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GOSFORD GOLF CLUB
COURSE ASSESSMENT – 25 May 2010

INTRODUCTION

A visit was made by Dr James Hull (Independent Turfgrass Consulting) to Gosford Golf Club to make an inspection and assessment of the golf course and course management operations. This visit was made at the request of the club management. The intent of the inspection was to make an assessment of the state of the golf course on the day of the visit, to review the course maintenance machinery, review the maintenance and renovation operations, and to provide an opinion on some specific topics regarding the maintenance schedule and various aspects of turf agronomy and operations.

Some of the aspects of golf course operations are not within the scope of this report, or the expertise of this consultant. The architecture of the golf course is an area that requires a specialist in that field. Other questions on the priority of works to be undertaken on the course are a matter of personal opinions, and thus must be decided in consultation between club management and staff. This report is intended to focus on agronomic aspects of turf management and the requirements of golf course operations.

There are obviously limitations to what can be inspected on any particular day, and this report is therefore limited in some areas. It is not possible to provide first-hand accounts of conditions at other times of the year, and there will be details of the golf course operation and condition that have been missed. An attempt has been made to include all critical areas, and those areas that were brought to my notice by the club management and superintendent.

METHODOLOGY

The inspection was made on a single day (Tuesday 25 May 2010) and consisted of a visual inspection of the course, and a measurement of several key factors affecting play. Some factors such as bunker sand resistance to penetration were not feasible on the day of the inspection, as there was heavy rain during the morning and many bunkers had standing water. The factors assessed, and the methods used, are described below.

Greens -

Speed – taken using a Stimpmeter. This is a length of aluminium channel with a notch in one end in which a golf ball will rest. Once the Stimpmeter is raised to a certain angle the golf ball rolls down the channel and across the green. The standard methodology is to use three rolls in each direction. The speed is then measured in metres (and feet) of roll using a tape measure. More information on the technology and application of the Stimpmeter can be found at the USGA website at
http://www.usga.org/course_care/articles/management/greens/Stimpmeter-Instruction-Booklet/

Hardness – Taken using Clegg Impact Tester (also known as the Clegg Hammer). The Clegg hammer is dropped four times onto the surface of the green and the hardness of the surface is measured in units of tens of gravities of deceleration. The measurement of the fourth drop of the 0.5 kg Impact Tester is the Clegg Impact Value (CIV). Variations of this device are used for sportsfields, cricket wickets, road construction and civil engineering.

Thatch depth – direct observation using core sampler

Species composition, disease, weed and insect incidence – visual observation

Bumpiness – assessed during speed measurement and rated on 0 – 9 scale, with 0 being unplayably bumpy and 9 being no sign of deviation from a smooth path during the Stimpmeter assessment

Green surrounds –

Hardness – Assessed by walking over the surround areas.

Species composition – visual assessment

Tees –

Levelness – visual assessment of deviation from a level surface, both locally and over the entire width/length of the tee

Uniformity of cover, species composition, disease, weed and insect incidence – visual observation

Fairways –

Uniformity of cover, species composition, disease, weed and insect incidence – visual observation

Bunkers –

Freedom from weeds and general presentation – visual assessment

Depth of sand – normally done by probing with a steel spike, but not conducted due to standing water in most bunkers

Penetration resistance – normally taken by measuring the force required to embed a golf ball to half its diameter, measured with a pocket penetrometer – not conducted due to water in bunkers and saturated sand.

Uniformity of sand – observation

Rough -

Uniformity of cover, species composition, disease, weed and insect incidence – visual observation

Bumpiness of surface – visual observation

Treescapes –

Presence of dead trees, branches, unground stumps, etc – visual observation

Other factors assessed –

Machinery age and condition
Irrigation system age and condition
Water quality and quantity
Staff levels
Workshed
Processes – Occupational Health and Safety and Environmental Management Systems

In addition to the above the Management of the Gosford Golf Club also sought comment on some aspects of the course budget and maintenance schedule.

Notes on measurement of course characteristics

Many of the playing characteristics of the course listed above have no 'correct' or 'ideal' values. Probably the most contentious of these characteristics would be green speed. The argument for faster or slower greens is probably as old as the game of golf, and occupies a large part of the literature on golf course maintenance. The measurement of speed in this assessment, and the conclusions drawn from that measurement, is not intended to provide comment on whether the greens should be faster or slower than they were on the day of the assessment. The greens were measured for *consistency* of green speed. The golfer should be able to go from one green to the next without having a nasty surprise when he or she strikes the next putt.

Similarly the golfer should be able to play a shot into the next green and have a reasonable expectation of the behaviour of the ball when it hits the surface. It is unfair to the golfer that the ball grips and 'sucks' on one green, then bounces off the next green as if it had hit concrete. The green surface hardness measurement was therefore an assessment of *consistency* of hardness, and no comment on whether the greens should be harder or softer should be derived from this measurement.

The assessment of thatch levels of the greens is an important factor in whether the greens will become excessively spongy and soft. A green with a high percentage of sand/soil in the upper layers can be manipulated to provide either a firmer or a more holding surface by varying the moisture level of the soil or by mechanical decompaction of the upper soil layers. An excessively intense thatch layer, which has a high percentage of organic material from dead and partially-decomposed organic material, will be spongy and soft when wet, will retain excessive moisture in the upper layers, promotes disease and poor plant root extension, and will dry out very quickly in warm weather leading to loss of grass cover.

The 'ideal' depth and characteristics of bunker sand is also a matter or personal preference though some standards have been set for acceptable sands (see appendices). Therefore this inspection process has only sought to assess consistency of sand throughout the course. Unfortunately the heavy rain on the morning of the inspection produced standing water in the bottom of the bunkers, preventing an assessment of the sand characteristics under normal playing conditions.

