**

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18840/26				**PARTICLE SIZE DISTRIBUTION** **SAND / SILT / CLAY** Test Report Number 18840/Z Page 1 of 2
100%				Milespit: TP5, 1.0M
				*** Stones present > 4mm **
07/04/22				Sample Received Date & Sample Test Date
moist				Sample Moisture (very wet, wet, moist, dry, n/a)
plastic				Sample Consistency (hard, friable, plastic, n/a)
high				Sample Homogeniety (high, medium, low, n/a)
				Particle Size Distribution – ASTM F1632-03 (Reapproved 2018)
0.5				% Sand 0.05 to 2.00 mm
17.3				% Silt 0.002 to 0.05 mm
82.2				% Clay less than 0.002 mm
Clay				Soil Classification

ASTM Method: F1632-03 (Reapproved 2018)
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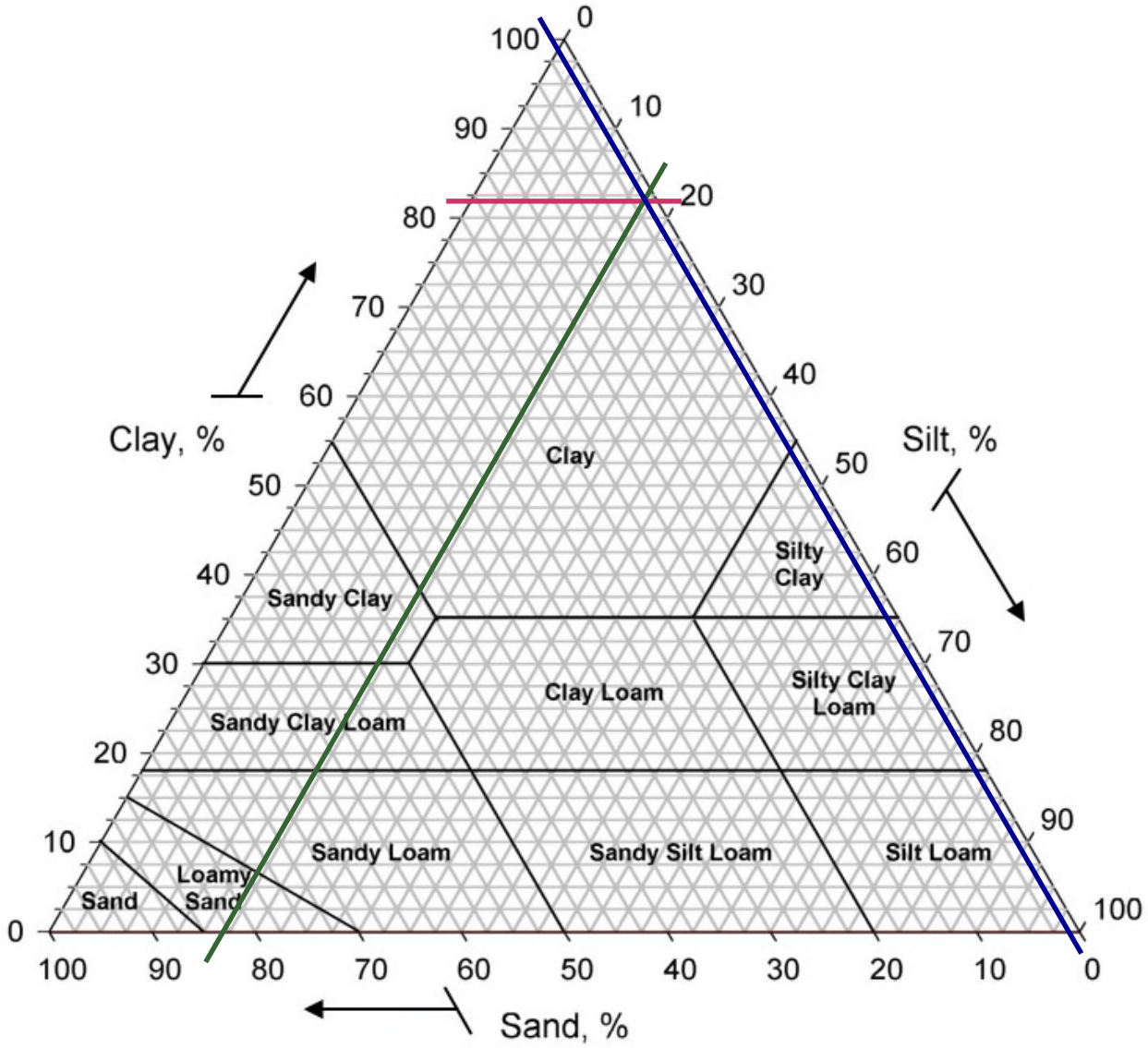


