1 DESIGN CONSIDERATIONS

1.1 Basic Irrigation Parameters

1.1.1 Area of Coverage

The sprinklers cover all in-play areas and extensively into the rough (essentially "wall to wall").

1.1.2 Peak Application

This is the amount (depth) of water that will be applied to the irrigated area during a full irrigation cycle (watering window).

The irrigation design is based on the Peak Application so that the irrigation system is capable of watering the golf course during the highest water demand (hottest, driest) periods. During normal operation the Irrigation Pump Station will still operate at its designed (maximum) flow but the watering window will be shortened.

a) Peak Application - 6 mm per day (1.65 inches per week)

This is based on replacing 80% of ET during the watering window. This is an optimum level of ET replacement based on balancing turf growth with water (and power) conservation.

b) Peak Evapo-Transpiration (ET)

We were not given ET data for this site. We have estimated peak ET to be 7.5 mm per day (2.1" per week) based on climate data available.

1.1.3 Watering Window

The watering window is the time taken to complete a full irrigation cycle. We have used a watering window of 8 hours. Typically this could be from 9 pm to 5 am.

One consideration with the watering window was the night golf on holes 19 to 27 (only). This has a restricted watering window (say 6 hours) and this has been taken into account by upsizing the mainline feeding these holes to allow for that.

1.2 Delineation of Irrigation Contractor's Responsibilities

The technical specification defines responsibilities that are normal for the Irrigation Contractor to undertake. There are some items (interfaces to the irrigation system) that normally are not within the control (or skills) of the Irrigation Contractor. The responsibility for these items lies with others (maybe the Main Contractor, the Employer or Developer). The Employer has the option of re-assigning these responsibilities with contractual conditions as they desire.

However, under the division in our documentation, the Irrigation Contractor is <u>not</u> responsible for:

1.2.1 Permanent Electrical Power to:

a) Irrigation Pump Station(s) including distribution board

b) Booster Pump Station(s) including distribution board

c) Transfer Pump Station(s) including distribution board

d) Nominated sources for satellite high voltage circuits

e) Central controller

1.2.2 Temporary Electrical Power

a) The need for this depends on the schedule for the project. Should permanent power not be available, then a party other than the Irrigation Contractor would be responsible for temporarily providing suitable, equivalent electrical power.

b) The capital and running cost of providing temporary power (particularly for extended periods) can be substantial. It is preferable to make early arrangements to avoid this high cost item.

c) See later in the report for power requirements (particularly the Pump Stations).

1.2.3 Temporary Pumping Plants

a) The need for this depends on the schedule for the project. There is no provision made within the specifications for the Contractor to provide any.

b) The need for temporary pumping plants can normally be avoided by planning the construction to start near the Irrigation Pump Station and work away from there.

1.2.4 Water for the Irrigation System

a) The Irrigation Contractor is responsible for the distribution of water (that is, the irrigation system), not the supply of water.

b) The supply of water is in the control of the Main Contractor (or sometimes the Employer). The supply is (primarily) determined by the Main Contractor's golf course construction program, particularly that related to the lakes and the water collection system. The program must ensure that there is sufficient water for the irrigation system. This is beyond the control of the Irrigation Contractor.

1.2.5 Pump House Structure

The Irrigation Contractor is responsible for the intake line, wet well and the pump station slab. The rest of the floor and the structure surrounding the pump station are by others.

Normally, buildings are not a core competency of an Irrigation Contractor. So it is more cost efficient to award these works to a more appropriate Contractor (normally the Main Contractor).

IMPORTANT NOTE:

For the proper construction of the intake line and wet well, the lakes must be empty.

If the construction program will be such that the Irrigation Contractor is not appointed early enough, then it would be expedient to separate this from the Irrigation Contractor's scope of works. The most likely alternative contractor to use would be the main contractor.

1.3 In Field Changes

To ensure the system (including booster and transfer pumps) will operate correctly when installed, the intent of the design must not be breached.

1.3.1 Staking of Sprinklers

Our plans are only indicative. Spacing and patterns must be maintained and staking approved by the on site superintendent.

1.3.2 Changes in Contour Levels

a) Significant changes in contour levels between the grading plans and the field, irrigation lake levels, pump levels, pressure regulating valve levels may cause hydraulic problems.

b) Depending on the location, a change of 5 m could be significant. Locations high, low and/or distant from pump station are the worst cases. In any case, a 10 m change will be significant.

c) Please submit proposals to Hydrogold for assessment.

1.3.3 Change of Pump Station Locations

This is most likely to change the design of the hydraulic and perhaps electrical systems. Please submit any proposals to Hydrogold for assessment.

