Making great sport happen

WIRRAL BOROUGH COUNCIL

GOLF COURSES

Course Drainage Assessment Report

Report Date: 3rd June 2021
Consultants: Michael Boyes & Jonathan Tucker

Contents

1.0 Executive Summary

- STRI Ltd has been commissioned by Wirral Council to present a Proposals Report outlining the findings of a detailed drainage and agronomic assessment of the four public golf courses it governs. This report and extended plan follow an initial site drainage assessment carried out on 22nd – 24th March 2021 (Jonathan Tucker/Michael Boyes), and a subsequent agronomic assessment of the courses by Emma Beggs between the 29th – 31st March 2021.
- A detailed topographical GPS levels survey was carried out between 20th -22nd April 2021 at Arrowe Park GC, Hoylake Municipal GC and Brackenwood GC. Warren GC is sited on a sand-based soil profile and therefore deemed not to require the extensive installed drainage envisaged for the other 3 sites.
- Condition assessments from the March reviews noted ground conditions to be naturally drying following a period of relatively dry, early spring conditions. The legacy of the ongoing drainage issues remained very evident across the surveyed courses with a number of the playing surfaces slow to recover, and in extreme circumstances wholly unplayable (i.e., 17th Green at Brackenwood).
- Soil compaction, in all low-lying and heavily trafficked areas, is common as an underlying cause of poor soil drainage potential and associated thatch issues combining to accentuate waterlogging and soft surface conditions.
- Physical organic matter (thatch) removal is essential on the vast majority of playing surfaces, in addition to routine pencil solid tine aeration and infrequent deep solid tine aeration (i.e., Verti-Drain) to alleviate compaction. Deep solid tine aeration, completely absent for a number of years on all of the sites, remains the principal practice which is missing and absolutely essential to undertake on an ongoing basis throughout all areas.
- All sites display evidence of historic networks of old tile and plastic drains, commonly leading to outfalls in ditches or ponds. These drains have aged over time and are not robust enough to meet the demands of today. Drainage ditches are an important feature and need to be maintained regularly and extended locally. Outfalls must be kept clear to ensure the function of the drainage.
- In general, drainage capacity of the soils in lower lying sections of the courses needs to be improved by installing primary pipe drainage and intensifying the surface connection, ideally through installation of secondary drainage in the most vulnerable areas and by applying cultural management operations to remove thatch.
- Installation of drainage will increase discharge from the golf course which may impact on areas further downstream. Requirements for approval must be reviewed by Wirral Borough Council before proceeding.
- Indicative costs are provided based on the extent of proposed plastic pipe network essential to drain the identified problematic areas, in conjunction with current contractor rates. The proposed drainage schemes could be scaled back but at risk. There will be options for a phased installation of pipe drainage to priority areas.
  - Arrowe Park GC - £815,657
    - Primary pipe drainage layout and associated fittings.
    - Additional costs for ditch renovation and drainage features TBC.
    - Attenuation controls subject to agreed designs.
  - Hoylake Municipal GC - £782,617
    - Primary pipe drainage and localised secondary sand slit drainage.
    - Additional costs for ditch renovations and drainage features TBC.
    - Attenuation controls subject to agreed designs.
  - Brackenwood GC - £795,118*
    - Primary pipe drainage and localised secondary sand slit drainage.
    - Ditching and drainage attenuation costs TBC.
    - *Additional recommendation to rebuild 16 greens to USGA design (section 5.3). Estimated cost of 45k per green to include green surround adjustments and associated features (budget £720,000 subject to design and possible discounts if constructing multiple greens).
  - Warren GC
    - No project spend outside of improved course maintenance.

2. Introduction and Background

STRI services were engaged by Wirral Council to conduct a drainage assessment of its four public golf courses and provide a holistic plan to improve course resilience and playing quality, principally during the winter months and spring recovery period. With more extreme weather events, and wetter/milder winters, the deficiencies of course drainage have become more acute, limiting course playability during the winter but also impacting on general course presentation and standards.

