

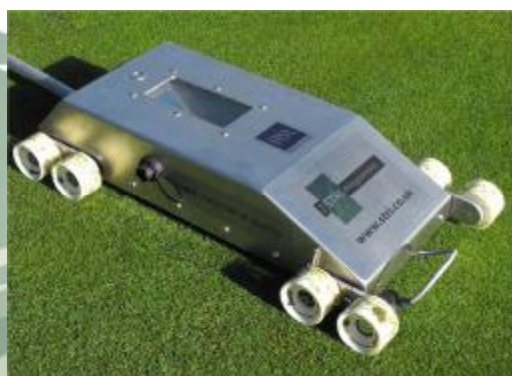
Annual Agronomy Report incorporating the STRI Programme



Monifieth Golf Links

Report Date: 27 October 2011

Consultant: Richard Windows



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Report Title	Annual Agronomy Report Incorporating the STRI Programme
Sports Facility Name	Monifieth Golf Links
Date of Visit	24 October 2011
Visit Objective	Review the annual condition of the course, take objective measurements of green performance and confirm ongoing maintenance requirements.
Present	Mr David Moncur – Green Convenor Mr Scott Rennie – Course Manager Mr Richard Windows – Turfgrass Agronomist, STRI Ltd

Executive Summary

- The course has played well this season despite some difficult periods of weather. Feedback regarding turf condition, playing quality and presentation from Members and Visitors has been positive.
- The major improvement to the course over the past twelve months has involved significant removal of trees to restore the links character of certain holes as well as helping to improve light and air flow around certain greens, e.g. 4 and 9.
- The objective measurements taken during the visit showed firmness levels to be very good despite the wet weather recently and ball roll quality of smoothness and trueness were within the target range despite a relaxed refinement programme due to the time of year. The results obtained clarify the positive feedback regarding green performance this season.
- The main issue discussed involved a need to improve the weak vigour and poor density of turf to patches across the majority of greens. Increased nutritional application (including phosphate), combined with ongoing regular minimally disruptive aeration and appropriate management of soil moisture is the strategy to improve the health and strength of these areas.
- The greens aeration programme was discussed in detail and shall be confirmed in the report. The general strategy involved a move from the use of larger diameter tines to more frequent operations using narrower tine. This will result in less disruption to golf.
- The purchase and subsequent use of a high quality soil moisture meter (e.g. ThetaProbe) would be very beneficial to accurately inform irrigation inputs on a greens specific basis.
- Perennial ryegrass removal using Rescue remains important to the green aprons and surrounds but should only be achieved on a very local basis. This means restricting

applications to relatively small areas each year to allow sufficient time to be channelled into grass cover restoration.

- The fairways were in good condition and have a strong cover of grass following the wet summer weather. The localised hollow coring and sand top dressing to rich/vigorous areas would be very beneficial.
- The tees were all in good condition but a programme of levelling shall be implemented over the next few years.
- Ongoing thinning is required to further reduce the poor quality conifer plantations around the course. The work achieved to date in this regard has been superb.

Introduction

In our report last year, positive comments were made regarding the general condition of the course. However, the main issue during the visit was the unevenness to the greens following the intensive Verti-drain operation implemented last August/September to relieve the underlying compaction. While this work was necessary, it was felt a less intensive aeration programme should be followed in the future to achieve the agronomic objectives without compromising the putting surfaces excessively. Soil laboratory analysis showed phosphate levels to be very low beneath the greens meaning applications of this nutrient were required to sustain strong and healthy growth. Organic matter levels were generally under control but slightly high beneath 6 and 17. Increased populations of fine fescue continued to be evident within the greens due to the sensible management and overseeding programme in place. A programme of perennial ryegrass removal to the green collars and surrounds was discussed using Rescue graminicide to improve the sward texture and presentation of these areas. The major thrust of the winter work programme would focus on tree removal primarily to 4, 7, 9 and 15.

The weather since the last visit has been very difficult at times. A relatively mild and damp autumn last year was followed by an incredibly cold winter with prolonged periods of snow cover. A warm and dry spring followed that allowed the presentation of authentic links playing surfaces. This was followed by a very average summer with prolonged periods of wet weather. The last couple of months in particular have been very poor with heavy periods of rain, strong winds and cool temperatures. In essence, 2011 has been a year to forget with regard to the weather. The course has really dried out and grass growth has been strong all season.

Despite the poor weather, the general feedback regarding course condition, playing quality and presentation has been positive from season ticket holders and visitors. Once the putting surfaces had settled from the Verti-draining last autumn, positive comments regarding green performance have been obtained throughout the season. Some patchiness has developed over the past two to three months that was a major source of discussion and investigation during the visit. Notwithstanding these issues, we were pleased with the condition of the course and felt significant progress had been made regarding tree removal, improving turf strength and quality to walk on/off areas of greens and the underfoot firmness of the greens in response to wet weather.

Greens

Review

The main issue to the greens during the last visit was the unevenness to the surfaces following the intensive Verti-drain operation to alleviate underlying soil compaction. The process of surface smoothing (by rolling and top dressing) was somewhat disrupted last autumn due to the early onset of severe winter conditions. Despite this, smooth surfaces were restored during the early part of the season feedback regarding green performance was good throughout the main season. It was felt ball roll qualities in terms of surface smoothness; trueness and speed were particularly consistent throughout the year. The refinement programme involving sensible mowing heights, regular rolling and ongoing light sand top dressing (using the Dalhousie medium/coarse material) was successful at creating the desirable playing qualities for routine play. Revolution wetting agent was successfully applied on a monthly basis from the early spring and no dry patch symptoms were observed throughout the season.

Nutritional inputs have been rather low and involved a light application of lawn sand during the early spring followed by the main spring/summer granular feed with analysis 14:5:10. Thereafter, light applications of liquid feed have been made throughout the summer to early autumn period. In total, approximately 40-45 kg/ha of nitrogen has been applied to the greens which is certainly on the low side of the ideal. We therefore need to increase nutritional inputs next year to improve sward vigour, density and turf strength. Low fertility was one of the reasons for the patchiness noted to the greens during the visit.

The presence of the aforementioned patches to the greens was a significant concern and has been present for much of the season. The patchiness was present to the majority of greens but considered to be worse to 2, 4, 8 and 9. The patches were considered to be become more evident at the end of a feeding cycle as the natural vigour and strength of the turf wanes. On investigation beneath these patches, root development was very weak and distinct root breaks were present at approximately 50 and 75 mm. It was felt these were being caused by the use of previous Fensoil based top dressings. The combination of the root breaks, slightly low fertility levels and low soil phosphate are the main contributing factors to the weak/patchy nature of certain sections of greens. We feel there is no major underlying issue regarding the soil profile.