Soil Sample: TGMS

Test Report 18840/Z

			After removal of gravel			
Sample	**% Gravel**		**% Sand**	**% Silt**	**% Clay**	**Soil Texture Classification**
Milespit: TP5, 1.0M	0.1		0.5	17.3	82.2	**Clay**

Signed: Sharon Singleton-Bruce

Date: **19th April 2022** **for European Turfgrass Laboratories Ltd**

EUROPEAN TURFGRASS LABORATORIES
GEOTECHNICAL (PUTTING GREEN MATERIALS) CERTIFICATE NO. 903-01
ACCREDITED

Unit 6, Millar Court
Alloa Business Park
Alloa, FK10 3SA, Scotland
Tel: +44 (0) 1259 725060
Fax: +44 (0) 1259 722289
europeanturf@etl-ltd.com
www.etl-ltd.com

18840/27				**PARTICLE SIZE DISTRIBUTION** **SAND / SILT / CLAY** Test Report Number 18840/AA Page 1 of 2
100%				Milespit: TP5, 2.0M
				*** No Stones Present *****
07/04/22				Sample Received Date & Sample Test Date
moist				Sample Moisture (very wet, wet, moist, dry, n/a)
plastic				Sample Consistency (hard, friable, plastic, n/a)
high				Sample Homogeniety (high, medium, low, n/a)
				Particle Size Distribution – ASTM F1632-03 (Reapproved 2018)
4.1				% Sand 0.05 to 2.00 mm
5.7				% Silt 0.002 to 0.05 mm
90.2				% Clay less than 0.002 mm
Clay				Soil Classification

ASTM Method: F1632-03 (Reapproved 2018)
"Particle Size Analysis and Sand Shape Grading of Golf Course Putting Green and Sports Field Root Zone Mixes"

Professional Sportsturf Design (NW) Ltd, trading as TGMS
Wigan Road, Leyland, Lancashire, PR25 5XW

