8.17 SPORTS PITCH AGRONOMIC ASSESSMENT

SPORTS PITCHES

AGRONOMIC ASSESSMENT REPORT

MARBLE HILL PARK

TWICKENHAM, LONDON

Prepared on behalf of:

ENGLISH HERITAGE

TOHA Document Ref:	TOHA/16/4003/CS
Document Revision:	00
Document Status	Issue 1
Document Issue Date:	20th December 2016

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1.0 INTRODUCTION

Tim O'Hare Associates LLP (TOHA) was commissioned by English Heritage to undertake an agronomic assessment of the sports pitches at Marble Hill Park, Twickenham, London.

Permission to carry out the work is provided by English Heritage Purchase Order No. 600012934, dated 8th November 2016.

1.1 Aim of Assessment

The following information is required by English Heritage in relation to the existing sports pitches at Marble Hill Park to inform the Management & Maintenance Plan:

- Current condition of the pitches (soil, grass species, pests/weeds etc)
- Renovation options and costs
- Annual maintenance costs

The existing sports facilities include a number of natural turf football and rugby pitches (further detail below), a cricket field with an artificial wicket and surfaced tennis courts.

An agronomic assessment was required for the existing natural turf pitches and cricket field to determine their current condition and ascertain any improvements that may be required, together with estimated budget costs for recommended works and maintenance operations.

1.2 Actions

TOHA has carried out an agronomic assessment to ascertain the current condition of the existing pitches and cricket field in line with Sport England guidelines to assess surface evenness, rooting depths, ground cover, weeds, pests and disease.

The survey has included a reinterpretation of the findings from the existing Soil Resource Survey (ref. TOHA/16/3995/CS, dated 03/11/2016), to provide information on soil fertility, soil depths and types, compaction and aeration. In-situ topsoil infiltration tests have also been carried out as part of the site work.

2.0 INFORMATION REVIEW

The following information has been reviewed to provide information on the project:

- J&L Gibbons – Drawing Ref. 581_SK_160909_JLG mark-up – dated September 2016
- Greenhatch Group – Drawing Ref. MHH16T17 – *Topographic Survey*
- English Heritage – Grounds Maintenance Contract – Marble Hill Sports Maintenance Section (received via email from Emily Parker (EH), dated 14/12/2016
- Email correspondence – Neil Davidson (J&L Gibbons) – dated 17/11/2016
- Email correspondence – Emily Parker (EH) / Brian Clarke (EH) – between 08/12/2016 to 15/12/2016

2.1 Pitch Layout and Dimensions

The locations of the pitches are indicated on the attached site plan in Appendix 1.

Football Pitches

For the purpose of this survey, the football pitches shall be referred to as indicated in Table 1 below (see also attached site plan). With reference to email correspondence from Brian Clarke (English Heritage Landscape Manager) on 08/12/2016, the current pitch sizes are as follows:

Table 1: Current Football Pitch Types and Size

Football Pitch Ref.	Pitch Type	Pitch Size
Pitch 1	Adult	100m x 54m
Pitch 2	Adult	100m x 54m
Pitch 3	Adult	100m x 54m
Pitch 4	Adult	100m x 54m
Pitch 5	Junior: 9 v 9	75m x 45m
Pitch 6	Junior: 7 v 7	60m x 30m
Pitch 7	Junior: 5 v 5	30m x 20m

Rugby Pitches

The rugby pitches shall be referred to as Rugby Pitch 1 and Rugby Pitch 2. These are understood to be 120m x 55m (Rugby Pitch 1) or 120 x 60m (Rugby Pitch 2). Rugby Pitch 1 is a little narrower to avoid the adjacent events access route.

Cricket Outfield

The cricket outfield is currently 64m from centre of the artificial wicket to the boundary, with the boundary measuring 400m in circumference. This would equate to an overall area of 12868m^2, of which 74m^2 is covered by the synthetic wicket (29.5m x 3.5m).

2.2 Pitch Orientation

The current orientations of the pitches are as shown in Table 2:

Table 2: Current Football Pitch Orientation

Pitch Ref.	Pitch Orientation
Pitch 1	Northwest/Southeast
Pitch 2	
Pitch 3	
Pitch 4	
Pitch 5	
Pitch 6	Southwest/Northeast
Pitch 7	Northwest/Southeast
Rugby Pitch 1	
Rugby Pitch 2	

The orientation of the pitch affects play in the direction of the sun when it is low in the sky, potentially putting players at a disadvantage if play is heading directly into it.

The Sport England and SAPCA guidelines recommend the pitch orientation range for football and rugby (goal to goal) to be between northwest 285 degrees to northeast 20 degrees. As such, the current orientation of the majority of the pitches appears to fall just inside the recommended range. The orientation of Pitch 6 (Junior 7 v 7 pitch) would fall outside the range.

2.3 Current Usage

With reference to email correspondence from Emily Parker (EH) dated 14/12/2016, it is understood that the football and rugby pitches are used collectively for approximately 20 hours per week. It is not known how this is distributed between the individual pitches. It is understood that one rugby pitch has been out of use in recent seasons and consistent problems have been experienced with pitch condition every winter (football and rugby), which leads to cancellation of fixtures.

During the last summer season, 61 matches were played on the cricket field however this could potentially be up to 90 matches depending on park events / maintenance work. Based on this information and assuming a season running from April to September, this would equate to approximately 3-4 matches a week.

2.4 Current Maintenance Programme

The current maintenance programme is as summarised in Tables 3 – 4 below.

Football and Rugby Pitches

For the football pitches, this information relates to the 4 No. adult size pitches only (Pitches 1 – 4). No information has been provided for the junior football pitches.

Table 3: Current Football and Rugby Pitch Maintenance Programme

Treatment	**Notes**
Mowing	*Football* – Maintained height between 25-50mm *Rugby* – Maintained height between 100-125mm (September – April). Mowing to be stopped during July or August (as advised by EH Contract Manager) Pedestrian guided, ride-on or tractor mounted cylinder mowers Arisings to remain on ground (except where indicated otherwise) and scattered evenly
Aeration	Twice a month – September to March inclusive Solid tine turf aerating equipment – tractor mounted or towed Minimum penetration depth 100mm
Topdressing	Annually during renovation works in April/May Goal mouths only
Harrowing	Twice a month – September to March inclusive Tractor towed chain harrow or similar Two directions at right angles
Scarifying	Annually during renovation works in April/May Tractor mounted or towed scarifying equipment Arisings collected immediately and disposed of
Fertilising	Annually during renovation works in April/May Rate as agreed with EH Contract Manager Vehicle mounted mechanical spreader
Overseeding	Annually during renovation works in April/May Rate of 200 Kg/Ha Tractor mounted twin disc contravator
Marking out	Immediately prior to each playing season and as frequently as necessary thereafter throughout the season.

Cricket

Table 4: Current Cricket Maintenance Programme

Treatment	Notes
Mowing	*Outfield* – Cut weekly to a height of 25mm – April to September. A 5 metre strip around the synthetic wicket is to be box mown to a height of 20mm (April – September) Pedestrian guided, ride-on or tractor mounted cylinder mowers (outfield) or box mower (around synthetic wicket) Arisings to remain on ground and scattered evenly (except around the wicket where they are to be collected and disposed of)
Aeration	Once a month – April to August inclusive and during renovation works in September/October Area surrounding cricket wicket only (500m^2) Pedestrian operated slit tine equipment Minimum penetration depth 100mm
Topdressing	Annually during renovation works in September/October Area surrounding cricket wicket only (500m^2) Light loam dressing 1m^3 per 1000m^2 Spread using lute or similar
Scarifying	Annually during renovation works in September/October Area surrounding synthetic cricket wicket (500m^2) and practice wickets (50m^2) only Pedestrian operated scarifying equipment Arisings collected immediately and disposed of Two directions at right angles
Rolling	*Outfield* – Twice annually – once in March and once in April Non-vibrating rolling equipment. Min. weight 300 Kg, max. weight 500 Kg Two directions at right angles
Fertilising	Annually during renovation works in September/October Area surrounding synthetic cricket wicket (500m^2) and practice wickets (50m^2) only Rate as agreed with EH Contract Manager Mechanical hand spreader
Overseeding	Annually during renovation works in September/October Area surrounding synthetic cricket wicket (500m^2) and practice wickets (50m^2) only Rate as agreed with EH Contract Manager Mechanical seed sower
Marking out	Immediately prior to each playing season and as frequently as necessary thereafter throughout the season.

2.5 Drainage System

With reference to email correspondence from Neil Davidson at J&L Gibbons (dated 17/11/2016), based on discussions with English Heritage, it is believed that there is no formal land drainage system for the sports pitches.

2.6 Levels

The supplied topographic survey drawing indicates that the overall gradients across the sports pitches and cricket outfield themselves are relatively shallow. However, the general topography undulates, particularly across the football pitches, with a number of ridges/hollows.

The existing overall gradients do not appear to exceed the recommendations given in the Sport England guidelines (ref. *Natural Turf for Sport* 2011). These recommendations state that generally the playing surface should be no steeper than 1:80 – 1:100 along the line of play (and no steeper than 1:40 – 1:50 across the line of play).

2.7 Underground Services

No information was supplied on the locations of underground or overground services prior to this survey.

Enquiries would need to be submitted to the utility companies as necessary prior to any drainage installation and pitch construction work to confirm whether they have any assets in the area, whether any apparatus present will influence the works and what precautions may need to be taken.

3.0 SITE ASSESSMENT

TOHA visited the site on 29th November 2016.

The park is situated to the east of Twickenham (approximate National Grid Reference of centre: TQ1734573656), adjacent to the River Thames.

3.1 Pitches

At the time of the visit, the football pitches were clearly marked out and re-marking was in progress for the rugby pitches. Based on our observations, the majority of the adult football and rugby pitches had fixed goal posts, whilst the junior football pitches did not. The cricket field boundary could be seen but had not been recently marked out, given the season.

3.2 Drainage

Based on observations made during the survey, no evidence of drainage infrastructure was recorded (e.g. gravel trenches, manhole covers, headwalls) nor open ditches on or around the site.