A further problem with these areas is their propensity to dry rapidly during dry periods of weather due to the lack of root development and high sand content of the upper soil profile. The latter is desirable as this creates dry and firm surfaces that provide authentic links surfaces and is an issue we have been working on over the past few years. Therefore, to improve these areas a more intensive approach is required involving increased nutrition, phosphate applications, and appropriate applications of irrigation to avoid the soil profiles becoming overly dry. All of these issues will be discussed further in the report.

Performance and Agronomic Assessment – STRI Programme

During the visit we measured the performance and agronomic condition of the greens. The speed, smoothness/trueness and firmness of selected greens were measured to define how they were performing on the day. Additional testing was also carried out to determine the moisture content, organic matter content and chemical status of the upper soil profile. Our aim was to conduct a thorough and accurate assessment of the greens to highlight the areas in need of attention. We selected three greens to provide a good cross section of the standards being set and allow us to determine the level of consistency being achieved across the course. The greens selected were 4, 6, 12 and 17.

By taking measurements of the playing qualities we can accurately describe the standards being set and also compare the results against our target performance levels. Essentially, our aim is to produce a set of greens that receive approach shots correctly then provide smooth/true and well-paced surfaces for putting. It is important that the greens are performing consistently on any given day and as well as possible throughout the year. At this time of year our target ranges for the various playing qualities are as follows:

- Speeds of 8 ft 6 in – 9 ft 6 in for routine play using the Stimpmeter
- Smoothness readings of 16 – 23 mm/m going up to 23-25 mm/m for winter play using the STRI Trueness Meter™
- Trueness readings of 6 – 10 mm/m using the STRI Trueness Meter™
- Firmness readings of 100 – 120 gravities using the Clegg Impact Hammer

It is understood that if we achieve all these target figures then the greens will be performing as desired for this time of year and indeed providing excellent surfaces for play. If we are failing to hit the desired target range then recommendations will be made to help rectify the situation. The results obtained on the day are outlined in the following table.

Performance Measurement Results							
Green No.	Speed (distance)	Smoothness (mm/m)	Trueness (mm/m)	Firmness Mean (gravities)	Firmness SEM (±)	Moisture Content (%)	Moisture Content SEM (±)
4	8 ft 9 in	22.46	9.03	105	1.8	28.0	0.7
6		21.53	9.06	101	3.0	29.7	1.7
12		20.92	8.35	101	2.4	25.7	0.6
17		22.26	8.66	93	2.1	28.2	0.6

Green Speed

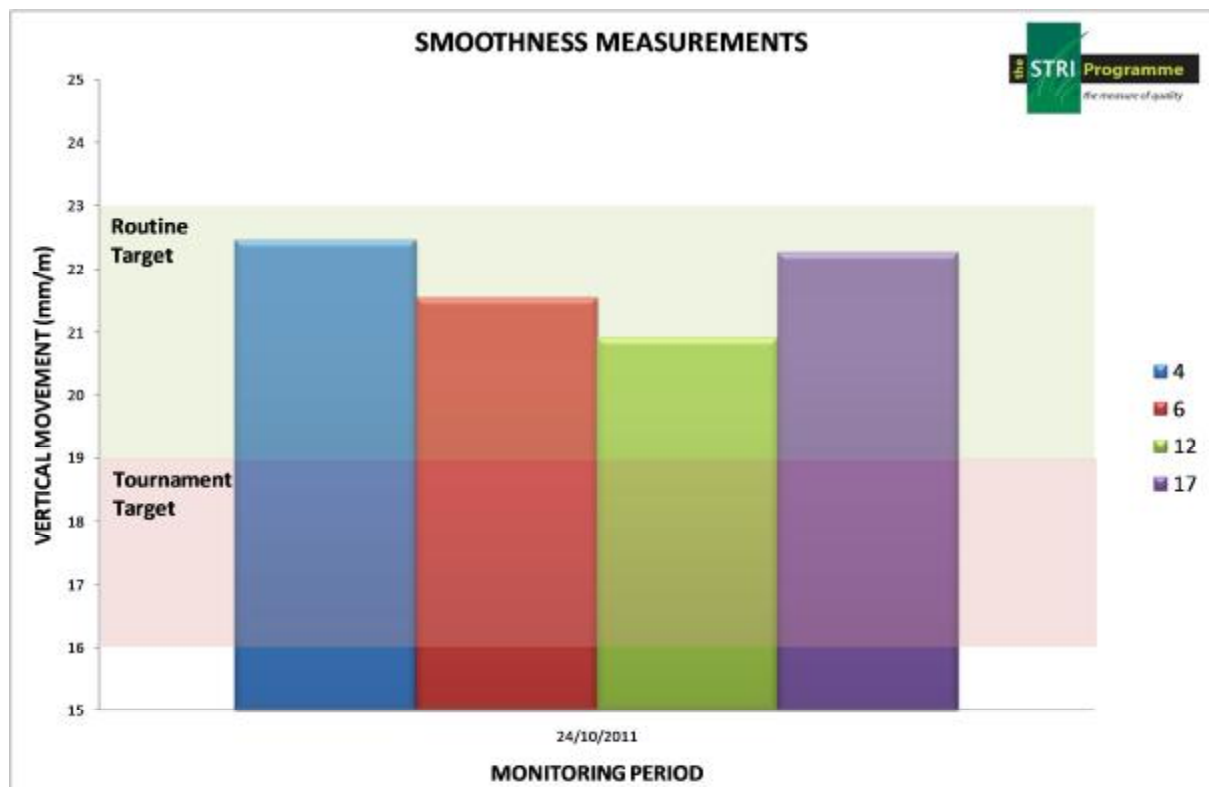
Due to the very high winds during the visit, it was not possible to take an accurate Stimpmeter reading of green speed. However, one reading was taken to the more sheltered 4th green and a very respectable reading of 8 ft 9 in. was obtained. It was felt the surface was reflective of the speeds to the other greens on the golf course which, in the case, shows a very good level of speed was being obtained for the time of year. What is more, feedback regarding green speed throughout the season has been positive due to the sensible refinement programme in place.