1.3.4 Mainline

a) Minor re-routing of mainline (say within 50 m at the same elevation) is not likely to cause hydraulic problems.

b) Addition/extension of mainlines is likely to increase hydraulic losses. Please submit any proposals to Hydrogold for assessment.

1.3.5 Sizing of Pipes

a) Our sizes are based on the internal diameter of the pipe.

b) Upsizing of pipe is always acceptable from a hydraulic point of view. From a cost perspective, it is normally prohibitive.

c) Downsizing of pipe is normally (nearly always) not acceptable. Please submit any proposals to Hydrogold for assessment.

1.3.6 Addition of Lateral Lines and Sprinklers

Provided our lateral patterns are maintained, additional lateral lines and sprinklers are not likely to cause hydraulic problems. However, it must be noted that this will extend the watering window beyond the design intent.

1.3.7 Satellites / Controllers

Relocating satellites within 100 m (328 ft) of our proposed locations is highly unlikely to cause voltage drops of consequence. Provided there are no additional controllers on the power feed, this is acceptable.

Adding controllers to the system (particularly near the end of a line) will result in higher than calculated voltage drops that may cause a malfunction of the control system. Please submit any proposals to Hydrogold for assessment.

1.3.8 Assembly details

Our assembly details have been proven in the field over many years. They are critical to the proper functioning of the irrigation system. Any alternative proposals must be sent to Hydrogold for assessment.

1.3.9 Product Substitution

The system has been designed with the specified products in mind. Any alternative proposals must be sent to Hydrogold for assessment.

1.4 Irrigation System and Water Quality - **IMPORTANT NOTE**

This is of particular importance to any pump station (the single-highest cost item affected).

1.4.1 We have not been provided with the results of any water test. We assume the water conforms to what we expect for normal standards of irrigation water for turf (not including the salt tolerant varieties). Specifically, a pH between 6 and 8 with Total Dissolved Solids (TDS) below 1,000 ppm (Electrical Conductivity below 1.56 mS/cm).

Please advise us if this is not the case.

1.4.2 When water quality falls outside these ranges, commercial aspects need to be considered. The shortened lifetime of the pumps needs to be balanced with the higher capital costs of higher grade materials used in the construction of corrosion resistant pumps.

1.4.3 A pH of 3 (particularly combined with high salt levels) can destroy a normal pump station in terms of months.

1.4.4 Total Dissolved Solids levels above 1,000 ppm (Electrical Conductivity above 1.56 mS/cm) accelerate corrosion.

1.5 General Pumping Configuration

We have minimised the pumps to:

1.5.1 One Irrigation Pump Station

This draws water from the irrigation lake for the whole golf course.

1.5.2 Two Booster Pump Station

These tap from the water supply from the Irrigation Pump Station and boost the pressure for the areas at the higher elevations.

We have deliberately kept both Booster Pump Stations to the same performance specification. This will provide a lower up-front cost but more importantly it will minimise spare, maintenance and improve backup.

1.5.3 Three Transfer Pump Stations

a) Transfer Water from the River

We have provided 2 identical Transfer Pump Stations. The pumping of the water from the river is critical since there is only 3 days storage in the irrigation lake (at full use).

That is, we have provided 100% backup (redundancy) for this critical task.

b) Top-up of Lake between Holes 3 and 4

This Transfer Pump Station allows this higher level lake to be topped up. It is not a critical function so we have not designed any backup for this pump.

1.6 Irrigation Pump Station

1.6.1 Pump Selection

We have selected vertical turbine pumps for the main pumps for their lower overall costs that results from higher pumping efficiency, longer life, lower maintenance costs

There are 3 main choices for pump

a) Turbines

We generally recommend turbine pumps for golf courses.

- ♦ Advantages:
  - Positively primed. This ensures reliable pumping every time (no loss of prime problems)
  - Highest efficiency. Around 80 to 85%. Reduces cost of cable runs and running costs for electricity.
  - Long life due to (typically) lower rotation speeds.

    For longer life we specify a nominal rotation speed of 1450 RPM rather than 2900 RPM. This slightly increases the up-front cost but greatly increase the life of the pumps and motors.
- ♦ Disadvantages:
  - Higher up front costs.
  - Should not be adjacent to residences since they can disturb people's sleep.

b) Submersible

We will generally recommend against submersible pumps.

