Bruce Reekie is the Environmental Co-ordinator for The Gleneagles Hotel. Here he explains the philosophy behind Gleneagles' approach to irrigation and water conservation and looks at possible future developments.

Water, water everywhere

Above: Rainfall, soil temperature, air temperature and wind speed all have to be taken into account before making a decision to irrigate. Here the irrigation system has been activated at the 9th on the Monarch Course. Photograph courtesy of Russell Kirk, Golflinks.

Introduction

Throughout history irrigation has been used as a method of conveying water for crop cultivation during periods of drought.

This means that water has always commanded a high value both economically and environmentally. This is more pertinent than ever with increasing demand from the public, industry and golf courses for potable water (drinking quality water).

The large majority of the general public argue that the use of potable water for golf course irrigation is not a sustainable practice. Golf courses and the greenkeepers who maintain them can have only two responses to this:

1. Conserve and manage existing water resources.
2. Seek alternatives to potable water.

In many cases the requirement to irrigate has been driven by members' needs to have their local courses brought up to the standards seen on the clubhouse television.

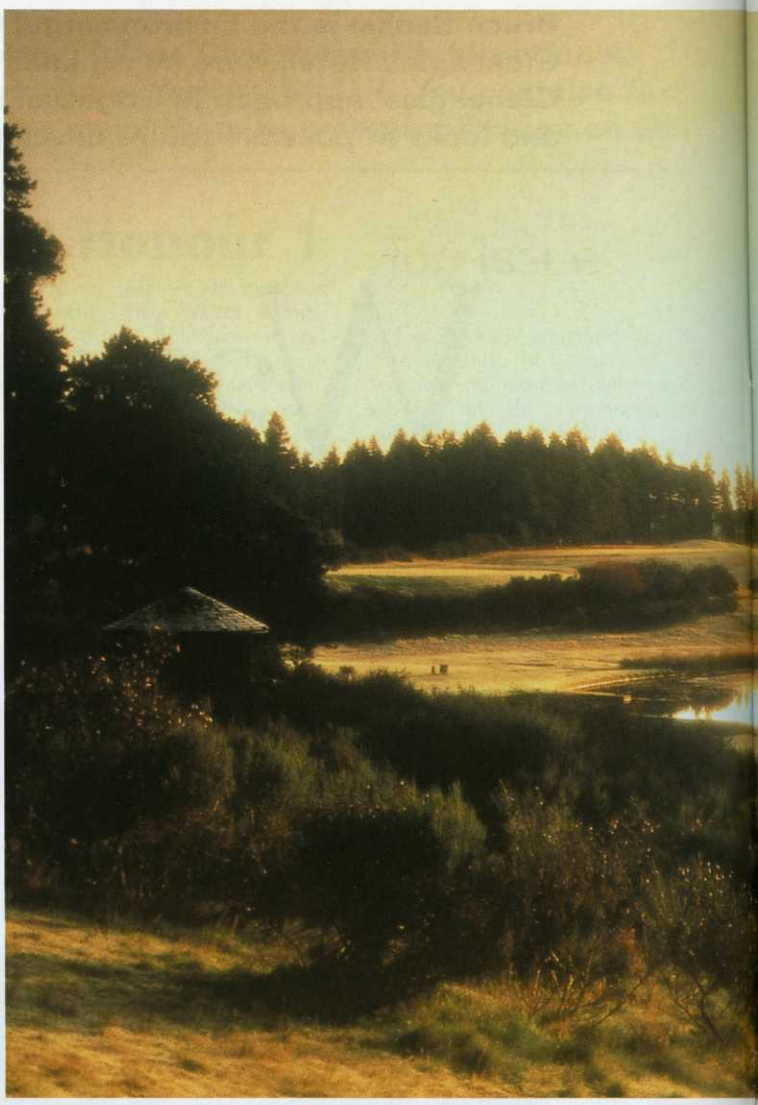
However, a note of caution has to be introduced as the expectations and perceived benefits of an irrigation system can often lead to disastrous consequences. In many cases over watering and compaction of poorly drained soils has led to water logging, a factor in the increased occurrence of patch diseases such as Fusarium and Take-All.

The conservation and management of water, avoiding the above scenario, begins by defining the irrigation priorities relative to the course.

What are the priority areas on the course?

1. Greens and Collars
2. Tees
3. Approach Areas
4. Fairway Landing Zones
5. Other Fairway Areas
6. Out-Of-Play Areas

For example, only small areas of fairways may be susceptible to dryness during the summer months, therefore hand watering may be all that is necessary, rather than installing a full fairway irrigation system. The main



Right: Loch-an-Eerie, between the 13th and 14th holes on the Queen's Course at Gleneagles acts as a natural reservoir for the irrigation system

benefit of lower priority areas receiving little or no water is that it allows them to rejuvenate into original features of the course, therefore retaining the natural feel of the surrounding environment.