STRI's remit was to investigate current conditions, existing formal drainage provision and functionality, factors contributing to poor drainage and thereby formulate appropriate remedial works. A preliminary report, prepared by Paul Woodham and dated 29th January 2021, highlighted some of the key issues and contributing factors to poor drainage with an outline of appropriate mitigation measures.

The scope of the current study and report deliverables is summarised as follows:

- Survey of identified problem areas to determine surface falls and catchment characteristics - using GPS surveying equipment.
- Identify existing drainage infrastructure, including the main ditches and significant drains (where visible).
- Assess the condition and function of past drainage systems.
- Review the principal factors contributing to poor drainage.
- Identify appropriate strategies and drainage options to mitigate areas of very poor drainage.
- Assess complementary agronomic treatments to enhance the resilience of areas through the green.
- Provide budget costs for the proposed drainage solutions.

3.0 Drainage Features

3.1 Soils

Arrowe Park GC - The local soils are characterised as slowly permeable, seasonally wet, slightly acid but base-rich loamy and clayey soils displaying impeded drainage characteristics.

Hoylake Municipal GC – Large areas of the course are classified as displaying naturally wet, very acid sandy and loamy soils which are naturally wet with a high-water table. Southern sections of the course are dominated by loamy and clayey floodplain soils, also with naturally high groundwater.

Brackenwood GC – The original holes on the golf course are based on what are reported to be largely freely draining, slightly acid, sandy soils. The newer section of the course, in contrast, is founded on slowly permeable, seasonally wet, slightly acid but base-rich loamy and clayey soils, displaying impeded drainage. Structural integrity of the soils has been significantly impacted through construction processes.

Relevant to all three courses – Ground compaction and lack of soil structure have a direct impact on:

1. Slow infiltration and limited movement of water through the profile.
2. Reduced root development.
3. Increased thatch production.

The development of thatch is significant as this is a biproduct of poor drainage and persistent wetness. However, it also exacerbates the situation due to its water retentive properties.

Topsoil depth is also limited on many sections of the golf course and therefore reaches saturation rapidly as infiltration into the subsoil is negligible.

Warren GC – The Warren GC is based on a sand dominated, free-draining profile which already displays high levels of permeability so does not require course wide or significant drainage on the basis of conditions perceived to be manageable through cultural maintenance alone.

3.2 Regional Climate, Hydrology and Site Topography

The average annual rainfall for the extended geographical area is approximately 670 millimetres. Compared with the UK average this is not particularly high, however, it does not reflect the increase in frequency of high rainfall events which have a direct impact on the Wirral Borough Council golf courses and the influence of course design and reported deterioration in soil and agronomic conditions.

The influence of the watershed and catchment characteristics are important as water from the higher areas of the courses will naturally move towards the lower sections which therefore tend to be wetter. This is compounded by the slow infiltration of water into the soils as noted above. During high rainfall events only a small proportion of water infiltrates into the ground therefore the majority flows downslope. As falls slacken, water is held on the surface by existing vegetation together with thatch and minor depressions in the surface. With loss of grass cover and surface disturbance, caused by golf and maintenance traffic, the situation is exacerbated, and a cycle of decline is established as the surface layers become saturated and lose stability.

Shaded areas, where restricted light influences key playing areas for prolonged periods over the winter, will be much slower to dry out.

3.3 Drainage Infrastructure

A detailed drainage assessment of existing known drainage layouts and drainage features and site topography is mapped on drawings:

- J004741 001 Arrowe Park GC Existing levels and drainage.
- J004741 003 Hoylake Municipal GC Existing levels and drainage.
- J004741 005 Brackenwood GC Existing levels and drainage.
- Note: Wirral GC was not mapped as the drainage requirements are naturally achieved but additional resources were used for the other courses due to the level of detail needed.

None of the Wirral Borough Council golf courses present a modern, formal primary system of drains and therefore rely largely on localised elements of drainage which have been installed on a piecemeal basis over many years, and their subsequent connection with drainage ditches on site. In the case of Warren GC, much of the drainage is natural laying above a sand dominated profile albeit with localised compaction issues within greens.

