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BOWMER AND KIRKLAND

A feasibility study for the construction of a new playing field for Turing House Free School.

5th April 2018 [REVISION 2 – 14th February 2020]

TGMS REF: 0865.24

TABLE OF CONTENTS

Please note: The aim of this report is to assess the condition of the playing field 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.

REVISION RECORD					
Rev	**Date**	**Description**	**Prepared**	**Checked**	**Approved**
0	05/04/2018	Document Creation	EW	MY	MY
1	18/04/2018	Revision to layout which includes amendments to slopes, orientations, drainage discharge rates and cost estimates.	EW	MY	MY
	14/02/2020	Revision to layout as provided by Bowmer and Kirkland, revision to costings.	MY	RE	RE

1 EXECUTIVE SUMMARY Bowmer and Kirkland

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

Site information

	1	**Objective:** To conduct a detailed site investigation for the development of a new playing field for Turing House Free School. The proposed layout was provided by the Client and comprises four natural turf winter sports pitches plus a cricket square and outfield area for summer use.
	2	**Location:** The development area is characterised by low-grade grassland and is part of land used by Sempervirens Nursery. The site is bounded by residential properties to the north, Hospital Bridge Road to the east, Borough Cemetery to the west and Heathland Recreation Ground to the south.
	3	**Topography:** Topographical data was provided by the Client. The existing gradients are compliant with both Sport England (SE) and The England & Wales Cricket Board (ECB) guidelines therefore cut and fill earthworks are not envisaged, with the exception of removing the large bund towards the east; additional site won or imported topsoil will be required. There are numerous depressions across the development area, therefore surface re-grading is recommended.
	4	**Layout:** The proposed winter sports pitches are orientated outside SE guidance and are therefore subject to low winter sunshine; the Client should consider reorientation of the pitches if possible. The proposed size of the cricket square will provide two pitches, as such, the square may not be able to provide significant cricket use. It is also not recommended to position cricket squares within the safety margins of winter sports pitches due to potential damage from footballer's studs. Man-made throwing circles within the footprint of winter sports pitches is not recommended, plus a 5 m runoff is advised for all four perimeters of rugby union pitch.
	5	**Hydrology:** No watercourses lie within or abut the site therefore outfall for a land drainage scheme is limited to either the use of public surface water drains (not identified onsite) or a soakaway.
	6	**Drainage discharge rates:** Climate data from the Flood Estimation Handbook indicate that the standard-period average annual rainfall (SAAR) for this catchment is 601 mm which is significantly lower than the average and will need to be considered in the development proposal. Drainage design should account for at least the 1:30, 24h outfall rate of 24.9 L/s.
	7	**Flood risk:** The site has a very low risk of flooding from rivers and seas with a chance of flooding of less than 0.1%. The site generally has a very low risk of flooding from surface water with a chance of flooding of less than 0.1%, however this risk increases to a low risk towards the centre of the site with a chance of flooding of between 0.1% and 1%.
	8	**Landfill:** The site does not appear to be located in an area formerly used for landfill which could affect surface levels or the nature of any earthworks.
	9	**Groundwater:** The site is not located within a Groundwater Source Protection Zone.
	10	**Soils:** According to the Soil Survey of England and Wales, the closest mapped association is the HUCKLESBROOK association, which is characterised as 'well drained coarse loamy and some sandy soils commonly over gravel, some similar permeable soils affected by groundwater'. This is in alignment with near surface soils identified in geotechnical site investigation provided by the Client.
	11	**Geology:** Data from the British Geological Survey indicates that the underlying bedrock geology comprises London Clay Formation. The geotechnical site investigation identified Clay at depths ranging from 3.40 m – 4.70 m bgl and was proven to a maximum depth of approximately 7.00 m bgl. This could inhibit the use of deep bored soakaways and may impact the viability of shallow soakaways as drainage outfall. If soakaways are envisaged, BRE 365 infiltration test data will be required to confirm soil/bedrock permeability which can then also be used to calculate attenuation requirements.
	12	**Test pits:** The topsoil depth and texture is very consistent across the site and comprises a ~300 mm depth of sandy silt loam containing the occasional stone. Subsoil texture varied but became gravelly at approximately 500-600 mm depth bgl. Surface regrading required to develop the site for sports use will destroy any existing, natural soil structure so that drainage performance will be very poor. Therefore, a new land drainage scheme is recommended – without this, the pitches will not drain efficiently.
	13	**Nutrient status:** The topsoil is deficient in the major plant nutrients Potassium and Magnesium and so fertiliser is recommended post-construction to address this deficiency. Soil pH in the range 5.6 to 6.3 is appropriate for the cultivation of Perennial ryegrass species.

	14	**Agronomic condition:** Current agronomic quality is not suitable for a sports playing field. Surface cultivations will be required to address minor undulations and so it is recommended that the site is sprayed with glyphosate prior to cultivations; a flail mower operation should also be budgeted for.
	15	**Other:** The site is situated adjacent to residential properties. With this in mind, further investigation may be required in evaluating the impact and risks associated with ball games played in the vicinity of residential properties. The implementation of safety precautions such as ball-stop netting will need to be considered by the Client.

Development summary

1.	Indicative costs for the development of the new playing field to the proposed layout are £264,895 including a 12-months maintenance package (excludes VAT and fees).
2.	Further detail on the components of these costs, and assumptions made, are included in the report.

(The above costs exclude the cost of permissions, planning etc.)

Please note that the Client should determine whether or not planning permission from the Local Authority is required for the proposed works. The outfall of drainage water is subject to the relative permissions. The costs for obtaining these permissions are not included within the estimates in this document and are the responsibility of the Client.

Elliot Wilson – April 2018

2 INTRODUCTION AND OBJECTIVES

TGMS Limited has been commissioned by Bowmer and Kirkland to conduct a detailed site investigation for the development of a new playing field for Turing House Free School as part of the Education Schools Funding Agency.

The objectives of the feasibility study are as follows:

- To undertake a baseline Performance Quality Standard Assessment using Sport England guidelines.
- To undertake a detailed site investigation to include assessment of current soil types and outfall opportunities.
- To review topographic information to assess playing field grades and levels.
- To derive indicative construction costs for budgetary purposes and present costed options where applicable.
- To provide an indicative work programme so that the Client has a clear picture of the duration of the proposed construction works and when the facility may be available for use.

3 PHYSICAL SITE SURVEY

Elliot Wilson of TGMS limited carried out a detailed site investigation of the site on the 8th March 2018.

3.1 Site location and access

The existing site is characterised by low-grade grassland and is part of land used by a garden centre for nursery plants and trees, plus turf and soil for landscaping projects.

Sempervirens Bridge Farm Nursery Hospital Bridge Road, Whitton Twickenham, Middlesex TW2 6LH	Grid reference (site centre); OS X (Eastings) 513306 OS Y (Northings) 173635

The site is bounded by residential properties to the north, Hospital Bridge Road to the east, Borough Cemetery to the west and Heathland Recreation Ground to the south.

Site access is from Hospital Bridge Road via the Sempervirens Nursery.