Conservation of irrigation water

The main factors affecting irrigation and water management are:

1. Turfgrass species
2. Weather patterns and data
3. Drainage and cultural practices
4. Irrigation system efficiency

Turfgrass Species

The tables below show grass species, their water requirements and their salt tolerance.

Weather patterns and data

Obviously, the weather has a major influence on the conservation of water supplies on golf courses. Therefore, carefully monitoring and predicting weather patterns can save both water and money.

Rainfall, soil temperature, air temperature and wind speed all have to be taken into account before making the decision to irrigate. This is a continuous day-to-day process through the summer months. Even in July in Northwest Europe 100mm of rain is not uncommon, and therefore natural irrigation is the best option.

To reduce the impact of evaporation losses, irrigation should be carried out when soil and air temperatures are at their lowest. This can be done early in the morning or late at night with manual irrigation systems or a cycled programme through the night with an automatic control system.

The benefits of running an irrigation system on a cycle is that water can be applied at a rate which the soil can absorb it, rather than irrigating with one large flush and producing waterlogged greens and tees. It also makes sense to delay irrigation when wind speeds are up as you are more likely to water your neighbour's crop or your cart path.

In the spring every year at Gleneagles water samples are taken from the main irrigation ponds and sent to a laboratory for testing. The main items that we look for in the analysis are:

1. pH
2. Nutrient Content
3. Sodium Content
4. Suspended Solids

A pH range of 6.0 - 7.5 allows for better availability of nutrients in general, but in particular this range allows favourable conditions for Nitrosomonas and Nitrobacter stimulation that transforms NH+4 into NO_3.

The sodium content is an important factor when utilising effluent wastewater and will be discussed in greater detail later in the article.

The test results will also identify the presence of suspended solids and if they are found to be present they should be filtered out to avoid causing damage to pumping equipment, sprinkler heads and nozzles.

Irrigation system efficiency

From October to March the majority of irrigation systems are shut down, the pipes are then drained and blown through with a compressor, which virtually eliminates the risk of frost damage.

In April, an external service engineer will carry out the start up of the system. This ensures the pump house systems are operating efficiently, that there are no leaks in the system and all sprinkler heads are operational.

A computer utilising irrigation software is the best way to ensure the efficient use of irrigation water on a golf course. Here at Gleneagles we have a Rain Bird system and my colleague, Scott Fenwick, Golf Maintenance Co-ordinator for Gleneagles' King's and Queen's Courses comments,

"Irrigation technology has made massive advances in the last decade, especially with the introduction of ever more powerful personal computers and this has enabled sophisticated systems to be managed from a desktop environment. We have invested over £500,000 in our Rain Bird system and it has proved a most worthwhile investment. The flexibility of the software that includes the ability to upgrade through a range of control packages without the need for major retraining is a huge benefit. However, if we are to make this level of investment we must ensure that the greenkeeping teams know how to operate it effectively.

We recently attended a training day, organised by Rain Bird and held here at Gleneagles, that provided an introduction to their range of computerised control systems. The duties associated with golf course management are becoming more diverse and lifetime learning is now part of the culture. That's why this type of training session is so important to get the maximum benefit from our significant investment."

Drainage and cultural practices

To ensure good water infiltration during the summer months, turf should be aerated during the spring months using hollow coring, vertidraining and tining.

Good cultural practices also help reduce the risk of soil compaction and allow the plant roots to grow and take up water more efficiently. Wetting agents are utilised through the spring and summer months to provide good infiltration rates into the soil and to ensure that the water is retained there. Wetting agents will also aid in water penetrating thatch.