The ditches are a vital part of the drainage system as they act as attenuation and conveyance systems for water as well as intercepting surface flows, and to a much lesser extent subsurface seepage, from higher ground.

The majority of ditches, most notably at Hoylake Municipal Golf Club, appear to have been simply formed by excavation to variable depth, with differing angles of bank slope, and are partially contaminated by vegetation and silted up in sections.

Various drainage systems could be identified across the respective sites, discharging into the ditches. These consisted of old clay or tile drains with no permeable backfill together with more modern plastic drains with stone backfill of variable inappropriate quality and degree of contamination. The function of these drains is therefore limited due to:

- Lack of sufficient intensity of drainage.
- Lack of permeable backfill and contamination of backfill reducing the effectiveness of surface drainage and infiltration.
- Development of thatch at the surface of drain and across wet areas, which again reduces surface infiltration and laminar flow of surface water towards drainage features.
- Breakdown of drainage (collapse of drains and blockages caused by soil accumulation and ingress of tree roots).

3.4 Thatch Accumulation

Thatch accumulation, as previously explained, is a biproduct of poor drainage. However, it also contributes to the issues, holding water near to the surface and creating soft, easily damaged playing surfaces.

4.0 Drainage Principles

The main requirement of drainage provision at three courses; Arrowe Park GC, Hoylake Municipal GC and Brackenwood GC, is to remove surface water as rapidly as possible due to the limited natural permeability of the underlying soils. Subsoil drainage alone will largely be ineffective at these sites as the hydraulic gradient (lateral subsurface movement of water) between any historic drainage is negligible (due to the prevailing soil characteristics) and control of water table levels is not a significant factor.

The main features of the proposed drainage system will be as follows:

a) Interception and diversion of surface water via existing and proposed ditches.
b) A system of pipe drainage at close centres to intercept and convey water to main drains and ditches.
c) Localised secondary drainage sand slitting, to bypass the upper topsoil layer and convey water to the lateral drains.
d) Localised application of sand dressing to build up a layer of permeable material at the surface (if financially feasible).

Each of the above are complementary elements as detailed below:

Drainage design will be greatly influenced by the respective uniformity of the natural slopes on the affected areas at each of the respective sites. These characteristics are taken into account within the proposed layouts.

Drainage Ditches

a) The ditches are effective for conveying large volumes of water and if strategically placed can serve to intercept surface flows from higher ground. If appropriately maintained they are less vulnerable to blockages from silt and vegetation, and work with very little effective gradient. Their location is also influenced by golfing factors as they can be penal and focus traffic over crossing points, so they need to be deployed judiciously.

Primary Pipe Drainage

b) The proposed pipe drainage system consists of a uniform pattern of lateral drains, at 5 - 3 metre centres, targeting the wettest sections of the golf course. A spacing of 3 metres is the preferred option in the areas indicated to provide an intensive system and minimise the distance of travel of surface water before it is picked up by a drain, but the inevitable financial impact is noted.

   Narrower “piped slits” may be proposed to provide an efficient but more cost-effective system, if a closer spacing of the drainage is adopted. In this scenario, 60mm diameter drains can be installed in 80-90mm width trenches. These 60mm drains can still convey significant quantities of water when laid to adequate fall.

c) The installation of new pipe drainage can be tied in with sand slit secondary drainage (see below), localised in low-lying, problematic and heavily trafficked areas, providing an intensive matrix of sand channels transmitting water to the permeable backfill over the pipe drainage.

The pipe drainage systems - particularly if spaced at 3 metre centres in certain areas - will provide effective surface interception of water provided that:

- Thatch is kept under control.
- A satisfactory depth of sand is built up at the immediate surface, directly above drain lines.
- Smooth levels are maintained to minimise water collection between the drainage lines.

Secondary Drainage – Identified 'high risk' wet areas at Brackenwood and Hoylake

Reference section 6.3

Sand slitting or banding can take several forms from sand grooves which are forced into the ground (e.g., Blec Vibra Sandmaster (~£1 m²), to more substantial Sand slits which are excavated and backfilled using the Koro Sandbander (~£2.5 m²). The narrow sand bands, while less robust, are quicker to install with lower capital cost.

