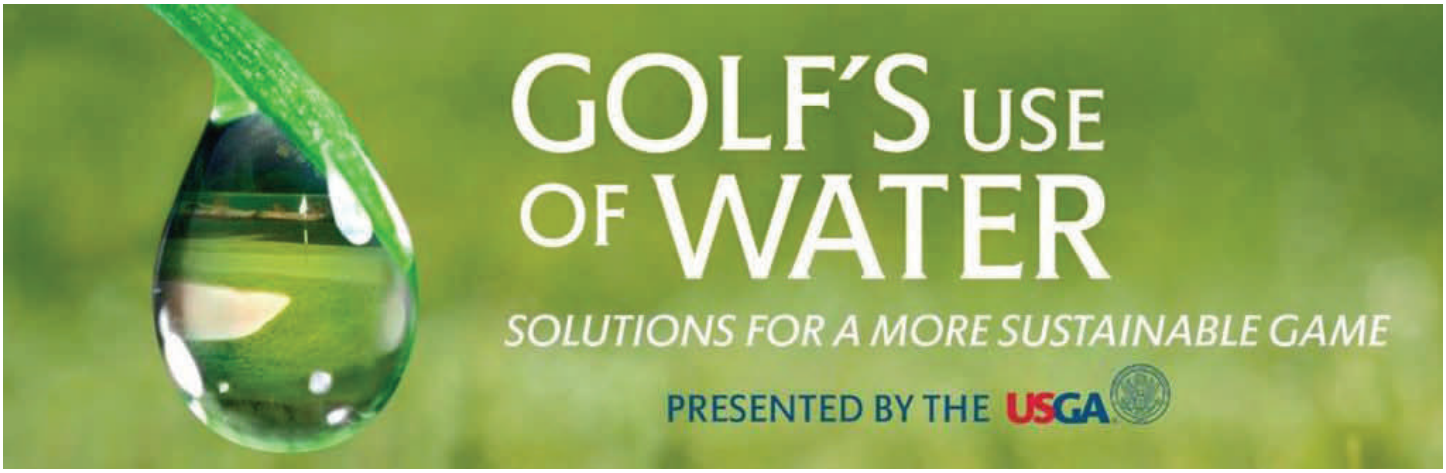

Irrigating with a Toxin

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We have a challenge concerning water, not necessarily the amount, but how it is distributed on the earth. From the farm to the city or golf course to home, everybody looks at water differently. Some are uncomfortable with too little or too much water, as well as the dangers of a drought or flood. There are many ways humans use water, and as the human imagination continues to grow, we create more new uses such as cold water infusion for energy creation in the Caribbean. Water is a precious resource, and in the midst of a drought, it is not just how water impacts farmers, city dwellers, or golf courses; there are negative impacts on fish and wildlife, and native plants as well.

Brackish Water for Golf Course Irrigation

Even though it rains a great deal in Florida, only one half of 1% of the rainfall that hits the ground is captured. There is a tug–a–war between industry, power utilities, agriculture, livestock, domestic, and landscapes for water. If people have to choose using water for showers versus golf course irrigation, we know the golf course is going to have to get by with less for irrigation. In order for golf to survive, alternative sources of water will need to be explored and used.

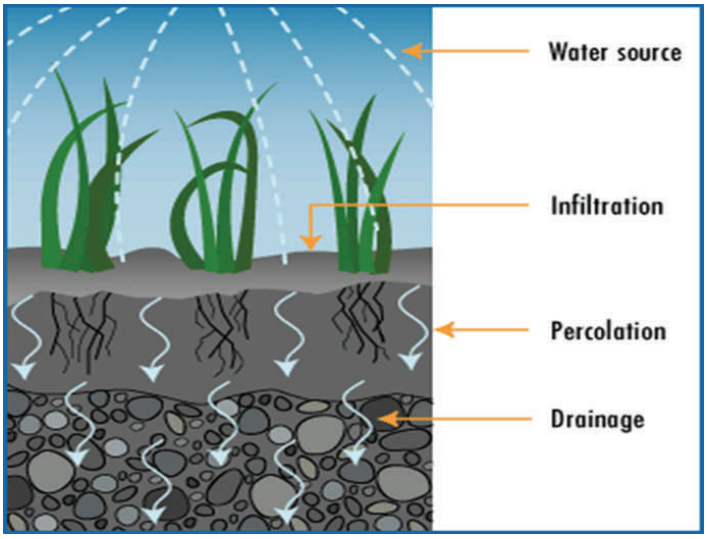
The Old Collier Golf Club lies on 270 acres located near the Cocohatchee River which is designated an "Outstanding Florida Waterway." If you are next to a river with this designation, you have much more stringent restrictions for a residential development or golf course. For example, only half an inch of water can drain from a property into the river during a 24–hour period. To mitigate this restriction, the fairways were elevated. In addition, the golf course was to be irrigated with brackish water high in salts, and therefore, elevation, drainage, and a coarse soil were needed to grow turf. For this golf course, it was brackish water or no water; seashore paspalum or no golf course. In fact, without the development of seashore paspalum and research supported by the USGA, the Old Collier Golf Club would not exist.