With reference to a conversation with the park warden on duty, the southwestern part of the site in the vicinity of the rugby pitches is understood to be subject to periodic flooding and waterlogging is also a common problem for Football Pitch 3.

3.3 Levels

Observations made onsite correlate with the information given in the supplied topographic survey, with shallow overall gradients across the sports pitches and cricket outfield themselves, with an undulating topography (microrelief), particularly across the football pitches.

Pitch 3 sits in a hollow, surrounded by a reasonably steep bank on its north-western and northern boundaries and to an extent the eastern side. There is bank beside the north-eastern corner of Rugby Pitch 1, with the ground rising within the boundary of the pitch.

As a whole the Park itself falls to the south and southwest towards the River Thames, with terracing to the south of the House, together with raised pathways.

The current variability in microrelief is not ideal for sports pitch use.

3.4 Shade

The majority of the pitches are affected by shade from trees within the Park and along the boundaries.

3.5 Underground Services

No evidence was seen on the surface of the sports pitches of underground service infrastructure, e.g. manholes, marker posts, valve housing etc.

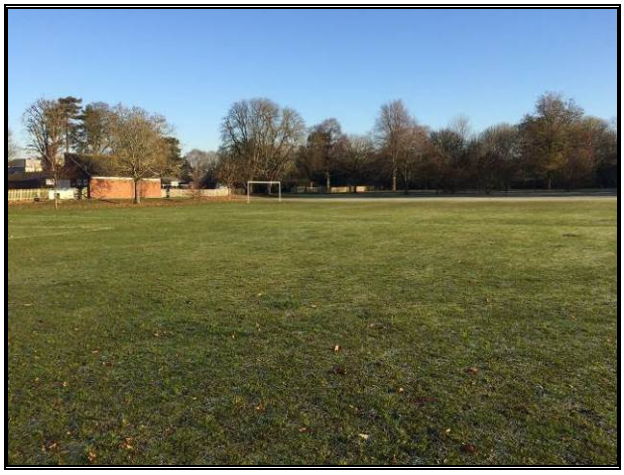

Plate 1: Pitch 1 and 2, facing east

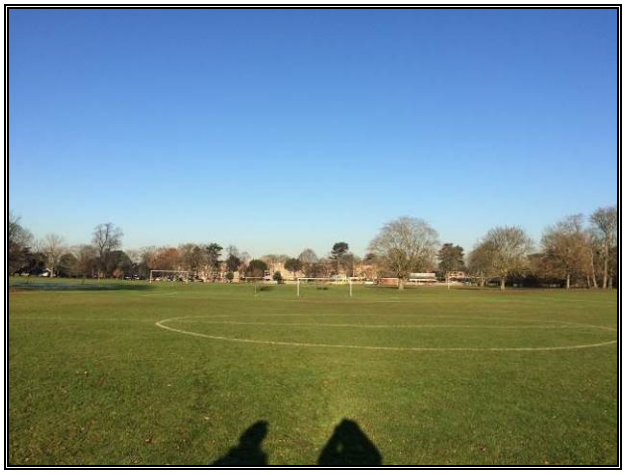

Plate 2: Pitch 3, facing north

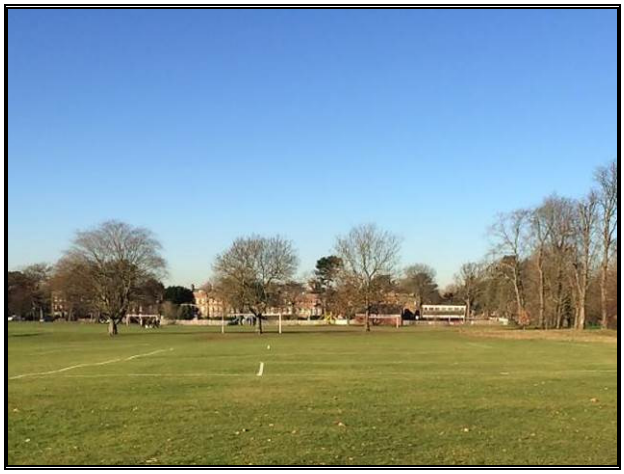

Plate 3: Pitch 7, facing north

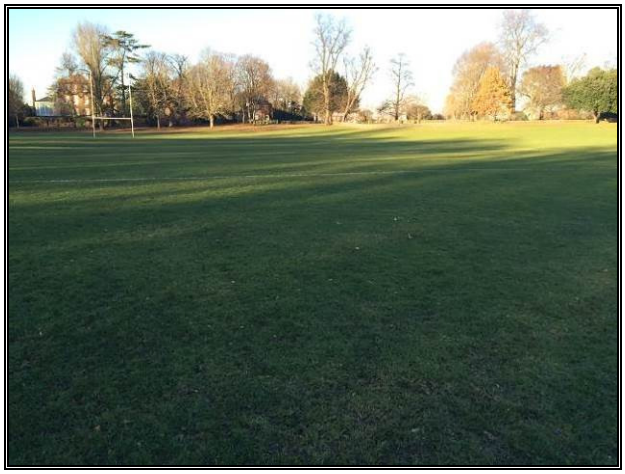

Plate 4: Rugby Pitch 1 – high shade levels

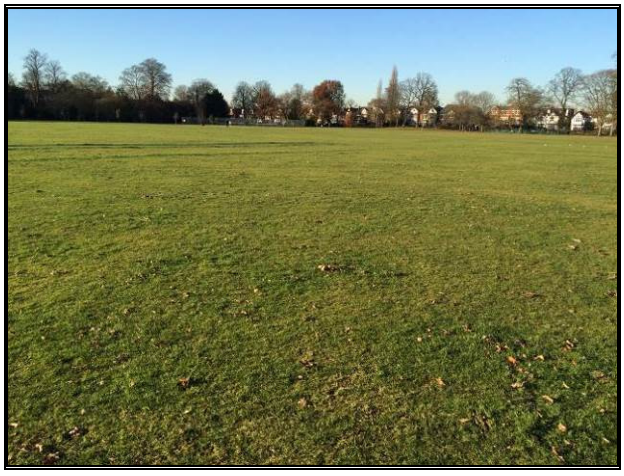

Plate 5: Cricket Outfield

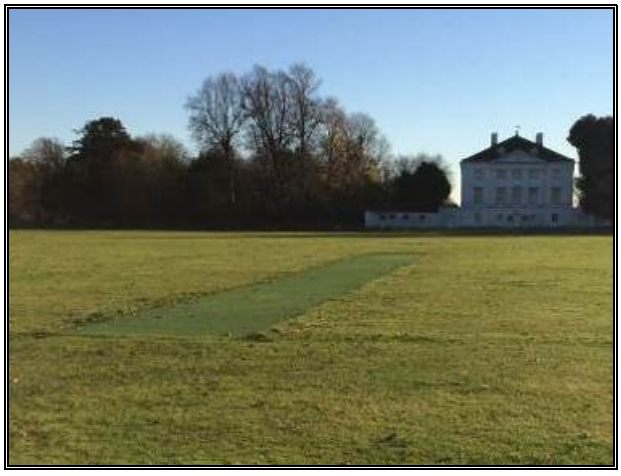

Plate 6: Cricket wicket

4.0 SOIL CONDITIONS

4.1 Geology

The *British Geological Survey* website (*Geology of Britain 1:50,000*) describes the site geology (Bedrock and Superficial Deposits) as follows:

- Bedrock – *London Clay Formation – Clay and Silt*.
- Superficial Deposits – *Langley Silt Member – Clay and Silt*
- Superficial Deposits – *Alluvium – Clay, Silty, Peaty and Sandy* (southern part of the site towards the River Thames only)

4.2 Soils Map of England Wales

The Soil Map of England and Wales (1:250,000 scale) classifies the soils of this site as:

Unsurveyed	Mainly urban and industrial areas.

Soils within urban and industrial areas are potentially subject to a wide range of natural and anthropologic influences and impacts, and can include building materials and soils which have been imported from outside of the subject site. In horticultural terms, this can result in variable soil conditions with regards to soil chemistry, fertility status and physical condition, including compaction and the presence of foreign matter within the soil matrix.

4.3 Soil Conditions

With reference to the findings of the existing Soil Resource Survey (ref. TOHA/16/3995/CS, dated 03/11/2016), three soil profile types were recorded across the Park as a whole. Two of these profile types (*Profile 1* and *Profile 3*) are applicable to the sports pitches as outlined below:

- *Profile 1 – Light to Medium Textured Soils.* Sandy loam topsoil over sandy loam or sandy clay loam subsoil.
- *Profile 3 – Heavy Textured Soils.* Clay loam topsoil over clay loam or clay subsoil.

Profile 1 was encountered within the majority of the sports pitches, whilst heavier textured, '*Profile 3*' type *subsoil* was recorded within parts of the rugby pitches only. These soil profiles are described in further detail within the Soil Resource Survey report (including soil horizon depths), with a summary given in Table 5.

Table 5: Soil Profile Characteristics

Profile 1 – Light to Medium Textured Soils	***Profile 3 – Heavy Textured Soils***
• Sandy loam to sandy clay loam soil textures • Fine textures – significant proportions of 'fines' (very fine sand, clay, silt) • Slightly broad particle size distribution • Virtually stone-free to slightly stony • Adequate structures (uncompacted below surface) • Acid to slightly alkaline soil reaction • Non-calcareous, with occasionally slightly calcareous subsoil • Non-saline • Topsoil has sufficient reserves of organic matter, nitrogen and magnesium • Topsoil is deficient in phosphorus and potassium	• Heavy clay loam to clay soil textures • Virtually stone-free to slightly stony • Alkaline to strongly alkaline soil reaction • Slightly calcareous • Non-saline • Topsoil has sufficient reserves of organic matter, nitrogen and magnesium • Topsoil is slightly deficient in phosphorus and potassium

The topsoil depths recorded in the sports pitch zones ranged between 200-510mm, typically being between 200-390mm.

Topsoil surface smearing was commonly recorded within Football Pitches 1 and 2. Smearing of the surface effectively prevents water from entering the soil profile, reducing soil aeration and drainage, resulting in unfavourable conditions for root growth. Continual or intensive use when wet may also destroy grass cover, further compounding the problem of poor aeration and impeded infiltration.