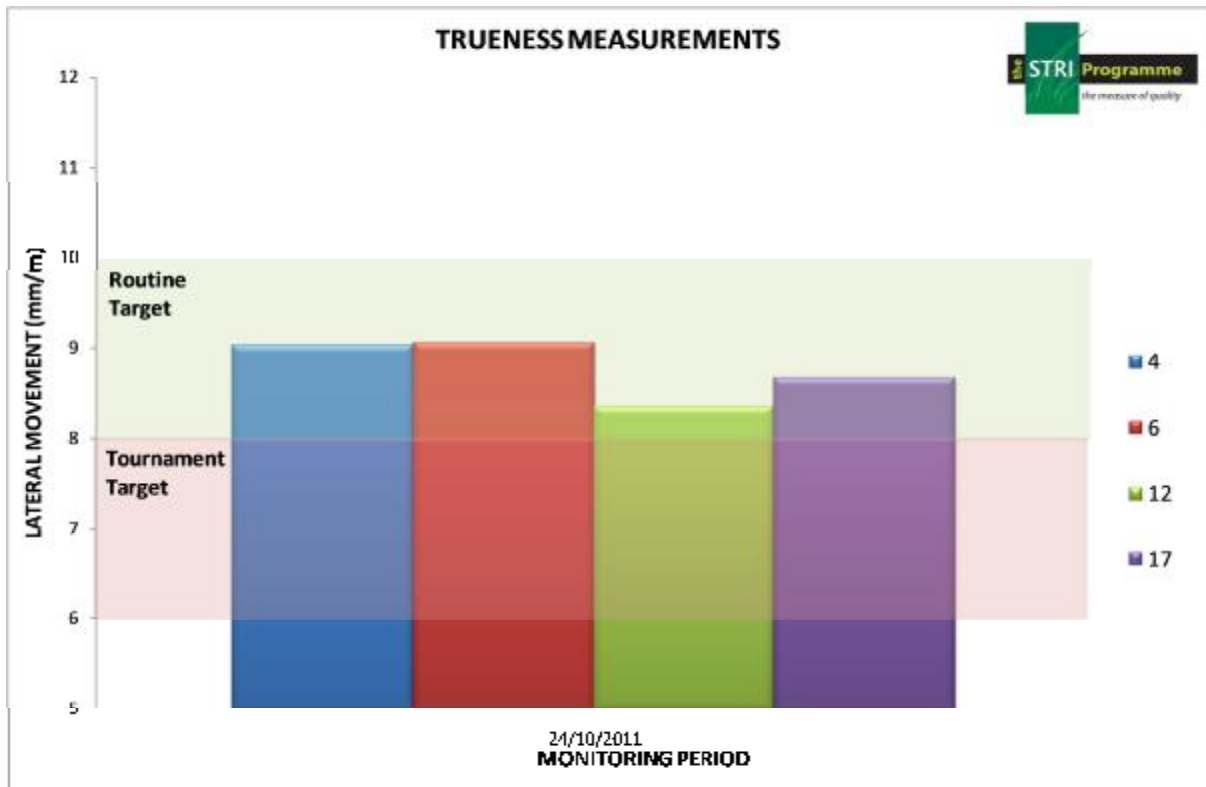
Smoothness/Trueness

The smoothness and trueness of the selected greens was measured using the Trueness Meter™. This device measures the smoothness (vertical deviation) and trueness (lateral deviation) of the putting surfaces with the level of deviation being expressed in millimeters per meter (mm/m). With these results, lower readings indicate a smoother or truer surface.

Our aim when maintaining the greens is to produce surfaces that are smooth and true for putting for as long as possible throughout the year. We are aiming to create smooth and true surfaces for putting that do not deflect the ball from its intended path (“snaking”) or kill its momentum (“bobbling” and “chattering”). During the main playing season, our target range for smoothness is 16 - 23 mm/m of vertical deviation and for trueness 6 - 10 mm/m of lateral deflection. The lower end of these target ranges represents fantastic putting surfaces (worthy of international tournament standard) with the higher end providing really good standards for routine play. These target ranges are very challenging but we are striving to achieve the highest standards for play. For winter conditions, slightly higher smoothness values of 23-25 mm/m would provide very good surfaces for winter play.

The results for smoothness and trueness are outlined in the two graphs below and they are compared against our target ranges.





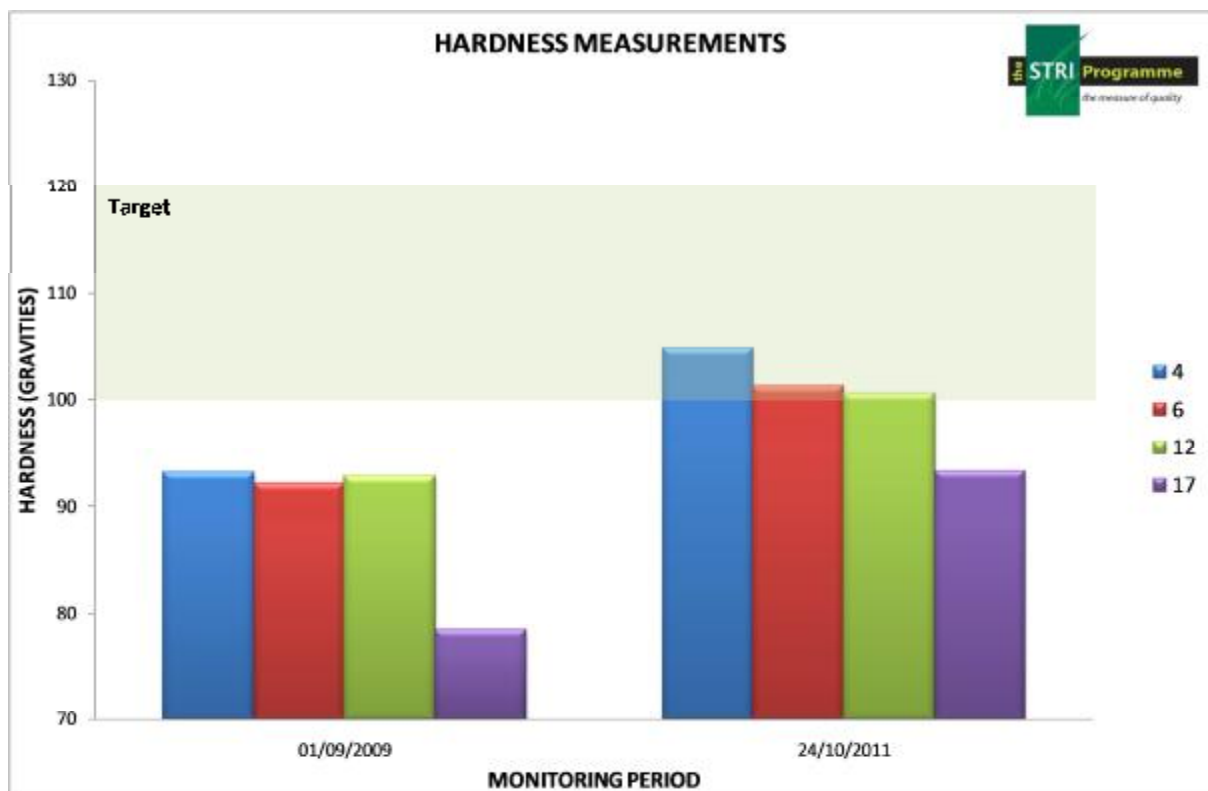
The smoothness values obtained were very good and all within the very challenging routine summer target range. It should be said, values beneath 25 mm/m of vertical deviation at this time of year are reflective of good putting surfaces and to obtain values within the routine target range is very good indeed. Again, these good values verify the positive feedback regarding surface smoothness so far this season and during the visit. The good results are attributable to the even texture of the sward and the good botanical composition of the turf. It was interesting to note the smoothest green was the 12th and this surface was less patchy and had a more even sward blend. Where the turf was most patchy, e.g. 4 and 17, smoothness and trueness was slightly compromised. Therefore, it is important to improve the density and vigour of the turf to further improve smoothness values.