- Advantages:
  - Lower cost than turbines
  - Installed below ground makes them quieter
- Disadvantages:
  - Problems with Variable Frequency Drives

    There are problems with driving motors for submersible pump with a variable frequency drive. With reduced flow, the cooling effect of the water becomes insufficient and the motors overheat.
  - Not as efficient as turbines (typically 70%)
  - Higher maintenance costs
  - The electric motors fail more frequently due to the confined space (motor geometry constricted to bore hole diameter) for electrical designers.
  - Service of the motors is more difficult due to having to remove the complete pump and column assembly for any maintenance.
  - Wet well depth is increased (typically by at least 1 m) since the motor is mounted beneath the pump.
  - They should be fitted with a stainless steel shroud to enhance the cooling of the electric motors when installed in a wet well.

c) End Suction (Centrifugal)

- ♦ Advantages
  - Lower up front cost
  - Low maintenance costs
- ♦ Disadvantages:
  - Loss of Prime - Low Reliability

    The end suction pump is normally installed above the water level. That is, it is not positively primed. Therefore it relies on the foot valve to keep water up to the pump. Foot valves are notoriously unreliable. This is more critical on automatic systems operating at night where reliability of the pumps is critical.

    Positive prime can be ensured by installing the pump below the lowest water level (flooded suction). Unless there is favourable topography surround the lake (ie, a suitable low area), a dry well is required. The cost of the dry well is higher than a wet well, maintenance is more difficult and there is the danger of flooding.
  - Less Efficient than Turbines

    Typically an end-suction pump runs at 65% efficiency. This means that cable sizes to the pump station will be larger and electricity costs about 30% higher than for a turbine.

1.6.2 Pump Control System

a) Function

The function of the pump control system is to operate the pump station at optimum efficiency while meeting the pressure and flow demands of the system. In doing so, it will minimise pressure surges into the piping system that will prolong the system life.

b) Programmable Logic Controller (PLC)

This computerised controller is able to take input from sensors and control operation of the pump station based on this. This allows the pump station to be operated at optimum efficiency based on the demands of the irrigation system.

c) Variable Frequency Drive (VFD)

- ♦ By varying the frequency of the power supply to the electric motors, we are able to operate the pumps at a range of speeds.
- ♦ This allows the pumps to deliver variable flows to match the demands of the system. This makes the system more efficient resulting in lower power consumption (lower electricity costs).
- ♦ We do not suffer the traditional on/off nature of the pump. That is, off (zero flow), on (full flow) and no control over the transition between the two. Pressure surges and damage to the pipes and fittings are minimised.

1.7 Filter

1.7.1 Screen Filter Specified

We have specified a screen filter on the discharge side of the Irrigation Pump Station since it will be an automatic irrigation system. The orifices in the solenoid valves require the water to be filtered.

Screen filters are not good for filtering algae (or other organics). Algae will clog the screen causing the filter to backwash frequently (as frequent as every 10 to 20 minutes).

1.7.2 Water Quality

Our advice is that the water quality should be maintained (typically by aeration and circulation) to control the algae so that it does not present a problem to the screen filter or irrigation system.

1.7.3 Filtering Algae

If the water quality cannot be maintained…

Algae can be effectively filtered using sand media filters. Sand media filters are too large to fit within a typical pump house (see sketch of generic pump house).

However, it is technically possible to retrofit a sand filter to the pump station. The extra loss across the sand filter (typically less than 20 kPa or 3 PSI) will not have a significant impact on the hydraulics of the system.

The filter would be fitted between the pump discharge and the screen filter. The screen filter would still be required to prevent sand from the sand filters entering the pipe system and clogging solenoid valves and sprinklers.

Consideration should also be given to fitting a chlorine injection unit at the pump discharge to kill the algae that may pass through the filter.

1.8 Fertigation Unit

We have specified a fertigation unit to be incorporated as part of the Irrigation Pump Station works. This will efficiently apply fertilisers and chemicals over the course.

There are two main reasons for not including a fertigation system. One is the lack of expertise to utilise the system (see below). The other reason may be a tight up-front budget. In this case, the up-front costs need to be balanced with the cost savings offered by a fertigation system during both turf establishment and on-going operation.

In view of this, I take this opportunity to list the features and benefits of the fertigation system:

1.8.1 During Turf Establishment (Grow-In)

In addition to the benefits for on-going turf maintenance (see below), fertigation offers the following special benefits during turf establishment:

a) More Consistent Application of Fertiliser

One of the main problems inhibiting the establishment of turf is inconsistent application of fertiliser. Fertigation provides consistent application and puts control in the hands of the Grow-In Superintendent.

b) Minimise Fertiliser Leaching

An often over-looked problem is fertiliser leaching. That is, a solid fertiliser is applied and then heavily (even over) watered.

Some fertiliser may be directly lost through surface run-off (though this would only happen during excessive over-watering).