Figure 1. Aerial view of site showing the indicative locations of the soil test pits (TP1 to TP6). The dashed red line demarcates the proposed development area for sports pitches (indicative, do not scale). The dashed yellow line demarcates land currently used by the nursery which was not investigated during the site visit.

Figure 2. General view of site looking west.

Figure 3. General view of site looking north-west.

Figure 4. General view of site looking east.

Figure 5. General view looking north towards residential properties.

3.2 Topographical (levels) survey and layout

An important aspect of site evaluation and remediation is appropriate utilisation of the natural grade (slope) of the site to optimise future earthworks and effect rapid removal of excess water.

Topographical data were supplied by the Client (Title: Topographical & Utility Survey, Drawing No: JKK9319-01 (Rev-A)). The pitch layout and orientations were determined from Drawing FS0316-ALA-00-XX-DR-L-0006 Rev PO3 also provided by the Client (Figure 6).

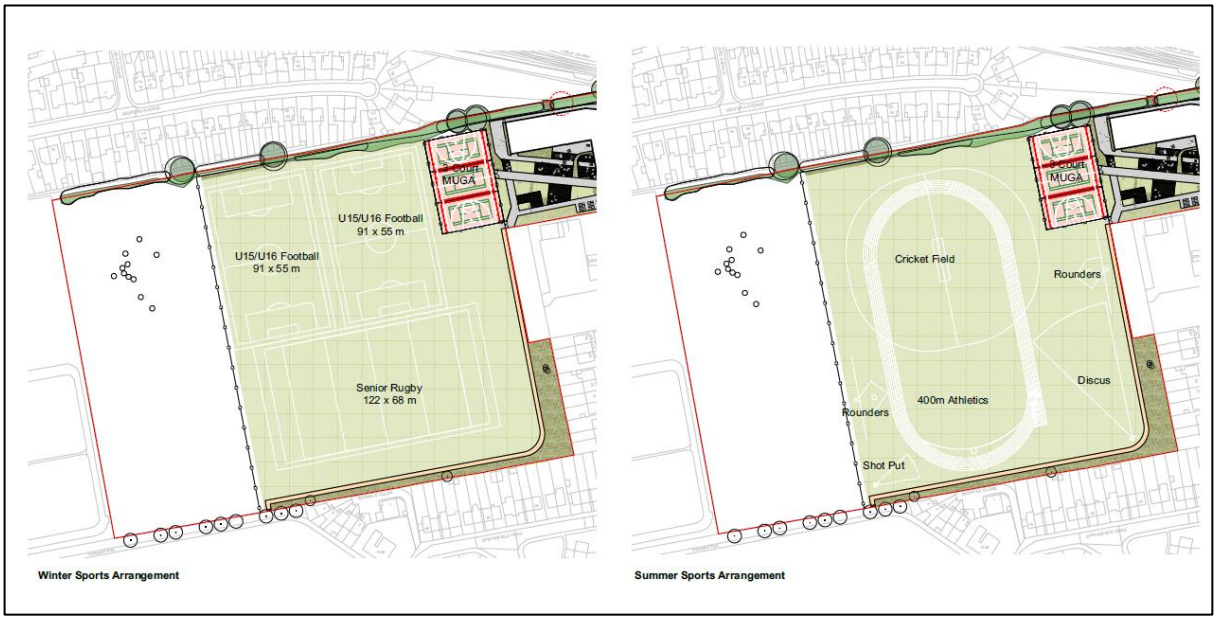

Figure 6. Proposed winter and summer sports pitch layout provided by the Client (reproduced by TGMS).

Sport England (SE) recommends that natural turf winter sports pitches should be on a single plane, ideally with a cross fall with a maximum fall in the playing direction of 1.25%, and 2.00% across play. The dimensions and slopes of the proposed pitches are given in Table 1.

Table 1. Dimensions and slopes of the proposed winter sports pitches as shown in Figure 6. Dimensions and orientations flagged in red are not compliant with Sport England recommendations. Please note that all gradients are indicative only.

Pitch	Length (m)	Width (m)	Safety Margin (m)	Area (m^2)	Slope (measured onsite)		Orientation
					Direction of play	Across play	
Senior Rugby Pitch	122*	68	6 / 3	9,916	0.20%**	0.31%**	258°
Football Pitch	91	55	3	5,917	0.31%	0.19%	350°
Football Pitch	91	55	3	5,917	0.31%	0.20%	350°
Total	-	-	-	21,750	-	-	

**includes 11 m in-goal areas for rugby.*
***does not account for large bund situated within the footprint of the proposed rugby pitch.*

In summary, the existing gradients measured onsite comply with SE guidance therefore cut and fill earthworks are not envisaged, with the exception of removing the large bund in the rugby pitch's location; additional site won or imported topsoil will be required. There are numerous depressions across the development area and so surface re-grading is recommended.

For cricket outfields, it is advantageous to have a slight slope ideally running away from the square to facilitate drainage, but in all cases, The England & Wales Cricket Board (ECB) recommend outfield gradients do not exceed 2.0% (1:50). Given this information and the aforementioned pitch gradients, the existing onsite gradients comply with ECB guidance.

The final surface levels of a cricket square should be of a consistent and uniform grade and blend in with the surrounding outfield. The ECB recommend that surface gradients along the direction of play should be level although a grade of 1.0% is acceptable, and gradients across the direction of play should ideally fall between 1.25 – 1.66%. The fine tuning of cricket square gradients can be addressed during the design phase if required.

3.2.1 Pitch orientation and layout

Sport England has published guidance on optimum pitch orientation for a range of sports (Figure 7). The limits of orientation are 285° and 20° for winter sports pitches, and 305° and 055° for cricket. These are set in order to mitigate against the effects of low winter sunshine projection.

With reference to Figure 6, the proposed football pitches are orientated at 350° and are therefore compliant with SE guidance. The Senior Rugby Pitch is orientated at 258° and therefore non-compliant with SE guidelines however due to the size of the site and limited scope for pitch layouts, this is not considered an issue. The cricket square is orientated at 350° and therefore compliant with ECB guidelines.

Other important notes on layout:

1. The proposed size of the cricket square (25 x 6 m) will provide two pitches. General guidelines suggest that a single cricket pitch can accommodate up to four matches per season before significant pitch deterioration. With this in mind, it may be prudent to note that the

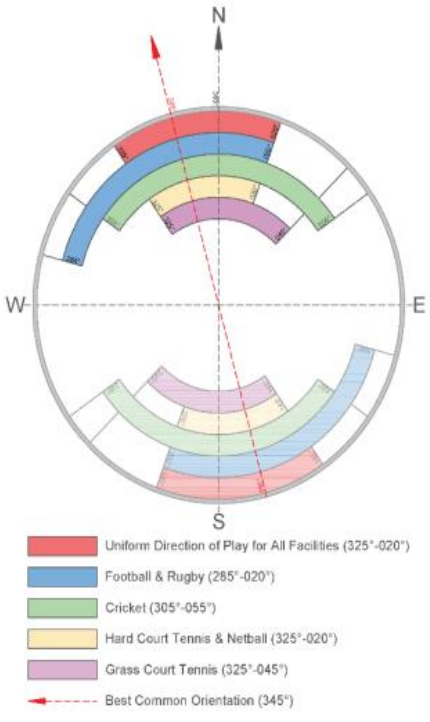

Figure 7. Optimum pitch orientation (Sport England).

proposed square may not be large enough to provide significant cricket use.