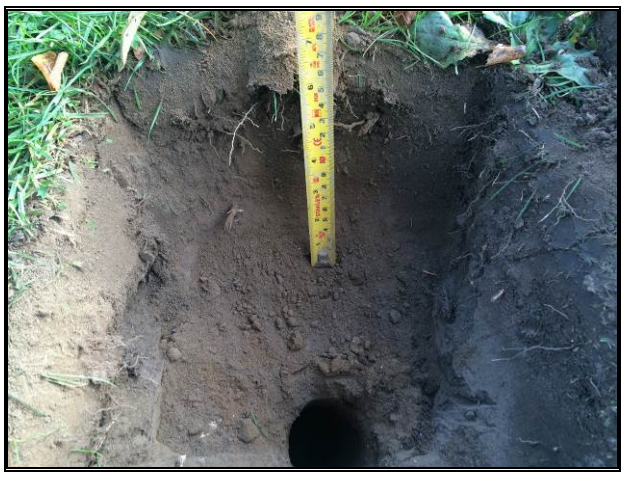

Plate 7: *Profile 1 Topsoil* at TH26

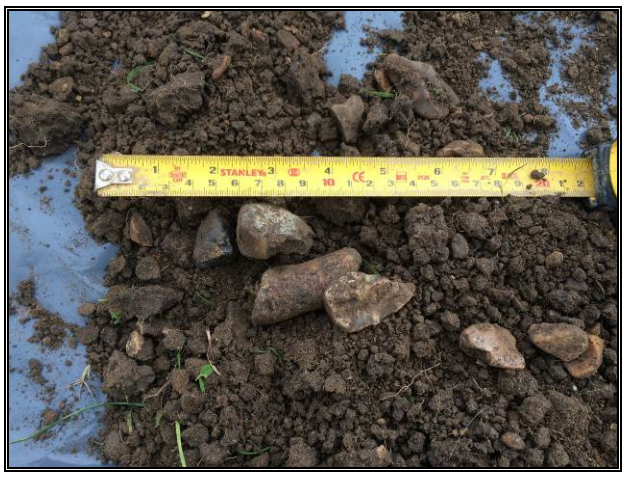

Plate 8: Subangular and subrounded, small to medium sized stones within *Profile 1 Topsoil*

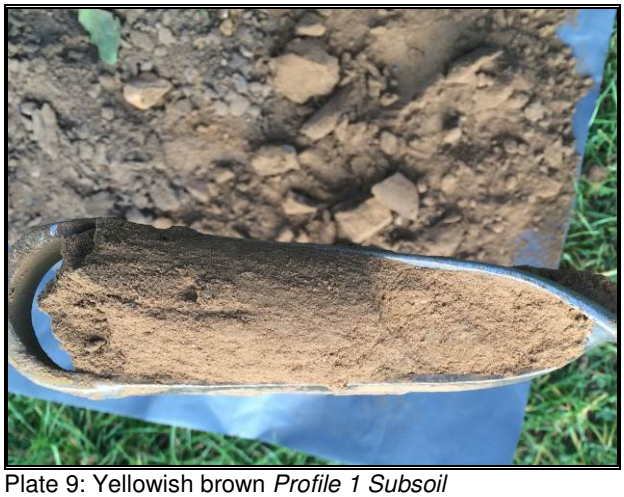

Plate 9: Yellowish brown *Profile 1 Subsoil*

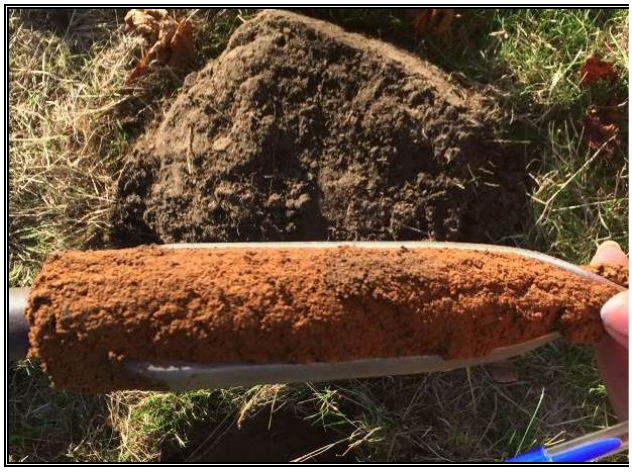

Plate 10: Strong brown *Profile 1 Subsoil*

4.4 Infiltration Tests

A total of 4 No. surface infiltration tests were carried out using double-ring infiltrometer apparatus. The test locations are indicated on the supplied plan in Appendix 2.

The results recorded were as shown in Table 6 below:

Table 6: Infiltration Test Results

Test Location	Result (mm/hr)
IF1	4
IF2	20
IF3	13
IF4	15

These results indicate that the pitch surface at three out of four of these locations has reasonable infiltration capacity.

At location IF1 the infiltration rate is lower, which is likely to be indicative of this pitch having heavy use, resulting in increased surface smearing and loss of infiltration performance.

Recent verti-draining/spiking is likely to have influenced the infiltration rate at locations IF2 and IF4.

5.0 TURF ASSESSMENT

An assessment of turf quality was carried out across the playing field in order to provide baseline data. The survey was carried out with reference to the Sport England guidelines.

The turf was examined using a quadrat at several locations across each pitch/outfield. A 2 metre long straight edge with measuring wedge was used to assess surface evenness.

A summary of the measurements is presented in Table 7 – Table 9 below. The full results for each performance property at each location examined are presented in the tables in Appendix 4. A site plan showing turf inspection locations is shown in Appendix 3.

Table 7: Turf Quality Assessment Summary – Football Pitches

Performance Property	Average Score
Ground Cover %	70
Bare Area %	29
Weeds %	6
Moss %	0
Algae/Lichen %	0
Undesirable Grass Species %	0
Desirable Grass Species %	100
Disease %	0
Worms %	2
Evenness: 2 m/st/e: mm	14

Table 8: Turf Quality Assessment Summary – Rugby Pitches

Performance Property	Average Score
Ground Cover %	93
Bare Area %	7
Weeds %	7
Moss %	0
Algae/Lichen %	0
Undesirable Grass Species %	0
Desirable Grass Species %	100
Disease %	0
Worms %	2
Evenness: 2 m/st/e: mm	8

Table 9: Turf Quality Assessment Summary – Cricket Outfield

Performance Property	Average Score
Ground Cover %	99
Bare Area %	1
Weeds %	2
Moss %	3
Algae/Lichen %	0
Undesirable Grass Species %	0
Desirable Grass Species %	100
Disease %	0
Worms %	1
Evenness: 2 m/st/e: mm	6

5.1 Summary of Findings

Ground Cover and Bare Areas

The average ground cover was moderate in the football pitches and was high across the rugby pitches and cricket outfield. Significant bare areas were recorded in play hotspots on the football pitches, including the goal mouths, centre circles and penalty spots.

Weed Infestation

There was a low to moderate weed population across the survey areas, with occasional broad-leaved weeds, including clover (*Trifolium repens*), yarrow (*Achillea millefolium*), daisy (*Bellis perennis*) and dandelion (*Taraxacum officinale*).

Algae/ Lichen/ Moss

There were no major populations of algae or lichen.

Moss was generally absent from the football and rugby pitches, with a patch identified within the cricket outfield (inspection location No. 30). Low soil pH can favour moss growth, which could be a factor in this location.

Undesirable Grass Species

Overall, undesirable grass species were not observed across the survey areas.

Desirable Grass Species

The survey area had a high population of desirable grass species comprising perennial ryegrass (*Lolium perenne*), which has a high wear tolerance.

Pests and Diseases

No evidence of disease was recorded and the sward was free of turf pests. However, the Park is heavily used by dog walkers, and excrement was occasionally seen on pitches, together with small patches of flush growth which could be associated with dog urine.

Worms

The proportion of worm casts on the playing field surface was low. Worm casts produce an unpleasant slippery surface in wet weather, and can also affect the mowing of the turf.

Evenness

An even playing surface is necessary for the safety of the players and for the consistent roll of the ball for certain sports, including football. In the football pitches there were a number of undulations greater than 25mm along a 2m straight edge recorded in wear hotpots, including the goal mouths and centre circles. These areas may need to be infilled and re-graded to improve evenness.

Numerous minor undulations were also noted, below the recommended maximum of 25mm along a 2m straight edge.

Whilst the evenness across the football pitches is generally satisfactory (except in wear spots), the overall microrelief is undulating as discussed in Section 2.6 above. This may need to be addressed by regrading work.

Depth of Topsoil

The topsoil depths recorded during the initial Soil Resource Survey (200-510mm) are considered sufficient for sports turf. A topsoil depth of at least 200mm is desirable to support a resilient grass sward.

Depth of Grass Roots

Root growth is an important factor for generating satisfactory grass growth at the surface. Root growth was generally good, typically reaching a depth of at least 150mm.

Depth of Thatch

There was no significant build-up of thatch across the pitches. Thatch is a layer of living and dead grass and roots which accumulates between the layer of actively-growing grass and the soil underneath. Excessive thatch can restrict movement of air and water to the soil and grass roots.

Length of Herbage

The grass height measured across the pitches would be considered suitable for the relevant sports at this point in the year (winter season).