RESULTS

Greens

The greens had a uniform cover of Wintergrass (*Poa annua*) and bent species (*Agrostis* spp.). There were no notable bare patches of green across the entire course. The grass was consistently growing up to the mowing height, without excessively worn areas that produce an uneven surface

Green speed
Green speed was taken on a total of 12 holes. Holes 2 – 5 were assessed during and immediately after heavy showers and had surface water evident. This would brake the ball roll and therefore the speed was not taken on these greens. Two greens had slopes of some sort on the entire green and had no flat area of sufficient size on which to assess speed.

Hole	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Speed (m)	2.55	*	*	*	*	2.7	2.5	2.7	**	2.7	2.7	2.55	2.65	2.65	2.65	2.7	**	2.7
Speed (ft)																		

*Not taken due to water on green
** no flat area on green

The average speed was 2.65 metres, or 8.8 feet. This is considered to be a medium green speed by the USGA and would be slightly faster had the day been dry rather than showery.

Surface hardness

The surface hardness measurement was taken on 12 greens. The other greens either had water on the surface, or close enough to the surface that the impact tester would simply splash on contact with the surface and the measurement would be compromised.

Hole	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
CIV Gmax x 10	*	*	*	*	*	10	10	10	9	10	9	9	10	10	9	10	*	9

*Not taken due to water on green and/or saturated surface

The measurement of the green surface hardness averaged 9.6 and there was very little variability between measurements when measurements were taken in the centre of the green. Local conditions on the green will always vary somewhat, and a test of a walk on/off area of the 11th green produced a reading of 12 CIV.

Thatch depth

Thatch depth was assessed by taking a core sample from near the centre of the green. There was no significant level of dense thatch observed during this inspection. This is largely due to regular coring and topdressing, which has produced an intermingled zone of decomposing organic material and sand. The photographs below illustrate the upper layers of the green profile.

The photographs above show the soil profiles of green 6, 10 and 16, showing the dilution of thatch with sand from regular topdressing

Some areas of greens were considerably sandier and harder than the majority of the green. These were generally on older greens, adjacent to bunkers. These areas also dry out rapidly in summer, due to the high sand content, low organic matter, relatively low fertility, and the depth of the sand.

Species composition

The greens were predominantly Wintergrass (*Poa annua*) with patches of bent (*Agrostis* species). Poa annua describes a multitude of biotypes, including perennial, prostrate-growing types. These are being used to breed perennial, turf-types *Poa annua* varieties for commercial release in the United States. The majority of the biotypes found in Australian greens seem to be true annual types. Individual plants of these types last a maximum of one year. An extensive study by Mary Lush in Victoria found that these plants in greens were constantly germinating, growing, seeding and dying, leaving a huge bank of seed in the soil. The ability of *Poa annua* to seed while being cut at greens height, its prolific seed production, and its adaptation to coastal conditions in south-eastern Australia make it a very challenging weed if its presence is not desired, or the logical choice for a greens grass species if the club does not want to undertake the enormous effort and expense of trying to keep it out. The retention of this species seems logical at Gosford Golf Club. It should be noted that several high profile, major losses of greens turf at large clubs in recent years are the result of *Poa annua* control programs.

Diseases

The greens were generally free of serious fungal diseases at the time of this inspection. There was a small amount of Dollar Spot (*Sclerotinia homeocarpa*) in several of the greens, though it is not excessively active at this time of year. In addition there was some Anthracnose (*Colletotricum graminicola*) on one green at the back and side of the green.

Both of these are generally diseases of low fertility, though aggressive strains will attack any grass. Normally a fungicide application (eg, propiconazole, iprodione or chlorothalonil will control Dollar Spot disease for lengths of time that vary according to the mode of action of the fungicide. This disease can be very aggressive during warm weather and the Sydney area has some very virulent strains, some of which may be resistant to some fungicides.

Anthracnose is classed by some pathologists as a senectopathic disorder, that is, it infects grass that is dying or extremely stressed. On golf greens it is generally seen on

Poa annua, though some strains can also infect bent. This disease is also normally a disease of low fertility. The areas of the green at Gosford that were significantly infected were adjacent to tree plantations, and it is reasonable to expect that tree roots were colonising those areas of the green. These tree roots are likely to be significantly reducing the fertility of those areas of the green.

Insects

There was no symptom or sign of significant insect or nematode infestation on any greens.

Weeds

The only weed of any significance in the greens was a small number of patches of Creeping Oxalis (*Oxalis corniculata*). This can be a very tough weed to control, due to the presence of underground plant parts from which the weed can regenerate. Good results have followed the application of Spearhead (a combination of three active ingredients). The superintendent has a program of application of this herbicide in place.

There were a couple of patches of couch grass (Cynodon dactylon) in at least one green. These are reportedly a remnant of earlier plantings. These can be difficult to selectively control, as the only herbicide registered for the control of couch in greens is siduron (Tupersan is one trade name of this chemical). The response of couch to this herbicide is very inconsistent, varying greatly with the variety of couch, the weather conditions, soil conditions, etc.

Bumpiness

The greens were very smooth and no significant irregularity in ball roll, either side-to-side or up-and-down was noticed during any of the Stimpmeter measurements, ie. a rating of 9 on a 0 – 9 scale for all measurements.

Greens surrounds

The surrounds of the greens are predominantly Kikuyu (*Pennisetum clandestinum*), with a presence of Narrow Leaf Carpet Grass (*Axonopus affinis*) and couch. The surrounds of a green are often challenging as, although they often consist of warm season species like couch or Kikuyu, they receive water from greens irrigation, and they can become soft and spongy. In general, the approaches to the greens at Gosford Golf Club were firm under foot, even after the rain on the day of inspection. Some of the surround areas at the sides of greens were soft, normally due to some thatchiness, but also due to water running into low-lying areas and swales, which then are subjected to foot and cart traffic. This is normal for any golf club, and traffic control is a part of course maintenance duties, particularly in wet, cool weather.