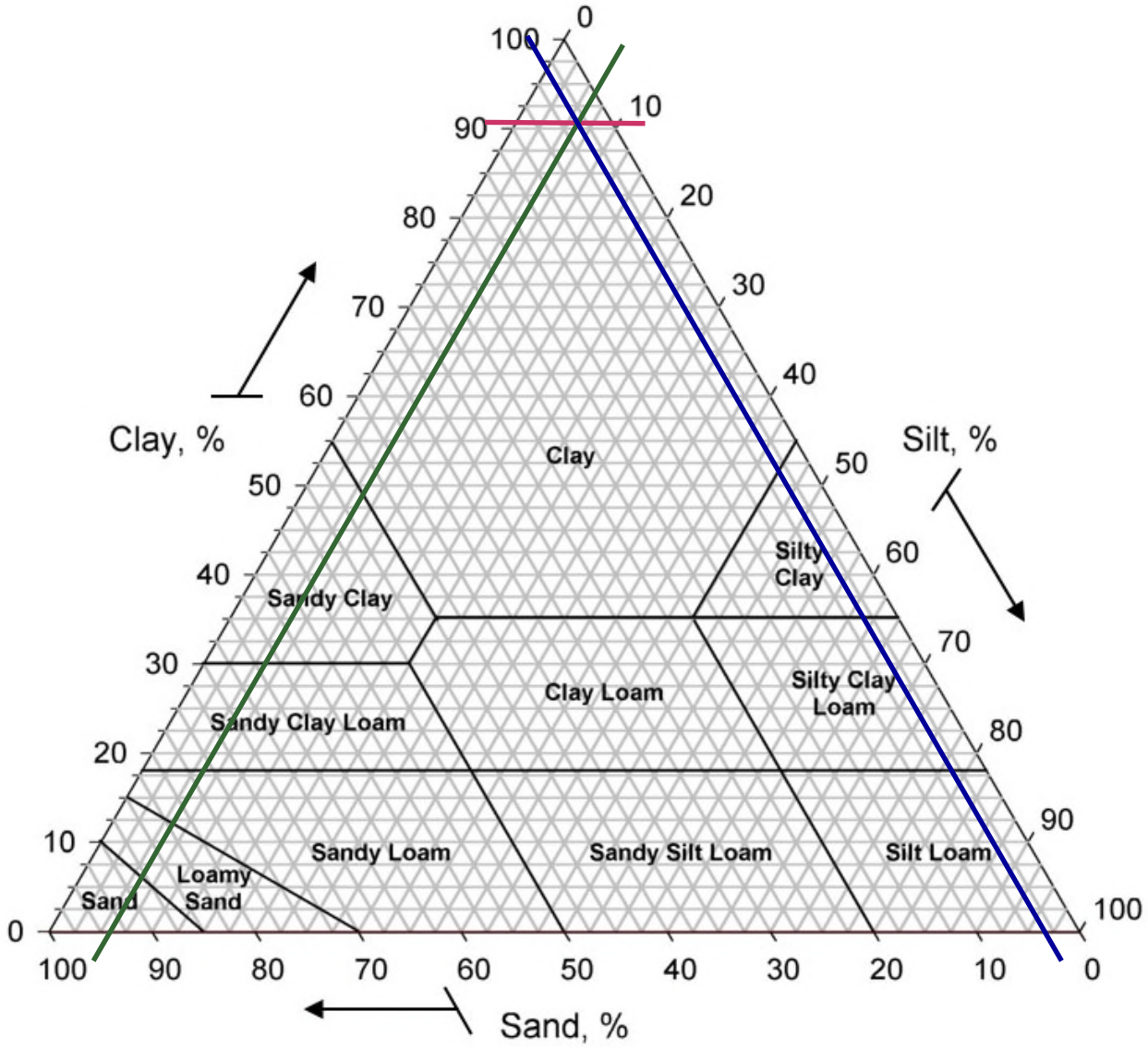
Approved by: Sara Singleton-Price **Date: 19th April 2022**

Managing Director, for European Turfgrass Laboratories Ltd

EUROPEAN TURFGRASS LABORATORIES

Triangle of Texture : Soil Classification

Date of Issue: Sept 2019, Revision 1,
Issuing Authority: Sharon Singleton-Bruce



Soil Sample: TGMS

Test Report 18840/AA

			After removal of gravel			
Sample	**% Gravel**		**% Sand**	**% Silt**	**% Clay**	**Soil Texture Classification**
Milespit: TP5, 2.0M	-		4.1	5.7	90.2	**Clay**

Signed: Sharon Singleton-Bruce

Date: **19th April 2022** **for European Turfgrass Laboratories Ltd**

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18840/28				**PARTICLE SIZE DISTRIBUTION** **SAND / SILT / CLAY** Test Report Number 18840/BB Page 1 of 2
100%				Milespit: TP5, 3.0M
				*** No Stones Present *****
07/04/22				Sample Received Date & Sample Test Date
moist				Sample Moisture (very wet, wet, moist, dry, n/a)
plastic				Sample Consistency (hard, friable, plastic, n/a)
high				Sample Homogeniety (high, medium, low, n/a)
				Particle Size Distribution – ASTM F1632-03 (Reapproved 2018)
3.4				% Sand 0.05 to 2.00 mm
7.4				% Silt 0.002 to 0.05 mm
89.2				% Clay less than 0.002 mm
Clay				Soil Classification