- 30-40mm – football pitches
- 60-75mm – rugby pitches
- 35-40mm – cricket outfield

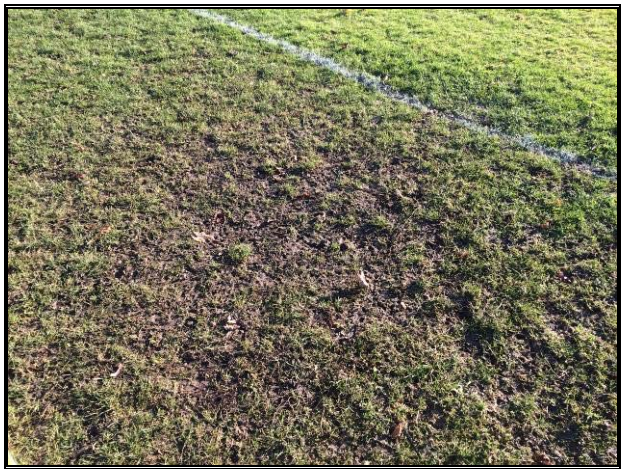

Plate 11: Worn centre circle in football pitch

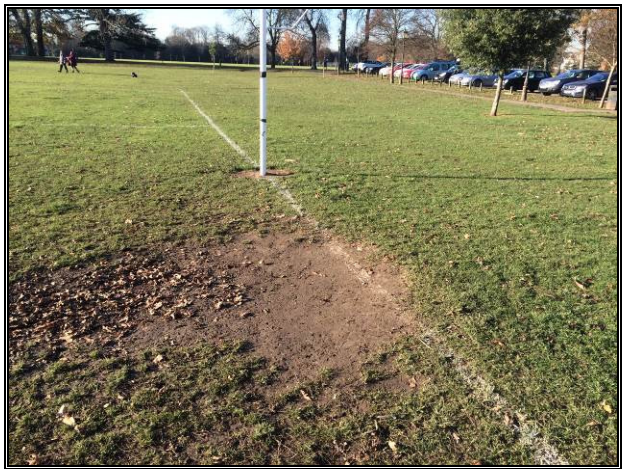

Plate 12: Worn football goal mouth

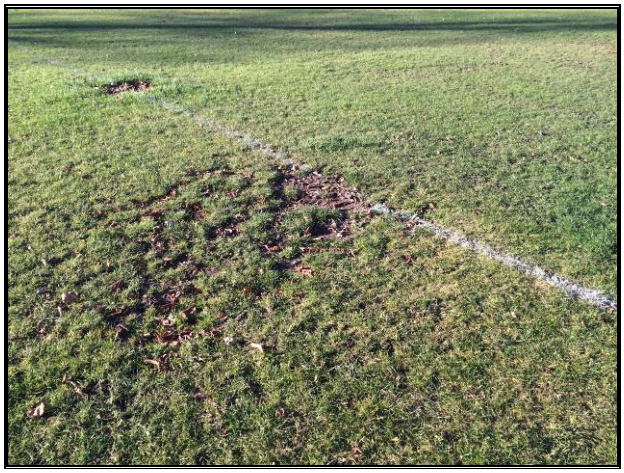

Plate 13: Slight wear in goal mouth – Pitch 4

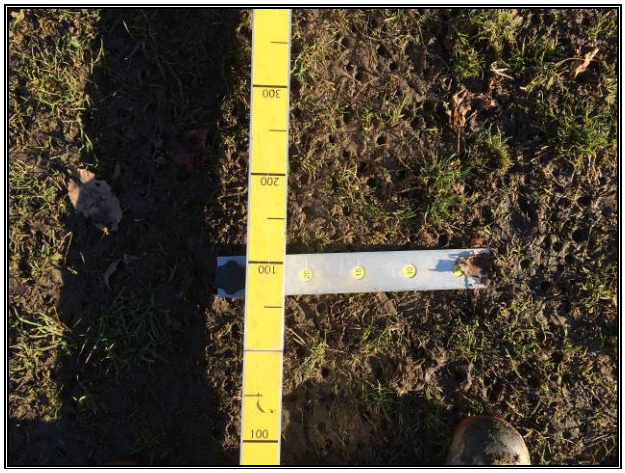

Plate 14: Undulation > 25mm depth – centre circle

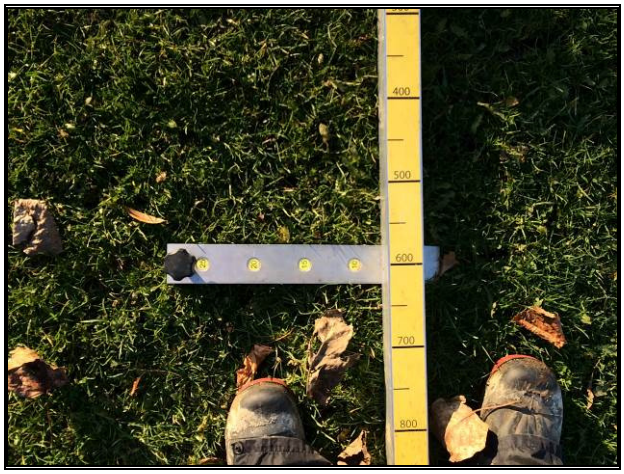

Plate 15: Minor undulation <5 mm

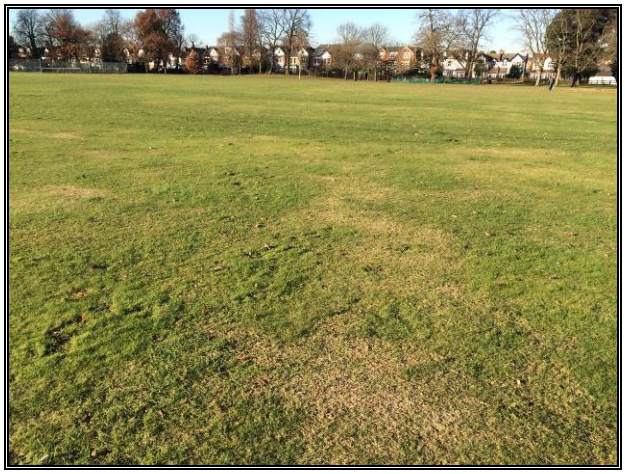

Plate 16: Patchy grass colour – cricket outfield

5.2 Pitch Maintenance

Based on our observations, evidence was seen for the following maintenance operations:

- Mowing – grass height is reasonably consistent in each area inspected
- Verti-draining/spiking – tine voids seen in rugby pitches and football pitches
- Marking-out – Measurements were being taken by groundsmen on the rugby pitches at the time of the visit

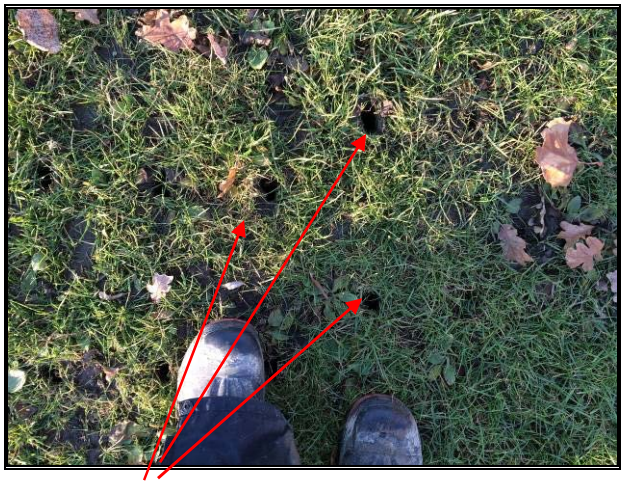

Plate 18: Verti-drain holes

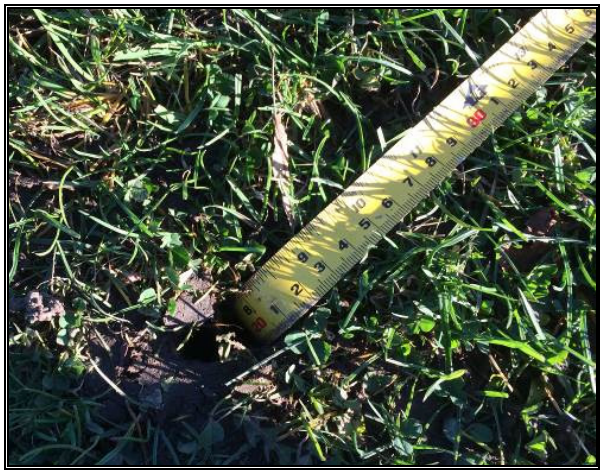

Plate 19: Measured depth of vert-drain hole 210mm

6.0 DISCUSSION AND RECOMMENDATIONS

Tim O'Hare Associates LLP has carried out an agronomic assessment to assess the quality of the existing soils and turf within the sports pitches at Marble Hill Park.

6.1 Site Conditions

The site constraints in relation to sports use are considered below.

Levels and Microrelief

Major modifications to the overall levels of the pitches should not be required, although selective re-grading is recommended, particularly across the football pitches, to remove surface undulations and to create a suitably flat playing surface.

Rugby Pitch 2 could potentially be shifted southwards to avoid the bank rising to the north-east.

Drainage System

There is currently no drainage infrastructure present on the site. It is understood that fixtures are frequently cancelled during the winter and Football Pitch 3 and Rugby Pitch 2 are commonly out of action due to waterlogging. As such, drainage assistance is likely to be necessary for the winter sports pitches to prevent cancellations and potentially increase pitch usage hours.

As cricket is played during the drier summer months and it is a lower impact sport, formal drainage infrastructure is unlikely to be necessary in this area.

More detailed discussion on drainage is given in Section 6.8 below.

Flooding

It is understood that the southwestern part of the site is susceptible to flooding from the River Thames, which can disrupt use of the rugby pitches whilst the area is flooded. To reduce the amount of lost usage, it is suggested that allowance is made for appropriate repair and reinstatement works once the water has dissipated. This will require sufficient capital to be set aside within the maintenance budget.

The most significant problems associated with flooding, aside from disruption of fixtures, are 'silt capping' resulting in loss of surface connection to any new drainage system, together with damage to the grass sward. If a drainage system is to be installed in this zone, it would be sensible to allow for the re-installation of secondary drainage (e.g. sand grooves) following flooding events to maintain the surface connection with the primary drains.

Shade

The rugby pitches and many of the football pitches may be susceptible to shade and leaf fall. As such, the selection of seed mixes and maintenance operations would need to take this into account.

Pitch Orientation

The current orientation of Pitch 6 (Junior 7 v 7 pitch) would fall outside the recommended range, however, nearby mature trees to the south alongside the river and to the west may mitigate the effects of low sun in the west.