The trueness values obtained were all within the very challenging routine target range and again attributable to the good density of the turf and sward species composition. Experience with the Trueness Meter™ has shown surfaces dominated by fine fescue tend to be significantly truer throughout the year than those dominated by browntop bent or annual meadow-grass. This provides the justification to sustain the existing fescue overseeding programme to deliver greater populations of this grass in the sward and better trueness values.

Overall, the ball qualities obtained during the visit were excellent for the time of year bearing in mind the poor weather recently and the relaxed refinement programme currently implemented due to the relaxation in growth. This shows how good the Monifieth surfaces are for autumn/winter play and ongoing occasional mowing combined with some rolling will continue to provide good quality putting surfaces for the winter period. Improving ball roll qualities further will involve reducing the patchy nature of the sward to certain surfaces as well as increasing fescue populations by ongoing overseeding.

Surface Firmness/Hardness

The firmness of the greens was measured using the Clegg Impact Hammer. A 9-point sampling grid was employed to allow us to calculate an average hardness reading for each green and also determine the level of consistency within the 9 readings. Monifieth is links in nature and our aim is to create very firm surfaces that place a real premium on true and accurate ball striking when playing into the greens. To achieve this, our target firmness range is between 100 – 120 gravities regardless of the weather conditions. At these firmness levels, balls from well struck shots taken from tight fairway lies will impact, release, check and roll out. Improperly struck shots, or those taken from the rough, offer far less (if any) control and will roll off putting platforms and finish further away from the greens. The following chart compares the average hardness results against our target figures.



The firmness values obtained were very encouraging considering the wet weather recently and slightly high soil moisture levels (see below). Despite these issues, the firmness values were all within the routine target range with the exception of the 17th that fell slightly short. These values combined with feedback and assessment of the interaction between ball and turf during the visit verifies the surfaces are currently performing in an authentic way even following wet periods of weather. This is attributable to the sensible management of the upper soil profile and excellent reduction in organic matter in recent years due to the sand top dressing programme implemented. In general, sand top dressing inputs should be sustained at the existing level but more intensive applications, in combination with localised hollow coring to certain greens such as the 6th and softer sections of the 17th, which receive limited traffic, will further help improve surface firmness.

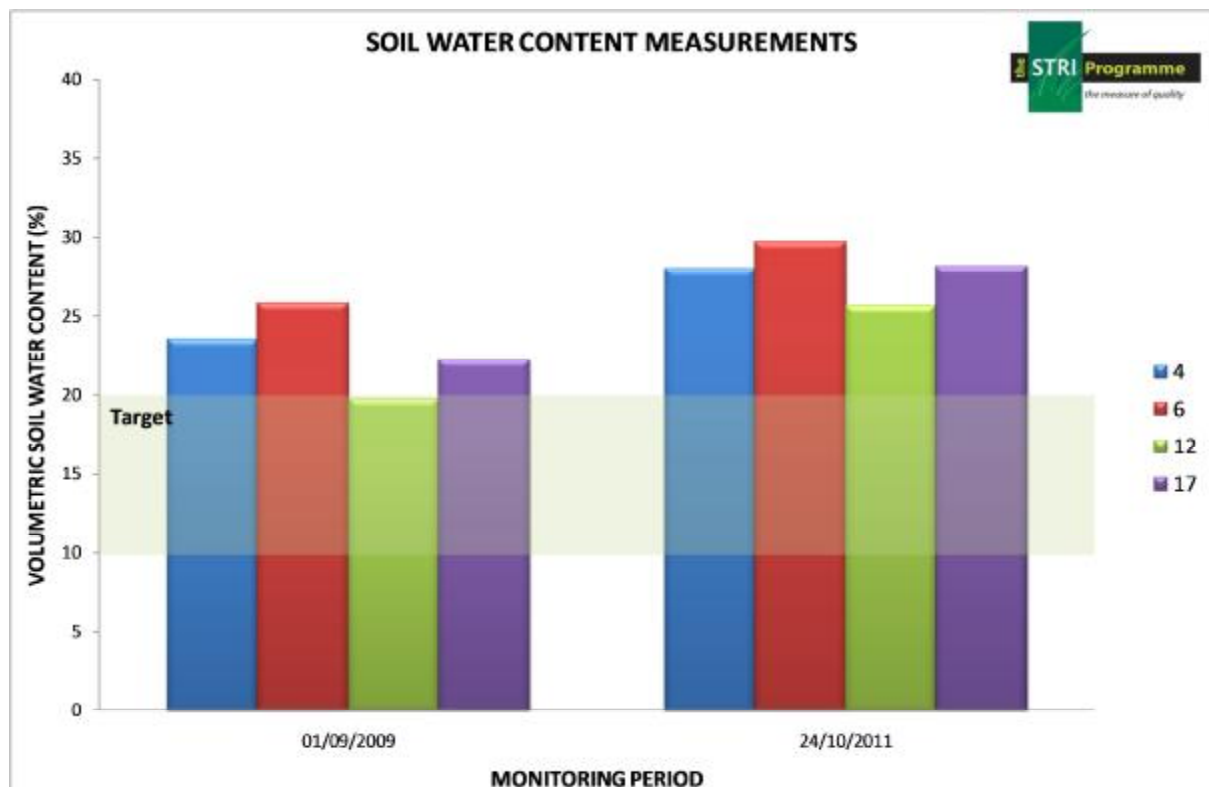
The consistency of firmness through each individual green was good and well below the threshold range. This means there was no soft or hard spots across each surface and the ball was reacting in a consistent manner regardless of where it landed on the surface.