Over time, localised sand top-dressing can be employed to develop a significant layer of sand which will also provide a pathway for the movement of water to the drainage. A closely spaced pipe drainage system will have the capacity to transmit much larger volumes of water rapidly without the risk of surcharging, compared with a wider spaced pipe drainage system with secondary slit drains without pipes.

5.0 Review of drainage provision and requirements by individual Golf Course

5.1 Arrowe Park Golf Club

Drainage proposals are set out in the schematic plan Drawing number J004741 002.

During the winter months (i.e., November to February) there are major limitations to course usage due to drainage deficiencies. This is manifested as wet, extremely soft fairways and roughs, as well as teeing platforms which rapidly deteriorate under the pressures of golf traffic and maintenance equipment.

Existing Drainage Features

- The perimeter ditch is partially filled-in and serving little function. Deeper ditch sections are associated with the localised pits/ponds, primarily within woodland areas.
- The widespread pits/ponds within the woodland areas are only partially linked and several appear to have no positive outfall or have been compromised by the filling in of ditches.
- Historic clay/tile drains are linked with the ridge and furrow topography which is widespread throughout the site. The depth of installed drains is variable and backfill predominantly consists of clinker ash (with pottery fragments and glass etc.) which has become consolidated and capped with clay soil, with associated thatch to 50-75mm.
- Main drains were installed over 20 years ago with diameters varying between 150 to 300mm.
- Positive discharge is apparent to the North West of the site into Arrowe Brook.

Soil Conditions/Profiles

- Dominated by clay soils, with a high level of fines, and very poor structure.
- Depth of topsoil is limited.
- Thatch accumulation was observed at approximately 50mm deep, and up to 75mm in areas.

Assessment of Course Drainage

Holes 2 to 8, which generally constitutes the perimeter of the golf course, are noted historically to be the wettest but the entire golf course is prone to deterioration over the winter months and following periods of extended inclement weather. Localised low areas become exceptionally wet, most notably directly in front of the teeing platforms. Thatch accumulation in the upper soil profile is extensive and a direct biproduct of poor drainage and lack of soil aeration. The local pits/ponds act as a collection point for water and provide a degree of drainage attenuation and storage.

Preliminary General Recommendations

- Thatch reduction through hollow core aeration and targeted scarification.
- Timely aeration – Deep solid tine aeration (i.e., Verti-Drain) and linear decompaction.
- High quality tee mats for winter play.
- Strategic paths- green to tee and tee to fairway to help bypass worst areas.
- Clear out ditches which link pits and check outfalls. If necessary, install new link mains for ditch network. Water levels in some pits are very high so outfalls need to be cleared or lowered.
- Install drainage as planned and review performance subject to the success of this and with application of cultural maintenance.

5.2 Hoylake Municipal Golf Club

Drainage proposals are set out in the schematic plan Drawing number J004741 004.

A critical issue for Hoylake Municipal Golf Club is that the primary ditch system within the golf course discharges through external ditches and streams, The Birket (a tributary of the River Mersey) and eventually the River Mersey itself. At times of high River flow the sluice gates into the Mersey are closed and consequently water backs up the system into the golf course.

The high-water table during the winter is the principal limitation to course usage and playability and in low lying areas the water table is relatively close to the surface and there is significant capillary rise through the fine textured soils. In these areas the soils are heavily mottled indicating prolonged saturation.

Soil Conditions/Profiles

- Native soils are generally fine sand to fine sand/silty loams, over a fine sand lower profile.
- Depth of soil is variable and ranges from around 150mm to 400mm plus.
- The 8th hole is based on clinker "made ground".

Assessment of Course Drainage

The lower section of the Hoylake Municipal Golf Course, primarily affecting holes 7th, 8th and 9th in particular, is situated within flood zone 2 and is reported to be exceptionally wet over the winter months and following periods of extended precipitation. Noted very wet sections were also linked with the 1st and 2nd holes and a central section of the course through the 11th and 17th holes.