Over watering (without surface run-off) carries the fertiliser past the shallow root zone (typically less than 25 mm or 1 inch), putting it out of reach of the turf. This wastes most of the fertiliser. Fertigation systems minimise this by applying more frequent applications with smaller amounts.

c) Eliminate Machinery Wheel Tracks

With fertigation, there is no machinery moving over the unestablished turf areas leaving wheel track (ruts).

1.8.2 On-Going Maintenance of Turf

a) Avoids Spikes in Nutrient Supply and Turf Growth

Fertigation provides nutrients (or chemicals) to the turf over a longer period of time (say a week or even longer). This provides uniform turf growth, eliminating growth spurts (and the associated, increased mowing).

b) Uniform Application Throughout the Golf Course

Fertigation provides a uniform application that cannot be achieved by machinery (much less by hand). This provides uniform texture and colour to the turf.

c) Avoid Fertiliser Run-Off

After an application of solid fertiliser, rain will wash away the fertiliser with the surface run-off. Not only is this a waste of fertiliser, it also pollutes the water bodies (particularly promoting the unwanted growth of algae).

With proper irrigation, there is no surface run-off and therefore all the fertiliser goes into the ground, available for the turf. Also with proper irrigation, the water does not permeate to the sub-soil drainage (thereby eliminating another potential loss to the environment). ***The ability to eliminate fertiliser run-off with fertigation systems is often a key feature on sites that are environmentally sensitive or within catchment areas.***

d) Efficiency and Control

Fertigation is efficient in terms of reducing labour costs and bringing control of the fertiliser application back to the Golf Course Superintendent.

1.8.3 Problems with Fertigation Systems

a) Lack of Expertise

If the Golf Course Superintendent does not know how (or does not want to know how) to use a fertigation system, there is little point to installing the system. Alternatively, training or employing a suitably trained person should be considered.

b) Targeted Applications are Difficult (if not impractical)

Targeted applications are applications that target (say for example) greens or tees. Greens are (typically) 5% of the irrigated area. Likewise, Tees are (typically) 5% of the irrigated area. That is, a targeted application may <u>not</u> want to apply the fertiliser to (say for example) 95% of the irrigated area.

Such targeted application of fertilisers (or chemicals) is achievable with only the most sophisticated fertigation systems with a very knowledgeable Golf Course Superintendent. It involves priming (and subsequently purging) of the pipe network with fertiliser and the running of tailored irrigation programming. The fertigation system we have specified is not intended to achieve this. Such a fertigation system would require much larger dosing pumps and a sophisticated injection controller (at a significantly higher cost).

Fertigation systems are best for general broadcasting (application) of fertiliser (or chemicals) to the entire irrigated area.

1.9 Soil Structure - **IMPORTANT NOTE**

We have not been provided with any soil reports. We have assumed that the soil is sufficiently stable to support the pipe system. Typically, subsidence of more than 50 mm (2") over the life of the system (typically 20 years or more) may create problems with the pipe system, particularly if the subsidence is not even.

The pipe system relies on the soil stability not to put excessive pressure on the pipe joints and to provide support for the thrust blocks (sufficient bearing pressure).

Soils (such as marine clay) that are unstable or areas that have been filled are areas that are likely to require special attention to the pipe jointing system. Other potential problem areas can be old rubbish dumps, rice paddies or fish ponds. Significant changes in water table levels may also affect soil settlement.

If there are areas of the site that may have such soil structure problems, please submit details to Hydrogold for our evaluation.

1.10 Mainline Pipe

1.10.1 Looping

We have looped the mainline pipe as much as practical. This:

a) Provides alternative routes for water when a section is isolated for maintenance.

b) Aids with the hydraulic performance since water can typically flow into a section from 2 directions. This reduces fluid velocity (and frictional losses) resulting in a lower pumping head (and consequently lower electricity cost for pumping).

1.10.2 Mainline Tends to Follow the Buggy Path

Some Contractors may want to locate the irrigation mainline to the opposite side of the fairway, away from the buggy path for easier buggy path construction. Our mainline tends to follow the buggy path because:

a) The Contractors concerns only apply for the relatively short construction period. The Owners concerns apply for the life of the systems (designed to be 20 to 30 years).

b) It is more convenient (and safer), for both golfers and staff, if maintenance staff do not to have to cross the fairway to access valves.

c) When mainlines have to cross bridges or roads, they normally do so in conjunction with the buggy path. Eg. Mainline is normally attached to the side of the bridge. Therefore it is more convenient to run them next to the buggy path. This also reduces the length (and cost) of the mainline and cables.

d) Satellites need to be located near the buggy path for convenient access by staff. If the mainline is on the opposite side of the fairway, there will be "dry" cable runs (cable runs without pipe) which increases the construction costs as well as the likelihood of damage to the unprotected cables.

e) Buggy paths tend to be on the side of the fairway away from the water body. This is more stable soil for laying of mainline pipes.

