Water – it's something we all need of course...

Water is an essential ingredient of life - that's no secret. It is central to the process of photosynthesis in plants, the complex set of chemical reactions that fuels the biosphere. Photosynthesis uses water extracted from soil, carbon dioxide from the atmosphere, and energy harnessed from sunlight as raw materials to produce simple sugars. These sugars are the basic building blocks for plant and animal tissue of all types, and fuel the vast array of metabolic processes in most all organisms. Water is an essential raw material in this miraculous process.

Water is also consumed in large volumes by plants in the process of transpiration. Water is pulled from root tissue through the plant to leaf tissue where it is lost to the atmosphere as water vapour.

Transpiration has a tremendous cooling effect on the plant and transports nutrients to the leaves in the process. Without water there would be no plant life. Without water there would be no life at all.

Turf on golf courses, like all other plant systems, uses water as a basic input. Without adequate supplies of soil moisture on a continuous basis high quality turf for golf is not possible. The only sources of water for turf are natural precipitation and irrigation.

In arid climates irrigation is essential for maintaining vigorous turf. In climates with adequate precipitation irrigation is used to supplement rainfall during dry periods. Despite the climate, underground irrigation systems have become common on golf courses around the world.

A question that most courses face at some point in time is whether or not to upgrade or to install a new irrigation system, both of which are expensive propositions. A number of factors can enter into a decision:

The cost of maintaining an old system can become a major concern when labour, availability of replacement parts and pumping costs are factored in. At some point the cost of continual repair of old technology can become too much.

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Upgrading old technology with more reliable new technology can be reason enough for change. Irrigation renovations can range from whole system replacements from pumps to sprinklers, to the repositioning of new sprinkler heads for better coverage, to the replacement of only the control system for improved timing and reporting.

A more likely reason for considering an upgrade is the unending quest for improved turf quality and improved playability. The golfing public is continually demanding better conditions.

New irrigation systems are typically designed to give broader coverage by increasing the amount of turf area watered. Double and triple rows of sprinkler heads in fairways has become the norm. 'Wall-to-wall' irrigation coverage across a course is not uncommon.

New systems are also designed to give more uniform coverage. In general, the more sprinkler heads on a course the more flexibility in applying water.

More heads typically increases the uniformity of distribution by allowing a given area of turf to be watered by multiple sprinklers. State-of-the-art heads are designed to increase the uniformity of distribution within their individual spray patterns.

New systems are designed with improved control, computerised control systems give substantially more power and flexibility to turf managers for customising and fine-tuning watering practices.

All of these factors together give turf managers the ability to improve turf uniformity and quality over larger areas and to minimise problems associated with undue wetness and dryness, such as reduced vigour from drought stress, disease, and susceptibility of soils to compaction.

The need to conserve water in golf turf management is becoming an increasingly important consideration in renovating irrigation systems, especially when combined with the golfing public's expectation for greater playability.

Water availability, the cost of water, and the quality of available irrigation water are all becoming major issues in turf.

The need to conserve water is no longer a problem specific to arid regions. It is becoming increasingly important where competition for water is intense, a growing problem in heavily populated urban areas.

In golf turf management water use is becoming a classic issue of 'getting more for less', or more specifically, better turf for less water. The ability to detect where and how much water is needed, and to then apply it with precision only in those locations is the ultimate challenge.