There was a significant presence of broadleaf weed in the surrounds of some greens. This was mainly Creeping Oxalis, with a smaller presence of sundry broadleaf species. These are all treatable with broadleaf herbicides and should be treated as part of the weed control program.

Tees

The majority of the tees were very generously sized, well aligned to the play, level and smooth, and well grassed. The good size of the tees allows for many tee placements which helps to keep the tee in good condition during the cool, wet months. The tees were firm underfoot and provide a stable surface for play.

The species of grass used on the tees are mainly couch or kikuyu, oversown in cool seasons with perennial ryegrass. There is a significant presence of a local couch variety in the tees which is performing very well, showing good colour retention even under partial shade.

The tees are essentially free of weed species, and show no signs or symptoms of insect activity or disease.

The 4th tee has a relatively small amount of its surface behind the ladies marker plate, limiting the amount of men's tee positions. It would be desirable if more of the tee could be used for men's competition days

The middle section of the 8th tee is mounded and uneven due to the build-up of divot sand on the surface. This effect is greatest on par 3 holes and periodic re-levelling of tees is a part of the maintenance program of golf clubs. The 14th tee is also somewhat bumpy in places for similar reasons.

The 12th tee is rather small for a par 3 tee, dangerously close to the 11th green, and its surface is uneven. This tee needs the services of golf course architect to give careful consideration to its location and direction.

Several tees have new extensions constructed of free-draining sandy soil. These areas that are often at the back of tees are largely shaded, and are grassed almost exclusively with perennial ryegrass. This combination of sandy soil and ryegrass can take a considerable period of time to produce a stable surface as nutrients leach quickly from the soil and the ryegrass does not have the stolon/rhizome system of couch or Kikuyu to stabilise the soil.

The majority of the tees have shade issues of varying intensity, caused by trees on the Northern, Eastern or Western sides. This shade dramatically shortens the growing season of couch, and reduces wear tolerance of all grass species. Where it is possible to remove trees that shade tees, or where they are lost naturally, they should not be replaced.

Many tees also have significant root encroachment from surrounding trees, some of considerable size. This leads to loss of fertility and moisture from the tee surface.

The tee environs were very well kept. Paths were neatly maintained, surrounding plants were well kept, and plantings defined tee shapes and direction of play.

Fairways

The fairways are generally well covered with a mixture of Kikuyu, couch and carpet grass, with a small amount of Queensland Blue Couch. They are firm and in general they seem to shed water into the rough.

Most of the fairways have generous width (the exception being the first fairway) and they are virtually free of broadleaf weeds. There are patches of bare ground and thin turf that could be returfed, though these often coincide with areas of tree root encroachment, so the underlying problems in these areas need to be addresses first.

The irrigation of the fairways reportedly varies from a single row of very old sprinklers to areas of no functional irrigation at all.

Bunkers

The bunkers are well maintained and are generally free of weeds on the faces. The sand, to the extent that it could be inspected, was uniform in texture and in the majority of cases seemed sufficient in depth. A comprehensive assessment of these factors could not be conducted due to ponding of water in most bunkers.

Some bunkers around the course had been drained in recent years, but most seem to have no, or insufficient, drainage.

Rough

The rough was generally well grassed with Kikuyu, couch, carpet grass, and sundry grasses such as Parramatta grass (Sporobolus africanus). The ground was not excessively bumpy and, with the exception of the presence of exposed tree roots, there were no significant hazards to play.

Treescapes and plantings

The trees and other plantings around Gosford Golf Club were exceptionally well maintained. With the exception of a couple of dead pine trees on the 13th and 16th holes, there was no significant presence of dead trees or branches around the course. The understory of the trees on the course was very neat and tidy. The bases of trees were trimmed, sprayed and free of debris. The course superintendent attributes this excellent condition to a group of volunteers, F-troop, who trim and prune trees as part of their duties.

The plantings around tees and the clubhouse are also very neatly maintained, which gives a very well-groomed appearance to the course.

As is common with most tree-lined golf courses, many trees are planted too close to the line of the fairway. There is significant incursion of tree roots into the fairways, with the consequent loss of turf quality due to extreme reduction in fertility and soil moisture. On some holes the trees also shade fairways and tees, leading to loss of vigour, and sometimes cover, of warm-season species such as couch and Kikuyu.

The trees also intrude on golf shots, but this inspection is not intended to make comment on course architecture and the strategic effect of planting on play is the province of course architects.

Machinery age and condition

The maintenance staff have the items of equipment that they desire for their operations, but many of the individual pieces of equipment are old, unreliable, and are costly in money and staff time to keep them in operating order.

The primary items of cutting equipment are relatively new and in good order. These consist of the newest fairway mower, the newest greens mower and the rough cutter. The second fairway mower is nearing the end of its operational life and should be replaced. The second greens mowers are overdue for replacement and can no longer be relied on to provide a high-quality cut. The second rough mower is not in operational condition and probably is not worth spending the required money on.

The trim mower (surrounds, tee banks etc) is very old and is in need of major refurbishment or replacement.

The tractors are generally in good condition, as is the Pro-Gator utility vehicle. The boom-spray tank is in operating condition, but lacks the versatility of some of the more modern spay equipment.

The Gator utility vehicles are operational, but nearing replacement age.

Renovation equipment consists of a large verti-drain machine, which is a very good machine for decompaction, aeration and coring operations. The size of this machine means that care is needed in its use on greens to prevent ripping of the surface on mounds. There is a core harvester that, though old, is still operational. The topdresser is larger than optimal for greens work, as it does not have enough wheels to spread the load. Again it must be (and is) used with care on greens. The topdresser is in good condition.

Irrigation system age and condition

The irrigation system has reportedly been upgraded with a new ring-main around the course and a new pump system. The irrigation system of 8 of the 18 course greens have been upgraded to individually controllable, valve-in-head sprinklers and the superintendent is happy with the results of the increased uniformity of application and flexibility that this installation allows. This installation work is being conducted in-house.