Figure 1. Turf on a golf course damaged by salt accumulation. Note the healthy turf over the drain line.

Brackish water is very difficult to deal with on several fronts. From solenoids in irrigation heads to the pumping station, corrosion of metal parts required industry to rethink the design of products to deal with high levels of salt. However, the special equipment designed for Old Collier is now used around the world for salty irrigation water.

Golf's Use of Water: Challenges and Opportunities.
A USGA Summit on Golf Course Water Use, November 2012.
TGIF Record Number 214424

Figure 2. Salts must be continuously moved downward through the soil profile.



Managing Salts in Irrigation Water

Salinity management requires careful attention to soil management that minimizes the accumulation of toxic salts. Irrigation water quality and salinity parameters have significant short–term and long–term impact on turfgrass sustainability. The concentration of toxic ions in soil will accumulate at the concentrations found in the incoming irrigation water unless there is frequent and sufficient rainfall to dilute salt concentrations. It is not unusual for soil salinity components to be two to five times above incoming irrigation water concentrations.

The following conditions can increase the accumulation of salts in the upper soil profile:

- High evapotranspiration (ET) conditions such as prolonged winds and full sunshine
- Extreme climatic conditions including heat, drought, cold, and excessive rain
- Soil profile such as texture (sand/silt/clay composition), particle size, and inorganic or organic amendments.

Cultivation and irrigation scheduling become important management strategies to reduce salt accumulation. Site–specific variability will require flexible adjustments in turfgrass management programs.

Salinity is the most complex environmental stress that can be imposed on perennial turfgrass ecosystems. What does a highly salt–tolerant turfgrass provide the grass manager when irrigating with saline water? Time to make management adjustments on a site–specific basis. Any highly salt–tolerant plant can be overwhelmed when salts accumulate in the soil at levels that exceed the genetically–controlled tolerance mechanisms inherent in the plant.

Poor quality water has high amounts of total dissolved salts or TDS (> 1250 ppm), sodium (> 1250 ppm or 5.43 meq/L), chlorides (> 350 ppm), sulfates (> 180 ppm), and, indirectly, bicarbonates (exceeding 120 ppm or 2.00 meq/L). Irrigating with brackish water can cause collateral damage to landscape plants, soil, and equipment. Syringing is a liability because it will allow salts to accumulate in upper soil zones. The leaching fraction is required to move salts down and through the soil profile into drainage lines. High ET rates can cause salts to migrate upward by capillary action, so it is necessary to provide enough water to leach salts into the drain lines. This is another reason for managing the leachate fraction or extra water to move salts through the soil profile.

A prescription irrigation system with low pressure (65 psi in the field) to reduce misting, and low angle heads (22o or less) to reduce drift from wind, are the foundation for managing salty irrigation on a golf course. Pulse irrigation cycles will effectively leach salts down through the soil profile. Pulse irrigation is the infiltration of water working in harmony with soil percolation rates. This virtually eliminates water run–off while flushing salts well below the root zone. Normal, effective pulse irrigation on greens will take between 10 to 12 hours for 18 greens depending on irrigation system efficiency. Except on a site–specific location basis, it is not practical to pulse irrigate entire fairways or roughs. A soil profile such as a sandy soil that percolates, with some elevation change, and a great drainage system are key ingredients for successful salt management. Pulse irrigation is the only effective way to flush or leach salts down through the soil profile.