ASTM Method: F1632-03 (Reapproved 2018)
"Particle Size Analysis and Sand Shape Grading of Golf Course Putting Green and Sports Field Root Zone Mixes"

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Approved by: Sara Singleton-Price **Date: 19th April 2022**

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Triangle of Texture : Soil Classification

Date of Issue: Sept 2019, Revision 1,
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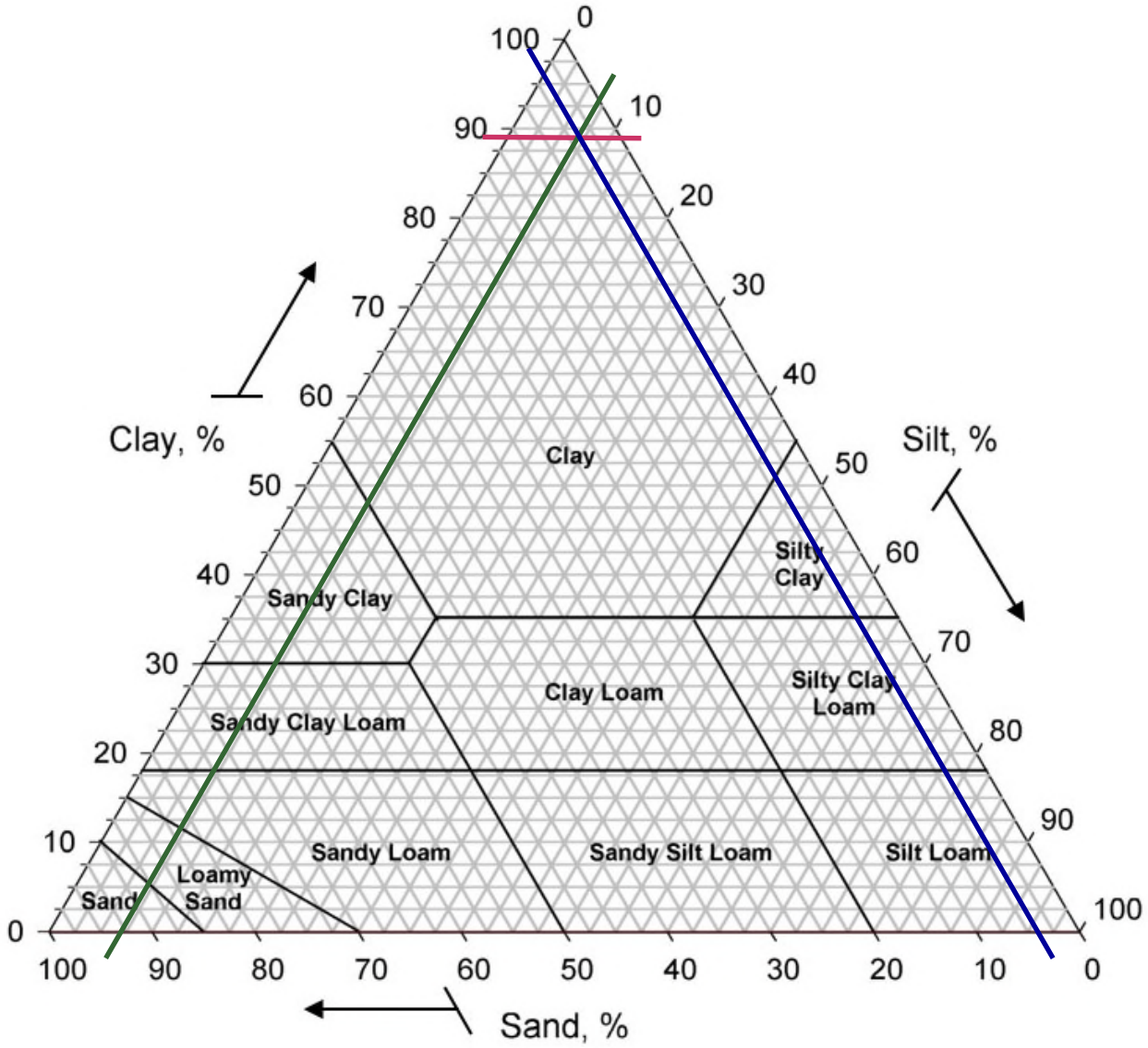