The primary ditch network on site is heavily silted, with significant iron ochre discharged through the drainage system. Localised drainage has been installed in recent years within holes 13, 14 and 15 and these constitute the traditionally drier areas of the golf course. There is evidence of older drainage systems, but functionality is dubious and significantly compromised by silted and heavily vegetated ditches.

Preliminary General Recommendations

- Appropriately timed ditch clearing is essential, avoiding disturbing banks (specialist operation), working from outfall.
- Extend pond on 7th hole (a doubling in size is envisaged) to incorporate wet low area.
- Depth of drains limited by outfall depth. If hydraulic gradients are not adequate, then the option for pumped drainage is possible to lift water from the lowest point.
- Improve immediate surface infiltration and hydraulic conductivity of the topsoil through deep solid tine aeration (i.e., Verti-drain) and linear decompaction.
- Remove poplars which are situated adjacent to installed drains.
- Focus aeration works on wet sections of 1st and 2nd holes, to link with 10th – 18th holes, for the provision of an 11 hole "loop" for winter golf to avoid problematic wet section of the course in the short term.

5.3 Brackenwood Golf Club

Drainage proposals are set out in the schematic plan Drawing number J004741 006.

The course at Brackenwood Golf Club constitutes two distinct sections, the original golf course to the West of Brackenwood Road (developed in the 1930's) with the newer section of golf course, comprising eight holes, to the East of Brackenwood Road on previous agricultural land developed in the late 1970's.

Soil Conditions/Profiles

- Topsoil generally comprises a very fine sand/silty clay loam of poor structure, approximately 300mm in depth, over a silty clay subsoil with significant stone content.
- There is also evidence of made ground (i.e., pottery fragments/ash).

Assessment of Course Drainage

There is only a rudimentary drainage system in localised areas, and in the main no formal drainage at all. Old field drains could be detected in the western section of the golf course, at times approximately some 30 to 40 metres apart.

Tees developed on the newer section of the golf course have been built up using poor quality fill material (spoil from the adjacent motorway construction). Certain sections are very soft underfoot.

Drainage characteristics on the putting surfaces are very poor, with the noted exception of the recently reconstructed 1st and 2nd Greens. A moisture content of 87% was recorded on the 3rd Green (target range 15-30%) and the 17th Green has been isolated, and an inspection pit excavated in the centre of the playing surface to ascertain the source of impediment.

Preliminary General Recommendations

- It was reported that no routine aeration operations have been undertaken across the site in at least the last 20 years. Deep solid tine aeration (i.e., Verti-Drain) and linear decompaction will improve conditions marginally when ground conditions permit the operations. Thatch removal and sand top-dressing operations would also prove advantageous.
- Pond by the 6th to be lowered with new outfall drain to the ditch and lower outlet on small pond by 11th tees.
- Improve temporary winter tee areas or upgrade mats.
- Focus works on original holes as they are slightly drier- to provide 9 playable holes in the short term (i.e., 1st,2nd and the 12th – 18th holes) over the wetter, winter period.
- Primary drainage is required over extensive areas of the golf course and a plastic pipe network plus a secondary drainage installation (i.e., sand banding), installed perpendicular to the primary plastic pipe, is highly recommended. Where pipes alone have been installed on the approach to 12th green, the area remains very wet.
- Complete green reconstruction, to a proven USGA specification, may represent the only course of action to rectify the extensive drainage impediment, evident on a number of the putting surfaces. This would ensure appropriate profile construction with the incorporation of a dedicated sub-surface drainage.

5.4 Warren Golf Club

The 9-hole Warren Golf Club is situated on a sandy, relatively free-draining site and as such there is no immediate requirement for extensive primary plastic pipe drainage, nor is there envisaged to be a future requirement, as outlined for Arrow Park GC, Hoylake Municipal GC and Brackenwood GC.

The main areas of concern are the putting surfaces where a combination of the use of poor construction materials and a historic lack of routine aeration and thatch removal operations has negatively impacted greens drainage potential. Three such examples (5th, 8th & 9th Greens) are highlighted in the Google earth image below). This has led to standing water during periods of extended rainfall, most noticeably throughout the wetter, winter months, which has contributed significantly to a softening of the playing surface and a deterioration of turf health, surface levels and overall playability.