Upgrading of the fairway irrigation has largely not commenced and it currently consists of a single row of sprinklers fed by an old fibro-cement line. This system is reportedly non-functional in areas. The maintenance of quality fairway surfaces is dependent on the provision of adequate irrigation, so this system should be upgraded as finances permit.

Water quality and quantity

The course has a number of ponds that mainly feed into the main irrigation pond. This gives the course a reasonable supply of water, though some summer rainfall is required to refill the ponds. The quality of the water is good, provided that there is no intrusion of the tidal water adjacent to the course. The presence of salt in the tidal water poses a threat to the soil structure on the course, as high salt levels in soil lead to degradation of soil aggregates and a loss of drainage and aeration.

The lakes and ponds are well maintained and clean. The banks are neatly mown and well defined, and the water plays a strategic part in the play of some holes. In general these ponds and lakes are an attractive part of the course and an asset to the club.

The river views are screened from view by a row of trees and shrubs on some holes. It is unknown to this consultant whether this is intentional or whether the screen has simply developed naturally over time. These views of the river could be a feature of some holes if that is desired by the club.

Staff levels

There are currently six staff members including the superintendent, one apprentice and no mechanic. The effective number is currently reduced on a day-by-day basis by the absence of the apprentice at trade school for 40 days per year, the 24 weeks of annual leave for six employees, and the desire of the club to reduce the liability represented by accrued annual leave. The effective staff level is therefore 5.4, minus any reduction in accrued annual leave.

Occupational Health and Safety

The club and course staff have obligations under the Occupational Health and Safety Act (2000) to provide a safe workplace, and the consequences of non-conformity to Act and regulations are severe. The course maintenance staff currently have put into place some of the individual items required, including Safe Operating Procedures for plant and equipment (posted on the wall of the workshed), spray records, and provision of safety equipment to the staff.

Environmental Management System

The maintenance staff have acquired the E-par Environmental Management System tool. This is a computer-based tool that provides step-by-step templates and instruction designed to allow the club to comply with the requirements of AS 14001 (Australian Standard for Environmental Management Systems). This system is time-consuming to implement and maintain, but the penalties for damage to the environment are severe. The status of the environmental management system of the club as a whole is unknown.

DISCUSSION

Green speed and hardness

The green speed and surface hardness were very uniform across the course, largely reflecting the consistent maintenance practices. The regular coring and topdressing of the greens helps to maintain a high percentage of sand in the upper layers of the green, which helps to maintain firm, well drained surfaces. In addition, recent drainage works on some greens have facilitated the removal of water from the soil profile, allowing the complete removal of water from the site of the greens. Because of this consistency, players can expect to get consistent results from consistent golf shots.

The green speed on the day of the assessment, after a morning of rain, was 2.65 metres (8.8 feet). This is rated as a medium speed for club play, and would have been slightly faster had the surfaces been dry. The subject of green speed is always contentious, because different golfers like different speeds, and therefore there is no 'right' green speed. Polling of players has revealed that over the last few decades the average preferred green speed has increased, often to the detriment of plant health.

Green speed is often correlated to smoothness in the minds of many golfers and turf maintenance staff. The idea is that if the grass is not growing uniformly up to the mowing height then the mowing height should be lowered to the minimum grass height. The lack of growth of turf that leads to this thinking is often the result of low fertility, high wear, insufficient green space, lack of pin positions, or grass stress caused by disease, insect damage, etc. Unfortunately, lowering the mower height in response to the above factors generally leads to more stress on the grass. It is preferable to grow healthy grass evenly to the desired mowing height, thus producing a smooth surface.

One factor that needs consideration when discussing green speed is the design of the greens. Many greens were simply not designed to run at speed of 11 or 12 feet, because the slopes on them are too severe or extensive for that speed. Several greens at Gosford Golf Club have no level areas (eg the 9th green). If the speed of these was to increase excessively then down-hill putts would become unpleasantly tricky. Other greens, especially the 17th, have limited flat areas on which to place the pin. As the speed increases these possible pin placement sites are diminished, which imposes excessive wear on too few areas, and results in large areas of the green on which a ball can never come to rest.

A link to an article from the USGA on the subject of green speed, slopes and pin positions is given in the appendices.

Weed control

Weeds, by definition, are undesirable plants, so a discussion of weed control needs to define which plants are undesirable in which situation. For instance, if a club wished to attempt to keep greens that were pure bent, then *Poa annua* is a weed. At Gosford Golf Club *Poa annua* is the dominant greens species, performs well in that environment and is not therefore a weed.

The main weed species at Gosford is Creeping Oxalis (*Oxalis corniculata*), the small, clover-like plant in green surrounds, and in small patches in some greens. This weed is identifiable by its heart-shaped leaflets. Creeping Oxalis has underground plant parts that allow it to regenerate when the entire top of the plant has been killed by herbicide, making it a tough weed to control. A research project in the US found that the only reliable herbicides to kill Creeping Oxalis in cool season grass was a combination of two herbicides, neither of which are registered for that use in NSW, and which would likely be damaging in greens. Some good results have been obtained with Spearhead, a combination product of MCPA, clopyralid and diflufenican. Repeat applications are likely to be necessary, and times of heat stress should be avoided. The course superintendent currently has a program of control using this product.

There are a couple of persistent patches of couch in the greens. Couch control in cool season greens has been a topic of research in turf management for decades. A major research project by Dr Peter Martin at the (now defunct) Australian Turf Research Institute (ATRI) found that the only registered herbicide for this use (Tupersan) was largely ineffective on native couch types, and that the only moderately effective herbicide was (and is still) not registered for use in NSW. For small patches of couch, physical removal to the full depth of the roots is probably the only viable option. Preceding this digging operation with the application of a non-selective herbicide like glyphosate (Roundup or similar) would be desirable, provided that the treated area can be isolated to prevent tracking of the herbicide into surrounding areas.