Soil Sample: TGMS

Test Report 18840/BB

			After removal of gravel			
Sample	**% Gravel**		**% Sand**	**% Silt**	**% Clay**	**Soil Texture Classification**
Milespit: TP5, 3.0M	-		3.4	7.4	89.2	**Clay**

Signed: Sharon Singleton-Bruce

Date: **19th April 2022** **for European Turfgrass Laboratories Ltd**

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18840/29				**PARTICLE SIZE DISTRIBUTION** **SAND / SILT / CLAY** Test Report Number 18840/CC Page 1 of 2
100%				Milespit: TP5, 4.0M
				*** No Stones Present *****
07/04/22				Sample Received Date & Sample Test Date
moist				Sample Moisture (very wet, wet, moist, dry, n/a)
plastic				Sample Consistency (hard, friable, plastic, n/a)
high				Sample Homogeniety (high, medium, low, n/a)
				Particle Size Distribution – ASTM F1632-03 (Reapproved 2018)
5.8				% Sand 0.05 to 2.00 mm
17.6				% Silt 0.002 to 0.05 mm
76.6				% Clay less than 0.002 mm
Clay				Soil Classification

ASTM Method: F1632-03 (Reapproved 2018)
"Particle Size Analysis and Sand Shape Grading of Golf Course Putting Green and Sports Field Root Zone Mixes"

Professional Sportsturf Design (NW) Ltd, trading as TGMS
Wigan Road, Leyland, Lancashire, PR25 5XW