2. The proposed cricket square is situated within the safety margin of the winter sports pitches. This is not recommended by TGMS as the square should be fenced off during the winter months to prevent surface damage from footballer's studs.

3. It is not recommended to position man-made throwing circles within the footprint of winter sports pitches as shown on the hockey pitch.

4. A minimum of 5 m runoff is recommended for rugby union pitches – not shown on drawing (assumed to be 3 metres along the touchline and 6 metres at the ends).

3.3 Geomorphology and climate

3.3.1 Hydrology

No watercourses lie within or abut the site. In terms of outfall for a new drainage scheme (if required), this could be achieved by utilising the schools new storm water system or by installing a system of shallow soakaways (providing soils/geology is suitable).

N.B. The responsibility of drainage outfall and obtaining the associated permissions lies with the Client.

3.3.2 Predicted drainage discharge rates

With respect to climate, data obtained from the Flood Estimation Handbook (FEH) indicate that the standard-period average annual rainfall (SAAR) = 601 mm for this location. This annual rainfall figure is significantly lower than average for the UK (2015 England, average of 883 mm/year) and will need to be considered in development options. In the absence of irrigation, sustaining good grass cover in sand based drainage which has low level moisture retention can prove problematic especially during periods of low level rainfall.

Predicted drainage outfall rates (2.95 ha) based on the 6 hr & 24 hr rainfall event for different return periods (FEH) are given in Table 2. Drainage design should account for at least the 1:30, 24h outfall rate of 24.9 L/s.

Table 2. Predicted drainage outfall rates (ADAS 345 Method) for the 6 hr and 24 hr duration events for the return periods shown.

Return period	Drainage Outfall Rate (6 hr FEH rainfall event) (L/s)	Drainage Outfall Rate (24 hr FEH rainfall event) (L/s)
1:1	4.3	7.2
1:30	17.9	24.9
1:100	24.6	32.8

3.3.3 Risk of flooding from rivers and seas

Based on information obtained from the Environment Agency (EA), the site has a very low risk of flooding from rivers and seas with a chance of flooding of less than 0.1%.

3.3.4 Risk of flooding from surface water

Based on information obtained from the EA, the site generally has a very low risk of flooding from surface water with a chance of flooding of less than 0.1%, however this risk increases to a low risk towards the centre of the site with a chance of flooding of between 0.1% and 1%.

3.3.5 Landfill

Based on information obtained from the EA, the site does not appear to be located in an area formerly used for landfill which could affect surface levels or the nature of any earthworks.

3.3.6 Groundwater

Based on information obtained from the EA, the site is not located within a Groundwater Source Protection Zone.

3.3.7 Soils and geology

The soil on site is not mapped by the Soil Survey of England due to the location being in an urban environment. The closest mapped association is the HUCKLESBROOK association, which is characterised as:

- Well drained coarse loamy and some sandy soils commonly over gravel.
- Some similar permeable soils affected by groundwater.
- Usually on flat land.

Data from the British Geological Survey indicates that the underlying geology comprises:

Superficial deposits
Taplow Gravel Member – Sand and Gravel. Superficial Deposits formed up to 2 million years ago in the Quaternary Period. Local environment previously dominated by rivers (U).

Bedrock geology
London Clay Formation – Clay and Silt. Sedimentary Bedrock formed approximately 48 to 56 million years ago in the Palaeogene Period. Local environment previously dominated by deep seas.

A geotechnical site investigation provided by the Client, undertaken by RPS Health, Safety & Environment (REF: HLEI49195/001R) indicates the presence of topsoil to depths ranging from 0.3 m – 0.45 m, overlying Taplow Gravel Formation to depths ranging from 3.05 m – 4.30 m, overlying London Clay Formation to depths ranging from 3.40 m – 4.70 m and was proven to a maximum depth of approximately 7.00 m. Groundwater was encountered at approximately 2.5 m within the Taplow Gravel Formation.

In summary, it is likely that the installation of a deep bored soakaway as drainage outfall would not be suitable due to the presence of London Clay Formation. This could also inhibit the use shallow soakaways as drainage outfall, this should be confirmed with BRE 365 infiltration test data to assess the permeability of the soils/geology which can be used to calculate attenuation requirements.

Ideally, the use of surface watercourses and/or storm water drainage infrastructure for outfall is more suitable and should be explored in the first instance as a means of achieving suitable drainage outfall.

3.4 Soil sampling

To evaluate soil type/structure further for the sports pitch development, six soil test pits (TP) were excavated at targeted locations (Figure 1). Soil samples were removed for laboratory analysis to determine soil texture and basic nutrient status.

	TP1	TP2	TP3
			
Topsoil depth	280 mm	300 mm	320 mm
Topsoil texture	Reasonably structured, dark brown sandy silt loam	Reasonably structured, dark brown sandy silt loam	Reasonably structured, dark brown sandy silt loam
Stones	Occasional stones in topsoil	Occasional stones in topsoil	Occasional stones in topsoil
Thatch content	10 mm	8 mm	10 mm
Subsoil texture and depth	Well structured, orange, moist sandy loam to 600 mm	Well structured, brown and orange, moist sandy silt loam to 500 mm	Well structured, dark orange, very moist loamy sand to 700 mm
Groundwater	None encountered	None encountered	None encountered

	TP4	TP5	TP6
			
Topsoil depth	300 mm	300 mm	300 mm
Topsoil texture	Reasonably structured, dark brown sandy silt loam	Well structured, dark brown sandy silt loam	Reasonably structured, dark brown sandy silt loam
Stones	None	Occasional stones in topsoil	Occasional stones in topsoil
Thatch content	8 mm	10 mm	8 mm
Subsoil texture and depth	Well structured, brown and orange, moist sandy silt loam to 500 mm	Well structured, brown, moist sandy silt loam to 500 mm	Well structured, brown and orange, moist sandy loam to 600 mm
Groundwater	None encountered	None encountered	None encountered

3.4.1 Soil texture

The results from a soil textural analysis of samples sent to contract laboratory are presented in Table 3. The results concur with observations made during the site investigation.

Table 3. Soil texture results.