Parramatta Grass is a persistent clumping weed, normally of rough areas as it does not seem to persist under close mowing. There have historically been no registered selective herbicides for the control of this weed, leaving spot treatment with glyphosate or other non-selective herbicides the only option to physical removal. Some results seem be be appearing after the application of some of the sulfonyurea class of herbicides (eg, Monument) to turf areas. More work is needed to explore the consistency of these results.

Tees and fairways (and roughs) at Gosford are a mixture of grass species. It is the aim of the superintendent to eventually convert all tees to couch (oversown with ryegrass where required). The conversion of Kikuyu to couch has some issues, the foremost of which is the persistent seed bank of Kikuyu. The Kikuyu seed is quite robust, and can remain dormant in soil for over ten years. Attempts to convert large areas of turf (eg. the fairways at Royal Sydney) to couch have resulted in an ongoing, time-consuming commitment to spot treatment of emerging Kikuyu seedlings. The successful conversion to couch therefore relies on the removal of the seedbank, which is contained in the thatch and upper soil layers.

The program for conversion of an area of turf from Kikuyu to couch starts with the application of glyphosate herbicides to the Kikuyu turf to thoroughly kill this species. Multiple applications at 10 -14 day intervals may be required. Once the Kikuyu is dead, the surface of the turf should be carefully removed by turf cutting, or milling with a machine such as a Field Topmaker. Care must be taken not to spread debris that could contain seed. The top layers should be removed back to the original soil surface. [*Peter McMaugh, a Sydney turf scientist, consultant and turf produced, used to burn the dried dead kikuyu on his turf farm, "popping the Kikuyu seed like popcorn".*] The newly prepared surface can then by returfed or sprigged with couch.

Needless to say, the conversion of large areas of Kikuyu such as fairways requires a major commitment of time and money. The advent of the plant growth regulator trinexapac (marketed as Primo or similar), which is already used on some areas at Gosford GC, has led many golf club and sportsfield managers to reconsider conversion to couch. This chemical retards growth of the upper plant parts. In contrast to older types of growth regulator it does not inhibit root growth, and therefore it can help to 'stress-proof' turf. The resulting surface has higher shoot density, less mowing requirement, and enhanced colour as chlorophyll production does not decrease.

Renovation

Comment has been sought from this consultant on the renovation practices used on the greens on the course. This seems to consist of major renovations of coring and topdressing, and regular tining of the greens through the warm months.

Major renovation time is never a happy time at any turf facility, and golf courses are no exception. The disruption to play causes economic loss to the club and pro-shop, loss of playing time to the members, and stress and hard work to the maintenance staff. The period of time to recovery, normally 2 -3 weeks is dependent on the weather, and players are forced to adapt their game for this time, or find somewhere else to play.

Unfortunately renovation is a major part of course maintenance for good reason. Plant roots, like most living things, need to respire, to take in oxygen and to expire carbon dioxide. The process of photosynthesis occurs in the green, above-ground parts of plants, and the resulting sugars and other products of photosynthesis are transported around the plant. Respiration takes place in every cell, and the resulting carbon dioxide must be expired from the plant locally. Carbon dioxide can build up to toxic levels in the rootzone if there are not sufficient air-filled spaces in the soil to provide an exchange of gases between the soil and the atmosphere. Therefore the root system of a grass plant needs an aerobic rootzone to function, and an anaerobic rootzone will lead to loss of root function (ie. uptake of water and nutrient) and a reduction in root depth. The process of aeration and decompaction is designed to maintain the channels between soil particles that allow the exchange of gases between the rootzone and the atmosphere; oxygen into the rootzone and carbon dioxide to the atmosphere.

In addition to plant health, an aerobic rootzone promotes microbial activity in the rootzone. Most of the bacteria and fungi that break down organic material require oxygen. Grass plants constantly produce organic material in the form of roots, stems, runners and leaves. Of these, the leaves are normally the most nutrient laden and most easily degraded organic material. Dead roots, stems and runners are often more resistant to decay, and if not controlled these can accumulate and produce a spongy, wet, thatch layer. This leads to shallow-rooted turf that is spongy in wet weather, and dries out quickly and dramatically in hot weather. Thatch also promotes fungal diseases. Some fungi are solely plant pathogens, preying on living plants. Other species of fungi are organisms that normally decompose dead organic matter, but can become pathogenic to plants when conditions are suitable. Plants growing in sub-optimal conditions are more susceptible to infection and damage from fungal diseases. Control of thatch is one of the major challenges in turf management.

Thatch control depends on the maintenance of conditions conducive to microbial activity. Aeration facilitates this activity in obvious ways. Topdressing serves two functions. It dilutes the thatch layer, and the course sand allows air to penetrate the layer, allowing the soil microbes to do their work. Work in Australia by David Nickson (on bent greens in Victoria) and Brett Morris (on dwarf hybrid couch greens in Queensland) showed that light frequent topdressing, or 'dusting' was the most effective method of controlling thatch. This gives local support to numerous overseas trials that have produced similar findings. Both of these trials were conducted on sand-based greens.

The second function of topdressing is to provide a firm, even surface. A high percentage of sand in the upper layer of the green creates a firm surface that resists plugging, and the act of topdressing fills depressions on the green and maintains a level surface free of bumps.

Hollow tining serves an essential function on soil greens, by creating channels through which water can be removed from the upper layers of the green. The prevention of prolonged saturation again allows oxygen to penetrate the green surface, and also rapidly restores the green surface to playable condition after rain. Filling the holes with sand maintains these channels, and progressively replaces old, heavy soil with fresh sand that resists compaction and remains aerobic.