1.10.3 Sharing Mainline Between Holes

Typically each hole has its own mainline. We tend not to share mainlines between holes because:

a) There is no significant increase in the cost of the project (compared to the benefits) and in some cases it can be cheaper. When mainlines are shared, the pipe sizes need to be increased accordingly. Eg. Two 150 mm pipes would need to be combined into one equivalent 250 mm (not 200 mm) pipe.

b) Construction is normally done on a hole by hole basis. Consequently one hole will be constructed before the other. With shared mainlines, tapping saddles and low voltage wiring will have to be done for both holes even though one of the holes will not be ready. This leads to guesswork that complicates the installation and results in error in installations. Our design keeps it simple.

c) Mounding between holes often makes shared mainlines impractical since trenches and valves will have to be deeper. This increases the cost of installation and maintenance.

d) The areas between holes often have trees. If they are existing trees, there are problems avoiding the roots. Landscape planting is (typically) heavy in these areas leading to damage to the pipes and fittings when planting.

e) Shared mainlines (tend to) eliminate loops from the system. This reduces the hydraulic efficiency leading to increased pumping costs. Redundancy is also reduced which leaves a less robust system, which has difficulty in delivering water to areas when sections are isolated for repairs.

f) Access to valves for the maintenance staff is much more difficult since they are further from the buggy path and hidden in the deep rough.

g) Sharing of mainlines is only practical if there is a short distance between fairways, there are no mounds, trees or landscaping between fairways (which is normally tight, if not dangerous golf) and the construction budget overrides good design practice.

1.11 Lateral Pipes

All lateral pipes and isolation valves are 50 mm (2"). This reduces installation and maintenance costs since it dramatically reduces the number of types of lateral fittings, valves and tapping saddles. It also eliminates the common installation error of using the wrong size lateral pipe.

1.12 Isolation Valves

1.12.1 Mainline Isolation Valves

a) These have been positioned so that (in general) each fairway can be isolated for maintenance. Typically a maximum of 3 mainline isolation valves is required to isolate an area.

b) Consideration is also given to re-directing flow from the pump station when sections are isolated for maintenance.

c) Typically there is a mainline isolation valve either side of a road crossing. These are particularly critical areas to isolate since a break in these areas can damage expensive third party property such as services that often run along roads (telecom, electricity, water, gas, etc), vehicles using the road and the road itself.

1.12.2 Lateral Isolation Valves

Each lateral line has its own isolation valve to facilitate lateral line repairs without affecting the rest of the system.

1.12.3 Quick Coupling Valves (QCVs)

One QCV has been provided on each greens lateral to provide backup when one lateral is isolated for maintenance.

1.13 Check Valve

We have connected the mainline from the Irrigation Pump Station to the mainline Booster Pump Station No 1 on hole 16. A check valve has been specified to prevent the high pressure of the Booster Pump Station flowing to the lower elevations and causing pipe breakages.

However, in the event of the failure of either the mainline underwater crossing (from hole 18 to hole 14), this provides an alternative route for water to reach this area.

1.14 Green Sprinklers

1.14.1 The system has been designed so that all green sprinklers can run simultaneously. This is a common requirement from superintendents.

1.14.2 There are never more than 2 full circle green sprinklers on a lateral, sometimes only 1 (see following notes). However, there may be supplementary and surround sprinklers on the same lateral which should not be operated at the same time as the green sprinklers.

1.14.3 There are part circle sprinklers on the greens in addition to the full circle sprinklers. This allows extra water to be added to the green without over-watering (saturating) the approach or green surrounds. This is particularly important when there are significant differences in the percolation rates between the green, the approach and its surrounds. (see sketch following):