Soil Moisture Content

The soil moisture content was measured using a Theta Probe moisture meter. Nine points were sampled on each green and the average was calculated.

The moisture content of the soil profile has a significant impact on the playing qualities of the greens and also the health of the turf. When the soil moisture content is too high, the surfaces can become soft and the turf health can also suffer. When the soil moisture content is too low the consistency and uniformity of the turf can become compromised. For these reasons, we aim to keep moisture content within an ideal range of 10 – 20 %. At these moisture levels the turf health and surface firmness will be optimal. Careful monitoring of moisture content and the regulation of irrigation inputs (as well as organic matter management) will help ensure that we are able to hold the moisture levels within our desired range.

The results of the moisture content testing are contained within the bar chart below and compared against our target ranges.



The soil moisture values were all slightly higher than the ideal target range due to the wet weather that has been experienced recently. However, the values were only slightly outside the ideal target range indicating the greens are not retaining excessive moisture following heavy rainfall events. The exception to this being the low lying sections of the 6th green that were significantly more moisture

retentive and exhibited values of 35-40%. Some localised hollow coring and sand filling would be beneficial to reduce moisture retention to these areas.

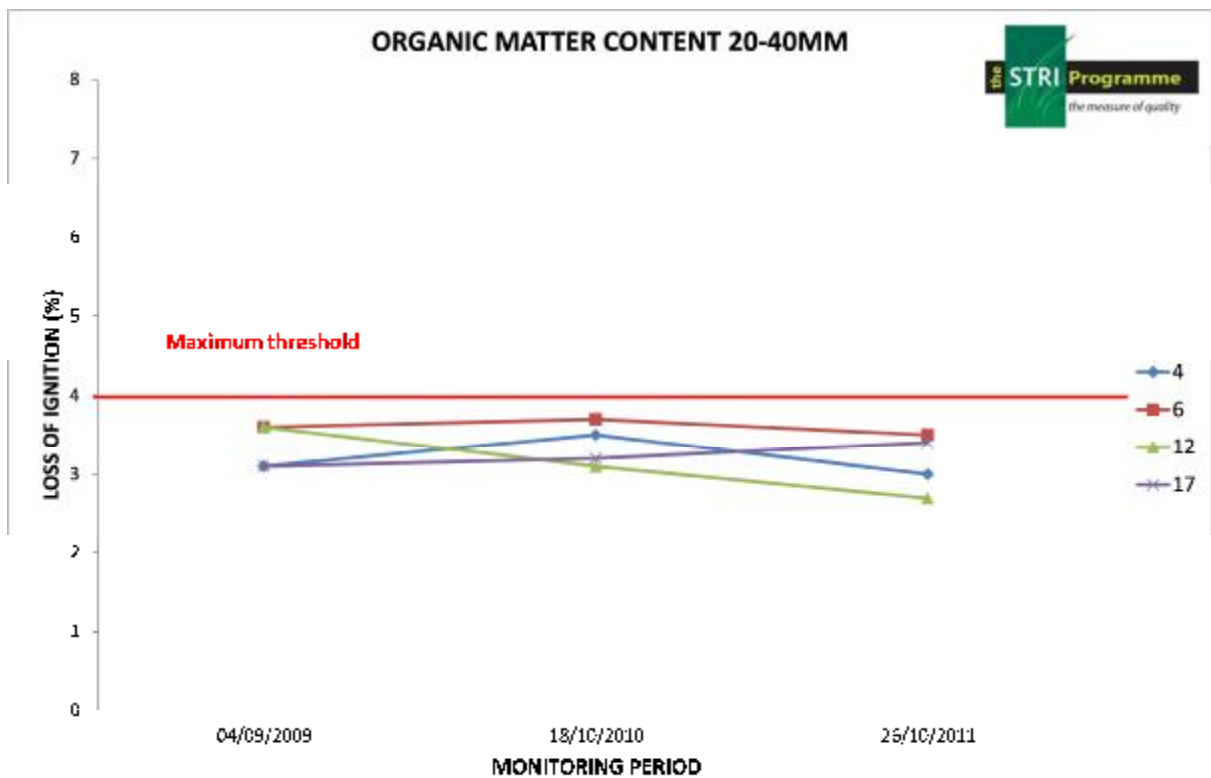
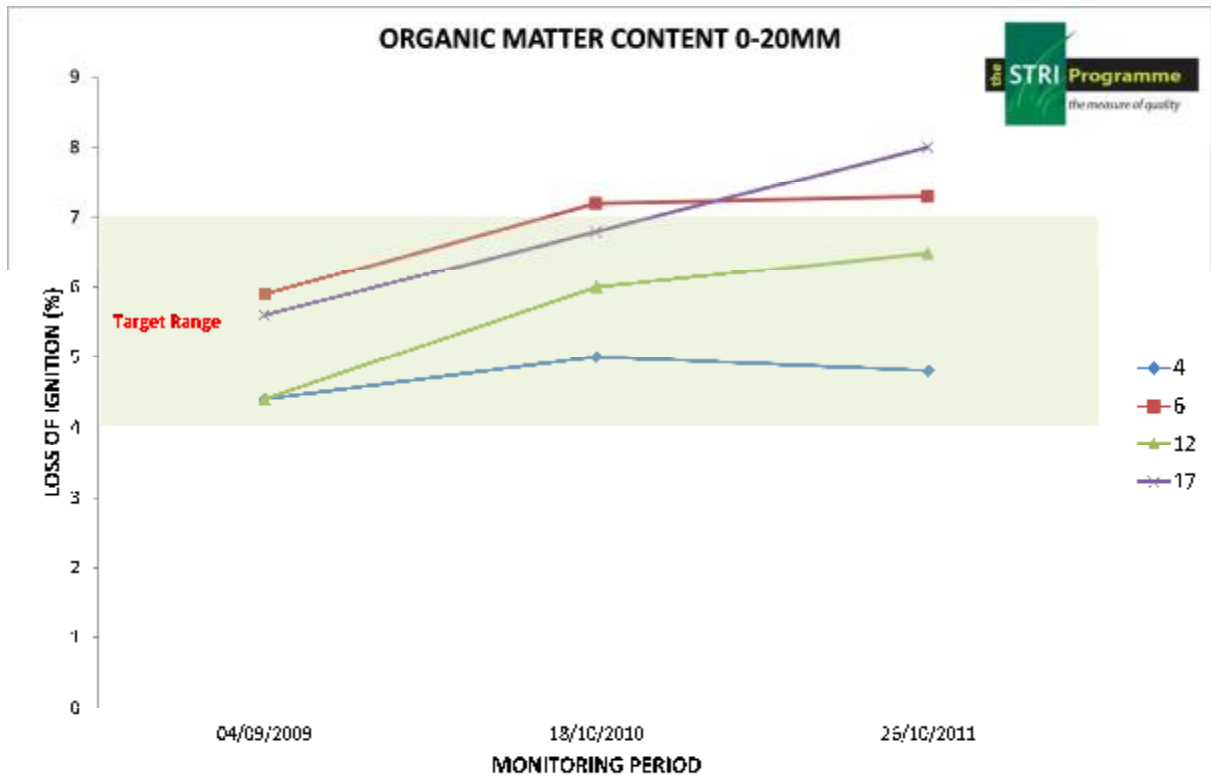
To help avoid weakening of the existing patchy sections of the greens next season, it is very important to retain appropriate soil moisture levels beneath these areas. Therefore, ongoing accurate monitoring using a high quality soil moisture probe (e.g. ThetaProbe) would be very beneficial to help inform decision making in this regard. In essence, irrigation applications should be applied to keep a minimum of 10% but more ideally 12-15% moisture beneath all these areas. Ongoing applications of Revolution wetting agent will help optimise penetration of water uniformly into these areas as well as aiding a little moisture retention to aid the production of healthy turf.