Trial Pit	Type	Sand (%)	Silt (%)	Clay (%)	Classification
1	Topsoil	49	36	15	Sandy Silt Loam
	Subsoil	72	16	12	Sandy Loam
2	Topsoil	45	39	16	Sandy Silt Loam
	Subsoil	33	49	18	Sandy Silt Loam
3	Topsoil	50	36	14	Sandy Silt Loam
	Subsoil	83	11	6	Loamy Sand
4	Topsoil	48	37	15	Sandy Silt Loam
	Subsoil	45	40	15	Sandy Silt Loam
5	Topsoil	46	38	16	Sandy Silt Loam
	Subsoil	38	44	18	Sandy Silt Loam
6	Topsoil	49	36	15	Sandy Silt Loam
	Subsoil	68	20	12	Sandy Loam

Soils can be classified based on their sand, silt and clay contents according to the Soil Classification of England and Wales (Figure 8). The relatively low clay content of the topsoil and subsoil (6-18%) may lead one to think that the site offers reasonable drainage rates. However, the reality can be counter-intuitive as soils containing high sand content are particularly susceptible to compaction as the soil tends not to re-structure naturally through shrink and swell processes that would normally be associated with clay dominated soils. The relatively high fraction of silt within the soils can also be detrimental to soil structure as silt particles tend to migrate towards and block pores in the soil that are normally associated with the transmission of drainage water and aeration.

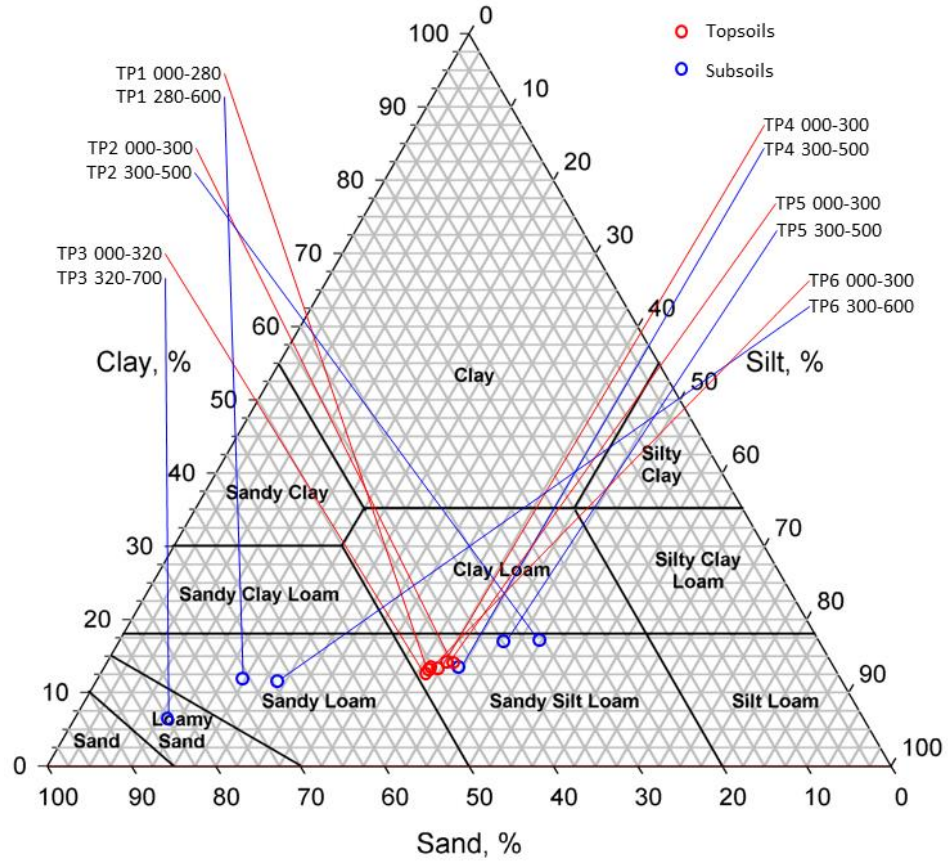

Figure 8. Classification triangle for soil texture based on the sand, silt and clay fractions.

3.4.2 Topsoil nutrient status

The results from an analysis of the nutrient status of samples of topsoil sent to a contract laboratory are presented in Table 4.

Table 4. Topsoil nutrient status.

Trial Pit	pH	Phosphorus (P) (mg/l)	Index	Potassium (K) (mg/l)	Index	Magnesium (Mg) (mg/l)	Index
1	6.3	52.2	4	45	0	41	1
2	6.1	56.6	4	83	1	44	1
3	6.1	59.2	4	64	1	38	1
4	6.3	63.0	4	188	2+	69	2
5	5.6	69.4	4	150	2-	52	2
6	6.0	56.0	4	59	0	42	1

Indices of 2 and above indicate that there is sufficient supply of a particular nutrient. With reference to Table 4, the nutrient status of the topsoil is deficient in the major plant nutrients Potassium and Magnesium (TP1-3 & TP6) and so fertiliser is recommended post-construction to address this deficiency. It should be noted that for reasons of soil chemistry this analysis does not include nitrogen which is often limiting to grass plant growth. Soil pH in the range 5.6 to 6.3 is appropriate for the cultivation of Perennial ryegrass species.

3.4.3 Soils summary

The topsoil depth and texture is very consistent across the site and comprises a ~300 mm depth of sandy silt loam containing the occasional stone. Subsoil texture varied slightly between soil test pits but was in general alignment with the geotechnical site investigation. Soils became gravelly at approximately 500-600 mm depth bgl which prevented further excavation by hand tools.

The soil in its current condition should offer moderate drainage rates. However, surface regrading required to develop the site for sports use will destroy any natural soil structure so that drainage performance will be very poor. In the absence of a new land drainage scheme, the surfaces will be prone to standing water during inclement weather (even during the summer months).

Therefore, consideration should be given to the installation of a land drainage scheme that is designed to intercept rain water at the surface before it has had an opportunity to soak in to the soil profile. These systems work by using a primary drainage system comprising closely spaced, deep lateral drains combined with a secondary drainage system of very closely spaced sand grooves or sand slits cut into the surface that link into the primary system below. A typical arrangement is presented in Figure 9.

It is also recommended that stones are removed from the near-surface profile of the new pitches to reduce the risk of laceration and impact injuries. A stone removal and not a stone burial technique should be used.