6.2 Soil Quality

The main limitation posed by the topsoil within the sports pitches is associated with its fine texture and broad particle size distribution. Such soils typically have low structural strength and are therefore prone to structural degradation and compaction, especially when they are in a wet and plastic state. These conditions affect the function and usage of the sports pitch, and this is exacerbated if the usage hours over the winter months are high. This is demonstrated by the reduced infiltration recorded in Football Pitch 1, which is understood to be heavily used.

The soils may restrict drainage from the overlying topsoil during periods of heavy or prolonged rainfall. The performance of the soil for sports pitch use could potentially be improved with some form of drainage assistance.

The overall stone content of the topsoil within the sports pitches was low, however occasional subangular small to medium sized stones (20-50mm) were recorded. As such, the overall proportions of stone should not constitute a limitation for the sports pitches, *provided* the soil profile remains undisturbed and good grass cover is maintained. If any regrading is proposed in future, it may be prudent to carry out a stone reduction exercise during the works.

The chemical composition of the soils is generally acceptable for sports pitch grass cultivars, provided the nutrient levels are supplemented by an appropriate annual fertiliser regime. The soil pH in the cricket outfield area was found to be strongly acid (pH 5.0) and as such, application of agricultural grade lime could be beneficial. Perennial ryegrass typically prefers a slightly acid to slightly alkaline pH range (pH 5.5 – 7.5).

6.3 Turf Quality

The overall quality of the turf is moderately high in relation to use for the sports catered for. Evidence of wear was observed in play 'hotspots', such as football goal mouths and centre circles. Significant surface undulations were recorded within these hotspots and as such, localised infilling and regrading may be necessary here.

With reference to the supplied background information, the existing maintenance schedule is fairly comprehensive and includes important operations such as aeration, overseeding, localised topdressing and a fertiliser regime. This has achieved a good quality sward on the whole. However, a more intensive maintenance programme may be considered (depending on budget constraints etc) to further improve the resilience of the sward and complement any new drainage infrastructure. Further discussion and recommendations are given below in Section 6.6. Appropriate management of usage should also be considered (see Section 6.11 below).

6.4 Current Quality and Usage Potential

The overall condition and quality of the existing sports pitches was good, with satisfactory overall ground cover, soil depths, root development and grass species.

Football and Rugby Pitches

The limitations for the winter sports pitches appear to be high usage levels, drainage restriction, and uneven microrelief. The high usage levels on certain pitches have resulted in a deterioration of the playing surface within goal mouths and centre circles. If the same level of usage is to be sustained or increased, additional treatments are recommended to maintain a satisfactory playing surface.

The pitches are currently undrained. With the existing soil conditions, this would generally allow up to 3 hours of junior play or 1-2 hours of adult play *per pitch per week* without a high risk of deterioration.

Sport England considers the following 'guideline' weekly usage hours to be applicable to the following drainage system types (although this does not necessarily consider other factors, such as soil type, climate and maintenance regimes):

Table 10: Sport England Guideline Weekly Usage

Drainage Type	Adult weekly use hours	Youth (15 years or below) weekly use hours*
Undrained	Up to 2	Up to 3
Pipe Drained	2 – 3	3 – 4.5
Pipe drained with mole drains	2 – 4	3 – 6
Pipe drained with sand grooves	3 – 6	4.5 – 9
Pipe drained with slit drains	3 – 6	4.5 – 9
Pipe drained with topsoil and drainage layer	3 – 6	4.5 – 9
Pipe drained with suspended water table	4 – 6	6 – 9

* Usage hours for players 15 years or younger will increase by approximately 50% compared to that of adults.

Cricket Outfield

As cricket is a summer sport, it is usually played during warmer and drier conditions. Furthermore, there is less wear from the nature of the sport, e.g.no tackling or scrummaging. As such, the sport places fewer demands on the sward. However, the summer months can present other considerations such as drought, and therefore a resilient sward is necessary to prevent generation of unsightly bare patches.

The physical characteristics of the existing soils within this area, including infiltration and drainage, appear to be sufficient to support grass for summer sport. However, the sward does appear to be a little 'hungry' in places and moss is occasionally present. As such, it may be beneficial to address the strong acidity and low fertility status of the topsoil in this area to support an improved sward.

The microrelief within the cricket outfield is reasonably even and this factor could be considered less crucial for this sport.

6.5 Pitch Improvement Options

Football and Rugby Pitches

Football and rugby are winter sports and are therefore often played during wet weather. This means that the grass surface can be subject to wear and tear in unfavourable conditions. Good drainage is essential to support play and potentially increase pitch usage.

In order to increase the quality of the football and rugby pitches and usage hours, a programme of improvements could be considered. A phased approach could be carried out as follows (depending on budget constraints):

- Short-Term Plan — Upgraded maintenance
- Medium Term Plan — Surface improvement
- Long-Term Plan — Regrading and draining the pitches

Further discussion on these improvement options, together with outline budget costs are given in Appendix 5.

Depending on budget constraints, it may be desirable to focus these improvements on the adult football pitches and rugby pitches. Junior players will subject the pitches to less impact and as such, improvements to the smaller pitches may be less important at this stage.

Cricket Outfield

As mentioned above, the quality of the existing cricket outfield is largely satisfactory and the current maintenance regime would be considered sufficient for the most part. However, some additional treatments could be beneficial to improve the colour and vigour of the sward (see Section 6.6 below in relation to the cricket outfield).

6.6 Upgraded Maintenance

Football and Rugby Pitches

In the short term, a more intensive maintenance programme could be considered to encourage a more resilient grass sward to sustain and potentially increase the existing usage levels.

The following additional maintenance treatments are suggested for the football and rugby pitches:

- Topdressing over the whole pitch rather than just the goal mouths
- Two fertiliser applications per annum

These recommendations are discussed below. An estimated budget is indicated in Appendix 5.

Topdressing

Budget permitting, sand top dressing over the whole of each pitch could be considered rather than just within goal mouths. Sand top dressing, especially when used in conjunction with aeration treatment, improves and maintains water infiltration and surface wear. Application with a drop spreader with drag mat immediately after spiking/verti-draining allows some of the sand to enter the voids created, and encourages grass roots to grow deeper. If it is carried out year on year, it partially replaces the surface soil layer and thereby improves the wear and tear properties of the pitch. Usually an application rate of between 60-80 tonnes per hectare is recommended.

Use of a pure sand topdressing is recommended as opposed to a sand/compost or sand/soil mix. The product should be selected to ensure that the grading of the topdressing sand is compatible with that of the topsoil to reduce risk of particle interpacking.

Fertiliser Application

At present fertiliser application is carried out once a year during Spring renovation works. Based on the findings of the Soil Resource Survey, the topsoil is deficient in phosphorus and potassium. Phosphorus is important for root growth and potassium is often needed to improve grass wear tolerance and resilience to cold, heat or drought stress. In order to provide greater input of nutrients to the soil over the year, improve colour and prepare the sward for winter, we would suggest also allowing for an Autumn fertiliser application.

Cricket Outfield

Most of the annual maintenance work to the cricket field focusses on the surrounds of the synthetic wicket (5 metres beyond the edge). This is considered acceptable on the whole as this is where play is typically focused.

An additional fertiliser application is recommended in Spring to prepare the grass for the season.

Lime application is also suggested to raise the pH and improve sward colour. Lime is normally applied every 2 to 3 years. Suitable lime products can include agricultural grade lime or crushed chalk, although some liquid products are also available.

It may be beneficial to carry out fertiliser and lime applications to the whole outfield to improve overall sward quality. Some localised moss treatment may also be necessary in the cricket outfield.

6.7 Surface Improvement – Winter Sports Pitches

Smearing of the topsoil surface on winter sports pitches will reduce infiltration, particularly as the season progresses. Whilst the twice monthly aeration treatment and recommended annual topdressing will help to mitigate this, there are two additional treatments that would improve the general wear tolerance and infiltration of the topsoil. These are topsoil sand amelioration and installation of sand grooves.

Amelioration of the topsoil surface with a heavy application of sand could be made to create a more resilient layer. This would typically involve placing a 25-50mm layer of sand and incorporating it into the upper 25mm of the topsoil surface (e.g. using a power harrow).

To be effective, this operation would necessitate prior removal of the existing grass (e.g. by herbicide application or using suitable equipment such as a Koro Field Top Maker) and followed by establishment of a new sward. The replacement grass will need a period of 'Establishment Maintenance' – see Section 6.9 below for recommendations.

Sand grooves will provide an efficient means of carrying water off the surface and through the topsoil layer. These are small slits (typically 150mm deep and 20mm wide) that are cut into the topsoil at 260mm centres and filled with washed sand. These grooves are forced into the soil with a tine rather than excavating a trench. Therefore, no arisings are created. Sand grooves usually need to be reinstalled every 3-5 years and topdressing is important to retain the integrity of the surface to reduce smearing and capping over the sand grooves.

Sand groove installation alone would not necessitate prior removal of the grass sward, although overseeding is recommended afterwards.

Effective sand groove installation will require the topsoil to be sufficiently consolidated. Therefore, if these works are carried out in conjunction with topsoil sand amelioration, the replacement grass sward should be allowed to establish satisfactorily before installing the grooves.

6.8 Regrading and Drainage Installation – Winter Sports Pitches

Regrading the ground surface to improve microrelief, together with drainage installation could be considered. These works will require considerable capital investment to initiate and will need to be maintained appropriately.

Regrading and drainage installation will cause significant disruption during the works. As such, it is recommended that these operations are carried out in tandem with one another. To minimise disruption, the works could potentially be carried out within one or two pitches at a time. However, it should be noted that this can make drainage installation more complex and imbalance material volumes during regrading.

The appointment of a specialist sports pitch construction contractor is recommended for any drainage and regrading work. The contractor should be a member of relevant reputable trade organisations such as SAPCA (Sports and Play Construction Association) and LDCA (Land Drainage Contractors Association).

Regrading

The microrelief of the football pitches in particular is currently considered quite variable and will adversely affect ball roll during play. In addition, the presence of hollows could encourage water to collect.