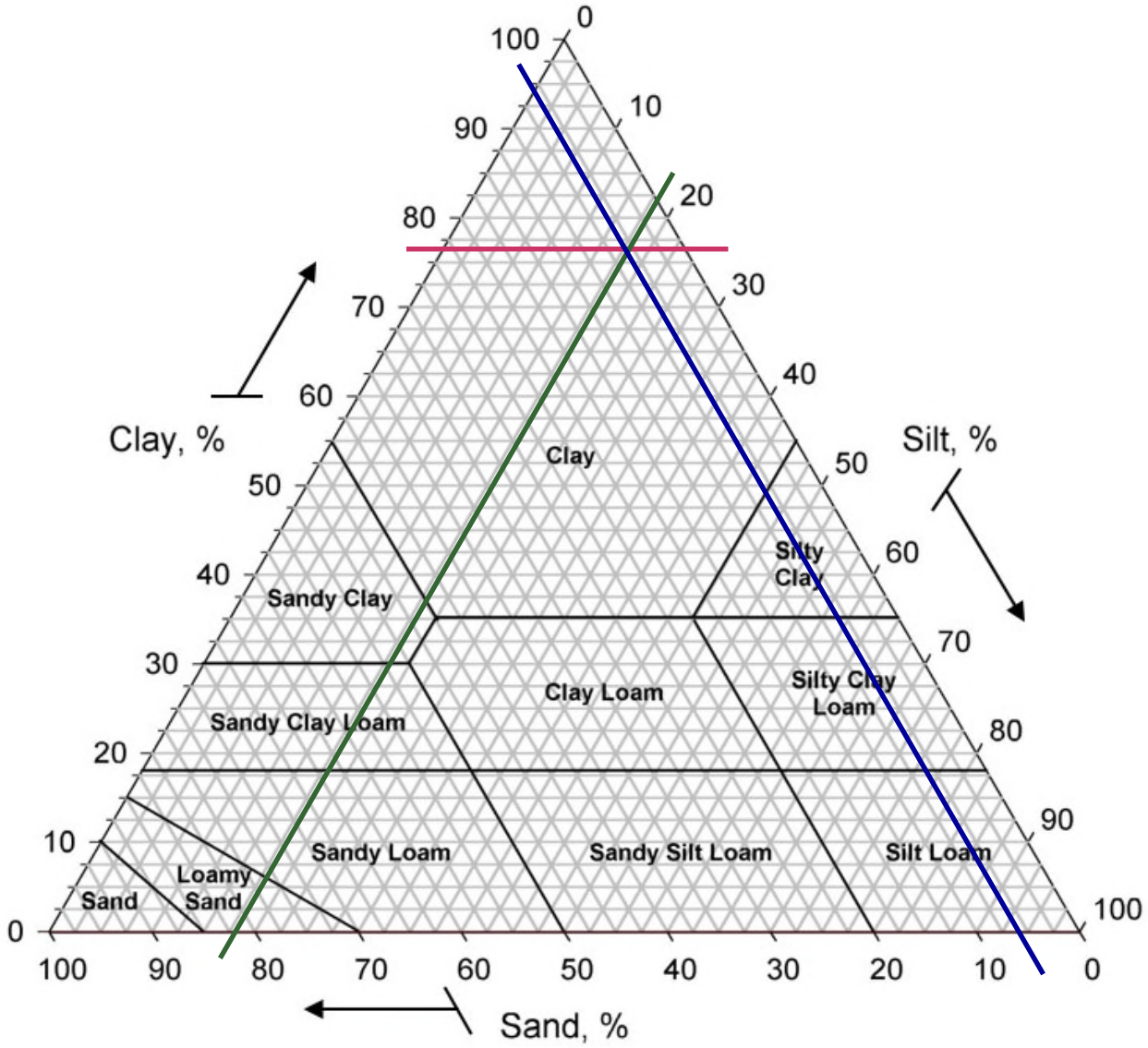
Approved by: Sara Singleton-Price **Date: 19th April 2022**

Managing Director, for European Turfgrass Laboratories Ltd

EUROPEAN TURFGRASS LABORATORIES

Triangle of Texture : Soil Classification

Date of Issue: Sept 2019, Revision 1,
Issuing Authority: Sharon Singleton-Bruce



Soil Sample: TGMS

Test Report 18840/CC

			After removal of gravel			
Sample	**% Gravel**		**% Sand**	**% Silt**	**% Clay**	**Soil Texture Classification**
Milespit: TP5, 4.0M	-		5.8	17.6	76.6	**Clay**

Signed: Sharon Singleton-Bruce

Date: **19th April 2022** **for European Turfgrass Laboratories Ltd**

EUROPEAN TURFGRASS LABORATORIES

Routine Nutrient Analysis Summary Report

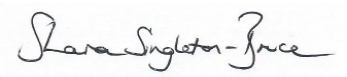
Client: **TGMS**

Date: **13/04/2022**

Order: **18840**

Sample: **Milespit: TP1, 0.1M**

Analysis	Result	Guideline	Interpretation	Comments
pH	5.2	6.0	Low	An acidic environment will reduce soil nutrient availability and the efficiency of any applied fertilisers or organic materials. A sub optimum pH will also impact on soil microbial populations and rates of activity
Phosphorus (ppm)	7	16	Very Low	(Index 0.7) Apply 120 kg/ha P_2O_5
Potassium (ppm)	224	121	Normal	(Index 2.9) Apply 40 kg/ha K_2O
Magnesium (ppm)	503	51	Very High	(Index 6.6) Possible interference on availability of Potassium

Signed:  **Date: 13th April 2022**

Position: **Sharon Singleton-Bruce, Managing Director, European Turfgrass Laboratories Ltd**

This is a Sub-Contracted Test – this sample has not been tested by ETL
This statement is a direct interpretation of the sample tested