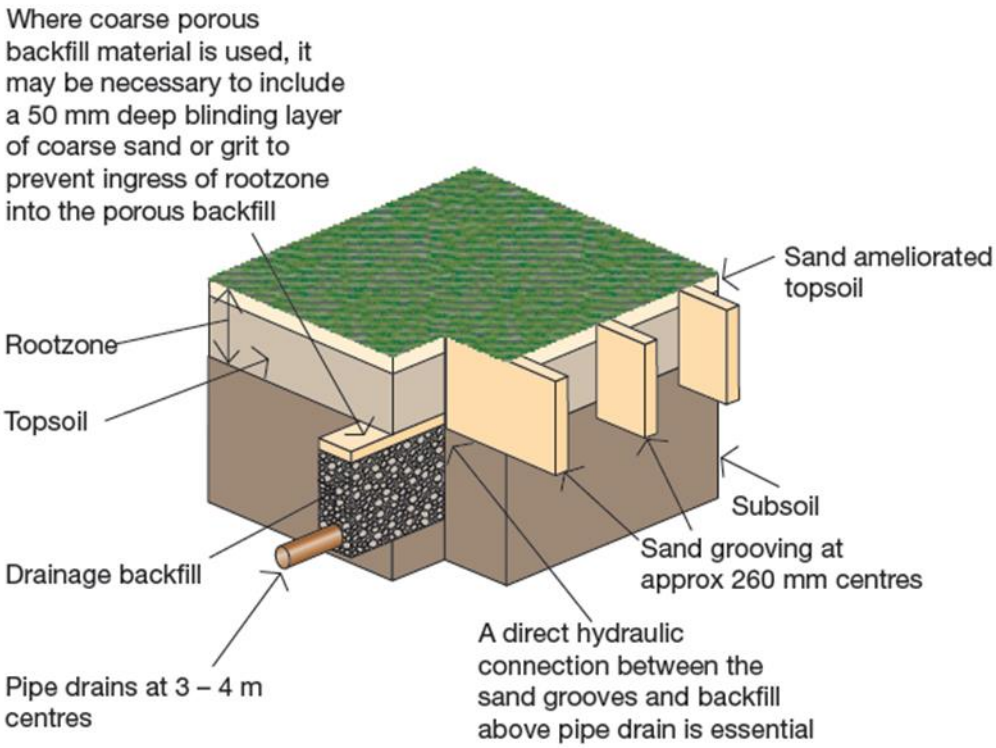

Figure 9. Typical sand groove based surface by-pass drainage system (Ref: Sport England Design Guidance Note "Natural Turf for Sport", 2011).

3.5 Agronomic assessment

Ground cover was at 90% and consisted of low-grade grassland containing a mix of pasture grasses (Figures 10, 11 & 12). The broad-leaved weed population within this cover occupied less than 5% which is very good, however grass height was long and ranged from 50 to 300 mm in areas.

There was also evidence of localised rutting caused by vehicles transporting supplies around the nursey (Figure 13). These areas highlighted the detrimental effects of soil compaction on the indigenous soils and the need for drainage as surface water ponding was evident.

Figure 10. General view of ground cover.

Figure 11. Close-up of ground cover.

Figure 12. Example of 100% ground cover.

Figure 13. Example of vehicular ruts.

Surface cultivations will be required to address minor undulations across the site and so it is recommended that the site is sprayed with glyphosate prior to cultivations; a flail mower operation should also be budgeted for.

A generic maintenance programme is presented in Appendix I.

3.6 Site usage

It is difficult to predict with any accuracy the likely improvement in hours of play achievable if a new drainage scheme were to be installed in the playing field as this depends on local weather conditions, schedule of use, age of participants and the quality of the ongoing maintenance, however Sport England considers the following to represent a reasonable estimation (Ref: Natural Turf for Sport, 2000, ISBN 1 86078 103 9 – 2nd Edition, 2011) (Table 5):

Table 5. Estimated usage levels.

Drainage status	Adult weekly use* (hours)
Undrained	Under 2
Pipe-drained	2 - 3
Pipe-drained with mole drains	2 - 4
Pipe-drained with sand grooves	3 - 6
Pipe-drained with slit drains	3 - 6
Pipe-drained with topsoil and drainage layer	3 - 6
Pipe and slit drained	3 - 6
Pipe-drained with suspended water table	4 - 6

*The usage levels shown will increase by ~50 % for players 15 years of age and under.

It is important to note that hours of use for an undrained pitch following surface grading earthworks to address undulations would be severely limited as a consequence of soil compaction and loss of soil structure (cracks, fissures, worm holes and root holes). Soil compaction can adversely affect the surface water infiltration rate until such time (years) that the natural soil structure can regenerate.

3.7 Performance Quality Standards (PQS)

Performance Quality Standards (PQS) provide a recommended minimum quality standard for the construction and maintenance of natural turf pitches. PQS were originally developed via a voluntary technical consortium with representation from the Sports Turf Research Institute, National Playing Fields Association and the Institute of Groundsmanship, and have now been adopted by Sport England and Governing Bodies of Sport (Ref: Appendix 4 of Natural Turf for Sport, 2000, ISBN 1 86078 103 9 – 2nd Edition, 2011).

Sport England has produced a pro forma for summarising the condition of natural turf sports pitches by conducting a Performance Quality Standard assessment and comparing the results

for a given site against minimum standards. The results of this assessment are presented in the Appendix.

3.8 Other items

Issues which can arise from natural grass pitch construction or remediation projects can be summarised as follows:

- **Ball stop netting** – The site is situated adjacent to residential properties. With this in mind, further investigation may be required in evaluating the impact and risks associated with ball games played in the vicinity of residential properties. The implementation of safety precautions such as ball-stop netting will need to be considered by the Client.
- **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 – the topographical survey provided by the Client shows a pipe like feature running through the centre of the site.
- **Planning permission** – Where cut and fill 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.
- **Irrigation** – The construction of natural grass pitches relies on optimal weather conditions to aid germination and grass plant establishment. In some cases, when construction is carried out in summer and during drought conditions, supplementary irrigation may be required, the costs of which should be factored in to the budget. It is the responsibility of the Client to provide sufficient irrigation during the duration of project construction phase and subsequent maintenance phase.
- **Outfall** – When discharging into existing drainage infrastructure or natural water courses, 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 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, in turn offering very low infiltration rates. With any cut and fill operations it is important that a drainage scheme is designed to mitigate the impact that over-consolidation and loss of soil structure may have on natural infiltration rates.
- **Maintenance scheme** – With any development, it is imperative that a well-structured intensive maintenance programme is implemented to maintain the pitch following large scale investment. Failure to implement the recommended maintenance operations will result in a deterioration of pitch condition and subsequent availability for use.
- **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.
- **Secondary drainage** – Secondary drainage relies on annual topdressing to maintain a direct hydraulic connection between the surface and piped infrastructure, the costs of which can be approximately £2-3k per annum (per pitch). This should be factored in to yearly budgets to optimise the efficacy of the land drainage scheme.