Regrading can be carried out in two main ways, either by regrading the topsoil surface or by first stripping the topsoil and regrading the subsoil beneath, prior to replacement of the topsoil to a smooth even grade. The method used will depend on the topsoil depth and height of the undulations. The existing topsoil depth range is reasonably thick and as such, it is unlikely that the topsoil would need to be stripped beforehand, although deeper hollows (e.g. worn goal mouths) are likely to need infilling. Further modelling of levels and determination of topsoil depths at higher resolution will be required to confirm the extent of any regrading works.

These works will disturb stones present in the topsoil and as such, stone removal is recommended prior to final levelling and seeding to remove stones from the surface.

Regrading will necessitate prior removal of the existing grass sward, followed by establishment of a new sward. The replacement grass will need a period of 'Establishment Maintenance' – see Section 6.9 below for recommendations.

Drainage

To provide a good playing surface, especially for winter games pitches, it is necessary to have well-drained turf. Experience has shown that winter pitches with consistently dry turf will withstand a large amount of play and only require minor renovations. Turf surfaces used for sport should be moist enough to sustain grass growth, but the surface should not be so moist as to adversely affect the quality of play.

Drainage assistance is often necessary in order to enable more play to take place and to reduce the risk of pitch deterioration. Three games a week can damage a pitch intensely and four games a week can be critical if the pitch is too wet and non-drained. One game played on a very wet pitch can damage the sward so intensively that the playing quality is affected for the rest of the season. Management of the pitches to prevent excessive wear when wet is therefore of vital importance (see Section 6.11 below).

It should be noted that the types of sports played on the playing field will influence usage hours. Winter sports such as football and rugby are considered higher impact and will subject the pitch to more wear and tear, particularly as they are typically played during the wetter months. Summer sports such as cricket are lower impact and the pitch surface is often drier in summer.

Problems of Poor Drainage

Poor drainage quickly becomes apparent as soon as too much play is permitted with wet ground conditions. By then it may be too late to rectify the situation until the winter is over and in the meantime the players have to contend with poor playing conditions, cancellations and disruption to fixture lists. It is however, the long-term effects which are likely to be the most damaging.

It is understood that poor drainage is currently restricting use of Rugby Pitch 2 and Football Pitch 3.

Excessive moisture on the surface will generally lead to:

- reduced aeration of the soil
- reduced root development
- no resistance to wear
- less drought resistance
- slow growth in Spring
- susceptibility to disease

The final result is a grass coverage that has no durability and that will not support the amount of play expected from a winter sports pitch.

Pitch Usage and Drainage Design

The extent to which drainage is required depends not only the natural drainage of the site, but also on the amount and type of use. There are a number of possible options for the drainage of the sports pitches, depending on the quality of pitch required, the hours of usage and the level of on-going maintenance provided.

The removal of excess water from the surface can be achieved by a number of means, some of which are discussed in the above report sections, including:

- decompaction treatments (e.g. verti-draining, groundbreaker)
- heavy sand top dressing
- installing a primary land drainage system
- installing sand slits/bands (secondary drainage)
- ameliorating the existing soils with sand
- importing a new rootzone material

In this instance, the performance and the potential usage capacity of the pitches could be improved by some form of positive drainage (e.g. pipe network with sand grooves). Furthermore, sand amelioration and ongoing topdressing (as discussed above) are essential to maintain the topsoil's resistance to smearing and compaction, and the connection between the surface and the drainage system.

If a piped positive drainage system is to be considered, a suitable outfall will be required. Sustainable drainage principles would need to be considered to retain drainage water on site to manage the flow of the water at the discharge point. The presence of London Clay beneath the site is likely to restrict the use of soakaways, although options to reduce flow at the discharge point(s) (e.g. attenuation basin and / or hydrobrake) could be considered. Outfall into existing surface water sewers or watercourses would require the necessary discharge consents to be obtained.

6.9 Establishment Period Maintenance (After Topsoil Sand Amelioration or Regrading) – Winter Sports Pitches

If the existing grass sward is removed and replaced to allow for sand amelioration or regrading works, a programme of maintenance is essential after seeding and before the pitches are used. This is referred to as the Establishment Period and involves a selection of treatments to encourage the growth and establishment of a tight grass sward.

Treatments will usually include:

- Mowing
- Irrigation
- Rolling
- Spiking
- Scarifying
- Harrowing
- Levelling hollows and bumps
- Fertiliser application
- Relieving turf compaction
- Weed and pest control

6.10 Post Flooding Treatment

In addition to the more routine maintenance operations, further treatments to repair the surface after any flooding events will be required within the affected area of the Rugby Pitches. It would be sensible to set aside a supplementary budget for re-installation of any sand grooves (if installed) and reseeding of damaged grass areas.

6.11 Management of Usage

Careful management of pitch usage is important to prevent unnecessary damage and prolong the life of good quality playing surfaces.

Natural turf pitches that are used in the non-growing season for four games a week spread out over a seven day period will not wear as fast as pitches that accommodate four consecutive games on the same day or on consecutive days. Cancelling matches when ground conditions are not suitable will ensure increased use in the long term, as the pitch will not become as severely damaged as if it would if played on in poor weather conditions.

Acceptable limits of usage need to be made so as not to make the game either dangerous or unacceptable, and to enable the structure of the surface to be retained to allow future games to take place without weeks of renovation being required.

When a pitch is played on in poor weather the surface can become denuded very quickly, this may substantially increase the cost of renovation works at the end of the season. One game played upon a pitch after or during inclement weather can seriously destroy the structure of the surface; in some instances making the pitch almost unplayable for the rest of the season.

7.0 FURTHER WORK

In light of our findings, the following additional input is suggested to inform future improvement works to the sports pitches.

- In order to determine the requirements for regrading and drainage works, detailed assessment and modelling work using the existing topographic survey information would need to be carried out.
- It is recommended that a performance led specification is produced for the selected playing field improvement works to ensure that the work can be priced on a like for like basis and to ensure that the desired standard is achieved.
- If drainage installation work is to be carried out, a detailed drainage layout should be produced to indicate the correct orientation and positioning of the required infrastructure and discharge point(s).
- Soakage tests are recommended to determine the feasibility of soakaways as a means of drainage outfall.

If you would like to pursue any of these items, we will be happy to discuss the relevant issues in further detail.

TOHA would like to thank English Heritage for entrusting the practice with this commission. TOHA trusts this report meets with your approval and provides the necessary information. Please do not hesitate to contact the undersigned for further assistance.

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Principal Consultant

For and on behalf of Tim O'Hare Associates LLP

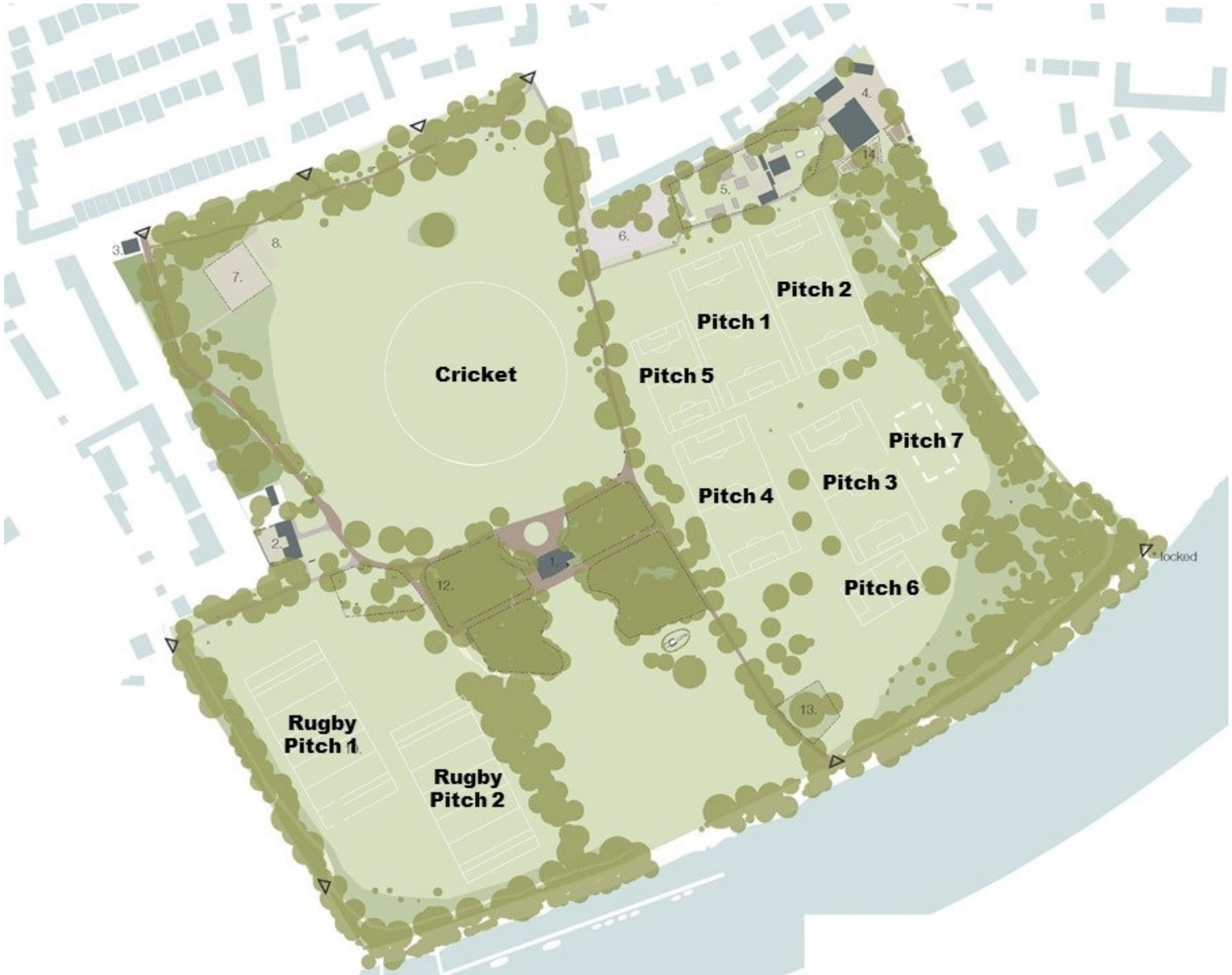
Report Qualifications

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

This investigation considers the quality and usage potential of the existing sports pitches at Marble Hill Park, Twickenham. It should not therefore be relied on for alternative end-uses or for other schemes. This report has been prepared solely for the benefit of the client English Heritage. No warranty is provided to any third party and no responsibility or liability will be accepted for any loss or damage in the event that this report is relied upon by a third party or is used in circumstances for which it was not originally intended.