Preliminary General Recommendations

- Once the weather and ground conditions are conducive, undertake deep solid tine aeration (i.e., Verti-Drain) and heavy sand top-dressing on all putting surfaces to improve drainage characteristics.
- Make provision for hollow core aeration and heavy sand top-dressing during August 2021 to facilitate significant removal of problematic thatch layer which has accumulated at the top of the soil profile in greens, for the subsequent integration of sand.
- Upon successful completion of the aforementioned renovative works, an audit of the putting surfaces at Warren GC should be carried out to ascertain if said operations have resolved the drainage issues or if there remains a necessity for the installation of formal dedicated primary plastic pipe network on certain greens.

6.0 Drainage Method Statements/Considerations

6.1 Ditches

The angle of bank slope is critical to reduce the risk of collapse and facilitate future maintenance. Generally, a 1:1 bank (45 degrees), would be appropriate for the soils encountered at Arrowe Park GC, Hoylake Municipal GC and Brackenwood GC. Depths will largely be dictated by the inverts of drains where they enter ditches but 750mm to 1m depth would generally be sufficient.

6.2 Pipe Drainage

Lateral drainage needs be kept relatively shallow as the primary purpose is to collect and convey surface runoff and therefore deeper subsurface drainage is superfluous. Furthermore, the depth of the irrigation infrastructure will conflict with the drainage If placed too deeply in the profile. Therefore, lateral drainage should be placed at generally 450mm depth, to 500mm maximum depth. 80mm diameter (unless otherwise stated), perforated, corrugated flexible pipe is appropriate installed trenched with an approved tractor mounted or tracked trenching tool. Narrower trenches to accommodate a 60mm diameter pipe could be considered to reduce aggregate requirements and disturbance to the surface.

Gravel backfill should consist of 2-6mm stone. Smaller stone is recommended to reduce the rate of soil contamination from soils surrounding the trench and to support the rootzone above without an additional “blinding layer”.

The upper part of the trenches is topped off with sand (compatible with that to be used for topdressing) which must also bridge with the gravel to avoid infiltration. This can be calculated from the particle distribution of the sand and gravel. A percentage of finely shredded peat or compost is mixed through the sand to provide a suitable rootzone (provisionally 10% peat or 15% compost by volume - to be determined following further testing). Depth of the rootzone will be between 125-150 mm depth. This will enable a good connection (ideally a minimum 50 mm interface) to be made with the gravel at below the surface when installing secondary sand bands. The “perching” effect (caused by capillary action) will also reduce the impact of drying out.

Where drains connect with ditches the end of the section of pipe should be protected with a section of solid wall pipe.

Where drains cut across existing drains, water from these should be picked up by the new system. However, if there is significant water flowing through the old drains, a positive connection should be made with the new drainage system.

For the lateral drains reinstatement by seeding is preferred as turf will cap off the surface of the drains. The main drains can be re-turfed using turf lifted from the line of the drain or seeded.

6.3 Sand Banding

Various options are available but the most widely used are the Blec Vibra SandMaster and Koro Topdrain (sand slits).

The Blec unit forces slits in the ground and backfills with sand in one pass, creating bands which are spaced at 260mm to nominal 150mm depth and 20mm width. The Blec sand bands are also generally less disruptive to the playing surface.

The Koro sand bands are creating by excavating narrow trenches (slits) to approximately 200mm depth by 40mm width at 0.5m centres and backfilling with sand immediately after excavation. They perform a similar function but to operate efficiently drains should be spaced no wider than 4m apart. The Koro bands are more robust but are approximately double the cost of the Blec Vibra SandMaster.

Timing is important for these operations as if soils are wet and "plastic" then the Koro sand bander may not work effectively. Equally if the ground is dry and hard it may also struggle. A reasonable moisture level is also required for the Blec unit.