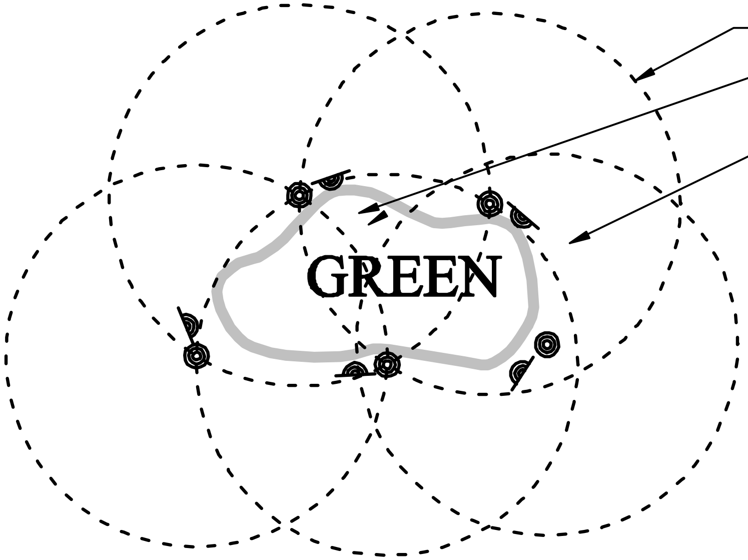
Approaches are the most critical area. They are often over-watered when full circle sprinklers on greens are used to over-water the greens. The greens normally can tolerate this since they have better drainage. However, the approach normally does not drain as well and hence often becomes "soggy".

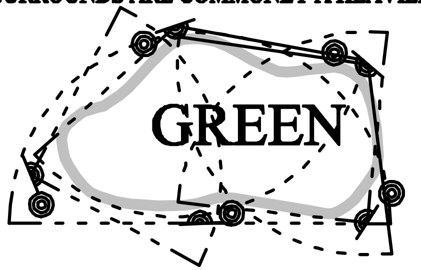
The same happens to the green surrounds on a wall to wall system but these areas are not as critical. Normally the surrounds are slopes which (surface) drain better while the approach is often a lower area (often due to tilting the green toward the golfer so they can have a look at the green). Also, golfers spend more time in the approach than the green surrounds so are more likely to notice it.

This problem is most pronounced where there are heavy or clay top soils in the approach or surrounds.

The problem can be (somewhat) alleviated by reducing the watering by the approach sprinklers. Some people may stretch the approach sprinklers further away from the greens but this is (of course) totally wrong. It will lead to dry spots that require hand watering. The best solution (of course) is the use of the double sprinklers on greens. It is a higher up-front cost but it reduces the on-going maintenance costs while improving the quality of the golf course.

Refer to the following sketch.





USE PART CIRCLE SPRINKLERS TO MAKE SUPPLEMENTAL WATERING TO THE GREEN ONLY (EG. 2 MM). THIS PREVENTS THE GREEN SURROUNDS BECOMING WATERLOGGED.

USE FULL CIRCLE SPRINKLERS TO MAKE A UNIFORM APPLICATION COMMON TO THE GREEN, APPROACH AND SURROUNDS (EG, 6 MM)

NOTE: THIS COMBINED USE OF A FULL AND PART CIRCLE SPRINKLER IS PREFERABLE TO THE ALTERNATIVE "BACK TO BACK" PART CIRCLE SPRINKLER ARRANGEMENT:

* LESS PROBLEMS ADJUSTING THE ARCS OF PART CIRCLE SPRINKLERS (MATCHING BACK TO BACK ARCS AND MAINTAINING ADJUSTMENT)
* HIGHER UNIFORMITY OF APPLICATION (MINIMISES DUMPING OF WATER AT THE END OF SPRINKLER ARCS)
* FULL CIRCLE SPRINKLERS REMAIN IN THE SPRINKLER GRID PROVIDING A UNIFORM APPLICATION. (NO STRETCHED SPRINKLER SPACING - NO DRY OR WET SPOTS)
* WHILE PART CIRCLE SPRINKLERS CAN BE "PINCHED" IN TO TARGET THE GREEN.
* LOWER MAINTENANCE (FULL CIRCLES HAVE LESS PROBLEMS, LONGER LIFE)
* EASIER PROGRAMMING (MINIMISES NON-STANDARD ARCS)
* THIS FULL/PART SPRINKLER CONCEPT CAN ALSO BE APPLIED IN SITUATIONS WHERE YOU WANT TO APPLY MORE WATER TO THE SURROUNDS. SIMPLY ADJUST THE PART CIRCLES SPRINKLERS TO THROW AWAY FROM THE GREEN.

WWW.HYDROGOLD.COM.AU	 NOT TO SCALE FILE: SK_MISC	DRAWING No 453-A4 SUPPLEMENTARY (PART-CIRCLE) SPRINKLERS ON GREENS

1.15 Landscape Irrigation

Quick Coupling Valves (QCVs) have been provided for hand watering of the adjacent landscape areas and supplemental watering of greens, tees and fairways.

1.16 Computerised Central Controller (CCC)

1.16.1 An Integral Part of the Design

The system is designed to apply the specified depth of water (Peak Application) during the specified Watering Window (refer to "Basic Irrigation Parameters" earlier in the report).