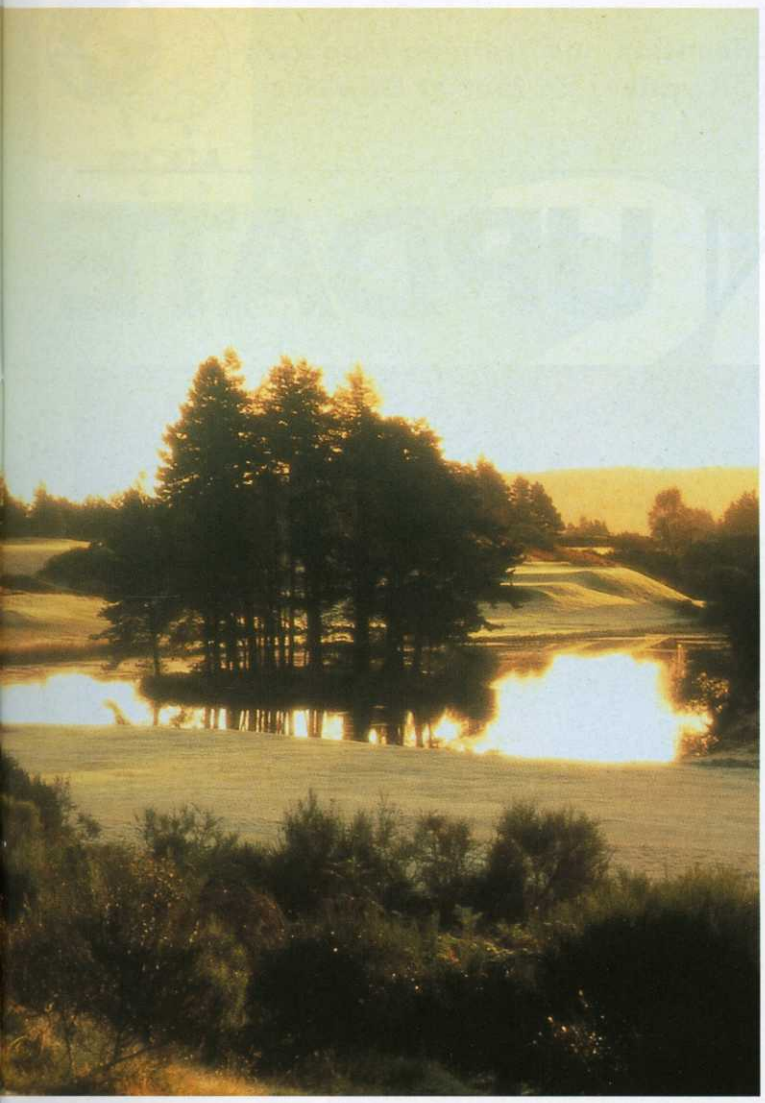
Careful selection of topdressing material is also required. Fine particles may make the surface impermeable and can cause damage to sprinkler heads. Also the height of cut during prolonged dry periods should be increased to ensure continuing photosynthesis in the green tissue, ensuring that root development will continue underground. Good root development will maximise the uptake of water from the soil. And, by maintaining a thick sward, the loss of water through evaporation and wind is minimised.

Trees situated close to tees and greens compete strongly with the turf for moisture. The Willow and Pine families are good examples of moisture loving trees. To overcome competition between trees and turf, stands of trees can either be thinned or have their lower branches removed.

Alternative sources of irrigation water

The use of other sources of water rather than potable supplies is obviously a major step towards conserving

WATER USE	SALT TOLERANCE
Low	Low
Medium	Medium
High	High
Buffalograss	Colonial bentgrass
Kentucky bluegrass	Tall fescue
Perennial ryegrass	Hybrid bermudagrasses
Bermudagrass	Most zoysia spp.
Velvet bentgrass	Perennial ryegrass
Creeping bentgrass	St. Augustinegrass
Zoysiagrass	Annual bluegrass
Red top	Common bermudagrass
Tall fescue	Seashore paspalum



such a precious resource.

In the United States the use and management of effluent water (sewage wastewater) is increasing in popularity as an alternative to diminishing potable supplies. A recent survey by the National Golf Foundation (NGF) reported that approximately 13% of golf courses in the United States use effluent irrigation sources, and this increases to 34% in the Southwest States where water availability is lower than average.

The biggest concern revolving around the use of effluent water on golf courses is the Sodium Adsorption Ratio (SAR). This test measures the sodium hazard present in the water. The higher the SAR, the greater the potential for damage to plants and soil. High SAR test results are usually down to a deficiency of calcium and magnesium in the effluent water. This situation, in most cases, is brought about by bicarbonate ions, which react with calcium and magnesium and remove them from the water.

Attention must also be paid to the level of nutrients contained within the effluent water. Nutrient levels vary, and are dependent on the type of effluent plant and type of effluent being processed. In many cases the ratio of salt and nutrients can be diluted or even eradicated through 'polishing' treatments before being used for irrigation. The effluent can be stored in holding ponds for dilution with surface water, rainwater and/or a limited potable supply.

In many cases the water can be passed through a wetland/reed bed system. These can be designed to consist of plant types, which are salt loving and will absorb much of the salt content of the water. They can also be interspersed with other types of reeds to aid nutrient absorption.

Although the use of effluent water carries a greater potential risk than using a potable supply, the implementation of an irrigation management plan can resolve many of these issues. By looking at the interaction between the incoming quality of effluent, the turf and soil types on the course, management techniques and weather data it is possible to run an irrigation system utilising effluent water, maintain good quality turf, reduce water costs and help conserve potable supplies.

In a changing world where water has the potential to become as valuable as oil, golf courses must adopt best practice in order to use water in a sustainable manner. In short this means constant analysis, monitoring and control.

Sources used in the compilation of this article include Audubon International, 1996; Carrow & Duncan, 2000; Christians, 1998 and NGF, 1999.