The conclusion from the above, supported by large amounts of research, is that renovation is unfortunately indispensible in turf management. Some turf managers have attempted at various times to maintain greens without renovation, and these attempts have invariable ended badly. One school of thought, aided by the presence of tough, local bent varieties on sandy soils, was that if the greens were maintained on very low fertility, then thatch production would be minimal. This led to unplayably hard greens that wilted under moderate conditions and, in one case, caused a major embarrassment to Australian golf. Other clubs have had to conduct major rebuilding of greens when thatch layers had reached the point where renovation was no longer an option, and others have been subjected to major disease issues and loss of grass.

In addition to major renovation the groundstaff reportedly tine the greens at frequent intervals during summer to maintain airflow into the green surface. This has been conducted using the Verti-drain fitted with hollow tines. The Verti-drain has an adjustable 'rake', that is, the tines move horizontally under the soil, decompacting the profile. This movement can be adjusted from extreme movement designed to shatter compacted layers, to no horizontal movement, allowing the tines to enter and exit the soil with minimal disruption. Deep tining and large tines often cause disruption to the rootzone in warm weather, causing injury to the turf.

A research project at Clemson University in the US compared the effects of various aeration practices on soil hardness[1]. On a creeping bent green the use of needle tines improved oxygen content and decreased carbon dioxide. The use of needle tines also resulted in significantly greater surface hardness than the use of deep hollow tining or deep solid tining. Most relevantly though, in a trial that included hollow tining (deep and shallow), solid tining (deep and shallow) and star tining, the researchers found that "a

[1] B.T. Bunnell, L.B. McCarty and H.S. Hill. 2001. Summer cultivation effects on a sand based creeping bentgrass golf green. International Turfgrass Society Research Journal, Volume 9 (part 2) pp843-849

variety of treatments used in this study were injurious to turf quality during summer months, except root zone injection and needle tining." They found that "Aggressive cultivation techniques such as conventional solid tining, conventional hollow tining, deep hollow tining and deep solid tining accelerated heat and drought stress…", and further, "These treatments possibly caused turf desiccation and/or severe turf bruising. In contrast, non-aggressive treatments such as needle tining and root-zone injection resulted in excellent turf quality compared to other treatments because of minimal surface and shoot disruption, thus possibly reducing turf damage and desiccation". The conclusion that could be drawn from this is that the use of needle tines on the verti-drain machine in summer, will still allow the desired aeration and drainage of the greens, without surface disruption, and may allow the greens to be maintained with slightly reduced soil moisture content without risking sudden drought stress. Needle tine adaptors are available for Verti-drain machines, fitting tines of approximately 7mm diameter.

Course operations

The maintenance staff does not currently include a mechanic, which means that the superintendent and an experienced greenkeeper spend time in the shed repairing machinery. This time could more profitably be spent on the course. It is the understanding of this consultant that a contract mechanic visits the course for one day per week, to perform the major servicing on the course machinery. Progressively replacing the oldest, most maintenance intensive machinery will allow the contract mechanic to spend more time keeping cutting equipment in optimum condition, rather than patching up broken equipment, and will allow the course staff to spend more time on the course.

OHS and EMS

Sporting clubs, like every other legal entity, have obligations to protect their workers and other people on sites that they control, and to protect the environment. Several high-profile environmental incidents (eg. Warringa GC, 2001, see http://www.environment.nsw.gov.au/resources/sustainbus/2007210caseStudies.pdf) and some preventable workplace accidents have seen clubs prosecuted and individual employees found liable for the damage and costs. Clubs therefore have an obligation to comply with the OHS act (2000), regulations, and associated acts, and the Protection of the Environment Operations Act (1997). Both of these involve a commitment by club management and staff, and impose a burden of time and expense on staff.

The OHS act provides for the creation of an OHS committee on which staff and management are represented. In the opinion of this consultant the maintenance of OHS systems are best achieved in this way, with co-operation between the various parts of the club to reduce duplication and to discuss problems. In addition, many clubs use external contractors to manage their OHS systems, though this does not remove the responsibilities of the club and staff to provide a safe workplace.

Similarly, the implementation and maintenance of an Environmental Management System (EMS) can be overwhelmingly time consuming for club staff. The ground staff currently possesses a computer-based tool for the implementation of an EMS, namely the E-par system. Acquisition of this tool involves a purchase price and a maintenance

fee that allows the club access to resources, advice, auditing and support. Again, this tool simply facilitates the implementation of an EMS, and the club and staff still need to commit to providing time and resources to making sure that they comply to the requirements of the Act and regulations. Again, this consultant sees a club-wide committee as the best means of achieving the desired outcomes, and stresses that commitment from the top-management (ie. Board of Directors) is required.

Maintenance schedules

The staff currently begins operations at 5AM on weekdays. The new award system in reportedly going to amalgamate the greenkeeping award into the Licensed Clubs award and the earliest start time allowed without penalty rates is 6AM. This is unfortunate as the hours before the commencement of play are the most productive hours in the greenkeepers day. Tasks like cutting greens, changing hole and tee positions, grooming bunkers, cleaning up debris after stormy nights, and other course preparation activities are much faster without interruption from play, and the experience of players is much enhanced by not having these activities taking place while they are playing. Other scheduled tasks like the cutting of fairways also proceed much more rapidly if they can be conducted in front of the play.

The other major early-morning task that is best conducted without the presence of players is pesticide spraying. The early morning hours are normally the least windy, which means that spray movement is minimised. The presence of players while spraying also leads to the interaction of player and pesticide, which is never desirable. Turf pesticides, while designed for the lowest toxicity possible, are still chemicals, and the staff take all care to protect themselves from contact with these products. It is not possible to protect players in the same way, except by closing the course for a period of time, which is normally politically unacceptable. Some few people do have sensitivities to some chemicals, and many more have psychosomatic reactions to the sight of pesticides being applied. This consultant has personal experience of posting notices of spraying one morning, but having to cancel the operation due to strong winds. The mere presence of the spray notices led to several complaints to the club manager of the onset of rashes and other irritations by players. It is very desirable not to have players present when spraying is being conducted.