To achieve this, the run times of all the sprinklers needs to coordinated to. The CCC is able to efficiently schedule the individual run times of each sprinkler. This efficiency (typically around 90%) is shown in our Irrigation Pump Station calculations as the "Scheduling Efficiency of the Central Controller". This reflects the ability of the CCC to efficiently schedule the start and run times of all sprinklers.

If you remove the CCC, this scheduling efficiency drops to 70% (if you had a very good, experienced programmer). That is, the pumping flow would need to be increased by 28% to cater for the less efficient scheduling. Furthermore the mainline size and 220 V cable sizes would have to be similarly increased in size to cater for the increased flow.

a) Cost Savings if the CCC is deleted:

- ♦ CCC - Say US$ 25,000
- ♦ Communication cable - Say US$ 15,000

b) Extra Costs if the CCC is deleted:

- ♦ Increased capacity of the IPS - Say US$ 40,000
- ♦ Increased Mainline Sizes- Say US$ 30,000
- ♦ Increased 220V Cable Sizes - About US$ 8,000
- ♦ Re-Design Fees - About US$ 5,000.

That is, you will increase the cost of the irrigation by about US$ 48,000 (indicative costs). You will also increase the long term running costs, for both water and electricity.

In Summary…

The Computerised Central Controller is an integral part of the irrigation system. With it you have good coordination in scheduling the irrigation. Without out it, you have poor scheduling and will require a larger capacity pump, larger mainlines, larger 220 V cables.

The CCC has (correctly) been described as the Conductor and the satellites as the Orchestra. With the Conductor (CCC), you have a symphony. Without it, you have a cacophony (chaotic music).

Deleting the CCC increases up-front costs and long term running costs. There is no rational basis for deleting it.

We strongly recommend that you retain the Computerised Central Controller as part of the system.

1.16.2 Benefits of the Computerised Central Controller

The Computerised Central Controller is essential for the day to day management of the irrigation system.

Its benefits are:

a) Flow Management Features of the Computer Software

The computer will match the demand created by the sprinklers to the performance of the pumps. This will lead to:

- ♦ Less stress on the PVC pipe system.
- ♦ Increased efficiency on the pumps since they will be running at the optimum speed.
- ♦ The shortest possible watering window since programming will be optimised by the computer.

  The alternative is the superintendent will have to work out all the watering times and program each of the satellites. He has to manually coordinate the schedules to place the correct demand on the pump station. He is unlikely to do as good a job as the computer and he will have little flexibility with his programming once it is finished.

b) Efficiency and Water Management

By using a central computer, the programming only needs to be done at the computer. This is more efficient than programming each of the satellites. More importantly, it places the control in the hands of the superintendent, which is critical for good water management.

c) Flexibility of Programming

If we use a central computer, adjustments to the programming are simple and fast. For example:

- One of the main pumps may not be operating. The control system can easily adjust for the changed flow rates.
- We want to change the application from 6 mm to 4 mm.
- Tonight we do not want to water particular fairways and another night, others.
- We need to run a different program for fertigation.
- We want to start irrigating earlier.

In each of these examples (and many more real life scenarios), the computer handles the changes with a few button pushes. The alternative is that each satellite in the field needs to be re-programmed.

1.17 Weather Station

A weather station helps the Golf Course Superintendent maintain optimum turf conditions without wasting water and power.

We have specified a weather station to be incorporated as part of the control system.

A weather station monitors several weather parameters (typically Wind Speed & Direction, Temperature, Relative Humidity, Solar Radiation and Rainfall) and provides an objective assessment of EvapoTranspiration (ET) potentials.

1.18 220 V Power Grid for Satellites

We have designed for a 220 V power grid for the high voltage power grid for the satellites. It offers us substantial savings (possibly around US$ 40,000) in high voltage cables than using the 110 V system.

NOTE If a 110 V power grid is used, the power cables will need to be upsized by a factor of at least double.

1.19 Armoured Cable

1.19.1 Our specification calls for armoured cable to be used. Sometimes this may be a requirement of local regulations but in any case we specify it as it gives added protection to workers and the control system.

1.19.2 However, from a purely technical point of view, armoured cable is not necessary for the function of the system. Though we recommend the use of armoured cable, the final decision can be with Employer taking account of local practices and regulations.

1.19.3 The use of non-armoured cable will generate significant savings.

1.20 Irrigation Control System

The Irrigation Control System is a hydrid system, combining the strength of the satellite system (backup/redundancy) and the decoders (less cabling, better lightning resistance, easier installation and maintenance).

1.20.1 Decoders

The decoders eliminate much of the active and common cables associated with a traditional satellite system. It is simpler in installation and maintenance. With the specified grounding system, it will have good lightning resistance.