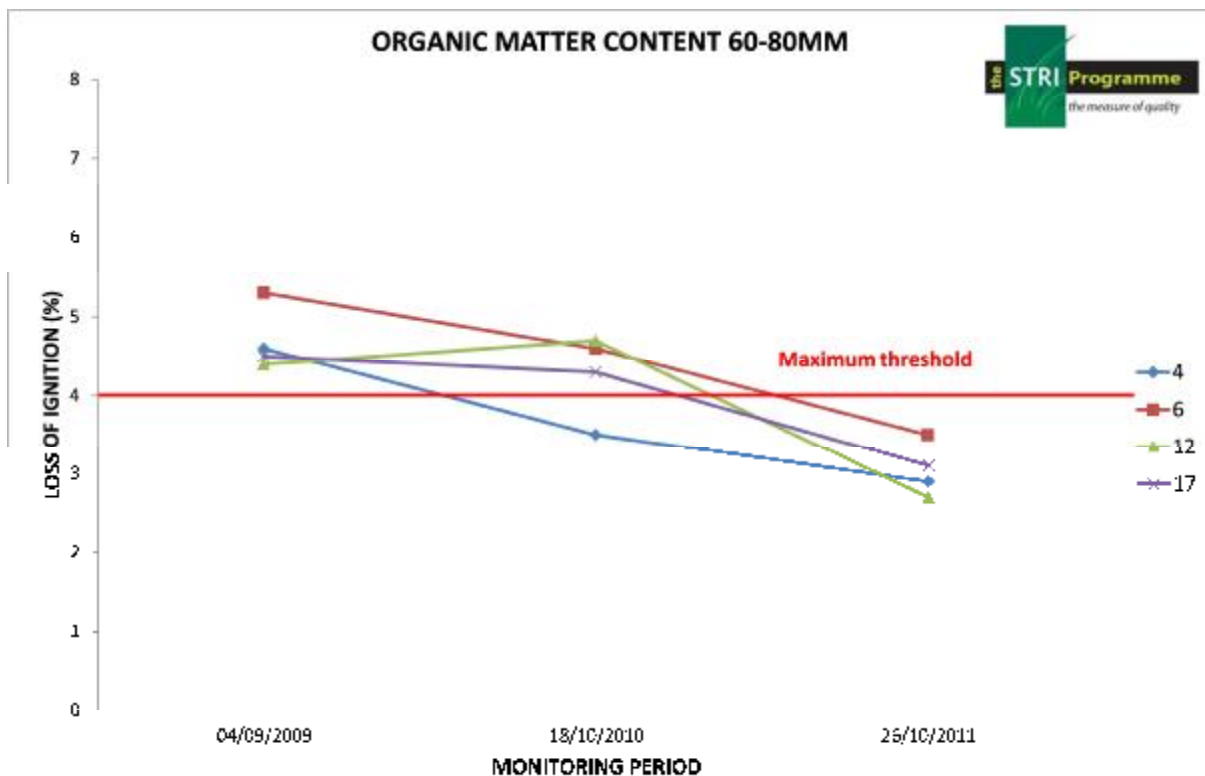
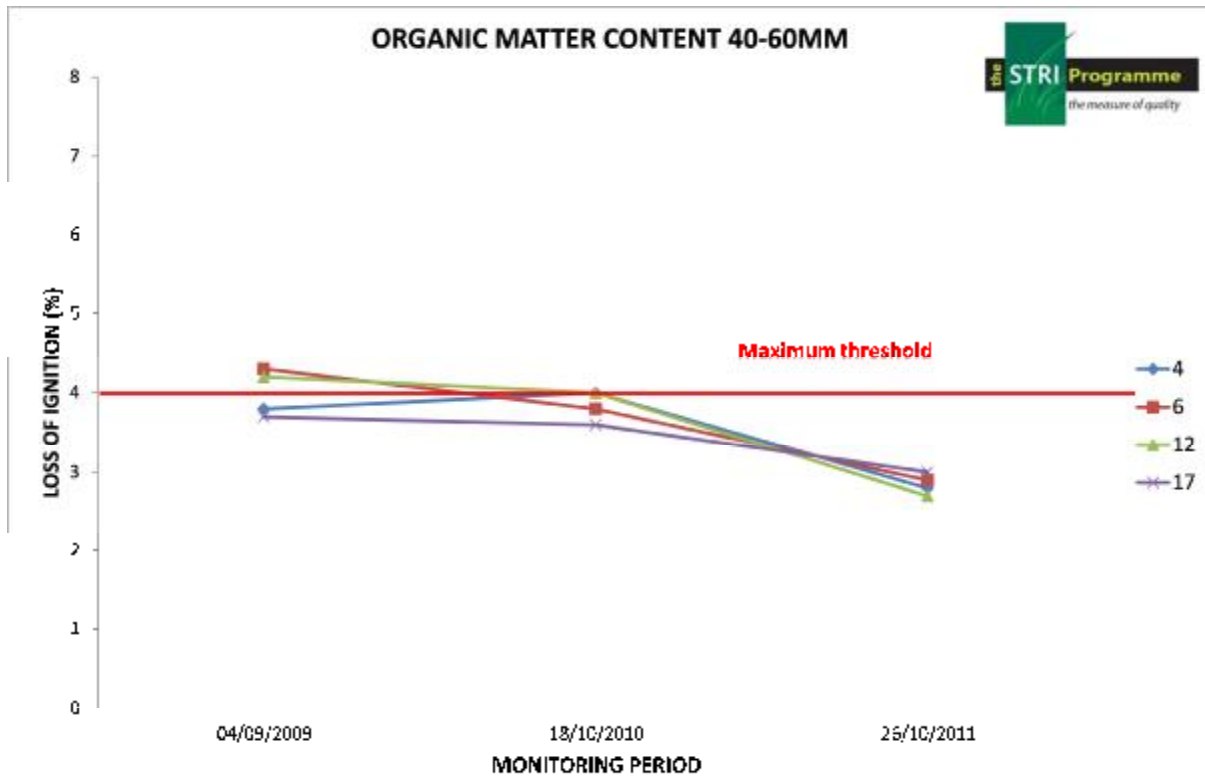
Organic Matter Content