The effectiveness of the sand bands in either case is determined by minimising contamination as they can rapidly be rendered useless by soil contamination through soft, unstable surfaces and worm casting. The narrow Blec sand bands will be particularly vulnerable in this respect. Therefore, ongoing sand top-dressing is absolutely vital to build a protective layer at the surface.

6.4 Catch Basin

These can be combined with an inspection chamber/silt trap (using preformed HDPE Twin wall chambers with integral base) with a 30cm grated lid. The HDPE chamber should be perforated and surrounded by gravel to improve drainage immediately around the catch basin. A minimum 300mm sump should be incorporated at the base of the chamber.

6.5 Outlets

The drainage system is only as good as the main outlets from the golf course.

7.0 Implementation/Procurement

The extent of the works, as set out, requires the engagement of a suitable contractor to undertake the drainage installation.

Potentially the ditches could be excavated, together with the minor works set out, for example on the restorative works prescribed for Warren Golf Club.

From a practical viewpoint works should be grouped into areas at each respective site and areas will need to be defined for disposal of the resulting spoil from drainage excavation/installation.

8.0 Supplementary Considerations/Risk Review

8.1 Consents/Sustainable Drainage

Drainage works should not require planning consent, however, increased discharge from the golf course as a result of drainage could lead to increased flood risk downstream. For new developments, a limit is often placed on drainage discharge to existing "Greenfield" rates pre-development.

For example, drainage from Arrowe Park GC appears to discharge into Arrowe Brook and Hoylake Municipal GC eventually discharges to the River Mersey and are therefore under Environment Agency jurisdiction. We would advise approaching the Local Authority or Lead Local flood Authority to determine if permission to discharge is required and supplementary information may be required.

Ideally sustainable drainage solutions (SuDS) should be implemented to minimise environmental impacts and potentially provide environmental gains. The hierarchy for discharge of water, under SuDS principles, is as follows:

1. Discharge to ground (soakaways).
2. Discharge to surface water bodies.
3. Discharge to site wide drainage.

Discharge to ground is not viable as the native soils lack adequate permeability. Water bodies such as ponds, lakes or wetlands, require land area and must be reconciled with the needs of golf.

Storage/water harvesting is integral to many SuDS schemes as it helps to limit the volume and rate of discharge from site. It also provides a means of recycling water which otherwise would simply be lost. A reservoir would need to be developed for this approach in an out of play area of the golf course. This would involve excavation and formation of retaining banks with the spoil.

8.2 Post drainage installation maintenance

This is critical to the long-term function and viability of the system. Ditches will require periodic maintenance/cleaning and catch basins cleared of silt. The importance of thatch control and sand dressing have already been highlighted. Outlets must be kept clear.

There is the risk of drying out of drain lines, shrinkage of soils and settlement. This can be controlled by effective irrigation and sand dressing to level out.

9.0 System Longevity

With appropriate maintenance the following provides indicative system longevity when it would be expected to operate with reasonable effectiveness.

- Pipe drainage system: 20 to 25 years +*
- Sand bands (Blec): 2-3 years
- Sand bands (Koro) 3-5 years +*

* + is dependant on good ongoing maintenance.

10.0 Drainage Costs

Budget costs are indicated for the installation of primary pipe drainage, secondary drainage where designed and other drainage infrastructure such as silt chambers and headwall mounts. Contractor preliminary setup fees are approximately 15% of the total value of the works. This would be applied to each course.

Itemised costs are based on linear meterage as designed.

80mm Ø Laterals/ connection – £10/m
150mm Ø Perforated mains – £18/m
300mm Ø Perforated mains – £25/m
300mm Ø Un-perforated outlet – £25/m
Renovation of existing ditches – TBC
Secondary drainage Koro - £2.50 m²
Silt chambers – £500
Headwalls – £250 (depending on size)
Sump drain – £75

Allowances are not made for ditching work, enhancement to existing pond features used for additional attenuation, or any new attenuation features. Costs are based on current contract rates.

The better option for Koro sand slit secondary drainage and a full drainage scheme as designed is used for the purpose of calculating budgets.