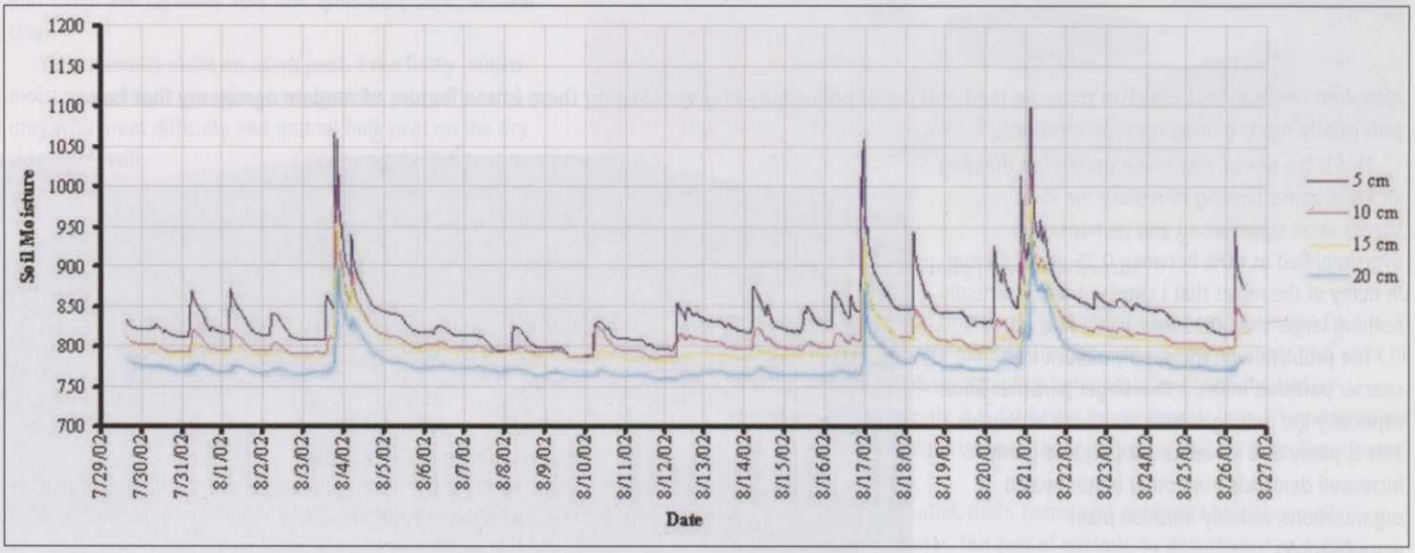
In the past the irrigation industry has focused with great success on applying water uniformly to non-uniform surfaces. The challenge now is to develop the ability to apply water non-uniformly depending on the need.

It is an issue of using high performance sprinkler heads with sophisticated controls in a well-designed layout that is tailored to the variability in soils and topography existing across a golf course.

Key to the conservation of water in turf management will be the incorporation of sensing technologies that measure or predict

TORO Count on it.

Van Cline, PhD, of Toro, studies the considerations for upgrading irrigation



moisture status across a golf course giving managers the ability to pinpoint applications. All of these pieces exist today, although the sensing component has not yet been effectively integrated into the complete irrigation system. Research is progressing in this important area however.

The precise application of water only where it is needed to optimise turf quality while conserving water depends on a better understanding of conditions affecting moisture dynamics than is the norm today on golf courses. Agronomists and engineers at Toro have been working with various sensing techniques to monitor moisture status on golf course fairways.

One promising technology under investigation is soil moisture sensing using both static or buried sensors located strategically in a fairway to represent a uniform set of conditions, and portable sensors that can be used to map soil moisture conditions at a given point in time over large turf areas.

Buried capacitance sensors can provide an accurate picture of changes in the soil moisture pool at multiple depths. This information can then provide feedback to the effectiveness of irrigation or rainfall.

The graph (**above**) illustrates changes under a bent grass turf at four depths (5, 10, 15 and 20cm) during a one-month period in the summer of 2002 on bent grass plots at the University of Minnesota.

The large sharp peaks were rainfall events while the smaller peaks were irrigation events. The stair-stepped pattern downward was the daily depletion in the soil moisture reservoir caused by transpiration.

This type of information can be used to set upper and lower limits for the optimum soil moisture condition under a turf acting as trigger points for turning irrigation on and off.

The second application of soil moisture sensors under investigation for input into irrigation control is the use of time domain reflectometry (TDR) measurements collected in a sampling scheme across a fairway to quantify soil moisture variation.

When used in combination with GPS locations this TDR data can be mapped giving a visual representation of soil moisture conditions at a given point in time.

When repeated several times during a growing season, predictable moisture patterns emerge showing areas that are consistently drier or wetter.

This type of information has the potential of being fed into a map-based irrigation control system to more efficiently apply water.

The maps (below) document changes in soil moisture on a Minnesota golf course fairway through the 2003 growing season.

The darker blues represent higher soil moisture while the lighter blues represent drier conditions. The concept is to use maps like these to adjust run times for individual heads depending on their location and its relative wetness or dryness.

In summary, a major challenge in irrigating golf turf today is to use water more efficiently to grow a higher quality product.

Any irrigation system upgrade should take this challenge to heart.

Better sprinklers, more versatile control systems, sensors that can provide feedback on moisture conditions, and system layouts that are sensitive to site conditions that influence moisture dynamics are all part of the solution.