The argument above is strongly in favour of starting as early in the morning as feasible. The actions that the club takes to work within the new restrictions must be decided between the club and maintenance staff. To comply with the new award, the options seem to be:

- Pay overtime for the hours 5 - 6 AM
- Pro-rata time off at the end of the day
- Bank pro-rata hours to be taken at another time
- Start at 6AM

Sundry Questions (Asked by management)

Q. Can couch be promoted over Kikuyu by the use of saline water?
A. In theory most varieties of couch are more tolerant of moderately high salinity levels than most varieties of kikuyu. However, there are salt tolerant Kikuyu varieties, and the use of salt to suppress Kikuyu is, in the opinion of this consultant, very unreliable. More

importantly, raising salt levels in the soil will lead to serious degradation of soils containing percentages of clay. Soil structure will be lost, drainage will effectively cease, and the soil aerobic status will be seriously affected. Using salt as a herbicide is only really viable on pure sand soil profiles.

Q. Gosford has a local couch species that seems well adapted to the site and also seems to be fairly shade tolerant. Can it be used on tees and fairways?
A. Many of the varieties of couch that are commercially available (eg, Legend, Conquest, Greenlees Park) are selections from natural situations that have been found by turf managers. The local couch may very well be well adapted to the area and may be suited to use on tees and fairways. My only suggestion is to isolate and propagate a small nursery of this couch, and to use it in experimental plots in play situations on tees and fairways, alongside commercially available varieties. This will answer the questions.

1. Is the couch suitable for use in these situations, and
2. Is this couch better in Gosford Golf Club's situations than commercially available varieties, or is the club better off using another variety.

Q. What can be done about low-lying areas of the course, especially where water encroaches when the ponds are full? Can these by areas be piped and the ground level raised?
A. The issue of the level at which the storage ponds should be kept is for the management of the club and the superintendent to decide. The swales in which water sits are an issue that can be addressed to improve the course in wet conditions. These areas of water flow can be raised by the addition of soil, and the water transported in pipes. It should be noted however, that this action alone is not a complete solution to the problem, as this area is still normally the lowest point, and surface water will flow down hill and into this area. Once in the swale large amounts of surface water will flow quickly off to the side of the fairway/rough (provided that there is fall in that direction) but the water among the grass will only move very, very slowly and is often subjected to cart and foot traffic, resulting in disturbance of the soil and muddy, soft conditions. Once these conditions establish it is difficult to restore firm surfaces until the onset of warm weather. Therefore, if the intention is to install a culvert and cover it with soil, the culvert should be able to act as an agricultural drain, and the soil placed over it should be permeable (ie, sandy) and relatively free-draining. This can create an area that requires some extra fertiliser and irrigation, but will remain firm and free of water in wet weather.

Q. How can summer annual grass weeds be kept out of turf surfaces such as tees?
A. Summergrass (*Digitaria sanguinalis*), Crabgrass (*Eleusine indica*) and Goosegrass (*Eleusine tristachya*) are serious weeds of turf in summer months. They can be controlled with both pre-emergent and/or post-emergent herbicides. Post emergent herbicides are applied to the growing weed plant, and can adversely affect the quality of the turf species.

Pre-emergent herbicide are normally preferable to post-emergent as the weed is never apparent, and damage to the turf species is normally less. The three most widely used herbicides are pendimethalin, dithiopyr and oxadiazon, though a fourth product (prodiamine) is in the process of registration. The great advantage of oxadiazon over pendimethalin and dithiopyr is that it does not affect root growth. The other two products prevent couch runners from producing new roots.

Oxadiazon and dithiopyr can both be applied at rates that last several months. If timing of application is uncertain, and weed germination is being missed, then these may have an advantage over pendimethalin. In addition, dithiopyr has a post-emergent effect on very young Summergrass plants, so even if the initial germination is missed, this product may still provide control.

Of course, there is a price differential and oxadiazon (marketed as Ronstar) and dithiopyr (marketed as Dimension) cost more than pendimethalin (various trade names). Various combination products are available that combine these herbicides on fertiliser prills, which makes application easier. This herbicide is not aware of a dithiopyr combination product in Australia yet.

The weakness of pre-emergent fertiliser in tee situations is that to be effective the soil has to be uniformly treated. Disturbance of the soil, or the addition of new soil by divotting or topdressing, creates an untreated seedbed that can be a source of weed establishment.

Q. Could we use dwarf hybrid couch on our greens?
A. Dwarf hybrid couch species (eg. Tifdwarf, Tifeagle, MS Supreme and many others) have been bred to be used on golf greens, but have maintenance issues of their own. They tend to thatch rapidly, and have fungal diseases equally as problematic as those of cool season grasses. There is a considerable amount of discussion in turf management publications involving managers converting greens from couch to bent, and from cool-season grasses to couch [Please note that when accessing overseas literature that the US and most other countries call couch (*Cynodon* spp.) Bermudagrass]. While the arguments for converting greens further north (eg. Sanctuary Cove) to dwarf hybrid couch were compelling, it is debatable whether the length of the respective warm and cool seasons of Gosford, and the climate in the areas support the same conclusions.

The major issues that influence the decision to use dwarf couch or cool season grass are summarised below:

	Pros	**Cons**
Dwarf couch	Heat tolerance, some drought tolerance	Winter inactivity, high thatch production. Poa control in winter. Shade intolerance
Poa/bent	Winter activity, naturalised grass (especially *Poa*). Shade tolerant	Relative heat and drought intolerance

Links to a couple of articles on the maintenance issues of dwarf couch greens are included in the appendices.

RECOMMENDATIONS

Agronomic recommendations

Weeds around greens and in green surfaces should be treated with broadleaf herbicides as required.