10.1 Drawing J004741 002 Arrowe Park Drainage Scheme

Item	Arrowe Park - Drainage	Unit	Quantity	£/unit	Cost (£)
A1	Pipe Drains				
A1.1	Supply and install 80mm Ø Lateral drains	m	33611	£15.00	504,165.00
A1.2	Supply and install 80mm Ø Lateral connections	nr	815	£35.00	28,525.00
A1.3	Supply and install 150 mm Ø perforated mains	m	5314	£30.00	159,420.00
A1.4	Supply and install 300 mm Ø perforated mains	m	1087	£51.00	55,437.00
A1.5	Supply and install 300 mm Ø TW unperforated mains	m	910	£41.00	37,310.00
A3	Items				
A3.1	Supply and install Silt chambers	Item	57	£500.00	28,500.00
A3.2	Supply and install Headwall	Item	8	£250.00	2,000.00
A3.3	Supply and install sump drain	Item	4	£75.00	300.00
A4	Renovation				
A4.1	Renovation of existing ditches - TBC	m			0.00
	Total Summary (Excluding VAT)				£815,657.00

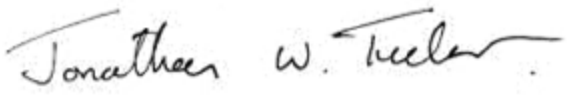
10.2 Drawing J004741 004 Hoylake Municipal GC Drainage Scheme

Item	Hoylake Municipal - Drainage	Unit	Quantity	£/unit	Cost (£)
B1	Pipe Drains				
B1.1	Supply and install 80mm Ø Lateral drains	m	32173	£15.00	482,595.00
B1.2	Supply and install 80mm Ø Lateral connections	nr	822	£35.00	28,770.00
B1.3	Supply and install 150 mm Ø perforated mains	m	4526	£30.00	135,780.00
B1.4	Supply and install 300 mm Ø perforated mains	m	283	£51.00	14,433.00
B2	Secondary drainage				
B2.1	Supply and install Koro or approved equivalent	m²	29297	£3.50	102,539.50
B3	Items				
B3.1	Supply and install Silt chambers	Item	33	£500.00	16,500.00
B3.2	Supply and install Headwall	Item	8	£250.00	2,000.00
B4	Renovation				
B4.1	Renovation of existing ditches - TBC	m			0.00
	Total Summary (Excluding VAT)				£782,617.50

10.3 Drawing J004741 006 Brackenwood GC Drainage Scheme

Item	Brackenwood - Drainage	Unit	Quantity	£/unit	Cost (£)
C1	Pipe Drains				
C1.1	Supply and install 80mm Ø Lateral drains	m	27346	£15.00	410,190.00
C1.2	Supply and install 80mm Ø Lateral connections	nr	826	£35.00	28,910.00
C1.3	Supply and install 150 mm Ø perforated mains	m	5507	£30.00	165,210.00
C1.4	Supply and install 300 mm Ø perforated mains	m	571	£51.00	29,121.00
A1.5	Supply and install 300 mm Ø TW unperforated mains	m	115	£41.00	4,715.00
C2	Secondary drainage				
C2.1	Supply and install Koro or approved equivalent	m²	34992	£3.50	122,472.00
C3	Items				
C3.1	Supply and install Silt chambers	Item	66	£500.00	33,000.00
C3.2	Supply and install Headwall	Item	6	£250.00	1,500.00
C4	Renovation				
C4.1	Renovation of existing ditches - TBC	m			0.00
	Total Summary (Excluding VAT)				£795,118.00

Signed



Michael Boyes BSc (Hons), MA, MBPR, FQA
Regional Turfgrass Agronomist
M. 07969 694496
t. +44 (0)1274 565131
e. michael.boyes@strigroup.com

Jonathan Tucker BSc (Hons), Senior Member EIGC
Senior Design Consultant
t. +44 (0)1274 565131
e. jonathan.tucker@strigroup.com

Michael Rowley BSc (Hons)
Digital Design Manager
t. +44 (0)1274 565131
e. michael.rowley@strigroup.com
www.strigroup.com