4 SUMMARY AND RECOMMENDATIONS

4.1 Principal site factors affecting the development

1. **Objective:** To conduct a detailed site investigation for the development of a new playing field for Turing House Free School. The proposed layout was provided by the Client and comprises four natural turf winter sports pitches plus a cricket square and outfield area for summer use.
2. **Location:** The development area is characterised by low-grade grassland and is part of land used by Sempervirens Nursery. The site is bounded by residential properties to the north, Hospital Bridge Road to the east, Borough Cemetery to the west and Heathland Recreation Ground to the south.
3. **Topography:** Topographical data was provided by the Client. The existing gradients are compliant with both Sport England (SE) and The England & Wales Cricket Board (ECB) guidelines therefore cut and fill earthworks are not envisaged, with the exception of removing the large bund towards the east; additional site won or imported topsoil will be required. There are numerous depressions across the development area, therefore surface re-grading is recommended.
4. **Layout:** The proposed winter sports pitches are orientated outside SE guidance and are therefore subject to low winter sunshine; the Client should consider reorientation of the pitches if possible. The proposed size of the cricket square will provide two pitches, as such, the square may not be able to provide significant cricket use. It is also not recommended to position cricket squares within the safety margins of winter sports pitches due to potential damage from footballer's studs. Man-made throwing circles within the footprint of winter sports pitches is not recommended, plus a 5 m runoff is advised for all four perimeters of rugby union pitch.
5. **Hydrology:** No watercourses lie within or abut the site therefore outfall for a land drainage scheme is limited to either the use of public surface water drains (not identified onsite) or a soakaway.
6. **Drainage discharge rates:** Climate data from the Flood Estimation Handbook indicate that the standard-period average annual rainfall (SAAR) for this catchment is 601 mm which is significantly lower than the average and will need to be considered in the development proposal. Drainage design should account for at least the 1:30, 24h outfall rate of 24.9 L/s.
7. **Flood risk:** The site has a very low risk of flooding from rivers and seas with a chance of flooding of less than 0.1%. The site generally has a very low risk of flooding from surface water with a chance of flooding of less than 0.1%, however this risk increases to a low risk towards the centre of the site with a chance of flooding of between 0.1% and 1%.
8. **Landfill:** The site does not appear to be located in an area formerly used for landfill which could affect surface levels or the nature of any earthworks.
9. **Groundwater:** The site is not located within a Groundwater Source Protection Zone.
10. **Soils:** According to the Soil Survey of England and Wales, the closest mapped association is the HUCKLESBROOK association, which is characterised as 'well drained coarse loamy and some sandy soils commonly over gravel, some similar permeable soils affected by groundwater'. This is in alignment with near surface soils identified in geotechnical site investigation provided by the Client.
11. **Geology:** Data from the British Geological Survey indicates that the underlying bedrock geology comprises London Clay Formation. The geotechnical site investigation identified Clay at depths ranging from 3.40 m – 4.70 m bgl and was proven to a maximum depth of approximately 7.00 m bgl. This could inhibit the use of deep bored soakaways and

may impact the viability of shallow soakaways as drainage outfall. If soakaways are envisaged, BRE 365 infiltration test data will be required to confirm soil/bedrock permeability which can then also be used to calculate attenuation requirements.

12. **Test pits:** The topsoil depth and texture is very consistent across the site and comprises a ~300 mm depth of sandy silt loam containing the occasional stone. Subsoil texture varied but became gravelly at approximately 500-600 mm depth bgl. Surface regrading required to develop the site for sports use will destroy any existing, natural soil structure so that drainage performance will be very poor. Therefore, a new land drainage scheme is recommended – without this, the pitches will not drain efficiently.

13. **Nutrient status:** The topsoil is deficient in the major plant nutrients Potassium and Magnesium and so fertiliser is recommended post-construction to address this deficiency. Soil pH in the range 5.6 to 6.3 is appropriate for the cultivation of Perennial ryegrass species.

14. **Agronomic condition:** Current agronomic quality is not suitable for a sports playing field. Surface cultivations will be required to address minor undulations and so it is recommended that the site is sprayed with glyphosate prior to cultivations; a flail mower operation should also be budgeted for.

15. **Other:** The site is situated adjacent to residential properties. With this in mind, further investigation may be required in evaluating the impact and risks associated with ball games played in the vicinity of residential properties. The implementation of safety precautions such as ball-stop netting will need to be considered by the Client.

4.2 Feasibility proposal (not for construction)

The objective of the feasibility study was to assess current conditions for the development of new natural turf playing field only.

Please note: the following is not a detailed design specification; these are options for consideration at the feasibility stage. TGMS Ltd will only warrant a full design specification following the production of a specification of method, materials and performance outcomes – this service can be provided and would form the basis of a tender package for reputable Contractors to price.

4.2.1 Construction of natural turf winter sports pitches/cricket outfield area

The following scope of works is recommended by TGMS for the construction of the proposed playing field, and incorporates both a primary and secondary drainage scheme. The recommended development will provide extended playability even during periods of inclement weather and should support in the region of 3-6 hours of usage per week (approximate, dependent on weather and ground conditions).

There may be an opportunity to review the requirement for sand grooves if the primary system is installed prior to the winter (given the low standard-period average annual rainfall (SAAR) of the site). Drainage performance could be reviewed prior to the planned installation of the sand grooves (normally after grass establishment in the spring). Clearly, as the intensity of the scheme is reduced so is the rapidity with which the site will drain down following rainfall.

If sand grooves are found to be necessary, it is very important to note that frequent (minimum 3) sand topdressing applications would be required in the first 12 – 18 months post construction to protect the grooves from contamination with the topsoil.

The works would comprise the following:

1. **Removal of existing vegetation** – spray-off existing vegetation using a total herbicide.
2. **Primary cultivations** – rotary cultivate the topsoil (ca 200 mm depth) to incorporate the organic matter residue and to create a suitable tilth for re-grading.
3. **Re-grade topsoil** – re-grade the topsoil to final levels and tolerances.
4. **Stone removal** – in situ stone removal to remove smaller sharp stones using mobile soil screener. In the absence of a blinding layer/buffer, complete stone removal/burial will not be achieved.
5. **Installation of a pipe drainage scheme at 4 metre wide centres** – outfall type and location to be confirmed by the Client.
6. **Final cultivations and establishment of a new grass sward (including seeding and fertiliser)** – it is recommended that a suitable 100% Rye Grass seed is used.
7. **Installation of a secondary bypass drainage scheme** – (sand grooves, if necessary based on performance of the primary drainage over the first winter).
8. **Application of sand topdressing** – to maintain hydraulic connectivity with the secondary drainage scheme (if required).

4.2.2 Post-construction agronomic maintenance

Depending on the construction timetable, it is possible that on-going maintenance will be required for the first 6-12 months following completion of the remediation works. This will include the following items:

1. Mowing.
2. Fertiliser applications.
3. Compaction alleviation (e.g. Verti-draining).
4. Overseeding (as required).
5. Selective weed control (as required).
6. Pest and disease control (as required).
7. Sand topdressing.

4.2.3 Cricket square

It is anticipated that the cricket square will be constructed in conjunction with the main natural turf works. A club standard cricket square will take approximately 12 months to establish and consolidate before it can be used. An intensive maintenance package should be included over a 12 month period; costs for this are estimated within the indicative costs section below.

Important: for natural turf cricket squares, it is highly important that there is access to a water supply to allow safe preparation of cricket pitches and the effective establishment of grass on the square.

4.3 Indicative costs

Please note that the following costs are indicative only and true cost can only be established by competitive tender.