Samples were taken and submitted to our laboratory to assess the organic matter content of the upper soil profile beneath the selected greens. Organic matter content is important because high levels can adversely affect playing quality (soft surfaces) and also increase the risk of potentially damaging conditions such as disease and dry patch developing. For Monifieth, our target range for organic matter content is 4 – 7 % in the top 20 mm moving down to < 4 % lower down. An accurate measure of the organic matter content helps us determine the intensity of work required to hit our target levels. The results of the organic matter content testing are contained in the table below.

Organic Matter Content				
Loss on Ignition (%)				
	Green 4	Green 6	Green 12	Green 17
0-20 mm	4.8	7.3	6.5	8.0
20-40 mm	3.0	3.5	2.7	3.4
40-60 mm	2.8	2.9	2.7	3.0
60-80 mm	2.9	3.5	2.7	3.1

The bar charts below show the results against the target range and in comparison to previous results.





The organic matter of the greens was generally good and continues to be within the desirable target range of 5-7% within the top 0-20 mm of soil profile. In general, we do not want to lower values further as consistent firmness levels are being obtained even following rainfall events. However, the exception to this is the remaining slightly soft greens where organic matter content remains slightly higher, e.g. 6 and 17. Localised hollow coring combined with sand top dressing should be implemented to these areas to help optimise surface firmness by reducing organic matter.

Organic matter levels are desirably below the threshold level of <4% at 20-80 mm beneath all the greens indicating there is no need for any operation other than sand top dressing to manage organic matter accumulations.

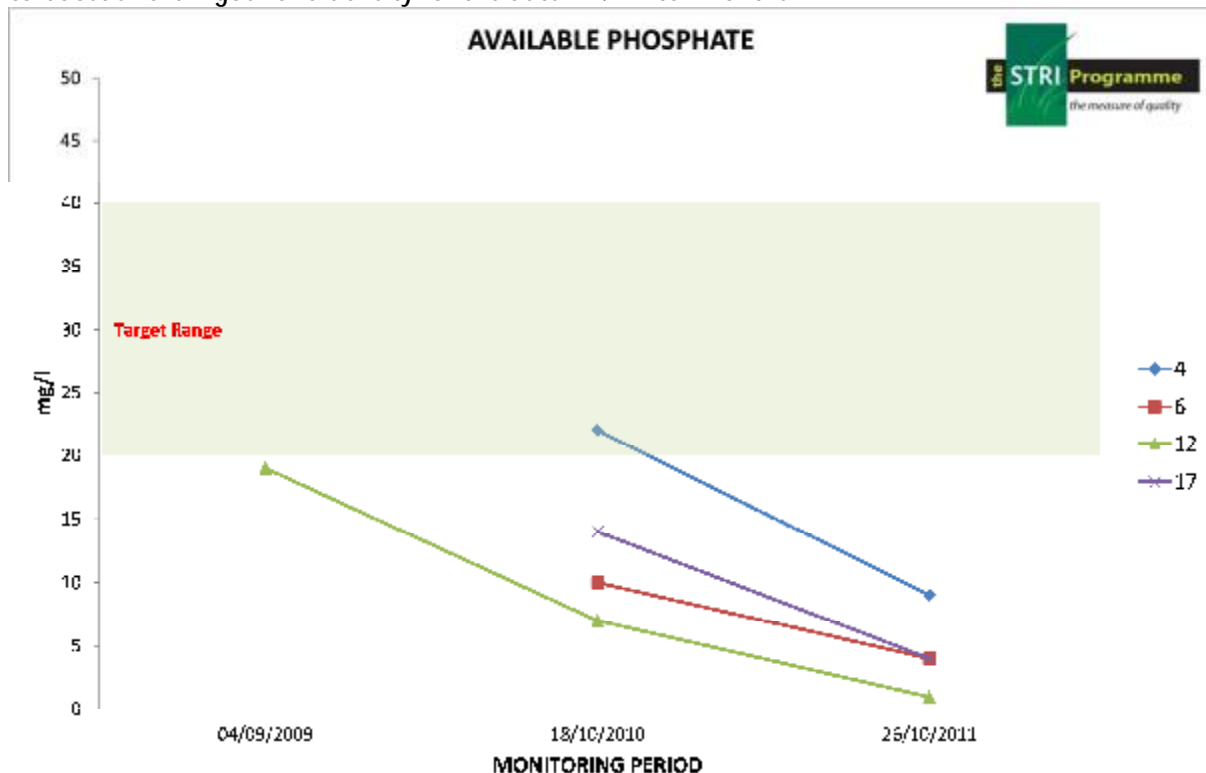
Soil Chemical Analysis

Samples were taken from each green for routine chemical analysis of soil pH, phosphate (P₂O₅) and potassium (K₂O). The results of the testing are outlined in the table below.

Soil Chemical Analysis			
	pH	P ₂ O ₅ (mg/l)	K ₂ O (mg/l)
Green 4	6.0	9	92
Green 6	5.7	4	106
Green 12	6.0	1	77
Green 17	5.7	4	71

The pH of the soil remains within the ideal target range for links greens and requires no action.

Soil phosphate levels were identified as being rather low last year and they have become lower this year (see graph below). The combination of low soil phosphate levels and distinct purpling of bentgrass leaf edges confirms the need to increase soil phosphate applications to the greens with immediate effect. Excessively low phosphate levels causes weakened turf with symptoms being expressed as weak patchy sections of turf like those currently experienced. We therefore need to increase the application of this nutrient over the next couple of years to provide stable levels around the 20-40 mg/litre mark. An immediate application was recommended during the visit in an effort to boost sward vigour and density for the autumn/winter months.



Potassium levels beneath the soil were satisfactory but ongoing applications should be made to sustain desirable levels.