Appendix 1

Site Plan Pitch Locations and References



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Client:	English Heritage		
Project:	Marble Hill Park Sports Pitches		
Job ref no.:	TOHA/16/4003/CS		
Drawing no.:	4003/1		
Drawing title	Pitch Locations and References		
Date:	Dec '16	Scale:	NTS
Drawn by:	RH	Checked by:	CS

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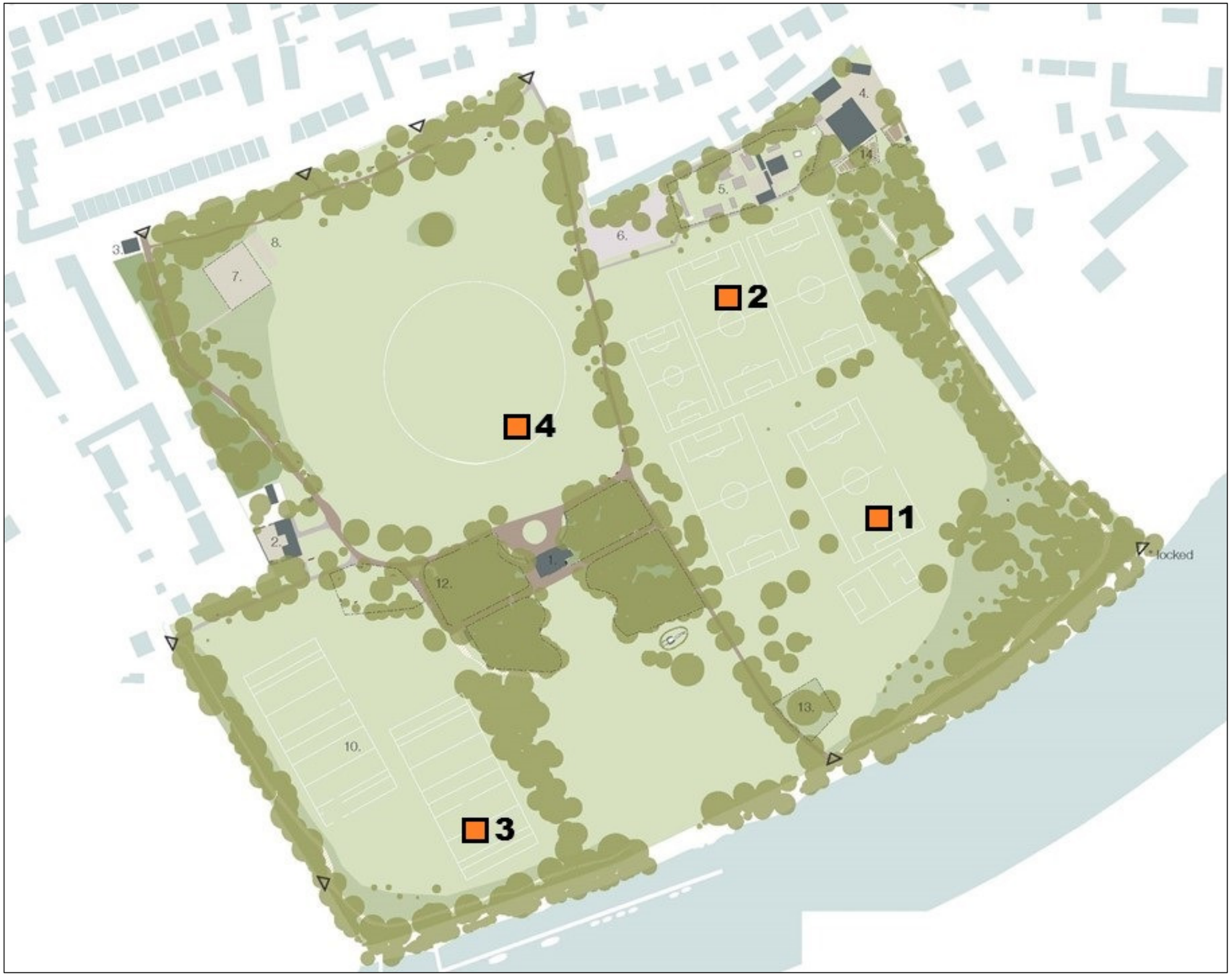
Appendix 2

Site Plan – Infiltration Test Locations



= Infiltration Test Locations (approx.)

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Client:	English Heritage		
Project:	Marble Hill Park Sports Pitches		
Job ref no.:	TOHA/16/4003/CS		
Drawing no.:	4003/2		
Drawing title	Infiltration Test Locations		
Date:	Dec '16	Scale:	NTS
Drawn by:	RH	Checked by:	CS

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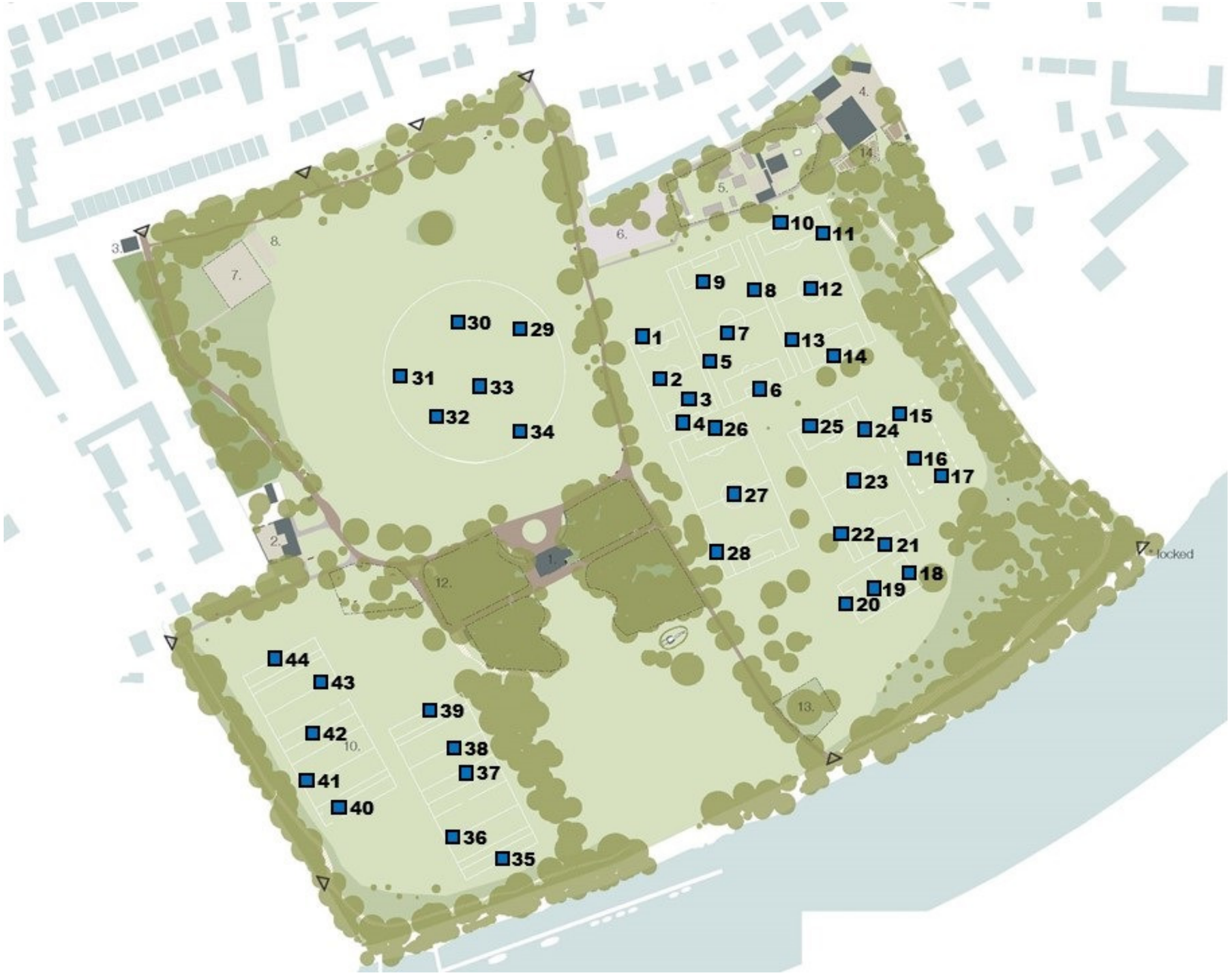
Appendix 3

Site Plan – Turf Assessment Locations



= Turf Inspection Locations (approx.)