	Proposal based on 2.20 ha
Construction phase for winter sports pitches/cricket outfield area	**Cost**
Spray off and remove existing vegetation	£2,237
Cultivate and grade (smooth) topsoil	£6,790
Stone removal	£4,638
Installation of a primary piped drainage scheme at 4 m wide centres – excludes costs of outfall	£55,375
Final cultivations	£4,685
Establishment of a new grass sward (includes seeding and fertiliser)	£8,832
Installation of secondary drainage (sand grooves, if required)	£22,500
Supply and spread 8 mm dressing of specified sand	£8,887
Prelims, mobilisation, setting out, as-built survey and reinstatement	£8,628
Subtotal (construction phase)	**£122,572**
Construction phase for cricket square	**Cost**
Construction and establishment of a 2 pitch cricket square using club cricket loam	£6,000
Installation a water supply to the cricket square	£1,000
Installation of a ring drain surrounding cricket square	£1,000
Prelims, mobilisation, setting out, as-built survey and reinstatement	£630
Subtotal (construction phase)	**£8,630**
Maintenance phase for all areas (grow-in to handover, assume 12 months)	**Cost**
Mowing (30 cuts)	£21,000
Fertiliser (3 applications)	£5,900
Decompaction / aeration (3 operations)	£4,500
Overseeding (1 operation)	£5,455
Selective herbicide (1 application)	£1,774
Pest and disease control (1 application)	£1,774
Sand topdressing (2 x 8 mm applications, if required)	£17,424
Cricket square maintenance	£4,000
Prelims & mobilisation	£5,799
Subtotal (maintenance phase)	**£67,626**
Summary	
Contract sum (construction + maintenance phases)	**£198,828**
Contingency (10%)	£19,882
Total (ex VAT)	**£218,710**

NOTES TO TABLE:

a. Costs are based on a general estimation of the works required. If conducted in isolation, the costs are like to increase and would need to be costed accordingly.
b. Costs assume that the arisings associated with drainage installation will be disposed of on-site.
c. Costs do not include temporary irrigation which may be required if dry weather is experienced during grass establishment.
d. Costs are based on recent Contractors rates (2016/17).

These costs do not include professional fees (ex VAT) for design and specification, tender production and evaluation and contract administration (supervision).

4.4 Indicative work programme

With respect to timescales for completing the project, it is recommended that the construction works are only completed under suitable ground and weather conditions to avoid any potential performance-related problems later on. The date for start of play is highly dependent on weather conditions during the construction phase and growing-in period.

Indicative work programme for constructing the natural turf football pitches/cricket outfield

	Year	YEAR 1												YEAR 2											
	Month	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Ideal project timescale	Mobilisation of Contractor(s)																								
	Remove existing vegetation																								
	Cultivations and re-grading																								
	Drainage works																								
	Grass establishment																								
	Install sand grooves																								
	Maintenance period																								
	Ready for full play																								

Indicative programme for the construction of a new cricket square

	Year	YEAR 1												YEAR 2												YEAR 3											
	Month	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Ideal project timescale	Mobilisation of Contractor(s)																																				
	Square development																																				
	Grass Establishment																																				
	Maintenance period																																				
	Light use																																				
	Ready for full play																																				

Please note: Following the construction of the cricket square, it is highly likely that performance of the square will be characterised by low and slow bounce. Performance characteristics should improve in the following year. It is envisaged that the square would be ready for play at the beginning of the season in year 3.

4.5 Implications of works on future maintenance, system longevity and usage

4.5.1 Maintenance issues

- With drainage systems, such as that recommended for the playing field here, it is essential that adequate allowance is made for annual sand topdressing as this helps to protect the sand bands/grooves from contamination with topsoil. As a guide it is recommended that a minimum 5 mm depth of sand should be applied annually as part of the renovations programme. Costs for 5 mm depth of sand over the playing field area would cost:
    - 180 t at a cost of approx. £5,445 + VAT per annum (supply and spread).

- 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.

- In general terms, a maintenance budget of **~£5-7 k** per pitch is normally required to maintain pitches of this type in good condition. This figure would include the cost for annual sand topdressing but excludes irrigation. Therefore annual maintenance budgets must be realistic and must be accounted for in the operational costs of the new facility going forward. Without good maintenance, the pitches will become unusable relatively quickly. With good maintenance the pitches will usable when many of the club's neighbour's pitches are not.

4.5.2 System longevity

- Whilst only a guide, the piped drainage system should have an operational lifespan of approximately 25 years if well maintained (e.g. silt traps regularly inspected and emptied and collector drains flushed).

- If managed well (i.e. annual sand topdressing) and not over-used (please see Item 4.5.3 below), the sand grooves should have an operational lifespan of 5-7 years, hence a sinking fund should be in place to repeat this operation periodically. The cost for re-installing sand grooves in the playing field is estimated to be approximately £29,500 + VAT therefore a sum of approximately £5,900 + VAT should be set aside annually for this purpose.

4.5.3 Usage

- Provided the site is well maintained, the type of drainage system proposed for this site should allow reasonable use (up to 6 hours/week) without causing detriment to the grass sward or soil structure. In very wet conditions, usage may be less.

5 CONFIDENTIALITY

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7 APPENDICES

Appendix I Performance Quality Standards.
Appendix II Outline Maintenance Recommendations.

Appendix I: Performance Quality Standards

Client: Bowmer and Kirkland Physical Site Survey date: 8th March 2018

Project Title: The development of a new playing field for Turing House Free School.

ELEMENT	LIMITS	METHOD OF TEST	Visit 1	Visit 2
Ground cover %	>70 for SH 25-30 >80 for SH 30-35	BS 7370 : P3 A6	✓	
Broad-leaved weeds %	<10	BS 7370 : P3 A6	✓	
Sward height mm	20-60 PS 20-75 SM	BS 7370 : P3 A3	×	
Thatch depth mm	<5	BS 7370 : P3 A7	×	
Hardness in g	35-200	STRI method of test using a 0.5 kg Clegg Impact Hammer from a drop height of 0.55 m	n/a	
*Water infiltration rate mm h^{-1}	5	BS 7370 : P3 A8	✓	
Evenness (2 metre straight edge)	<20 mm	BS 7370 : P3 A6	×	
Slope: Direction of play Across play	<1.25% <2.00%	BS 7370 : P3 A5	✓ ✓	
pH value	5.5 – 7.5	ISO 10390	✓	
GUIDANCE FOR ROOTZONE LAYER				
Maximum diameter	<32 mm	Particle Size Distribution	×	

KEY: SH = Sward Height PS = Playing Season SM = Summer Maintenance

* Based on previous experience of pitches on similar soils it is expected that once the soils are wet to depth during the winter, the rate of infiltration will decline to less than 5 mm / hr.

Visual assessment is an acceptable alternative method of testing, if undertaken by a turfgrass consultant who is able to satisfy the selection criteria identified within the Turfgrass Consultants – Construction/Upgrade Brief.

Assessment undertaken by: Elliot Wilson Consultancy: TGMS Limited

Appendix II: Outline Maintenance Recommendations

WINTER SPORTS PITCHES

Mowing. The grass shall be maintained between a height of 20 and 25 mm using cylinder mowing equipment. The grass should never be allowed to exceed a height of 30 mm. If the grass does become too long, the height of cut should be reduced gradually over 3 – 4 cuts allowing some time for recovery in between. N.B. On no account should the grass height be reduced by more than 50% on any one occasion. Overall, approximately 30 mowing operations may be required each year, depending on weather and growing conditions.

Fertiliser application. Allowance should be made for a sufficient number of fertiliser applications to maintain healthy growth and colour. The fertiliser regime should be based on the results of annual soil sampling to determine nutrient concentrations, but the following programme is provided as a guide:

- April 12:6:6 at 350 kg/ha
- September 5:5:20 at 350 kg/ha

Fertiliser shall be applied with appropriate equipment that ensures a uniform distribution.