1.20.2 Satellites

The weakness with a standard decoder system is if the Computerised Central Controller is not operating, none of the Irrigation Control System operates. Also, if one communication cable was cut, a quarter of the golf course would not be able to be irrigated (aside from manually turning on sprinklers).

This golf course is too large (both in area and number of sprinklers) to rely on a traditional decoder system.

The satellites provide independence from the Computerised Central Controller. The decoders would normally be operated from the Computerised Central Controller but in the event of a failure (or for convenient field access), the satellites can be used.

1.20.3 Satellite Locations

In a traditional satellite system, satellites are placed to provide visibility of operating sprinklers from the satellite. However, it is not the intention that the sprinklers be operated from the satellites. They are there as a backup to the Computerised Central Controller in the event of a failure.

1.21 Products Specified

1.21.1 Brand Name (Proprietary) Products

Our design is based on the Rain Bird product range.

1.21.2 Imported Products

a) It would be beneficial if the project can utilise imported irrigation product throughout. This will:

- ♦ Provide better quality control on product.
- ♦ Having all the products on site at the beginning of the project will ensure that we are not held up by material shortages during the project.

b) There is a significant lead-time (in terms of months) for imported product and the Employer should confirm lead times with suppliers/contractors to incorporate in the project schedule.

c) It is likely that there will be Letter of Credit or other financial arrangements to be made for the purchase of materials on the part of the Contractor. This may affect contractual arrangements between the Employer and Contractor.

1.21.3 Pipe Fittings

a) Mainline Fittings

Our mainline fittings are always specified with cast/ductile iron fittings for tees and bends. ***The mainline integrity must never be compromised by using PVC tees or bends***. The frequent opening/closing of valves on golf course systems (combined with the high pressures) leads to the failure of PVC fittings that, based on their pressure rating, should withstand the system pressures.

b) Lateral Fittings

The lateral fittings downstream of the isolation valve are always specified as British Class F, Australian Class 18 or US Schedule 40 (or PN16 in the case of HDPE pipe).

This is a (deliberately) higher pressure rating than the pipe. Industry experience over many years has shown that the lateral fittings need to have a higher pressure rating than the pipe. Fittings have a more complex geometry that produces thermal stress points in moulding as well as physical weak points (eg corner radii, shape transitions).

1.21.4 Local Products

a) In-Field, Time-Proven, Golf-Specialty Products

Most of the products we specify have stood the test of time in the field (proven performance). This is particularly so with pipes and fittings since golf courses have significantly higher pressures than landscape and agricultural irrigation (nominally double). Also electrical cables and joiners have to be stable in the ground (sometimes water logged) for at least 20 years. They need to be certified for direct burial and life expectancy.

Some products are specifically designed for golf course applications (eg, Sprinklers, control systems, swing-joint or articulated O-ring risers…).

b) Standards and Quality Control

Many times we are assessing products that (technically) meet the standards specified. Eg. Pipes (or fittings) that have the same pressure rating that we have specified.

However, we also need to consider Quality Control. Are the requirements of the standards actually being met? What percentage of their pipe will fail?

Consider this. A typical 18-hole golf course has about 30,000 m of pipe, approximately (5,000 lengths of 6 m long pipe). If 1% of the pipe fails during the life of the project, that is 50 lengths. That would be a disastrous project. We need to have a failure rate less than 0.1%. That is, a minimum of 99.9% (but preferably 99.99%) of the product to perform without failure.

c) Basis for Accepting Local Products

While there may be local products to substitute for our preferred imports (either for lower cost or local sensitivities), they often do not have a proven track record in golf course applications. Without such golf references, our assessment for approval of local products is limited. While product literature gives features, standards and performance data, it is not as good as time-proven performance in the ground.

It would be easy to reject most local products on this basis. However, when proposed, we assess the local products on the basis of reasonableness. We expect that the actual product will meet the standards, quality, performance and features as put forward in their literature (sometimes they do not). We also expect the local supplier/manufacturer to have a good reputation (as assessed by the Owner, not us).

In most instances, the lower prices of local products is often reflecting the lower quality. The desire to use local products is nearly always driven by price, not quality.

1.22 Spares

We have included spares that are commonly required by the golf course during the first year of maintenance. The advantage of purchasing them with the bulk order for the project:

1.22.1 Allows the Employer to purchase spares at a low price.

1.22.2 Provides spares at the start of operation of the irrigation system.

1.22.3 Gives the superintendent the required materials to effect speedy repairs to the system. Not dependent on local suppliers in cases of emergency.

1.22.4 Allows immediate minor additions to the system.