Soil Conditions

Extensive examinations of the underlying soil profile were made during the visit to assess whether soil conditions were impacting on turf health. On analysis of the underlying soil profiles, root development was generally weak beneath the greens due to the presence of root breaks at approximate depths of 50 mm and 75 mm. In areas of weak turf, root development was even weaker with very few roots holding the upper soil profile together. Conversely, where turf health and vigour was naturally stronger, e.g. rear of 12th green and rear of 6th green root development was stronger.

The main cause of this weak rooting is considered to be due to the previous use of Fensoil based top dressings which are slightly coarse in nature and the sub rounded particle shape causes a shearing effect under the influence of maintenance operations. This situation is common at other links courses we visit that had similar material used for top dressing in the past.

Analysis of the soil at depth shows a layer of finely textured material that does have the ability to become tight and compact meaning ongoing deep aeration is necessary to retain its structure and general performance.

So, the soil profiles are far from ideal but none of the problems require drastic or disruptive action. The general policies should continue which involve ongoing sand top dressing to dilute the underlying Fensoil and build accumulations of better quality material at the sward base in combination with ongoing minimally disruptive aeration. With regard to the latter, a slightly different approach should be implemented involving more regular use of the narrower 8 mm solid tines throughout the year leaving the use of the larger 10-12 mm tines to localised treatments of traffic hot spots across individual greens. It was felt this approach should offer minimal disruption to golf at the same time as achieving the agronomic objective of improving root development. This programme in combination with increased fertility and phosphate application should help improve rooting and the general vigour of the sward.

Sward Composition

Significant strides have been made regarding improving the sward species composition of the greens especially regarding the fescue component of the sward. The fescue overseeding programme is working well and should be continued. However, to obtain optimum results from this operation with minimum disruption to golf, a couple of shallow solid tining operations using 10-12 mm tines set to a shallow depth of 25 mm should be implemented in the spring and late summer to ensure fescue can be appropriately inserted into the ground to further improve sward quality. In addition to this, ongoing local fescue overseeding should be implemented to the existing weak sections to boost vigour and take advantage of the reduced composition of the surrounding grasses.

Summary

In general, the existing greens maintenance programme is working well and should be continued. A good sward refinement programme is in place and is delivering good ball roll qualities on a consistent basis. The organic matter reduction programme involving sand top dressing is working well and delivering good firmness values regardless of the weather conditions. More intensive localised treatments are required to improve the consistency of greens further.

The main focus of greens maintenance must involve reducing the patchy nature of the turf to many sections of the greens. In addition, a revised aeration programme is warranted to minimise disruption to golf at the same time as achieving the agronomic objectives of improving root development. The methods in which these objectives will be achieved are described in the section below.

Confirmation of Greens Maintenance Recommendations

The following confirms the maintenance discussions made the visit:-

- An immediate application of fertiliser (containing significant phosphate) should be made with analysis 3:10:5 to boost the density and vigour of the sward.
- Due to the potential of a growth flush following the above feed, consideration should be given to the application of the preventative fungicide in the form of Instrata or Banner-Maxx or equivalent product from another supplier.
- The aeration programme should be revised slightly and involve four to six weekly operations using the narrow 8 mm tines set to achieve a varying depth of 100-200 mm throughout the year. More intensive applications using slightly larger tines (10-12 mm) should be restricted to the heavily trafficked sections of individual greens. Ongoing Hydrojecting should also be integrated into this programme.
- Twice yearly fescue overseeding should be implemented using 10-12 mm shallow solid tining to prepare the seed bed. Ensure high quality fescue seed is used and applied at a good rate of 15-20 g/m². Additional overseeding operations should be implemented to the weak sections of individual greens.
- The nutritional programme should be altered to increase the amount of nitrogen applied to the greens each year. The aim should be to apply approximately 60-65 kg/ha of nitrogen over an eight month period. This will be achieved with an application of 6:5:10 feed in the early spring followed by the main 14:5:10 feed in the late spring/early summer. Occasional liquid should be applied through the summer season to sustain gentle growth with a further application of 6:5:10 fertiliser in the last summer/early autumn.
- Iron sulphate applications along with seaweed should continue to be made throughout the autumn/winter months.

- Continue to use the Dalhousie medium to medium coarse sand top dressing at least until we get on top of the current patchy issues with the sward. Once these have been improved serious consideration to the use of the medium to medium fine product should be given.
- Sustain regular applications of the Revolution wetting agent ensuring the first application of the product is made during the early spring before any drying has been noted.
- The purchase and subsequent use of the high quality ThetaProbe soil moisture meter would be beneficial to ensure the greens do not become overly dry and accurate applications of irrigation can be focused into the appropriate greens and sections of the greens. This is particularly important to ensure the weak sections do not become overly dry and thus weaker.
- We strongly agree with the proposal to rest the weak 9th green as this will help provide a better quality surface next spring. The increased annual meadow-grass component of this sward (due to the previous shade issues) has reacted to the more exposed conditions the turf now receives following tree removal.

Other areas of discussion

Green Surrounds & Aprons

The perennial ryegrass removal programme implemented last autumn was initially successful but recovery was severely compromised due to the early onset of winter weather. This meant some of the treated areas had to be re-turfed to restore grass cover in the spring.

As perennial ryegrass continues to be a problem to these sections of the course, it is important to remove them using Rescue over the next few years. However, to ensure grass cover can be appropriately restored on the treated areas, the plan should be revised to reduce the extent of application on an annual basis to a couple of relatively small sections each year. Once the product has been applied, intensive fescue overseeding and fertiliser application can be channelled into these sections appropriately.

The 3:10:5 fertiliser recommended for the greens should be extended into all the green surrounds and aprons to improve the density and vigour of these areas for the winter months.

Tees

The tees were generally considered to be in good condition but a programme of levelling shall be implemented over the next few years to provide better quality platforms.

Fairways

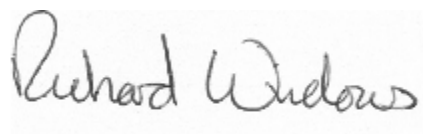
The fairways were in good condition and all supported a strong cover of grass following the wet summer this year. A programme of sand top dressing following hollow coring should be implemented to low lying and/or more productive sections of the fairways.

Rough

We are absolutely delighted to see significant populations of conifer plantations have been removed from strategic areas of the course. The results of this work have been excellent to holes such as 4, 7, 9 and 15. The links character has been appropriately restored and much more favourable environmental conditions are now present around the previously shaded playing platforms.

Further similar tree thinning work shall be completed around certain sections of the course over the next few years.

Signed

A handwritten signature in black ink that reads 'Richard Windows'. The signature is written in a cursive, flowing style.

Richard Windows B.Sc. (Hons.) MBPR, RIPTA
Turfgrass Agronomist
Agronomist to the R&A Championship Committee