Weed control. Apply a selective herbicide in the spring (if required) to combat the weeds present. This to be applied at least two weeks after the first fertiliser treatment (April) and at a time when grass growth is strong and healthy. NB. Do not apply herbicide during periods of potential turf stress, i.e. if the weather is hot and dry or if frosts are forecast. Apply herbicide strictly according to the manufacturers label recommendations and only by suitably qualified personnel.

Pesticide/Fungicide [If required]. A pesticide/fungicide application may be required should disease be present within the grass sward. An approved fungicide should be used with activity against the pathogens present and be applied following the manufacturers label recommendations by suitably qualified personnel.

Aeration / Compaction Alleviation. Verti-drain (or other similar de-compaction treatment) the pitches on at least two occasions in the spring and autumn. Use 18 mm diameter solid tines working to a minimum depth of 200 mm below the surface set to provide some heave. Verti-draining must not be carried out if ground conditions are too soft or during frost.

Additional aeration treatments (e.g. slitting or spiking) during the playing season would also be highly beneficial to maintain surface drainage rates. These treatments should only be undertaken when ground conditions are suitable.

Sand topdressing. Supply and spread an approved medium-fine sand suitable for sports use during the renovations period at the rate of 85 t/ha. After each application, the sand should be worked into the surface with brushes or drag mats.

Overseeding. Overseed the pitches and safety margins as required at the application rate of approximately 200 kg/ha immediately after the end of season topdressing application. Use at least three cultivars of perennial ryegrass chosen form the latest Turfgrass Seed booklet with live ground cover and visual merit ratings of 6.5 or more. Make at least two passes with seeding equipment designed to place the seed approximately 5 mm below the surface.

Divot repair [Playing season]. After each match, divot and tread the divots back into position. This will remove any bare soil which allows weeds and weed grasses to germinate. Filling in divots with seed/soil mix will help to maintain better grass coverage.

Renovation of worn areas [Playing season]. Areas of high wear should be dressed and seeded using a divot repair mix (seed/rootzone) during the playing season as required in order to maintain good grass cover. These areas should be hand watered (if necessary) to ensure rapid grass germination and establishment.

Line Marking [Playing season]. Line marking should be undertaken on a weekly basis during the playing season.

CRICKET OUTFIELDS

Mowing. The grass shall be maintained between a height of 12 and 18 mm using cylinder mowing equipment. The grass should never be allowed to exceed a height of 20 mm. If the grass does become too long, the height of cut should be reduced gradually over 3 – 4 cuts allowing some time for recovery in between. N.B. On no account should the grass height be reduced by more than 50% on any one occasion. Overall, approximately 30 mowing operations may be required each year, depending on weather and growing conditions.

Fertiliser application. Allowance should be made for a sufficient number of fertiliser applications to maintain healthy growth and colour. The fertiliser regime should be based on the results of annual soil sampling to determine nutrient concentrations, but the following programme is provided as a guide:

- April 12:6:6 at 350 kg/ha

- September 5:5:20 at 350 kg/ha

Fertiliser shall be applied with appropriate equipment that ensures a uniform distribution.

Weed control. Apply a selective herbicide in the spring (if required) to combat the weeds present. This to be applied at least two weeks after the first fertiliser treatment (April) and at a time when grass growth is strong and healthy. NB. Do not apply herbicide during periods of potential turf stress, i.e. if the weather is hot and dry or if frosts are forecast. Apply herbicide strictly according to the manufacturers label recommendations and only by suitably qualified personnel.

Pesticide/Fungicide [If required]. A pesticide/fungicide application may be required should disease be present within the grass sward. An approved fungicide should be used with activity against the pathogens present and be applied following the manufacturers label recommendations by suitably qualified personnel.

Aeration / Compaction Alleviation. Verti-drain (or other similar de-compaction treatment) the pitches on at least two occasions in the spring and autumn. Use 18 mm diameter solid tines working to a minimum depth of 200 mm below the surface set to provide some heave. Verti-draining must not be carried out if ground conditions are too soft or during frost.

Additional aeration treatments (e.g. slitting or spiking) during the playing season would also be highly beneficial to maintain surface drainage rates. These treatments should only be undertaken when ground conditions are suitable.

Sand topdressing (if drained). Supply and spread an approved medium-fine sand suitable for sports use during the renovations period at the rate of 85 t/ha. After each application, the sand should be worked into the surface with brushes or drag mats.

Overseeding. Over-seed the pitches and safety margins as required at the application rate of approximately 200 kg/ha immediately after the end of season topdressing application. Use at least three cultivars of perennial ryegrass chosen form the latest Turfgrass Seed booklet with live ground cover and visual merit ratings of 6.5 or more. Make at least two passes with seeding equipment designed to place the seed approximately 5 mm below the surface.

Renovation of worn areas [Playing season]. Areas of high wear should be dressed and seeded using a divot repair mix (seed/rootzone) during the playing season as required in order to maintain good grass cover. These areas should be hand watered (if necessary) to ensure rapid grass germination and establishment.

CRICKET SQUARES

Mowing. The grass shall be maintained between heights of 15 - 25 mm using cylinder mowing equipment. The grass should never be allowed to exceed a height of 30 mm. If the grass does become too long, the height of cut should be reduced gradually over 3 – 4 cuts allowing some time for recovery in between. N.B. On no account should the grass height be reduced by more than 50% on any one occasion. Overall, approximately 30 mowing operations may be required each year, depending on weather and growing conditions.

Fertiliser application. Allowance should be made for a sufficient number of fertiliser applications to maintain healthy growth and colour. The fertiliser regime should be based on the results of annual soil sampling to determine nutrient concentrations, but the following programme is provided as a guide:

September 12:6:6 at 350 kg/ha
February 5:5:20 at 350 kg/ha

Fertiliser shall be applied with appropriate equipment that ensures a uniform distribution.

Weed control. Apply a selective herbicide to the outfield and/or square in the spring (if required) to combat the weeds present. This to be applied at least four to six weeks after the first fertiliser treatment (April) and at a time when grass growth is strong and healthy. NB. Do not apply herbicide during periods of potential turf stress, i.e. if the weather is hot and dry or if frosts are forecast. Apply herbicide strictly according to the manufacturers label recommendations and only by suitably qualified personnel.

Pesticide/Fungicide [If required]. A pesticide/fungicide application may be required should disease be present within the grass sward. An approved fungicide should be used with activity against the pathogens present and be applied following the manufacturers label recommendations by suitably qualified personnel.

Aeration / Compaction Alleviation. Shallow spike the new square twice in the first full year after construction using a machine fitted with narrow needle tines working to 100mm depth.

Overseeding. Overseed the square areas and safety margins as required at the application rate of approximately 200 kg/ha in May and September 2013. Use at least three cultivars of perennial ryegrass chosen form the latest

Turfgrass Seed booklet with live ground cover and visual merit ratings of 6.5 or more. Make at least two passes with seeding equipment designed to place the seed approximately 5 mm below the surface.

Rolling. Consolidation but not compaction should be achieved in the 2013 establishment phase. Repeat mowing using a roller-based mower will help to firm the surface. Once stable, the weight of the machine should be increased to improve rolling results and build the depth of consolidation further into the soil profile.