Any plants subject to salt drift or irrigation on or near the course must be halophytic in order to tolerate damage from the salt. Some examples include seashore dropseed (*Sporobolus virginicus*) and sea oxeye daisy (*Borrichia arborescens*). Excessive salts can predispose

Figure 3. Southern wax myrtle damaged from the salt in spray drift from the irrigation system.

Figure 4. In-ground moisture meters assist in proper irrigation applications.

turfgrass plants and make them more susceptible to disease, insect damage, wet wilt, wear from golf carts, and other undesirable problems. If bicarbonates are in excess of 120 ppm, the bicarbonate compounds can seal the soil surface, impeding water infiltration into the soil. On turf irrigated with brackish or salty water, soil microbial populations may shift but they will still be effective in soil organic decomposition and other nutrient release functions under aerobic conditions.

Salt is a growth regulator. The higher the salt content, the more it regulates or slows down growth. Most golf courses, including The Old Collier Golf Club, use PGRs (plant growth regulators). Using a PGR with brackish water is uncharted territory depending on turf species and cultivar being grown. Under the wrong weather conditions such as severe drought, heat, or abnormally cold weather, damage to the soil and subsequently the turfgrass can result. If a golf course is irrigated with brackish water, the proper amount of calcium, potassium, and other minor fertilizer nutrients must be applied on a timely basis. Various penetrating wetting agents will be necessary in drought conditions to facilitate downward movement of water through the soil profile. If bicarbonates are high, acidifying forms of fertilizer may be necessary to mitigate the soil binding properties of the bicarbonates. For extremely high bicarbonate levels, acidification of the irrigation water may be warranted.

Since salt acts as a growth regulator, it would probably be unwise to grow-in or establish a new golf course using highly brackish water. Any water in excess of 1500 TDS (total dissolved salts) is not recommended for growing in bermudagrass or bentgrass. For seashore paspalum, irrigation water in excess of 3000 TDS would slow down the grow-in and establishment of the turf.

If brackish water is the sole irrigation source, a high annual rainfall would help to mitigate the accumulation of salts. Any region not receiving at least 30 to 40 inches of annual rainfall could encounter extreme salt accumulation. It is imperative that either rainfall or course irrigation provides enough water to leach salts through the soil profile. One question that will be raised by regulators and the public will be: Where will these salts eventually drain? It is unlikely that you will be able to use brackish water if the golf course is located on or near well fields for drinking water.

Seashore paspalum is a salt-tolerant grass but it is not salt-resistant. Salt can be toxic. For example, only eight teaspoons of table salt will kill 50% of men weighing 150 pounds. When managing brackish irrigation on seashore paspalum, you must first manage the soil, then the water, and then the turfgrass. Seashore paspalum is different from any other turfgrass, and, if you are using brackish water, management protocols can be extremely difficult and need to be dialed-in to site-specific issues.

Conclusion

In the large picture, managing the whole watershed on the property must be done with care and precision. Proper soil testing, water testing, wet lab tissue analysis, and other proactive monitoring disciplines are integral to successful watershed management. If the use of brackish water is in your future, consider the following advice. Be willing to ask for help, and more important, know when to ask for help. Make sure to do your homework and research how to best manage your particular climate and soil. Last, choose the most appropriate cultivar with the best adaptation and salt tolerance for site.

Table 1. The salt load can be very high when thousands of gallons of water are applied for golf course irrigation.

Salt Load in Water

Salinity level ppm	lbs Salt /100 gals	500,000 g	lbs Salt 750,000 g	900,000 g
500	0.415	2075	3113	3735
1000	0.83	4150	6225	7470
1500	1.245	6225	9338	11,205
2000	1.66	8300	12,450	14,940
3000	2.49	12,450	18,675	22,410
4000	3.32	16,600	24,900	29,880
5000	4.15	20,750	31,125	37,350
10,000	8.3	41,500	62,250	70,008
15,000	12.45	62,250	93,375	112,050
20,000	16.6	83,000	124,500	149,400
34,500	28.635	143,175	214,763	257,715

Publication: Duncan and Carrow. 2005. Just a grain of salt. Golfdom 61(7):70-75 (Turfgrass Trends, July)