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Client:	English Heritage		
Project:	Marble Hill Park Sports Pitches		
Job ref no.:	TOHA/16/4003/CS		
Drawing no.:	4003/3		
Drawing title	Turf Inspection Locations		
Date:	Dec '16	Scale:	NTS
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Appendix 4

Turf Assessment Results

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SOIL & LANDSCAPE CONSULTANCY

Marble Hill Park - Sports Pitches Turf Assessment - 29/11/2016

Football Pitches

Performance Property	Pitch No.	P5	P5	P5	P5	P1	P1	P1	P1	P1	P2	P2	P2	P2	P2	P7	P7	P7	P6	P6	P6	P3	P3	P3	P3	P3	P4	P4	P4	Average
	Location No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
	Unit	Score																												
Ground Cover	%	99	17	99	7	99	94	21	98	0	1	96	2	98	8	99	100	99	94	100	98	69	100	99	100	0	65	100	98	70
Bare Area	%	1	73	1	93	1	6	79	2	100	99	4	98	2	82	1	0	1	2	0	2	31	0	1	0	100	35	0	2	29
Weeds	%	0	0	11	0	3	0	0	10	0	0	4	1	3	0	5	7	4	15	25	10	2	9	0	8	0	15	25	10	6
Moss	%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Algae/Lichen	%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Undesirable Grass Species	%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Desirable Grass Species	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Disease	%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Worms	%	6	7	4	4	2	3	1	8	1	2	2	1	3	2	2	1	2	2	1	0	1	1	2	1	0	2	1	0	2
Evenness	3 m/st/e: mm	9	9	8	35	6	40	10	10	40	35	9	5	8	21	12	8	7	11	6	9	14	4	7	5	35	20	6	9	14

Rugby Pitches

Performance Property	Pitch No.	P2	P2	P2	P2	P2	P1	P1	P1	P1	P1	Average
	Location No.	35	36	37	38	39	40	41	42	43	44	
	Unit	Score										
Ground Cover	%	100	100	100	98	98	89	54	92	99	99	93
Bare Area	%	0	0	0	2	2	11	46	8	1	1	7
Weeds	%	9	2	15	2	4	6	11	9	8	7	7
Moss	%	0	0	0	0	0	0	0	0	0	0	0
Algae/Lichen	%	0	0	0	0	0	0	0	0	0	0	0
Undesirable Grass Species	%	0	0	0	0	0	0	0	0	0	0	0
Desirable Grass Species	%	100	100	100	100	100	100	100	100	100	100	100
Disease	%	0	0	0	0	0	0	0	0	0	0	0
Worms	%	2	2	3	0	0	2	2	1	5	1	2
Evenness	3 m/st/e: mm	13	8	6	4	3	7	16	6	9	6	8

Cricket Outfield

Performance Property	Pitch No.	29	30	31	32	33	34	Average
	Location No.							
	Unit	Score						
Ground Cover	%	98	100	99	100	98	99	99
Bare Area	%	2	0	1	0	2	1	1
Weeds	%	3	3	0	2	1	2	2
Moss	%	0	20	0	0	0	0	3
Algae/Lichen	%	0	0	0	0	0	0	0
Undesirable Grass Species	%	0	0	0	0	0	0	0
Desirable Grass Species	%	100	100	100	100	100	100	100
Disease	%	0	0	0	0	0	0	0
Worms	%	0	1	1	2	1	1	1
Evenness	3 m/st/e: mm	7	4	7	6	4	5	6

Appendix 5

Estimated Costs

ESTIMATED COSTS

This Appendix contains a series of estimated budget costs for works discussed in Sections 6.6 – Section 6.10 of the above report.

Please note, all budget cost estimates are intended as a guide only and do not include any associated costs relating to transport and preliminaries, setting out, ancillary boundary installation (e.g. fencing / landscaping) or contingency allowance.

These estimates are based on the pitch dimensions indicated above in Section 2.1 of the above report.

1.0 Upgraded Maintenance Operations

Winter Sports Pitches

Estimated annual budgets for the suggested upgraded maintenance operations (not including current operations) are given in Tables 1.1 and 1.2 below. The estimate given in Table 1.1 is for all of the football and rugby pitches. Table 2.2 contains an estimate for the *adult* football pitches only and the rugby pitches.

Table 1.1 – Estimated Budget for Upgraded Maintenance Operations – All Winter Sports Pitches

Treatment	Estimated Cost
• Topdressing (1 application @ 80 tonnes per hectare) • Fertiliser (1 application *in addition to current Spring application*) **TOTAL:**	£11000.00 £1500.00 **£12500.00**

Table 1.2 – Estimated Budget for Upgraded Maintenance Operations – Adult Football Pitches and Rugby Pitches

Treatment	Estimated Cost
• Topdressing (1 application @ 80 tonnes per hectare) • Fertiliser (1 application *in addition to current Spring application*) **TOTAL:**	£9000.00 £1500.00 **£10500.00**

Cricket Outfield

Estimated budgets for the suggested additional fertiliser application and lime treatment is given in Tables 1.3 and 1.4 below:

The estimate given in Table 1.3 is based on application to the area surrounding the synthetic wicket only (500m^2). Table 1.4 contains an estimate for the whole outfield (approx. 12800m^2).

Table 1.3 – Estimated Budget for Upgraded Maintenance Operations – Cricket – Area Surrounding Wicket only

Treatment	**Estimated Cost**
• Fertiliser (1 application *in addition to current Autumn application*)	£50.00
• Lime (1 application)	£100.00

Table 1.4 – Estimated Budget for Upgraded Maintenance Operations – Cricket – Whole Outfield

Treatment	**Estimated Cost**
• Spring Fertiliser (1 application *in addition to current Autumn application*)	£900.00
• Autumn Fertiliser application to *remainder of outfield*	£850.00
• Lime (1 application)	£2500.00

2.0 Surface Improvement – Winter Sports Pitches

Estimated costs for topsoil sand amelioration and sand groove installation for the winter sports pitches are indicated in Tables 1.5 and 1.6 below.

The estimate given in Table 1.5 is for all of the football and rugby pitches. Table 1.6 contains an estimate for the *adult* football pitches only and the rugby pitches.

Table 1.5 – Estimated Budget for Sand Amelioration and Sand Groove Installation – All Winter Sports Pitches

Item	Estimated Cost
Topsoil Sand Amelioration	
• Vegetation Treatment^	£1500.00
• Sand Amelioration*	£75000.00
• Fertiliser Application and Seeding	£15000.00
Sand Groove Installation	
• Sand Groove Installation	£45000.00
• Overseeding	£8000.00
^ Based on herbicide application *assumes a 25mm layer of sand incorporated into surface of topsoil.	

Table 1.6 – Estimated Budget for Sand Amelioration and Sand Groove Installation – Adult Football Pitches and Rugby Pitches

Item	Estimated Cost
Topsoil Sand Amelioration	
• Vegetation Treatment^	£1000.00
• Sand Amelioration*	£65000.00
• Fertiliser Application and Seeding	£12000.00
Sand Groove Installation	
• Sand Groove Installation	£40000.00
• Overseeding	£7000.00
^ Based on herbicide application *assumes a 25mm layer of sand incorporated into surface of topsoil.	

3.0 Regrading and Drainage Installation – Winter Sports Pitches

Estimated costs for regrading and drainage installation are indicated in Tables 1.7 and 1.8 below.

The estimated costs for regrading are based on modifying the topsoil surface only (i.e. no prior stripping of the topsoil layer).

Drainage installation costs are based on a piped drainage system with a secondary sand groove system (e.g. Sport England 'Type 4' system). At this stage, a rough cost estimate has been made for installing drainage to a site of this size, without allowance for gradient variability or network complexity. A detailed drainage layout would need to be designed to enable accurate costs to be calculated. No allowance is made at this stage for installation of attenuation systems or discharge of site. The budget costs do not include allowance for removal of drainage excavation spoil from the site.

The estimate given in Table 1.7 is for all of the football and rugby pitches. Table 1.8 contains an estimate for the *adult* football pitches only and the rugby pitches.

Table 1.7 – Estimated Budget for Regrading and Drainage Installation – All Winter Sports Pitches

Item	Estimated Cost
• Vegetation Treatment^	£1500.00
• Topsoil Regrading	£15000.00
• Primary Drainage Installation#	£150,000.00
• Final Cultivation and Levelling	£3500
• Sand Amelioration*	£75000.00
• Fertiliser Application and Seeding	£15000.00
• Secondary Drainage Installation~	£53000.00
TOTAL:	**£313,000.00**
^ Based on herbicide application #Primary drainage installation cost assumes a 4m lateral drain spacing *assumes a 25mm layer of sand incorporated into surface of topsoil. ~ Includes overseeding	

Table 1.8 – Estimated Budget for Regrading and Drainage Installation – Adult Football Pitches and Rugby Pitches

Item	Estimated Cost
• Vegetation Treatment^	£1000.00
• Topsoil Regrading	£13000.00
• Primary Drainage Installation#	£130,000.00
• Final Cultivation and Levelling	£3000.00
• Sand Amelioration*	£65000.00
• Fertiliser Application and Seeding	£13000.00
• Secondary Drainage Installation~	£47000.00
TOTAL:	**£272,000.00**
^ Based on herbicide application #Primary drainage installation cost assumes a 4m lateral drain spacing *assumes a 25mm layer of sand incorporated into surface of topsoil. ~ Includes overseeding	

4.0 Establishment Period Maintenance – Winter Sports Pitches

An estimated maintenance budget for a 12 month 'Establishment Period' (assuming Autumn seeding) could be as follows in Tables 1.9 – 1.10 below. This would be considered the minimum requirement and it excludes other possible treatments such as temporary irrigation, overseeding, and pest control. Contingency allowance has been omitted.

The estimate given in Table 1.9 is for all of the football and rugby pitches. Table 1.10 contains an estimate for the *adult* football pitches only and the rugby pitches.

Table 1.9 – Estimated Establishment Period Maintenance Budget – All Winter Sports Pitches

Treatment	Estimated Cost
• Mowing*	£11000.00
• Decompaction (min. 2 treatments)*	£2000.00
• Topdressing (1 application @ 80 tonnes per hectare)	£11000.00
• Fertiliser (2 applications)	£3000.00
• Herbicide (1 application)	£1500.00
TOTAL:	**£28500.00**

* If undertaken by a sports pitch contractor. Alternatively, this could be undertaken by the Park's grounds staff.

Table 1.10 – Estimated Establishment Period Maintenance Budget – Adult Football Pitches and Rugby Pitches

Treatment	Estimated Cost
• Mowing*	£9000.00
• Decompaction (min. 2 treatments)*	£1500.00
• Topdressing (1 application @ 80 tonnes per hectare)	£9000.00
• Fertiliser (2 applications)	£3000.00
• Herbicide (1 application)	£1000.00
TOTAL:	**£23500.00**

* If undertaken by a sports pitch contractor. Alternatively, this could be undertaken by the Park's grounds staff.

5.0 Post Flooding Treatment – Rugby Pitches

Estimated costs for post flooding treatment operations to the rugby pitches would be as indicated in Table 1.11.

Table 1.11 – Estimated Post Flooding Treatment Budget – Rugby Pitches

Treatment	Estimated Cost
• Sand groove installation (including sand supply)	£15000.00
• Overseeding:	£2500.00