Routine Nutrient Analysis Summary Report

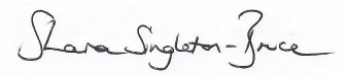
Client: **TGMS**

Date: **13/04/2022**

Order: **18840**

Sample: **Milespit: TP2, 0.1M**

Analysis	Result	Guideline	Interpretation	Comments
pH	6.0	6.0	Normal	Maintain pH to ensure optimum nutrient availability and ideal conditions for an active soil biology
Phosphorus (ppm)	9	16	Very Low	(Index 0.9) Apply 120 kg/ha P_2O_5
Potassium (ppm)	284	121	High	(Index 3.3) Adequate level
Magnesium (ppm)	819	51	Very High	(Index 7.5) Possible interference on availability of Potassium

Signed:  **Date: 13th April 2022**

Position: **Sharon Singleton-Bruce, Managing Director, European Turfgrass Laboratories Ltd**

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EUROPEAN TURFGRASS LABORATORIES

Routine Nutrient Analysis Summary Report

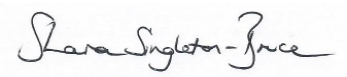
Client: **TGMS**

Date: **13/04/2022**

Order: **18840**

Sample: **Milespit: TP3, 0.1M**

Analysis	Result	Guideline	Interpretation	Comments
pH	4.6	6.0	Very Low	A strongly acidic environment will reduce soil nutrient availability and the efficiency of any applied fertilisers or organic materials. A sub optimum pH will also impact on soil microbial populations and rates of activity
Phosphorus (ppm)	8	16	Very Low	(Index 0.8) Apply 120 kg/ha P_2O_5
Potassium (ppm)	114	121	Low	(Index 1.9) Apply 80 kg/ha K_2O
Magnesium (ppm)	432	51	Very High	(Index 6.3) Possible interference on availability of Potassium

Signed:  **Date:** **13th April 2022**

Position: **Sharon Singleton-Bruce, Managing Director, European Turfgrass Laboratories Ltd**

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EUROPEAN TURFGRASS LABORATORIES

Routine Nutrient Analysis Summary Report

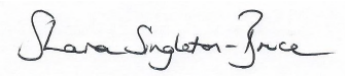
Client: **TGMS**

Date: **13/04/2022**

Order: **18840**

Sample: **Milespit: TP4, 0.1M**

Analysis	Result	Guideline	Interpretation	Comments
pH	4.7	6.0	Very Low	A strongly acidic environment will reduce soil nutrient availability and the efficiency of any applied fertilisers or organic materials. A sub optimum pH will also impact on soil microbial populations and rates of activity
Phosphorus (ppm)	9	16	Very Low	(Index 0.9) Apply 120 kg/ha P_2O_5
Potassium (ppm)	256	121	High	(Index 3.1) Adequate level
Magnesium (ppm)	324	51	Very High	(Index 5.7) Possible interference on availability of Potassium

Signed:  **Date: 13th April 2022**

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EUROPEAN TURFGRASS LABORATORIES

Routine Nutrient Analysis Summary Report

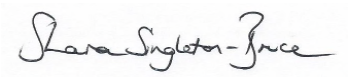
Client: **TGMS**

Date: **13/04/2022**

Order: **18840**

Sample: **Milespit: TP5, 0.1M**

Analysis	Result	Guideline	Interpretation	Comments
pH	4.4	6.0	Very Low	A strongly acidic environment will reduce soil nutrient availability and the efficiency of any applied fertilisers or organic materials. A sub optimum pH will also impact on soil microbial populations and rates of activity
Phosphorus (ppm)	9	16	Very Low	(Index 0.9) Apply 120 kg/ha P_2O_5
Potassium (ppm)	143	121	Normal	(Index 2.2) Apply 60 kg/ha K_2O
Magnesium (ppm)	177	51	Very High	(Index 4.0) Possible interference on availability of Potassium

Signed:  **Date: 13th April 2022**

Position: **Sharon Singleton-Bruce, Managing Director, European Turfgrass Laboratories Ltd**

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