Selective fertiliser application using controlled release granular product should be undertaken on parts of greens that are

i. Subject to root incursion from surrounding trees
ii. Adjacent to bunkers where large amounts of bunker sand have created sandy mounds on the green.

New tee areas that are sandy and lacking in vigour should be given monthly fertilisation with a complete organic fertiliser (eg. pelletted, sterilised poultry manure). This will ensure the addition of the complete suite of essential plant nutrients, and add a small amount organic matter. This application is in addition to the fertiliser program used over the whole tee surface.

A trial of needle tines, used with minimal rake, should be undertaken on greens in place of the current Verti-drain tines through warmer months. This may allow this essential aeration to take place while minimising disruption to the soil profile and root-zone of the turf plants. This may allow the moisture status of the green to be at a slightly lower level during summer months, as root function may be better.

The progressive replacement of greens sprinklers with individually controllable, valve-in-head sprinklers should continue as a matter of priority. The old sprinklers configuration, in which all the sprinklers on a green operate together, and have minimally sized pipes supplying water to them, leads to sections of the green being over-irrigated in order to supply sufficient water to all sections of the green. Having controllable sprinklers, operating correctly and distributing water evenly, will enable much greater uniformity of soil moisture in greens.

It is recommended that the club experiment with the hybrid couch practice green for some years before making a decision on desirable greens grass. Monitor thatch production, disease infestation, and response to shade. Impose wear on the green in the cooler months to replicate the effect of play on the course during winter.

Where possible root pruning should be used to control root incursion into greens, tees and fairways. The root incursion is creating some very problematic areas on these surfaces. Some root pruning has taken place during trenching operations for irrigation and drainage installation, and this has assisted in maintaining the turf surface in those areas. Specialist root cutting machines area available that can cut through roots that are too thick for trenching machines.

Other recommendations.

Machinery replacement

The current age and state of the machinery is requiring a large input of money and time to keep it functional. Major servicing of the equipment is provided by a contract mechanic, but all other work to keep mowing equipment in operating condition is conducted by the course superintendent and an experienced greenkeeper. This is not an efficient use of the superintendent's time and takes turf tradesmen away from the course. The items of machinery to be purchased are, in order of priority

1. trim mower
2. greensmower
3. rough cutter

This priority is of course based on present observations, and does not allow for the complete collapse of another item of equipment. The actual order of replacement should be established in consultation with the course superintendent.

There are several options for machinery replacement including purchase of new equipment, purchase of reconditioned equipment, lease, and lease with maintenance agreement. The best option for the club will be for the club management to ascertain.

The club should begin to consider a provision for the replacement of the machinery shed. It is currently well organised and as neat as possible, but it is crowded, poorly lit in areas and old, and keeping it completely compliant to OHS regulations and principles is going to prove difficult.

OHS and EMS

It is strongly recommended that the club should institute a committee to consider the OHS and Environmental obligations of the club, and how they will meet them. Adopting a club-wide approach will prevent duplication of effort in each section of the club.

[*An approach that was adopted by a number of clubs with which this consultant was previously associated, was to group with other local clubs to employ an independent contractor to guide them through the OHS process. Alternatively, the company that provides the E-par system also provide OHS systems for golf clubs. Please note that these are not recommendations*]

Future programs

The scope of this assessment and report is not sufficiently broad to attempt to make detailed recommendations on future works. The strong recommendation therefore is that Match and Greens Committee meetings must result in consensus as to the priorities with which resources are to be allocated. Meetings should not finish with the immediate future of course works undecided. Plans for medium term (1-5 years) and longer term programs should be documented, so that progress can be monitored, and reasons for non-achievement of goals can be established.

I would like to thank the club CEO, Mr Alvin Kan, and the club superintendent, Mr David Nicholls for their co-operation in the assessment process.

Please contact me if I can provide any further information

Regards

Dr Jim Hull
Independent Turfgrass Consulting

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Appendices

Further reading

The green speed/contour/pin-position discussion
A very interesting discussion paper by a golf course architect
www.usga.org/workarea/linkit.aspx?linkidentifier=id&itemid=11384

Greens renovation articles of relevance
http://turf.lib.msu.edu/2000s/2004/040509.pdf
http://turf.lib.msu.edu/2000s/2003/030301.pdf

Bunker sand standards
http://www.usga.org/course_care/articles/construction/bunkers/How-to-Select-the-Best-Sand-for-Your-Bunkers/

There is also a paper on Australian Research on bunker sands, produced by the Australian Turf Research Institute and a publication for golf clubs derived from this research was circulated by Australian Golf Union (now Golf Australia). The reference for the scientific paper is:

R.B. Dewar, G.W.Beehag. (1994) Australian bunker sands – quantifying playability. In Science and Golf II: Proceedings of the 1994 World Scientific Congress of Golf, St Andrews, Scotland. (A.J. Cochran and M.R. Farelly, Eds.)

Couch (Bermudagrass in the US) v Cool season grass greens

Note that most of these articles are from hot, humid parts of the US where cool-season grasses are not viable, and therefore do not directly compare the two different systems. Each club has to assess its own location and decide how well adapted each system is at that site.

http://turf.lib.msu.edu/2000s/2009/090301.pdf

Fairly technical article on maintenance of dwarf couch varieties
http://www.plantmanagementnetwork.org/pub/cm/research/2004/ultradwarf/

http://turf.lib.msu.edu/2000s/2001/011114.pdf

https://www.bestcourseforgolf.org/content/greenkeepers/turfgrass/species_selecti_2/bermudagrass_cy

http://www.gcsaa.org/gcm/1998/jul98/07bermuda.html

A set of articles over time on maintenance of couch greens.
http://turf.lib.msu.edu/gsr/1990s/1991/910701.pdf
http://turf.lib.msu.edu/2000s/2000/001101.pdf
http://turf.lib.msu.edu/2000s/2008/080112.pdf